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FEASIBILITY STUDY REPORT

SULLIVAN'S LEDGE
NEW BEDFORD, MASSACHUSETTS

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7.0 IDENTIFICATION OF REMEDIAL RESPONSE OBJECTIVES

Remedial response objectives drive the formulation and selection of a response action. Such objectives are developed after considering criteria outlined in Section 300.68(e)(2) of the NCP and Section 121 of SARA. This section summarizes the environmental laws governing a response action, outlines the primary response objectives for Superfund sites, and presents the site-specific remedial response objectives for both source control and management of migration measures.

7.1 INTRODUCTION

Prior to SARA's enactment on October 17, 1986, actions taken in response to releases of hazardous substances were conducted in accordance with the revised NCP (40 CFR Part 300) dated November 20, 1985. While the existing NCP and the standards and procedures established by SARA overlap in many areas, there are some differences between the two. Section 121 of SARA, for example, added certain new clean-up objectives to CERCLA. In the interim, until the NCP is revised, the procedures and standards employed by the EPA in responding to releases of hazardous substances, pollutants, and contaminants are to comply with Section 121 of CERCLA and, to the maximum extent practicable, the existing NCP.

SARA retained the original CERCLA mandate to conduct protective and cost-effective remedial actions. Remedial actions, as defined by 300.68(a)(1) of the NCP, are those responses to releases that are consistent with a permanent remedy to protect against or minimize release of hazardous substances, pollutants, or contaminants so that they do not migrate to cause substantial danger to present or future public health and welfare or the environment.

In formulating a remedy, CERCLA now requires EPA to place emphasis on risk reduction through destruction or treatment of hazardous waste. Section 121 of SARA establishes a statutory preference for remedies that permanently and significantly reduce the volume, toxicity, or mobility of hazardous waste over remedies that do not use such treatment. Section 121 also requires that EPA select a remedy that is protective of human health and the environment, is cost-effective, and utilizes permanent solutions and alternative treatment technologies, to the maximum extent practicable. Furthermore, Section 121 requires that, upon completion, remedies must attain applicable or relevant and appropriate federal and state requirements (ARARs) unless specified waivers are granted.

Therefore, in accordance with CERCLA and the NCP, the primary remedial response objectives for Superfund remedial actions are as follows:

- prevent or mitigate further releases of contaminants to surrounding environmental media;
- eliminate or minimize the threat posed to public health and welfare or the environment;
- reduce the volume, toxicity, or mobility of hazardous waste through the use of treatment technologies; and
- utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

Section 300.68 of the NCP, in conjunction with the EPA guidance document entitled, "Guidance on Feasibility Studies under CERCLA" sets forth the remedial alternative development and remedy selection process. This process consists of the following:

(1) Identify the nature and extent of contamination and threat presented by the release (300.68(e)(2)).

(2) Identify general response objectives for site remediation.

(3) Identify and screen remedial technologies potentially applicable to wastes and site conditions.

(4) Develop alternatives to achieve site-specific response objectives (300.68(f)).

(5) Initial screening of alternatives (300.68(f)).

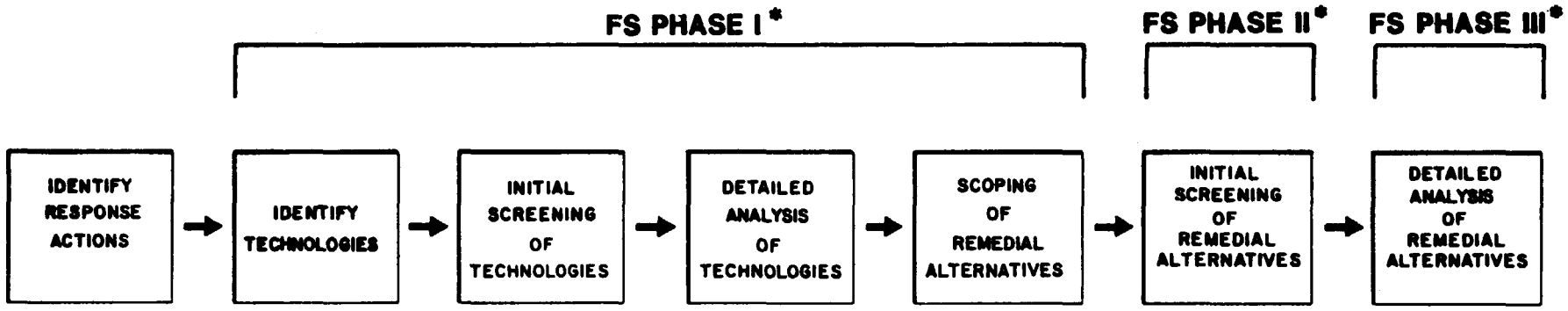
(6) Detailed analysis of alternatives (300.68(g)).

(7) Selection of remedy (300.68(h)).

An overview of the FS process is illustrated on Figure 7-1.

Both the CERCLA and the NCP require first the identification of the nature and extent of site contamination. Beyond initial site characterization, Section 121 retains the basic framework for the remedial alternatives development and remedy selection process enacted through NCP, but each phase must be modified to reflect the provisions of SARA.

The nature and distribution of contamination and the threat posed by the release of contaminants at the Sullivan's Ledge site are documented in the Phase 1 and Phase II RI reports and Section 5.0 of this report. A discussion of how CERCLA affects



* EPA OSWER DIRECTIVE DECEMBER 24, 1986:
"INTERIM GUIDANCE ON SUPERFUND SELECTION OF REMEDY"

FIGURE 7-1
OVERVIEW OF THE FS PROCESS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

each particular phase of the remedy selection process (i.e., Steps 2 through 7) is detailed in this report.

7.2 SITE-SPECIFIC REMEDIAL RESPONSE OBJECTIVES

Consistent with the NCP, remedial response objectives were developed for SC measures and MM measures. SC measures address source areas of contamination, whereas MM measures address media or areas that have been affected by contaminant migration from the source area.

The Phase I and Phase II RIs identified three sources of contamination at the Sullivan's Ledge site:

- the quarry pits, which were filled with hazardous waste and other waste material (e.g., automobiles, timbers, and tires)
- site soils consisting of fill material used to cover the pits and regrade the site
- PCB-contaminated sediments in the unnamed stream, Middle Marsh, and Apponagansett Swamp

Based on the conditions described previously, the remedial response objectives for SC measures are as follows:

- Prevent or mitigate the continued release of hazardous substances to the unnamed stream, Middle Marsh, and Apponagansett Swamp.
- Reduce risks to human health associated with direct contact with and accidential ingestion of contaminants in the surface and subsurface soils, and sediments.
- Reduce risks to terrestrial and aquatic life associated with contact with the surface soils and PCB-contaminated sediments. Aquatic life includes both sediment-dwelling organisms and those at higher trophic levels.
- Reduce the volume, toxicity, or mobility of the hazardous contaminants.

The RI also determined that contaminants from the quarry pits have contaminated on- and off-site groundwater and surface water in the unnamed stream. Remediation of the contaminated groundwater is necessary to address surface water contaminants, because the source of this contamination is groundwater discharge. In addition, on-site remediation may result in increased airborne contamination. The remedial response objectives for the MM measures include the following:

- Reduce risks to human health associated with direct contact with seeps and inhalation of VOCs and PCBs potentially released from the site.

- Minimize the threat posed to public health and the environment from current and potential future distribution of contaminant migration in the groundwater and surface water.

- Maintain air quality at protective levels for on-site workers and the public during site remediation.

- Reduce the volume, toxicity, or mobility of the hazardous contaminants.

8.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

8.1 IDENTIFICATION OF TECHNOLOGIES

Based on the environmental contamination at the Sullivan's Ledge site and the remedial response objectives, treatment technologies were identified. Seventy-five technologies were evaluated by reviewing literature sources, obtaining vendor information, and reviewing other FSs. The sources of information on these technologies include Ebasco, 1987c; EPA, December 1986; EPA, September 1986; EPA, 1981; EPA, January 1987; and Cheremisinoff, 1987. Of the 75 technologies evaluated, 36 were considered potentially applicable to attain SC and MM response objectives.

SC technologies primarily address situations in which hazardous substances remain at or near the area at which they were originally located and are not adequately contained to prevent migration into the environment. At the Sullivan's Ledge site, SC technologies would be applied to address contaminated material inside the quarry pits, on-site contaminated surface soils and subsoils, and PCB-contaminated sediments in the unnamed stream, Middle Marsh, and Apponagansett Swamp.

Table 8-1 outlines technologies that were identified for SC measures. This table lists the technologies, provides brief descriptions, and characterizes their applicability tosite-specific media (i.e., quarry pits, site soils, or sediments). The technologies presented in Table 8-1 are separated into five primary response categories: no-action, containment, treatment, disposal, and ancillary treatment. Response categories represent a group or class of response actions that could potentially meet the remedial objectives. Technologies are grouped into response categories to facilitate the development of alternatives (see Section 9.0).

Technologies pertaining to MM alternatives are presented in Table 8-2. At the Sullivan's Ledge site, these technologies address the migration of contaminated groundwater in bedrock and overburden from the site, and the seeps contaminating the surface waters adjacent to the site. As with SC technologies, MM technologies are grouped into five response categories: no-action, containment, treatment, disposal, and extraction.

8.2 SCREENING OF TECHNOLOGIES

The initial assessment of technologies is based on engineering feasibility and implementability. The screening step consists of evaluating each identified technology to determine its probable effectiveness based on actual site conditions, identified and suspected contaminants, and affected environmental media. In addition, the waste residuals left by the technology are evaluated to assess their potential for

TABLE 8-1
IDENTIFICATION OF APPLICABLE SOURCE CONTROL TECHNOLOGIES
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	FUNCTION	APPLICABLE SC COMPONENTS		
		SOILS	PITS	SEDIMENTS
NO ACTION				
-Fencing/Signs	Restrict site access with a chainlink fence; post warning signs.	X	X	X
-Institutional Controls	Implement zoning or other restrictions to prohibit future land use of the site.	X	X	X
-Environmental Monitoring	Evaluate changes in site conditions and potential risks over time.	X	X	X
CONTAINMENT				
-Capping	Prevent precipitation/infiltration to and dermal contact with contaminated materials by installing a RCRA multi-layer cap or other appropriate capping material.	X	X	X
-Hydraulic Barriers	Restrict surface water and overburden groundwater around contaminated zones using slurry walls/sheet piling.	X	X	X
-Fracture Grouting	Restrict groundwater movement through contaminated zones by grouting bedrock fractures.		X	
TREATMENT				
-Dechlorination (APEG)*	Remove chlorine atoms from PCBs by mixing contaminated materials with an alkali polyethylene glycol (APEG) in a batch operation.	X		X
-In-situ Vitrification*	Transform soils into glass by placing electrodes around contaminated areas and charging with electricity. The current would cause soil and rocks to melt which would later cool into glass similar to obsidian.	X	X	

* Innovative Technology

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TABLE 8-1 (continued)
IDENTIFICATION OF APPLICABLE SOURCE CONTROL TECHNOLOGIES
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	FUNCTION	APPLICABLE SC COMPONENTS		
		SOILS	PITS	SEDIMENTS
-Solidification	Add a solidifying agent (e.g., cement, fly ash, lime) to excavated materials, mix, and cure to form a solid, low permeability matrix.	X	X	X
-Incineration	Thermally destroy wastes in either an on- or off-site incinerator.	X	X	X
-Solvent Extraction*	Remove organic/inorganic chemicals from excavated soils using chemical-specific solvents or a supercritical fluid as flushing agents.	X	X	X
-Thermal Soil Aeration*	Remove VOCs and some SVOCs from excavated materials through contact with a heated surface within a reaction vessel.	X		
-In-situ Biological*	Introduce bacteria, fungi, or algae along with nutrients (e.g., nitrogen, phosphorus, oxygen) to enhance biological activity to degrade organic contaminants.	X	X	X
-Vacuum Extraction*	Remove VOCs in-situ by applying a vacuum to a series of interconnected wells, causing air-flow through the soil to strip out the VOCs.	X		
DISPOSAL				
-Landfill	Deposit excavated fill materials, surface debris (e.g., concrete pillars, barrels, telephone poles), treatment waste residue (e.g., incinerator ash, solidified materials) in an off-site RCRA facility or municipal landfill.	X	X	X
-On-site	Dispose treated and/or untreated wastes on-site in conjunction with a RCRA cap.	X		X

* Innovative Technology

TABLE 8-1 (continued)
IDENTIFICATION OF APPLICABLE SOURCE CONTROL TECHNOLOGIES
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	FUNCTION	APPLICABLE SC COMPONENTS		
		SOILS	PITS	SEDIMENTS
ANCILLARY				
-Excavation	Set up staging area on-site, remove contaminated materials with excavating equipment (e.g., bulldozer, scraper, dragline, crane, front-end loader, dump truck) prior to treatment or disposal.	X	X	X
-Screening	Separate out bulky objects, rocks, timbers, and other debris from excavated materials manually or with mesh screens set-up on-site.	X	X	X
-Dewatering	Remove water from excavated materials with a belt filter press or air drying prior to treatment (e.g., incineration, dechlorination, thermal aeration) or disposal.	X	X	X
-Pumping	Remove groundwater/surface water from work zones during excavation operations.	X	X	X
-Revegetation	Stabilize disturbed areas with grasses and trees; restore marsh; improve aesthetic appearance.	X		X
-Water Treatment	Treat contaminated water collected during excavation or dewatering operations. Possible scenarios include: on-site treatment, discharge to the New Bedford Sewage Treatment Plant, or transportation to a nearby vendor (e.g., CECOS of Bristol, CT).		X	X
-Trucking	Transport materials off-site with appropriate vehicles.	X	X	X

* Innovative Technology

TABLE 8-2
IDENTIFICATION OF APPLICABLE MANAGEMENT OF MIGRATION TECHNOLOGIES - GROUNDWATER
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	FUNCTION
NO ACTION	
-Fencing/Signs	Restrict site access with a chainlink fence; post warning signs.
-Institutional Controls	Implement zoning or other restrictions to prohibit the use of groundwater in and around the site area.
-Environmental Monitoring	Evaluate migration and distribution of contaminants over time using the existing monitoring wells, Westbay wells, and surface water samples from the seep areas.
CONTAINMENT	
-Capping	Prevent precipitation infiltration to contaminated zones with a RCRA multi-layer cap/or other capping materials.
-Hydraulic Barrier	Divert overburden groundwater flow around contaminated zones with slurry wall/sheet piling.
-Groundwater Interceptor Trench	Establish a bedrock trench hydraulically upgradient of the site to lower the water table in contaminated zones and shut off the seeps to the unnamed stream.
-Fracture Grouting	Prevent groundwater movement through contaminated zones by grouting bedrock fractures.
-Waterways	Divert surface water flow (e.g., unnamed stream, runoff) through ditches, channels, or culverts to minimize volume of contaminated water.
TREATMENT	
-In-situ Biological*	Introduce microorganisms and nutrients into the groundwater using a matrix of extraction wells and recirculation techniques.

* Innovative Technology

TABLE 8-2 (continued)
IDENTIFICATION OF APPLICABLE MANAGEMENT OF MIGRATION TECHNOLOGIES - GROUNDWATER
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	FUNCTION
-UV/Ozonation*	Oxidize organics in extracted groundwater with a simultaneous application of (UV) ultraviolet light and ozone.
-Supercritical Water Oxidation*	Destroy organic contaminants in an aqueous solution by inducing supercritical water at high temperature and pressure. Critical water enhances the oxidation of organic compounds to carbon dioxide and water.
-Thin Film Evaporation*	Separate contaminants from extracted groundwater by boiling off water and leaving behind a concentrated wastestream.
-Biological Treatment	Aerobically break down organic wastes by passing aqueous stream through an aerated, activated-sludge basin or through a fixed film biological reactor (e.g., a trickling filter, rotating biological contactors).
-Air Stripping	Remove VOCs and some SVOCs in a column packed with inert material. Water descends down the column and air is forced up the column to promote the mass transfer of VOCs/SVOCs from an aqueous to a gaseous phase.
-Carbon Adsorption	Remove aqueous or gaseous phase organics through sorption onto granular activated carbon. Primarily used as a polishing step after treatment (e.g., UV/Ozonation) to remove unreacted constituents.
-Precipitation/Flocculation/ Sedimentation	Convert dissolved metals to a more insoluble form (i.e., sulfide or hydroxide); agglomerate suspended solids; settle solids out by gravity.
-Aeration	Aerate the groundwater prior to treatment to precipitate out inorganic iron and manganese.

* Innovative Technology

TABLE 8-2 (continued)
IDENTIFICATION OF APPLICABLE MANAGEMENT OF MIGRATION TECHNOLOGIES - GROUNDWATER
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	FUNCTION
-Filtration	Remove suspended solids from the wastewater stream by forcing the water through a sand filter or cartridge-type filter.
-Municipal Wastewater Treatment Facility	Discharge collected surface water and/or extracted groundwater to the New Bedford Sewage Treatment Plan for treatment. Water must meet pretreatment standards before discharge to the facility.
EXTRACTION	
-Subsurface Drains	Utilize tile drains and piping to passively collect (gravity flow) contaminated seep water and transport to an on-site treatment operation or into sewers for subsequent treatment at the New Bedford Sewage Treatment Plant.
-Groundwater Pumping	Extract groundwater from one or more unconnected wells to control or remove the shallow contaminant plume. Groundwater would be treated on-site or discharged into sewers for transport to the New Bedford Sewage Treatment Plant.
Disposal	
-Landfill	Secure treatment residuals (e.g., spent carbon) in an off-site RCRA facility.
-On-site	Dispose of treatment residuals (e.g., spent carbon) on-site in a surface impoundment or RCRA cell.
-Incineration	Incinerate treatment residuals (e.g., spent carbon) at an off-site facility.
-Storm Drain/Sewer/Receiving Stream	Discharge treated water into the New Bedford municipal storm drainage or sewer network, or into the unnamed stream. The actual receiving source will be determined based on final effluent quality. Final effluent will be subject to discharge permitting.

* Innovative Technology

TABLE 8-2 (continued)
IDENTIFICATION OF APPLICABLE MANAGEMENT OF MIGRATION TECHNOLOGIES - GROUNDWATER
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	FUNCTION
-Filtration	Remove suspended solids from the wastewater stream by forcing the water through a sand filter or cartridge-type filter.
-Municipal Wastewater Treatment Facility	Discharge collected surface water and/or extracted groundwater to the New Bedford Sewage Treatment Plan for treatment. Water must meet pretreatment standards before discharge to the facility.
EXTRACTION	
-Subsurface Drains	Utilize tile drains and piping to passively collect (gravity flow) contaminated seep water and transport to an on-site treatment operation or into sewers for subsequent treatment at the New Bedford Sewage Treatment Plant.
-Groundwater Pumping	Extract groundwater from one or more unconnected wells to control or remove the shallow contaminant plume. Groundwater would be treated on-site or discharged into sewers for transport to the New Bedford Sewage Treatment Plant.
Disposal	
-Landfill	Secure treatment residuals (e.g., spent carbon) in an off-site RCRA facility.
-On-site	Dispose of treatment residuals (e.g., spent carbon) on-site in a surface impoundment or RCRA cell.
-Incineration	Incinerate treatment residuals (e.g., spent carbon) at an off-site facility.
-Storm Drain/Sewer/Receiving Stream	Discharge treated water into the New Bedford municipal storm drainage or sewer network, or into the unnamed stream. The actual receiving source will be determined based on final effluent quality. Final effluent will be subject to discharge permitting.

* Innovative Technology

affecting the environment. Therefore, the assessment considers the waste and site characteristics, as well as potential waste residual.

Waste characteristics include physical properties (e.g., volatility, solubility, and specific-chemical constituents) and properties that affect the performance of a technology. Table 7-14 in the Phase I RI report was consulted to aid in screening groundwater treatment technologies (NUS, 1987). In Table 7-14, physical and chemical properties of compounds identified as groundwater contaminants are summarized; this information provided a basis for evaluating which technologies would be appropriate for the site contaminants.

Site characteristics were reviewed to identify conditions that may limit or favor the use of certain remedial technologies. The assessment of potential waste residuals from the technologies is important because certain technologies may decrease the mobility or volume of the contaminant while increasing the toxicity. The more toxic waste residual could not be left untreated on-site and would require further treatment and/or disposal.

Tables 8-3 through 8-6 present the screening of technologies, and Tables 8-7 and 8-8 list technologies remaining after screening. The technologies remaining after screening will be used to develop potential remedial alternatives for the site.

TABLE 8-3
SCREENING OF APPLICABLE SOURCE CONTROL TECHNOLOGIES - SOILS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS	WASTE RESIDUALS	STATUS
NO ACTION				
-Fencing/Signs	None	None	Contaminant concentrations are left to decrease through natural attenuation.	Retain
-Environmental Monitoring	None	None		Retain
-Institutional Controls	None	None		Retain
CONTAINMENT				
-Capping	The northeastern corner of the site lies in the 100-year floodplain of the unnamed stream. Surface obstructions need to be removed.	None	Contamination will still remain on-site.	Retain. Account for floodplain in design, haul off surface obstructions, and grade site.
-Hydraulic Barriers	Slurry wall or sheet piling will not form a good seal with the bedrock due to its fractured nature.	None	None	Screen out. This would not be implementable on-site due to waste material deposited in the site soils.
TREATMENT				
-Dechlorination (APEG)*	Excavation of site soils would be required. Soil moisture inhibits APEG's effectiveness. Debris (e.g., timber, granite blocks) are not treatable.	Treats PCBs only. Process has not been demonstrated for initial concentrations <25 ppm.	PCBs converted to biphenyl ether. Treated soils would contain PCBs < 5 ppm and residual APEG reagent of approximately 1,300 ppm.	Retain. Evaluate for use on PCB hot spot soils.
-In-situ Vitrification*	Vitrified areas will take over 1 year to cool down; cover is necessary.	None. Organics are thermally destroyed, inorganics are immobilized within glass.	Combustion off-gases.	Retain for treating PCB hot spot soils.
-Vacuum Extraction	High groundwater table (lies within 6 feet of surface).	Process applicable to VOCs. PCBs and PAHs are not strippable by this process.	Off-gases are typically treated with carbon. Spent carbon would be regenerated or disposed of.	Screen out. Not feasbile for removing soil contaminants of concern (e.g., PCBs, PAHs).

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TABLE 8-3 (Continued)
SCREENING OF APPLICABLE SOURCE CONTROL TECHNOLOGIES - SOILS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS	WASTE RESIDUALS	STATUS
-Solidification	Excavation would be required. Water table is within five feet of the surface. This would preclude on-site disposal of solidified monoliths within the water table.	Fill contains debris (e.g., tires, timbers), which would make solidification difficult.	Contaminants are incorporated into the solidified matrix.	Retain. Remove and decontaminate debris before solidifying soils. Dispose solidified matrix above existing ground surface.
-Incineration	Excavation would be required. Saturated soils would inhibit efficiency.	Granite blocks, concrete rubble, cars, and other debris are non-combustible.	Ash containing metals.	Retain. Separate out and decontaminate debris; analyze ash and send it to secure landfill, if necessary.
-Solvent Extraction*	Excavation would be required.	Mixtures of several contaminants may necessitate several treatment steps, each with a particular solvent. Mixtures of chemicals generally complicate extraction procedures.	Concentrated wastestream of extracted organics.	Screenout. Specific solvent extraction processes (e.g., RCC's B.E.S.T. process) have been proven to be effective for removal of organic contaminants in oily sludges and sediments. However, site soil characteristics (low water and low oil content) make this technology unfeasible.
-Thermal Soil Aeration*	Excavation would be required.	PCBs and some PAHs cannot be aerated. Large debris mixed with the soils will complicate processing.	VOC/SVOC off-gas.	Screen out. Not effective for contaminants of concern (e.g., PCBs, BAP).
-In-situ Biological*	Soils are devoid of nutrients. Soils have waste materials throughout and would limit effectiveness.	Some heavy metals and organics (e.g., TCE) at concentrations above a few ppm are toxic to microorganisms. In-situ testing has not been attempted on PCBs.	None.	Screen out. Concentration of heavy metals and VOCs are expected to be toxic to microorganisms. Site soils are not amenable to technology. In-situ biological treatment has not been demonstrated on PCBs.

* Innovative Technology

TABLE 8-3 (Continued)
SCREENING OF APPLICABLE SOURCE CONTROL TECHNOLOGIES - SOILS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS	WASTE RESIDUALS	STATUS
-Vacuum Extraction*	Groundwater table lies within top 5 feet. There is limited VOC contamination in the unsaturated zone.	PCBs and PAHs are not volatile and will not be removed by process.	VOCs are discharged to the air.	Screen out. Minimal unsaturated zone, and technology is not effective at removing contaminants of concern (e.g., PCBs, BAP).
DISPOSAL				
-Landfill	Excavation would be required.	None	None	Retain. Solidified fill, decontaminated debris, and waste residuals could be landfilled.
-On-site Disposal	Excavation would be required.	None	None	Retain. Decontaminated debris and treated materials could remain on-site.
ANCILLARY				
-Excavation	Groundwater/surface water water flow into excavation zones would necessitate pumping.	Large debris (e.g., timber, blocks) would make excavation difficult.	Excavated materials would require temporary stockpiles.	Retain. Necessary for several treatment technologies.
-Hydraulic Barriers	None	None	N/A	Retain. Sheet piling is typically used during excavation operations.
-Screening	None	None	Screened material would require temporary stockpiles.	Retain. Necessary for several treatment technologies.
-Dewatering	None	None	Contaminated water.	Retain. Collect and treat water.
-Pumping	None	None	Contaminated water.	Retain. Collect and treat water.
-Wastewater Treatment	None	The greater the variety of contaminants, the more unit operations required.	Sludge	Retain. Necessary to treat collected water from other operations (e.g., dewatering).
-Revegetation	Poor soil conditions.	None	N/A	Retain. Would serve to restore disturbed areas.
-Trucking	None	None	N/A	Retain. Necessary to haul materials off-site for treatment or disposal.

* Innovative Technology

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TABLE 8-4
SCREENING OF APPLICABLE SOURCE CONTROL TECHNOLOGIES - PITS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS	WASTE RESIDUALS	STATUS
NO ACTION				
-Fencing/Signs	None	None	Contaminant concentrations would slowly decrease through natural attenuation.	Retain
-Environmental Monitoring	Pit depths approximately 150 feet filled with numerous debris.	Non-homogeneity of waste. Potential of DNAPLS.	N/A	Retain
-Institutional Controls	None	None	N/A	Retain
CONTAMINANT				
-Capping	Northeastern corner of the site lies in the 100-year floodplain of the unnamed stream. Surface obstructions (e.g., concrete pillars, cobblestones, telephone poles, and timbers) will hinder capping.	None	Contamination would remain untreated but capped.	Retain. Account for flood-plain in design; haul off surface obstructions for salvage or to a municipal landfill for disposal.
-Hydraulic Barriers	Barriers will not inhibit bedrock aquifer flow through the pits because the shallow bedrock is highly fractured.	None	N/A	Retain. Use to control the overburden water table which may shut off the seeps.
-Fracture Grouting	Bedrock highly fractured; technically infeasible to identify all fractures.	None	N/A	Retain. Use to seal known fractures to reduce groundwater flow into the pits.
TREATMENT				
-In-situ Vitrification*	Pits may be up to 150 feet deep; process is only feasible to a depth of 50 feet. Vitrified areas will take over 1 year to cool down; earthen cover is necessary.	None. Inorganics are immobilized within glass.	Off-gases will be treated.	Screen out. Not feasible for depths over 50 feet.

* Innovative Technology

TABLE 8-4 (Continued)
SCREENING OF APPLICABLE SOURCE CONTROL TECHNOLOGIES - PITS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS	WASTE RESIDUALS	STATUS
TREATMENT (Cont'd)				
-Solidification	Space is not available to stockpile excavated debris. Total excavation of the pits may be infeasible.	VOCs may not be incorporated into the solidified matrix. Large debris are not readily solidifiable.	Solidified matrix may remain on-site.	Retain. Bulk debris can be screened out and earthen contents solidified.
-Incineration	Space is not available to stockpile excavated debris. Total excavation of the pits may be technically infeasible.	Cars, transformers, debris cannot be incinerated.	Ash containing metals.	Retain. Separate out and decontaminate debris, cars, transformers; send ash to secure landfill, if necessary.
-In-situ Biological*	Depth of pits are approximately 150 feet.	TCE is toxic to microorganisms in concentrations >10 ppm. Nutrient addition would be required.	None	Retain. Would be more advantageous because excavation of the waste would not be required.
DISPOSAL				
-Landfill	None	Land disposal restrictions for PCBs, other wastes, may be applicable.	None	Retain. Wastes could be treated before disposal.
-On-site Disposal	RCRA and other permits may apply.	Land disposal restrictions for PCBs, other wastes, may be applicable.	Contaminated material would remain as long-term residuals.	Return. Decontaminated and treated materials could remain on-site.
ANCILLARY				
-Excavation	Space is not available to stockpile excavated debris. Total excavation of the pits may be technically infeasible due to the depth of the pits and the mixture of solid and liquid waste deposited within the pits.	Large debris may make excavation difficult.	Excavated debris would be temporarily stored on-site.	Retain. Obtain crane, if necessary.
-Screening	None	Large debris.	Screened debris would be temporarily stored on-site.	Retain
-Dewatering	None	Nature of excavated material may not be amenable to dewatering technologies.	Contaminated water.	Retain. Collect and treat water.
-Pumping	None	Pumped water may be contaminated.	Contaminated water.	Retain. Collect and treat water.

* Innovative Technology

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TABLE 8-4 (Continued)
SCREENING OF APPLICABLE SOURCE CONTROL TECHNOLOGIES - PITS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS	WASTE RESIDUALS	STATUS
ANCILLARY (Cont'd)				
-Wastewater Treatment	None	Water may require several treatment steps to remove or destroy contaminants.	Sludge, spent carbon	Retain. Treat on-site in a mobile wastewater treatment operation; send sludge to a RCRA landfill if required.
-Trucking	None	Nature of debris may not be amenable to trucking (i.e., cars).	N/A	Retain. Necessary to haul material off-site for disposal.

* Innovative Technology

TABLE 8-5
SCREENING OF APPLICABLE SOURCE CONTROL TECHNOLOGIES - SEDIMENTS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS	WASTE RESIDUALS	STATUS
NO ACTION				
-Fencing/Signs	None	None	PCB contamination would remain in the sediments.	Retain
-Environmental Monitoring	Areas are located within an operating golf course.	None	PCB contamination would remain in the sediments.	Retain
-Institutional Controls	Areas are located within an operating golf course.	None	PCB contamination would remain in the sediments.	Retain
CONTAINMENT				
-Capping	Major portion of areas are designated as wetlands. Cycles of flooding and recession could cause damage to a cap. Trees, vegetation would have to be removed.	None	Contamination would remain untreated but capped.	Retain. Harvest trees, channel surface water flow.
TREATMENT				
-Dechlorination (APEG)*	Saturated sediments are not treatable without dewatering. Excavation of wetlands would be required.	PCBs generally less than 25 ppm; APEG is not effective at these low concentrations.	PCBs converted to biphenyl ether. Treated sediments would contain PCBs <5 ppm and residual APEG reagent of approximately 1,300 ppm.	Screen out. Not effective for site sediment concentrations (average PCB concentrations are 10 to 15 ppm).
-Solidification	Excavation of wetlands would be required.	None	The solidified sediments would still be a PCB material.	Retain. Solidified sediments must be disposed of off- or on-site and capped.
-Incineration	Saturated sediments are not treatable without dewatering. Excavation of wetlands would be required.	None	Ash	Retain. Dewater before treatment; send ash to a secure landfill if necessary.
-Solvent Extraction*	Excavation of wetlands would be required.	Not effective for low contaminant concentrations (<1%).	Concentrated waste stream of extracted organics.	Screen out. Low sediment PCB concentrations (less than 60 ppm) and low oil content of the sediments make this technology less feasible for clean up of stream and marsh sediments.

* Innovative Technology

TABLE 8-5 (Continued)
SCREENING OF APPLICABLE SOURCE CONTROL TECHNOLOGIES - SEDIMENTS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS	WASTE RESIDUALS	STATUS
-In-situ Biological*	Sediments are covered with an organic layer which may inhibit biological access to the contaminants.	PCBs are difficult to biodegrade.	None	Retain. May require pilot studies; would save wetlands (i.e., Middle Marsh and the Apponogansett Swamp) from major disruptions.
DISPOSAL				
-Landfill	Would require excavation of wetlands and construction of roads in wetland areas.	PCB-disposal regulations	N/A	Retain. Restore wetlands.
-On-site Disposal	Would require excavation of wetlands and construction of roads in wetlands areas.	PCB-disposal regulations	N/A	Retain. Restore wetlands.
ANCILLARY				
-Excavation	Middle Marsh is heavily wooded and would be impacted during excavation.	None	N/A	Retain. May have to restore wetland.
-Hydraulic Barriers	None	None	N/A	Retain. Sheet piling is tyically used during excavation operations.
-Dewatering	None	None	Contaminated water.	Retain. Collect and treat water.
-Pumping	None	None	Pumped water may be contaminated.	Retain. Collect and treat water.
-Wastewater Treatment	None	Water must be analyzed to determine appropriate treatment requirements.	Sludge, spent carbon.	Retain. Send to appropriate treatment facility or procure mobile units as necessary.
-Revegetation	Restoration of the Middle Marsh would take years.	None	N/A	Retain.
-Trucking	Roads would need to be constructed on the golf course and in wetland areas.	None	N/A	Retain. Necessary to haul sediments on-site for treatment.

* Innovative Technology

TABLE 8-6
SCREENING OF APPLICABLE MANAGEMENT OF MIGRATION TECHNOLOGIES - GROUNDWATER
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS	WASTE RESIDUALS	STATUS
NO ACTION				
-Fencing/Signs	None	None	N/A	Retain
-Institutional Controls	None	None	N/A	Retain
-Environmental Monitoring	May temporarily disrupt golf course activities.	None	N/A	Retain. Utilize Westbay permanent sampler wells.
CONTAINMENT				
-Capping	The northeastern corner of the site lies in the 100-year floodplain of the unnamed stream. Surface obstructions (e.g., concrete pillars, cobblestones, telephone poles, and timbers) are hinderances.	None	Soil contamination will still remain on-site.	Retain. Account for floodplain in design; haul off surface obstructions for salvage or to a municipal landfill for disposal.
-Hydraulic Barrier	Controls only the overburden aquifer. The bedrock horizontal confining layer is highly fractured; will allow leakage under barrier.	Groundwater contamination increases with depth.	N/A	Screen out. Would not be effective in controlling migration due to highly fractured bedrock, including deep bedrock fractures.
-Groundwater Interceptor Trench	Hydrogeology is not completely understood.	None	N/A	Retain. Use to control overburden and upper bedrock aquifers.
-Fracture Grouting	Bedrock highly fractured. Technically infeasible to identify all fractures.	None	N/A	Retain. Would be used in conjunction with a groundwater interceptor trench to seal the bedrock face to maximum extent possible.
-Waterway Diversions	A portion of the unnamed streambed (adjacent to the car wash) lies in the 100-year floodplain. Would be disruptive to adjacent establishments.	None	N/A	Retain. Account for floodplain in design.

TABLE 8-6 (Continued)
SCREENING OF APPLICABLE MANAGEMENT OF MIGRATION TECHNOLOGIES - GROUNDWATER
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS	WASTE RESIDUALS	STATUS
TREATMENT				
-In-Situ Biological*	Contamination in the bedrock aquifer may not be accessible.	Some heavy metals and organics at concentrations above a few ppm are toxic to microorganisms.	Non-aqueous phase liquids, if present, would persist.	Screen out. Process is not effective for TCE in concentrations >10 ppm.
-UV/Ozonation*	None	Process does not treat metals; suspended solids interfere with the passage of UV light through the wastewater.	Effluent containing dissolved metals, some unreacted organics.	Retain. Remove suspended solids before treatment; precipitate out metals; add polishing step to remove unreacted organics.
-Supercritical Water* Oxidation	None	Not suitable for inorganics or low concentrations of organics (<1%).	Effluent containing dissolved metals, unreacted organics.	Screen out. Not technically feasible for low waste concentrations.
-Thin Film Evaporation*	None	Difficult to separate organics with boiling points close to water (i.e., 100°C).	Concentrated wastestream of extracted contaminants.	Screen out. Process primarily used for desalination operations; not demonstrated for organics removal.
-Biological treatment (e.g., rotating contactors, activated sludge)	Low flow rate and contaminant concentrations would preclude use of biological treatment.	Some heavy metals and organics (e.g., TCE) at concentrations above a few ppm are toxic to microorganisms.	Effluent containing dissolved metals, sludge containing biomass.	Screen out. Biomass would be too vulnerable to toxic shock due to site-specific contaminants (e.g., TCE, vinyl chloride).
-Air Stripping	None	Iron and manganese may cause fouling. Process removes only VOCs.	Off-gases containing gas-phase VOCs. Some SVOCs would remain in effluent.	Retain. Collect VOCs in off-gas.
-Carbon Sorption	None	Suspended solids >50 ppm cause clogging.	Contaminated activated carbon.	Retain. Use as polishing step for gas-phase or aqueous-phase organics.
-Precipitation/ Flocculation/ Sedimentation	None	Process removes metals and some PCBs adsorbed to suspended particles.	Metal sludge. Effluent would contain untreated organics.	Retain. Use for metals removal; dispose of sludge as required.
-Aeration	None	VOCs may be released into the air during the aeration process.	Metal sludge. Off-gases would contain VOCs. Effluent would contain untreated SVOCs.	Retain. Collect off-gases.

* Innovative Technology

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TABLE 8-6 (Continued)
SCREENING OF APPLICABLE MANAGEMENT OF MIGRATION TECHNOLOGIES - GROUNDWATER
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	SITE-LIMITING CHARACTERISTICS	WASTE-LIMITING CHARACTERISTICS	WASTE RESIDUALS	STATUS
-Filtration	None	DNAPLS could clog or coat filters.	Filters will need to be backwashed or disposed, as appropriate.	Retain. Use in conjunction with other unit processes.
-Municipal Wastewater Treatment Facility	Capacity of the New Bedford Sewage Treatment Plant may not handle discharge flow, and it is only a primary treatment facility.	Discharge concentrations must conform to the New Bedford facility's pretreatment standards. PCB-contaminated wastewater may not be acceptable.	None	Retain. Pretreat if necessary.
EXTRACTION				
-Subsurface Drains	The northeastern corner of the site lies in the 100-year floodplain of the unnamed stream.	Contamination at significant depths.	Contaminated groundwater will need treatment.	Retain. Account for floodplain in design.
-Groundwater Pumping	Permeability of on-site soils and bedrock may restrict groundwater extraction.	None	Contaminated groundwater will need treatment.	Retain. Perform pumping tests during remedial design.
DISPOSAL				
-Landfill	None	Land disposal restrictions may apply	N/A	Retain. Assess sludge generation quantities.
-On-site Disposal		Land disposal restrictions may apply.	Contaminated material would remain as long-term residuals.	Retain. Treatment residuals not under land ban could be disposed of on-site.
-Incineration of organic residuals	None	None	Ash	Retain
-Storm Drain/Sewer/ Receiving Stream	None	Effluent must meet discharge requirements.	Not Applicable	Retain

* Innovative Technology

TABLE 8-7
SUMMARY OF SOURCE CONTROL TECHNOLOGIES
RETAINED AFTER SCREENING
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	RETAINED FOR SOILS	PITS	SEDIMENTS
NO ACTION			
Fencing/Signs	X	X	X
Institutional Controls	X	X	X
Environmental Monitoring	X	X	X
CONTAINMENT			
Capping	X	X	X
Hydraulic Barriers	X	X	X
Fracture Grouting		X	
TREATMENT			
APEG Dechlorination*	X		
In-situ Vitrification*	X		
Solidification	X	X	X
Incineration	X	X	X
Solvent Extraction*			
Thermal Soil Aeration*			
In-situ Biological*		X	X
Vacuum Extraction*			
DISPOSAL			
Landfill	X	X	X
On-site	X	X	X
ANCILLARY			
Excavation	X	X	X
Screening	X	X	X
Dewatering	X	X	X
Pumping	X	X	X
Revegetation	X		X
Water Treatment	X	X	X
Trucking	X	X	X

* Innovative Technologies

TABLE 8-8
SUMMARY OF SCREENING OF MANAGEMENT OF MIGRATION TECHNOLOGIES
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

TECHNOLOGY	RETAINED YES	RETAINED NO
NO ACTION		
Fencing/Signs	X	
Institutional Controls	X	
Environmental Monitoring	X	
CONTAINMENT		
Capping	X	
Hydraulic Barrier		X
Groundwater Interceptor Trench	X	
Fracture Grouting	X	
Waterway Diversion	X	
TREATMENT		
In-situ Biological*		X
UV/Ozonation*	X	
Supercritical Water Oxidation*		X
Thin Film Evaporation*		X
Biological Treatment		X
Air Stripping	X	
Carbon Sorption	X	
Precipitation/Flocculation/Sedimentation	X	
Aeration	X	
Filtration	X	
Municipal Wastewater Treatment Facility	X	
EXTRACTION		
Subsurface Drains	X	
Groundwater Pumping	X	
DISPOSAL		
Landfill	X	
On-site	X	
Incineration of Organic Residuals	X	
Storm Drain/Sewer/Receiving Stream	X	

*Innovative Technologies

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9.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

9.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Development of alternatives must comply with the requirements of Section 121 of CERCLA. Of most importance, Section 121(d) codifies the CERCLA Compliance Policy. First published as an appendix to the preamble of the NCP, this policy requires that Superfund remedial actions attain ARARs of other federal statutes. While Section 300.68 (f) of the NCP specifically refers to ARARs in regard to the Development of Alternatives, Section 121 incorporates this requirement into the statute and adds the provision that remedial actions also attain state requirements that are more stringent than federal requirements, to the extent they are also applicable or relevant and appropriate and are identified to EPA in a timely manner. Further, the new statutory requirements and preference for treatment that reduces the volume, toxicity, or mobility of hazardous waste modify the processes by which alternatives are developed.

In accordance with CERCLA and, to the extent practicable, the NCP, treatment alternatives were developed for the Sullivan's Ledge site ranging from an alternative that, to the degree possible, would eliminate the need for long-term management at the site, to alternatives involving treatment that would reduce the volume, toxicity, or mobility of the hazardous substances as their principal element. In addition to the range of treatment alternatives, containment options involving little or no treatment and no-action alternatives were developed.

The development of site alternatives is discussed in Section 12.0. At the Sullivan's Ledge site, interaction between the source areas and groundwater is not significant; that is, SC alternatives will have minimal effect on groundwater and surface water. Because of this lack of interaction, the development of site alternatives has been delayed until after the detailed analysis of SC and MM alternatives (Sections 10.0 and 11.0). This approach allows greater flexibility in developing alternatives and simplifies the analysis of alternatives.

Alternatives were first developed for both SC and MM by assembling the technologies that passed the initial screening process. The SC alternatives were further subdivided into non-removal and removal alternatives. Non-removal alternatives are alternatives that leave the source material in place; these include no-action, containment, and in-situ treatment alternatives. Removal alternatives have excavation as their first component and include treatment and disposal alternatives.

Flow diagrams were prepared to aid in the development of alternatives. The diagrams enable the development of

alternatives to be visualized and the results of the alternative development step to be summarized. Figures 9-1 through 9-6 present results of the alternative development step for the SC alternatives. To facilitate the alternative development, SC alternatives were developed for each of the affected media: the quarry pits, site soils, and sediments. Figure 9-7 outlines the MM alternatives developed in this step.

9.2 COMPATIBILITY EVALUATION

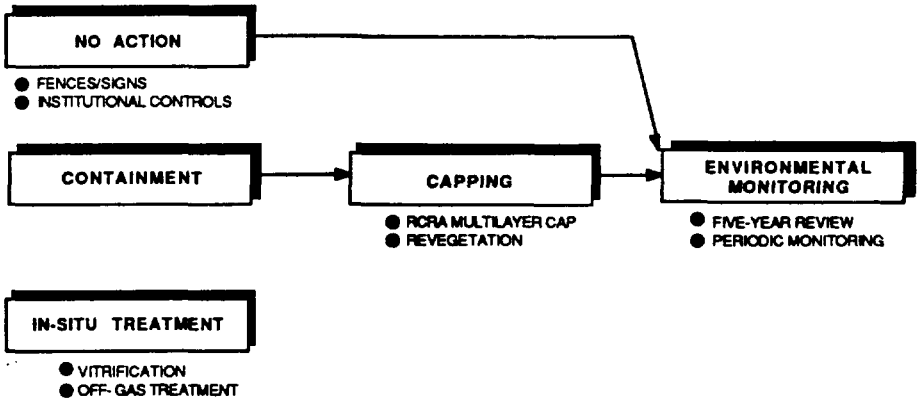
As discussed earlier, there is a difference between on-site soils and groundwater contaminants. PCBs and PAHs are the major soil contaminants. These compounds are larger molecules and are adsorbed to soil particles. Although these compounds were detected in the groundwater, they were detected in small amounts. The major groundwater contaminants are VOCs. Because of this difference between the two media (i.e., soils and groundwater), remediation of these media can be evaluated independently of one another. In developing separate alternatives for each source area and the groundwater, many components are similar. Therefore, there is redundancy in the alternatives. The purpose of the compatibility evaluation is to highlight the interconnected components and eliminate the redundant alternatives, if possible.

One of the most obvious redundancies is the development of a no-action alternative for each of the three source areas. To remedy this unnecessity, the three no-action alternatives (i.e., SC-Pit-1, SC-Soils-1, and SC-Sed-1) will be combined and evaluated together as Alternative SC-1.

Another redundancy is exhibited between Alternatives SC-Soils-2 and MM-2. Both are containment alternatives for site soils. SC-Soils-2 involves using a multi-layer cap to minimize dermal contact with site soils and minimize precipitation infiltration through the soils. MM-2 contains site soils with a multi-layer cap to minimize infiltration into the quarry pits. The two alternatives appear identical in their objective and nearly identical in their components; both attempt to achieve similar results. Therefore, both need not be evaluated; MM-2 will be eliminated from further evaluation, and the analysis of SC-Soils-2 will be expanded to incorporate the objectives of MM-2.

Equally important, but less obvious, is the relationship between the MM alternatives and the soil removal alternatives (i.e., SC-Soil-4 through SC-Soil-8). When treating or containing a groundwater plume, it is important to minimize infiltration/ inflow into the groundwater so that uncontaminated water does not enter the site and require treatment.

FIGURE 9-1
DEVELOPMENT OF NON-REMOVAL ALTERNATIVES
SOURCE CONTROL - SOILS

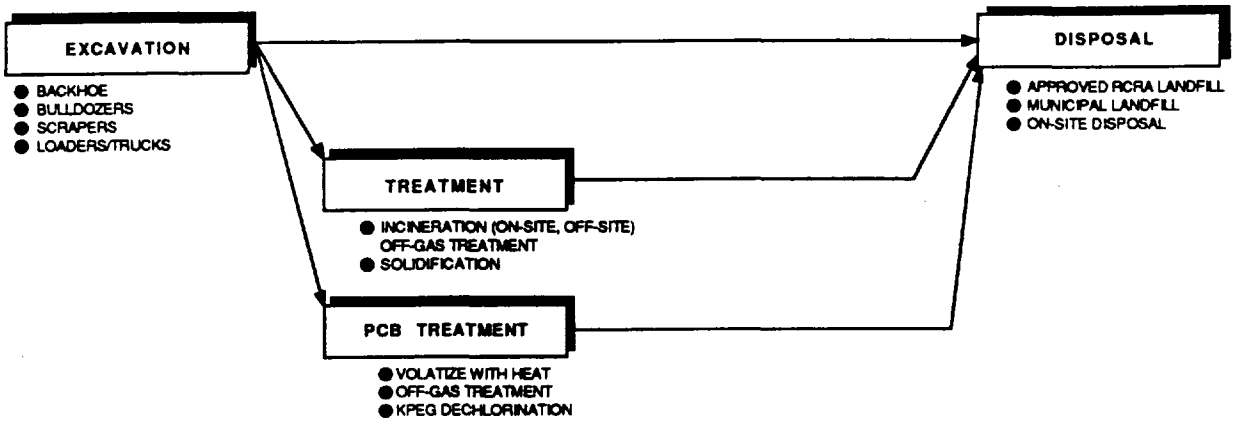


SC-SOILS-1 NO ACTION - No action involves installing a site perimeter fence, posting bilingual warning signs (in English and Portuguese), and initiating institutional controls to protect the public from direct contact hazards. Additionally, an environmental monitoring program would be implemented to allow an evaluation of site conditions over time.

SC-SOILS-2 CONTAINMENT - Containment entails capping contaminated soils with a multi-layer cap to minimize migration of soils due to erosion. Additionally, an environmental monitoring program would be implemented to allow an evaluation of site conditions over time.

SC-SOILS-3 IN-SITU VITRIFICATION - Contaminated site soils would be fused into an inert glass. The process combusts organics and immobilizes inorganics within the cooled, vitrified matrix. Off-gases are treated prior to release into the atmosphere.

FIGURE 9-2
DEVELOPMENT OF REMOVAL ALTERNATIVES
SOURCE CONTROL - SOILS



SC-SOILS-4 OFF-SITE RCRA LANDFILL - Contaminated soils would be excavated, screened, and transported to an approved RCRA landfill. The site will be regraded and screened material will also be transported to an approved RCRA landfill.

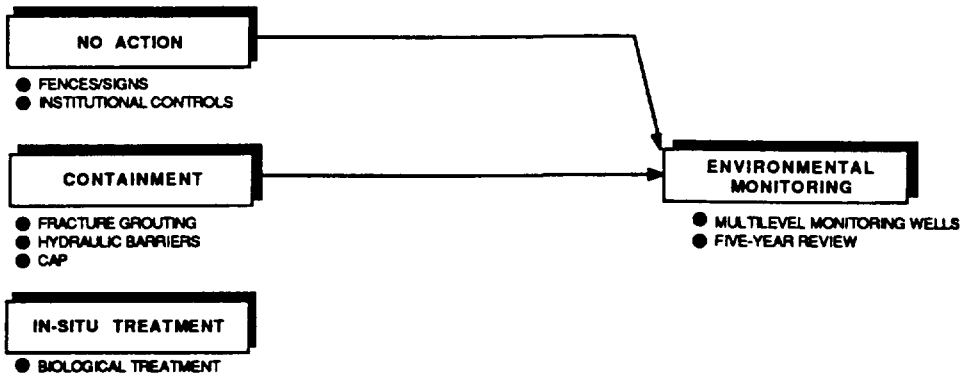
SC-SOILS-5 ON-SITE INCINERATION - Contaminated soils would be excavated, screened, and incinerated on-site using a mobile unit. Incinerated soils would be disposed of on-site. Off-gases will be treated prior to release into the atmosphere. Screened material and ash would be disposed of on- or off-site, as appropriate.

SC-SOILS-6 OFF-SITE INCINERATION - Excavated/screened soils would be transported to a permitted PCB incinerator. Temporary on-site storage may be necessary due to limited available incinerator feed capacities. The site will be regraded and screened material will be transported to an approved RCRA landfill.

SC-SOILS-7 VOC REMOVAL/PCB DECHLORINATION - Soils would be excavated, screened, and treated by alkali polyethylene glycol. As part of the APEG process, the soil would be heated 150°C to drive off VOCs and moisture. An alkali polyethylene glycol would then be added and allowed to react with the PCBs to remove chlorine atoms. The treated soils and screened debris would be disposed on-site.

SC-SOILS-8 SOLIDIFICATION - After excavation and screening to remove debris, soils would be solidified with setting agents (e.g., Portland cement, fly ash, kiln dust, lime). The solidified soils and screened debris would remain on-site and would be capped to minimize the leaching of contaminants initiated by precipitation infiltration. Environmental monitoring would be required to determine the long term effectiveness of the solidified material.

FIGURE 9-3
DEVELOPMENT OF NON-REMOVAL ALTERNATIVES
SOURCE CONTROL - PITS

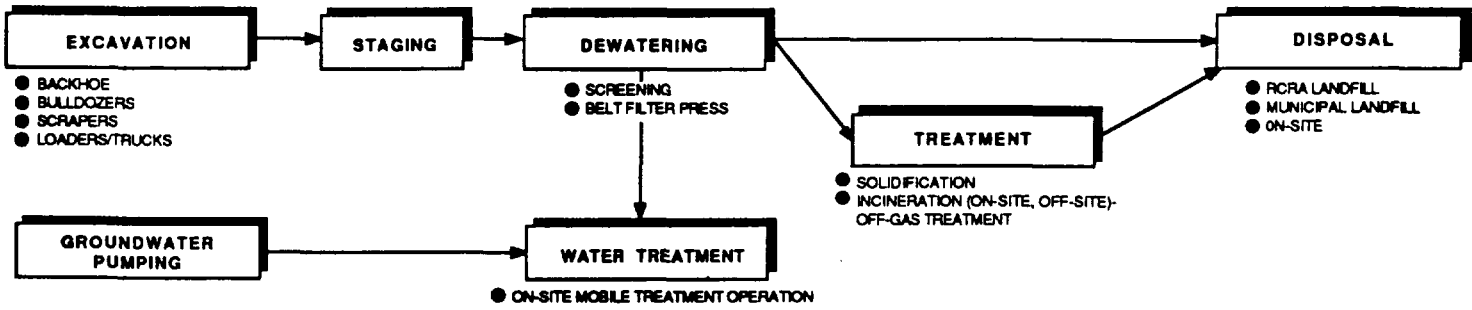


SC-PITS-1 NO ACTION - No action involves installing a site perimeter fence, posting bilingual warning signs (in English and Portuguese), and initiating institutional controls to protect the public from direct contact hazards. Additionally, an environmental monitoring program would be implemented to allow an evaluation of site conditions over time.

SC-PITS-2 CONTAINMENT - Containment would attempt to eliminate all routes of water influx to the pits. A cap would minimize precipitation infiltration; hydraulic barriers would restrict overburden groundwater influx; and fracture grouting would minimize bedrock groundwater influx. Additionally, an environmental monitoring program would be implemented to allow an evaluation of site conditions over time.

SC-PITS-3 IN-SITU BIOLOGICAL - Nutrients would be introduced into the pits via groundwater recirculation using a series of recharge wells. Periodic well sampling would serve to monitor the reduction of contamination over time.

FIGURE 9-4
DEVELOPMENT OF REMOVAL ALTERNATIVES
SOURCE CONTROL - PITS



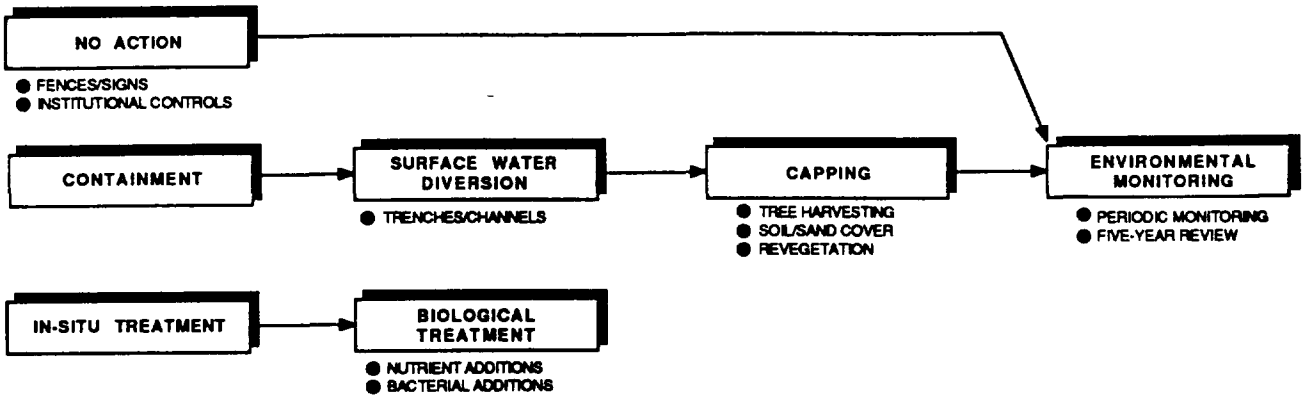
SC-PITS-4 OFF-SITE RCRA LANDFILL - Each pit would be excavated to the maximum extent possible. This would necessitate pumping to keep the groundwater table below working zones and treating the removed water. Bulk debris would be screened out and decontaminated on-site. Decontamination water would be collected and treated along with pumped groundwater. Excavated materials would be transported to a RCRA facility for disposal.

SC-PITS-5 SOLIDIFICATION/OFF-SITE RCRA LANDFILL - Each pit would be excavated to the maximum extent possible, large debris screened out, and contaminated fill solidified. After solidification, the resulting monoliths would be sent to a RCRA landfill. In addition, contaminated debris would go to a RCRA facility. Metal objects (e.g., cars) and other large debris would be decontaminated by gritblasting and sent to either a metal salvage facility or a municipal landfill.

SC-PITS-6 ON-SITE INCINERATION - Excavation of the pits would be followed by dewatering and incineration of fill/debris in a mobile unit. Large objects that could not be accommodated by such a unit would be screened out prior to incineration. Uncontaminated fill, as determined by mobile lab analysis, would not be incinerated, but backfilled into the pits. Large objects (e.g., cars, boulders) would be decontaminated and disposed of as necessary. The treated material would be disposed on-site, and contaminated water would be treated, as appropriate.

SC-PITS-7 OFF-SITE INCINERATION - Excavated fill would be transported to a permitted incinerator. Large objects (e.g., timbers, junk cars, blocks) would be decontaminated and recovered for salvage value, sent to a municipal landfill, or backfilled into the pits. Uncontaminated fill, as determined by mobile lab analyses, would be stockpiled and placed back into the pits after excavation is complete.

FIGURE 9-5
DEVELOPMENT OF NON-REMOVAL ALTERNATIVES
SOURCE CONTROL - SEDIMENTS

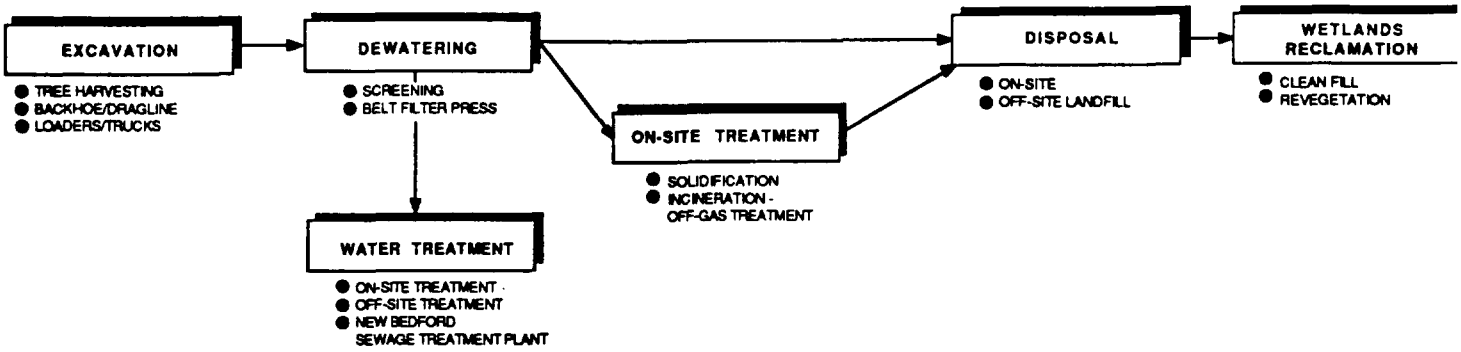


SC-SED-1 NO ACTION - No action involves installing a site perimeter fence, posting bilingual warning signs (in English and Portuguese), and initiating institutional controls to protect the public from direct contact hazards. Additionally, an environmental monitoring program would be implemented to allow an evaluation of site conditions over time.

SC-SED-2 CONTAINMENT - Middle Marsh sediments would be contained with an earthen cover (i.e., either clay or soil/sand), while the unnamed stream would be dredged. Dredged sediment would be used as fill in conjunction with the installation of a RCRA cap (containment alternative SC-SOILS-2 or SC-PITS-2) or sent to a RCRA landfill. Additionally, an environmental monitoring program would be implemented to allow an evaluation of site conditions over time.

SC-SED-3 IN-SITU BIOLOGICAL - Nutrients (e.g., nitrogen, oxygen, phosphorus, trace minerals) would be added to the sediments to stimulate microbial activity to biodegrade PCB contaminants.

FIGURE 9-6
DEVELOPMENT OF REMOVAL ALTERNATIVES
SOURCE CONTROL - SEDIMENTS

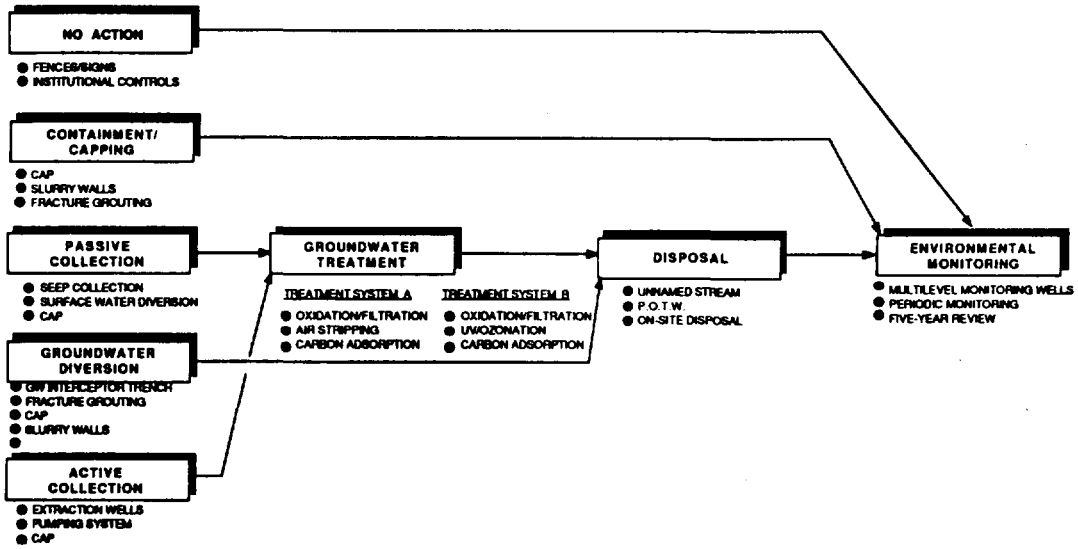


SC-SED-4 REMOVAL/DISPOSAL - Contaminated sediments from the Middle Marsh and the unnamed stream would be excavated/dredged, dewatered, and stockpiled. Debris would be screened out prior to dewatering and stockpiled along with dewatered sediment, awaiting final disposal (either on- or off-site), as appropriate. Stockpiled materials could be used as fill during installation of a RCRA cap, provided that capping is a component of the preferred alternative. Contaminated water would be treated appropriately and wetlands restored.

SC-SED-5 SOLIDIFICATION/DISPOSAL - Excavated and dewatered sediments would be solidified using a common setting agent (e.g., Portland cement, fly ash, kiln dust, lime) to bind PCBs within the hardened matrix. Treated sediments would be disposed on-site and the wetlands restored. Contaminated water would be treated appropriately.

SC-SED-6 ON-SITE INCINERATION - Excavated and dewatered sediments would be incinerated in a mobile unit. After incineration is complete, the Middle Marsh would be restored as a wetland or sodded for expansion of the golf course. Treated sediments would be disposed on-site. Contaminated water will be treated appropriately.

FIGURE 9-7
DEVELOPMENT OF ALTERNATIVES
MANAGEMENT OF MIGRATION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS



MM-1 NO ACTION - This alternative consists of maintaining signs and initiating institutional controls to protect the public, and would include an environmental monitoring program to assess contaminant movement and natural attenuation.

MM-2 CONTAINMENT - The containment alternative would control movement of groundwater in the on-site overburden soils and reduce infiltration. Implementation of the alternative would incorporate the use of surface capping, and hydraulic barriers such as slurry walls and fracture grouting. An environmental monitoring program would also be implemented.

MM-3 PASSIVE COLLECTION - The passive collection alternative would make use of a system to collect and treat seepage discharging to the unnamed stream and along the northern edge of Hathaway Road. Additional components of the alternative include a surface cap, surface water diversion, an on-site water treatment facility, and an environmental monitoring program.

MM-4 GROUNDWATER DIVERSION - This alternative would make use of a groundwater interceptor trench constructed upgradient of the quarry pits. The interceptor trench would be designed to divert clean groundwater around the site, and thus lower the water table to shut off the seeps. A surface cap and an environmental monitoring program would be included as part of the alternative.

MM-5 ACTIVE COLLECTION - ON-SITE GROUNDWATER - Alternative MM-5 would employ a groundwater extraction and treatment system. The goals of this alternative would be to restore the on-site groundwater (< 150') through collection and treatment, and reduce seepage of contaminated groundwater to surface water systems. The alternative would also include the use of a cap, surface water diversion, and an environmental monitoring program.

MM-6 ACTIVE COLLECTION - DEEP GROUNDWATER IN BEDROCK FRACTURES - This alternative would consist of a system to extract and treat deep bedrock groundwater. It is anticipated that the extraction system would be located within or near the highly contaminated fractures. An environmental monitoring program would be employed to assess any change in contaminant migration.

A multi-layer cap over the site will reduce rainfall infiltration. Rainfall infiltration at the Sullivan's Ledge site can be significant (see Section 4.2), because the fill soil over the pits is shallow and highly permeable. Therefore, the cap is an important component for each of the MM alternatives. Alternative SC-Soil-4 (i.e., excavation and off-site disposal in a RCRA facility) will be eliminated from further consideration during this compatability evaluation. Landfilling of waste does not comply with land disposal restrictions, nor is it likely that landfill space is available due to the anticipated volumes of waste. In addition, off-site disposal of the contaminated soil is costly and not consistent with SARA's preference for permanent treatment. If disposal of contaminated soil without treatment is determined to be a viable alternative, then on-site disposal in conjunction with a RCRA cap could be selected.

9.3 SCREENING OF REMEDIAL ALTERNATIVES

Each alternative developed in Section 9.1 and not eliminated by the compatibility evaluation (Section 9.2) was subject to a screening step. The objective of this screening step was to eliminate alternatives that are ineffective, difficult to implement, or have unreasonable costs; while still preserving a range of options. The screening criteria outlined in 300.68(g)(h)(2) and (3) of the NCP and modified by Section 121(b)(1)A-G factors were used in this process. The SARA A through G factors are summarized as follows:

A = The long-term uncertainties associated with land disposal.

B = The goals, objectives, and requirements of the Solid Waste Disposal Act (SWDA).

C = The persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.

D = Short- and long-term potential for adverse health effects from human exposure.

E = Long-term maintenance costs.

F = The potential for future remedial action costs if the alternative remedial action in question were to fail.

G = The potential threat to human health and the environment associated with excavation, transportation, and redisposal or containment.

For each alternative, a matrix was developed highlighting its advantages and disadvantages with respect to effectiveness, implementability, and cost. The SARA A through G factors were then used to evaluate the alternative by placing the appropriate factor as an advantage, if the alternative achieves the factor, or a disadvantage, if the alternative fails to satisfy the appropriate SARA factor.

The alternative evaluation matrix presents a clear, concise procedure for screening potential remedial alternatives. Based on this matrix, a decision is made about retaining the alternative for detailed evaluation or eliminating it from further consideration. This decision is documented under the conclusions summary.

In addition to the evaluation matrix, potential action-specific ARARs were identified for each alternative. Federal and Massachusetts guidance documents and criteria are not identified in this section, but will be addressed in the FS during the detailed evaluation of alternatives. Regulations identified as potential ARARs for possible remedial alternatives are presented in Table 9-1. Major requirements that must be obtained are highlighted in these tables. Action-specific ARARs for each remedial alternative that passes the initial screening are discussed in more detail in Sections 10.0 and 11.0. Location-specific and chemical-specific ARARs are listed in Appendix F.

RCRA regulations are considered to be relevant and appropriate for the PAH contaminants in the site soils and the organic contamination in the groundwater. Although the source or prior use of these chemicals is unknown, the majority of these compounds are listed in the RCRA regulations as hazardous waste. Therefore, RCRA is considered to be an ARAR for these media.

The TSCA (40 CFR 761, Subpart G - PB Spill Clean-up Policy) governs clean-up standards for PCB spills. Because the policy establishes requirements for PCB spills that occur after the effective date of this policy (May 4, 1987), and because disposal operations at the Sullivan's Ledge site ceased in the 1970s, these requirements are not ARARs.

In addition to the Spill Cleanup Policy, EPA promulgated the 1979 TSCA regulations for the storage, disposal, and marking of materials containing PCBs greater than 50 parts per million (ppm). The Sullivan's Ledge site was not in operation at the time of the promulgation of this regulation; however, this regulation is applicable when material regulated under TSCA is removed from the original disposal area. The TSCA disposal requirements, therefore, are ARARs for remedial actions involving excavation of soils.

TABLE 9-1

POTENTIAL ACTION-SPECIFIC ARARs
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ARARs	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARs
RCRA - General Facility Standards (40 CFR 264.10 - 264.18)	General facility requirements outline general waste analysis, security measures, inspections, and training requirements.	Any facilities will be constructed, fenced, posted, and operated in accordance with this requirement. All workers will be properly trained. Process wastes will be evaluated for the characteristics of hazardous wastes to assess further landing requirements.
RCRA - Preparedness and Prevention (40 CFR 264.30 - 264.31)	This regulation outlines requirements for safety equipment and spill control.	Safety and communication equipment will be installed at the site; local authorities will be familiarized with site operations.
RCRA - Contingency Plan and Emergency Procedures (40 CFR 264.50 - 264.56)	This regulation outlines the requirements for emergency procedures to be used following explosions, fires, etc.	Plans will be developed and implemented during site work including installation of monitoring wells, and implementation of site remedies. Copies of the plans will be kept on-site.
RCRA - Manifesting, Recordkeeping, and Reporting (40 CFR 264.70 - 264.77)	This regulation specifies the recordkeeping and reporting requirements for RCRA facilities.	Records of facility activities will be developed and maintained during remedial actions.
RCRA - Releases from Solid Waste Management Units (40 CFR 264.90 - 264.109)	This regulation details requirements for a groundwater monitoring program to be installed at the site.	A groundwater monitoring program is a component of all alternatives. RCRA regulations will be utilized as guidance during development of this program.
RCRA - Closure and Post-closure (40 CFR 264.110 - 264.120)	This regulation details specific requirements for closure and post-closure of hazardous waste facilities.	Those parts of the regulation concerned with long-term monitoring and maintenance of the site will be incorporated into the design.
RCRA - Regulations on Land Disposal Restrictions (40 CFR 268)	This regulation outlines land disposal requirements and restrictions for hazardous wastes.	Contaminated soils as listed in the regulations will be treated to the Best Demonstrated Available Technology levels before being placed or replaced on the land. Hazardous waste cannot be stored except for accumulation for recovery, treatment, or disposal.
RCRA - Surface Impoundments items (40 CFR 264.220 - 264.249)	This regulation details the design, construction, operation, monitoring, inspection, and contingency plans for a RCRA surface impoundment. Also provides three closure options for CERCLA sites; Clean closure, containment closure, and alternate closure.	To comply with clean closure, owner must remove or decontaminate all waste. To comply with containment closure, the owner must eliminate free liquid, stabilize remaining waste, and cover impoundment with a cover that complies with the regulation. Integrity of cover must be maintained, groundwater system monitored, and runoff controlled. To comply with alternate closure, all pathways of exposure to contaminants must be eliminated and long-term monitoring provided.
RCRA - Waste Piles (40 CFR 264.250 - 264.269)	Details procedures, operating requirements, and closure and post-closure options for waste piles. If removal or decontamination of all contaminated subsoils is not possible, closure and post-closure requirements for landfills must be attained.	According to RCRA, waste piles used for treatment or storage of non-containerized accumulation of solid, non-flowing hazardous waste may comply with either the waste pile or landfill requirements. The temporary storage of solid waste on-site, therefore, must comply with one or the other subpart.

TABLE 9-1 (continued)

POTENTIAL ACTION-SPECIFIC ARARs
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ARARs	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARs
RCRA - Landfills (40 CFR 264.300 - 264.339)	This regulation details the design, operation, monitoring, inspection, recordkeeping, closure, and permit requirements for a RCRA landfill.	Disposal of contaminated materials from the Sullivan's Ledge site would be to a RCRA-permitted facility that complies with RCRA landfill regulations, including closure and post-closure. On-site disposal would include a RCRA designed cap.
RCRA - Incinerators (40 CFR 264.340 - 264.599)	This regulation specifies the performance standards, operating requirements, monitoring, inspection, and closure guidelines of any incinerator burning hazardous waste.	On-site thermal treatment must comply with the appropriate requirements specified in this subpart of RCRA.
RCRA - Miscellaneous Units (40 CFR 264.600 - 264.999)	These standards are applicable to miscellaneous units not previously defined under existing RCRA regulations for treatment, storage, and disposal units.	Units not previously defined under RCRA must comply with these requirements.
TSCA Disposal Requirements (40 CFR Part 761.60)	PCBs at concentrations greater than 50 ppm, but less than 500 ppm, must be disposed of either in an incinerator, or in a chemical waste landfill, or by another technology capable of providing equal treatment. PCBs at concentrations greater than 500 ppm must be disposed of in an incinerator or treated by an alternate technology capable of equal treatment or disposed of in a chemical waste landfill.	PCB Treatment must comply with these regulations during remedial action.
OSHA - General Industry Standards (29 CFR Part 1910)	These regulations specify the 8-hour time-weighted average concentration for various organic compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 9910.120.	Proper respiratory equipment will be worn if it is impossible to maintain the work atmosphere below the concentrations. Workers performing remedial activities would be required to have completed specified training requirements.
OSHA - Safety and Health Standards (29 CFR Part 1926)	This regulation specifies the type of safety equipment and procedures to be followed during site remediation.	All appropriate safety equipment will be on-site. In addition, safety procedures will be followed during on-site activities.
OSHA - Recordkeeping, Reporting, and Related Regulations (29 CFR 1904)	This regulation outlines the recordkeeping and reporting requirements for an employer under OSHA.	These requirements apply to all site contractors and subcontractors and must be followed during all site work.
CWA - 40 CFR Part 403	This regulation specifies pretreatment standards for discharges to a publicly owned treatment works (POTW).	If a leachate collection system is installed and the discharge is sent to a POTW, the POTW must have an approved pretreatment program. The collected leachate runoff must be in compliance with the approved program. Prior to discharging, a report must be submitted containing identifying information, list of approved permits, description of operations, flow measurements, measurement of pollutants, certification by a qualified professional, and a compliance schedule.

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TABLE 9-1 (continued)

POTENTIAL ACTION-SPECIFIC ARARs
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ARARs	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARs
CWA - 40 CFR Part 404	This regulation outlines requirements for discharges of dredged or fill material. Under this requirement, no activity that impacts a wetland shall be permitted if a practicable alternative that has less impact on the wetland is available. If there is no other practicable alternative, impacts must be mitigated.	During the identification, screening, and evaluation of alternatives, the effects on wetlands must be evaluated.
National Environmental Policy Act (40 CFR 6)	This act sets forth the policy for carrying out the provisions of the Floodplain Management and the Protection of Wetlands Executive Orders.	The policies for management of floodplains and protection of wetlands should be considered during remedial alternative implementation.
Regulations on Disposal Site Determinations Under the Water Act (40 CFR 231)	These regulations apply to all existing, proposed, or potential disposal sites for discharges of dredged or fill material into U.S. waters, which include wetlands.	The dredged or fill material should not be discharged unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact on the wetlands.
CAA - NAAQS for Total Suspended Particulates (40 CFR 129.105,750)	This regulation specifies maximum primary and secondary 24-hour concentrations for particulate matter.	Fugitive dust emissions from site excavation activities will be maintained below 260 ug/m^3 (primary standard) by dust suppressants, if necessary.
Fish and Wildlife Coordination Act 16 USC661 et.seq.	This act requires that before undertaking any federal action that causes the impoundment, diversion, or other modification of any body of water the following agencies must be consulted: the appropriate state agency exercising jurisdiction over Wildlife Resources and the U.S. Fish and Wildlife Service.	Before excavating wetlands, the appropriate agencies will be consulted and their recommendations incorporated into an environmental assessment.
Protection of Archeological Resources (32 CFR Part 229,229.4; 43 CFR Parts 107, 171.1-171.5)	This regulation develops procedures for the protection of archeological resources.	If archeological resources are encountered during soil excavation, work will stop until the area has been reviewed by federal and state archeologists.
Army Corps of Engineers Permit Program Regulations (33 CFR 320-330)	These regulations prescribe the statutory authorities, and general and special policies and procedures applicable to the review of applications for Department of the Army (DA) permits for controlling certain activities in U.S. waters; this includes discharge of dredged or fill material.	Dredging and filling of the wetlands must be shown to cause minimal adverse impacts, a less environmentally damaging alternative does not exist, and the project is in the overall public interest.
Protection of Wetlands - Executive Order (EO 11990)	Under this regulation, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands.	The proposed dredging must include all practicable measures to minimize harm to the wetlands.

TABLE 9-1 (continued)

POTENTIAL ACTION-SPECIFIC ARARs
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ARARs	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARs
Floodplain Management - Executive Order (EO 11988)	This regulation requires federal agencies to minimize potential harm to or within floodplains and to avoid the long- and short-term adverse impacts associated with the occupancy and modification of floodplains.	The agency may need to design or modify its action in order to minimize adverse effects and incompatible development in the floodplains.
DOT Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171.1-171.5)	This regulation outlines procedures for the packaging, labelling, manifesting, and transporting of hazardous materials.	Contaminated materials will be packaged, manifested, and transported to a licensed off-site disposal facility in compliance with these regulations.
DEQE - Hazardous Waste Regulations, Phases I and II. (310 CMR 30.000, MGL Ch. ZIC)	This regulation provides a comprehensive program for the handling, storage, and recordkeeping at hazardous waste facilities. They supplement RCRA regulations.	Because these requirements supplement RCRA hazardous waste regulations, they must also be considered at the Sullivan's Ledge site.
Massachusetts Environmental Policy Act Regulations (30 CMR 10.00)	These regulations describe the process for filing an Environmental Impact Report (EIR).	DEQE has filed an Environmental Notification form with the MEPA unit. MEPA will continue to review major documents as specified in the MEPA certificate.
DEQE - Air Quality, Air Pollution (310 CMR 6.00 - 8.00)	This regulation outlines the standards and requirements for air pollution control in the State of Massachusetts; all provisions, procedures, and definitions are described.	Particulate matter emissions from site excavation activities must be maintained at an annual geometric mean of 75 $\mu g/m^3$ and a maximum 24-hour concentration of 40 mg/m^3 (primary standards).
DEQE - Wetlands Protection (310 CMR 10.00)	This regulation outlines the requirements necessary to work within 100 feet of a coastal or inland wetland. The Act sets forth a public review and decision-making process by which activities affecting waters of the state are to be regulated in order to contribute to their protection.	Any person who proposes to do work that will remove, fill, dredge, or alter a wetland must file a notice of intent. A public hearing will be held and the conservation commission will make a decision and may issue an order of conditions. Any person who files a notice of intent for wetland work must demonstrate that the area is not significant to the wetland or that the proposed work will contribute to the protection of the wetland.
MDWPC - Massachusetts Surface Water Discharge Permit Program (314 CMR 1.00-7.00)	This section outlines the requirements for obtaining an NPDES permit in Massachusetts.	Pollutant discharges to surface water must comply with NPDES permit requirements. Permit conditions and standards for different classes of water are specified.
NDWPC - Supplemental Requirements for Hazardous Waste Management Facilities (314 CMR 8.00)	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulations. These regulations are applicable to: a water treatment unit; a surface impoundment that treats influent wastewater; and a POTW that generates, accumulates, and treats hazardous waste.	All owners and operators of RCRA facilities shall comply with the management standards of 310 CMR 30.500, the technical standards of 310 CMR 30.600, the location standards of 310 CMR 30.700, the financial responsibility requirements of 310 CMR 30.900, and in the case of POTWs, the standards for generators in 310 CRM 30.300.

TABLE 9-1 (continued)

POTENTIAL ACTION-SPECIFIC ARARs
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ARARs	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARs
Waterways Regulations (314 CMR 9.00 MGL Ch. 91)	This regulation is promulgated to establish procedures, criteria, and standards for the water quality certification of dredging and dredged material disposal.	Applications for proposed dredging/fill work need to be submitted and approved before work commences. Three categories have been established for dredge or fill material based on the chemical constituents. Approved methods for dredging, handling, and disposal options for the three categories must be met.
DPH - Right to Know (105 CMR 670)	This regulation establishes the Massachusetts Substance List. The goal of this regulation is to protect public health by providing information concerning hazardous substances.	This regulation will be attained during the implementation of the remedial alternative by providing all workers with hazardous substance information.
DEQE - Disposal of Solid Waste by Sanitary Landfill (310 CMR 19.00)	This regulation establishes rules and requirements for solid waste disposal facilities.	Landfilling of screened, non-hazardous material will comply with this regulation.
DEQE - Right to Know (310 CMR 33.00)	This regulation establishes rules and requirements for the dissemination of information related to hazardous substances to the public.	This regulation will be attained during the implementation of the remedial alternative by providing the public with hazardous substance information.
DOI - Right to Know (441 CMR 21.00)	This regulation establishes requirements for worker "right to know."	This regulation will be attained during the implementation of the remedial alternative by providing all workers with hazardous substance information.

9.3.1 Source Control Alternatives

Figures 9-8 through 9-25 present the SC alternatives by medium. A description of each alternative is provided followed by the screening matrix and a conclusion as to whether the alternative will be eliminated or retained for detailed evaluation.

SC-1: NO-ACTION

Description. The no-action SC alternative is to restrict human and large terrestrial animal access to the site and to minimize human dermal contact with contaminated soils, pits, and sediments. A site perimeter fence with warning signs posted at appropriate intervals would impede potential human receptors. Warning signs would be posted in English and Portuguese due to the local population of Portuguese Americans. Long-term environmental monitoring results would be used to assess potential exposure risks over time, while institutional controls would place restrictions on future site development.

To determine contaminant migration and natural attenuation, environmental monitoring is an integral component of the no-action alternative. Monitoring would include surface soil sampling, surface water sampling, groundwater sampling (i.e., using the multilevel monitoring wells), and sediment sampling in the unnamed stream and Middle Marsh. Data collected as part of the monitoring program would be evaluated during the required five-year review, with recommendations on a potential remedial action presented at that time.

Institutional controls would be drafted, implemented, and enforced in cooperation with state and local governments. These controls would regulate and/or restrict future land development of the site.

Screening Evaluation. (See Figure 9-8.)

Conclusion. The no-action alternative will be carried into detailed analysis as required by the NCP. It will serve as the baseline for comparison of other SC alternatives.

SC-SOILS-2: CONTAINMENT

Description. Containment technologies confine the potential hazards and may reduce mobility, but do not reduce toxicity and volume of site contaminants. They primarily attempt to eliminate potential routes of exposure through isolation. Containment technologies require continual monitoring to determine whether remedial measures are performing successfully. Reevaluation of the containment option is required every five years.

FIGURE 9-8
SCREENING OF ALTERNATIVES
SOURCE CONTROL
SC-1 NO ACTION

Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• None	• Fencing has proven short-term reliability at restricting site access to humans and large terrestrial organisms (e.g., dogs).	• Minimal construction and capital costs - lowest of all alternatives.
	• Installation of fencing and posting of warning signs are simple construction tasks - local contractors and materials are available.	• Low long-term O&M costs for fence repair.
	• Monitoring of effectiveness easily performed - including sampling existing multilevel monitoring wells and downstream sediments.	
	• O&M easily performable - repair fencing, replace warning signs.	
	• Would not interfere with ability to perform future remedial action.	
Disadvantages	**Disadvantages**	**Disadvantages**
• No reduction in toxicity, mobility, or volume of contaminants.	• Unfavorable community response expected.	• Long-term costs for environmental monitoring.
• No short-term reduction of existing risks - would not attain target risk levels.	• Highly unlikely to obtain federal and state approval.	• High potential for costly future remedial action.
• Residual risk - potential for exposure via dermal contact with soils and sediments.	• Compliance with ARARs - would not conform with DEQE - Wetlands Protection (310 CMR 10.00) - wetland (i.e., Middle Marsh) would remain impacted due to PCBs.	• Long-term five year review costs.
• Protection achievement time would be decades - achievable through natural attenuation only.	• Not consistent with SARAs emphasis to prefer remedial actions that utilize permanent solutions and alternative treatment technologies.	
• Compliance with ARARs - would not comply with federal and state drinking water standards, water quality standards.		
• High potential for future remedial action.		

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The alternative would entail capping contaminated soils with a multi-layer cap to reduce soil erosion and minimize precipitation infiltration; and constructing subsurface barriers and grouting known fractures to reduce groundwater flow through the pits. Surface water controls would include drainage ditches and the installation of a concrete liner within the unnamed stream channel. The concrete liner would tie into the multi-layer cap to seal off present seeps to the unnamed stream. Obstructions (e.g., concrete pillars, telephone poles, and cobblestones) would have to be removed prior to capping. Routine groundwater and sediment sampling and analysis would constitute environmental monitoring; analyses would be evaluated in the five-year review.

Screening Evaluation. (See Figure 9-9.)

Conclusion. The containment alternative will be carried into detailed analysis. A multi-layer cap would prevent the erosion of contaminated soils, thereby significantly decreasing contaminant mobility. A multi-layer cap also has proven short- and long-term reliability (30 years).

SC-SOILS-3: IN-SITU VITRIFICATION (ISV)

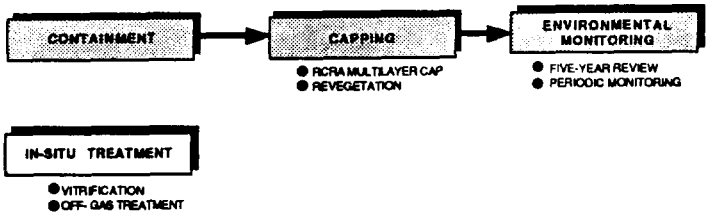
Description. Contaminated soils and debris within the soils would be turned into a glass-like material by surrounding the contaminated overburden zones with large electrodes (sunk 5 to 10 feet down to bedrock) and applying an electric current. The current melts soil and rocks and breaks down the organic contaminants by pyrolysis. A hood over the processing area captures the combustion gases, which are drawn into an off-gas treatment system. The melt later cools into a solid glass matrix, encapsulating inorganic materials within the vitrified mass.

The vitrified mass would be covered with fill material because of a slow cooling process and subsidence inherent after treatment. Leaching tests (e.g., EP Toxicity, TCLP) would be performed on a periodic basis to evaluate the reduction in mobility of inorganics.

Screening Evaluation. (See Figure 9-10.)

Conclusion. ISV will be carried into detailed analysis for treatment of contaminated soils. It would permanently destroy PCBs, PAHs, and VOCs without the handling requirements associated with an excavation/incineration scenario, and would significantly reduce the mobility of lead. ISV is an innovative

FIGURE 9-9
SCREENING OF NON-REMOVAL ALTERNATIVES
SOURCE CONTROL - SOILS
SC-SOILS-2 CONTAINMENT



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Reduces exposure risk to dermal contact with on-site soils and risk due to the migration of soils.	• Standard construction procedures - equipment and materials are readily available.	• Less capital costs than treatment alternatives.
• Multi-layer cap reduces the mobility of contaminants - prevents erosion.	• Proven short-term reliability.	• Construction and short-term capital and operating costs are well defined.
• Long-term reliability - designed for useful period of 30 to 50 years.	• O&M functions are established post-closure care procedures - adherence to a post-closure plan would minimize problems.	• Low O&M costs - cap repair.
• Protection achievement time of approximately one to two years.	• Federal, state, and community approval likely.	
• Minimizes groundwater migration by preventing the infiltration of precipitation.	• Minimal time frame for implementation.	
• Chemical specific ARARs can be attained during cap construction (NAQS 40 CFR 40; DEQE - 310 CMR 6.00-8.00).	• Will attain location-specific ARARs by preventing further migration of contaminated site soils (CWA 40 CFR 230; DEQE 310 CMR 10.00).	
Disadvantages	**Disadvantages**	**Disadvantages**
• No reduction in toxicity or volume of contaminants.	• Not consistent with SARAs emphasis to prefer remedial actions that utilize permanent solutions and alternative treatment technologies.	• Long-term expenditures (e.g., maintenance, environmental monitoring).
• Short-term risk to workers during placement of cap.	• Northeast corner of the site lies in the 100 year floodplain of the unnamed stream.	• Long-term five year review costs.
• Potential for increase in magnitude of residual risk and in future exposure risk due to liner failure.		• Potential for future remedial action costs.
• Potential for future exposure to contaminated soils.		

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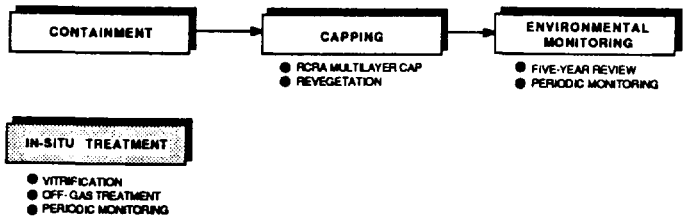
FIGURE 9-10
SCREENING OF NON-REMOVAL ALTERNATIVES
SOURCE CONTROL - SOILS
SC-SOILS-3 IN-SITU VITRIFICATION *



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Permanent reduction in toxicity and mobility - organics would be combusted during processing.	• Vendor is available to provide turnkey services - would supply equipment, engineering details, and specialists to perform O&M functions.	• Total treatment costs are lower than other permanent destruction technologies (e.g., incineration).
• Glass matrix would significantly reduce the mobility of lead.	• Federal and state approval likely.	• No long-term O&M or environmental monitoring costs.
• Long-term reliability - testing has estimated vitrified soil is durable for thousands of years.	• Excavation and waste handling would be eliminated.	• No five year review costs.
• Compliance with ARARS - would meet chemical specific ARARs (NAQs 40 CFR 40; DEQE 310 CMR 6.00-8.00).	• Consistent with SARAs emphasis on permanent treatment and innovative treatment technologies, if applicable.	
• Minimal short-term risk to workers - waste handling unnecessary, off-gases would be collected with a hood.	• Complies with location-specific ARARS (CWA-40 CFR 230; DEQE-310 CMR 10.00).	
Disadvantages	**Disadvantages**	**Disadvantages**
• Minimum of one year for vitrified material to completely cool off-gas.	• Glass matrix would complicate additional remedial measures, if required.	• Above average mobilization costs.
• Residual glass matrix may limit future site development.	• Off-gas treatment required.	• Additional costs for off-gas treatment.
	• The overburden aquifer would increase energy requirements.	
	• Technology not extensively treated for PCB-contaminated soils.	
	• Mixed community response expected.	

* INNOVATIVE TECHNOLOGY

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technology, and is consistent with SARA's emphasis on permanent treatment.

SC-SOILS-4: OFF-SITE RCRA LANDFILL

This alternative was eliminated during the compatibility evaluation and will no longer be considered.

SC-SOILS-5: ON-SITE INCINERATION

Description. Contaminated soils (i.e., maximum PCB concentration zones) would be excavated and incinerated on-site in a mobile incinerator. Mobile incinerators are of two general designs: rotary kiln and infrared. The two systems are similar in destruction and removal efficiency (DRE) (i.e., both can achieve greater than 99.99 percent DRE) and cost. Therefore, no distinction will be made between the two designs.

Treatment of soils would result in the permanent destruction of organics; however, the treated soil generated could potentially be hazardous. This soil would be analyzed and disposed of appropriately. On-site disposal is anticipated, but high lead or other metal concentrations may warrant solidification or disposal in a RCRA facility.

Air pollution control equipment would be necessary to comply with federal and state air quality standards. This equipment is standard on mobile incinerators. Both the infrared and rotary kiln systems use a packed tower to control hydrochloric acid emissions, followed by a wet venturi scrubber to control particulates.

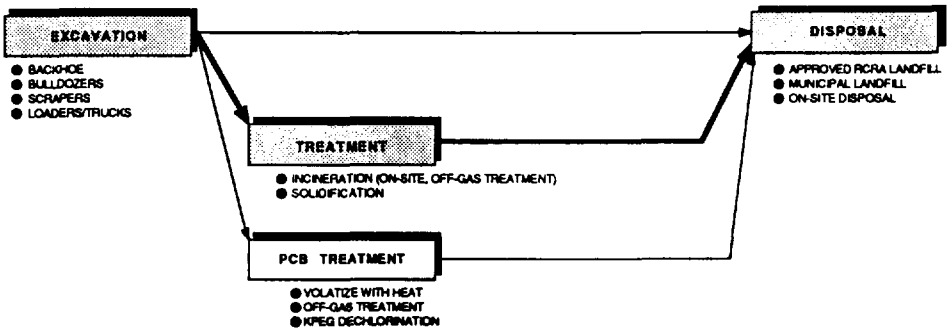
Screening Evaluation. (See Figure 9-11.)

Conclusion. On-site incineration of contaminated soils will be carried into detailed analysis as a proven technology. Treatment would result in the permanent reduction of existing risks. Several vendors have mobile units available for turnkey operations and are equipped with air pollution control equipment; the units would comply with air quality standards and other ARARs.

SC-SOILS-6: OFF-SITE INCINERATION

Description. PCB-contaminated soils would be excavated, transported to a licensed facility, and incinerated. These facilities are required to perform annual testing to determine compliance with limits placed on hydrochloric acid emissions, particulate emissions, and DRE. Semiannual inspections are required to confirm compliance with other aspects of these regulations. Whenever a facility is being considered as a

FIGURE 9-11
SCREENING OF REMOVAL ALTERNATIVES
SOURCE CONTROL - SOILS
SC-SOILS-5 ON-SITE INCINERATION



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Permanent reduction of existing risks - organic destruction removal efficiency of 99.9%.	• Well-established technology.	• No five year review costs.
• Permanent reduction of toxicity, mobility, and volume.	• Vendors are available to assemble and operate a mobile unit.	• No long-term O&M costs.
• Protection achievement time less than two years.	• Compliance with ARARs - would meet action-specific and location-specific ARARs.	• No long-term environmental monitoring costs if treated soil is non-hazardous.
• Excellent long-term reliability - low potential for replacement alternative.	• Excellent short-term reliability.	• Minimum potential for future remedial action costs.
• Compliance with ARARS - would meet chemical-specific air quality regulations (NAQS 40 CFR 40; DEQE 310 CMR 6.0-8.0).	• No long-term environmental monitoring responsibilities.	
	• Would not interfere with ability to perform a future remedial action.	
	• Consistent with SARAs emphasis on permanent treatment.	
Disadvantages	**Disadvantages**	**Disadvantages**
• Short-term risk to workers during processing.	• Community response uncertain.	• Short-term costs are highest of all on-site treatment technologies.
• Lead may remain as a residual.	• Commonwealth of Massachusetts generally opposes on-site incineration.	• Costs are not well defined - vendors optimistically quote anywhere from $250 to $500 per ton.
		• Additional costs related to off-gas treatment and disposal of treated soil.

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disposal option, it is necessary to verify that the treatment unit is in compliance with all RCRA storage, treatment, and disposal requirements. Commercial facilities that may be available are as follows:

- Chemical Waste Management
  SCA Incinerator
  Chicago, Illinois

- Chemical Waste
  TWI Incinerator
  Sauget, Illinois

- Stablex
  Columbia, South Carolina

- ENSCO
  Eldorado, Arkansas

- Marine Shale Processors
  Louisiana

Generally, wastes must be packed in fiber or plastic drums (e.g., 15-, 30-, or 55-gallon) before shipment to the commercial facility. The ENSCO facility, however, can accept 20-cy roll-offs. Utilization of this facility would eliminate drumming costs. All five facilities have limited storage space and feed capacity, which would inhibit the processing of large volumes of wastes in a short period of time. Moreover, capacity limitations may become more severe as the land disposal restrictions and the landfill ban of November 1986 come into effect.

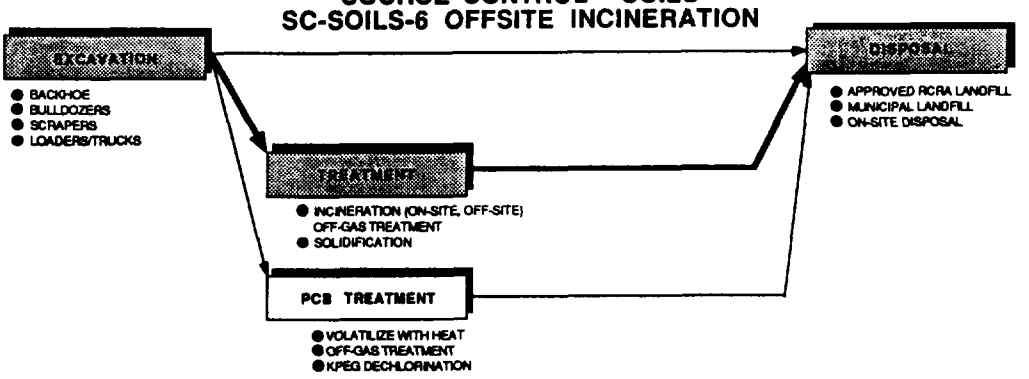
Screening Evaluation. (See Figure 9-12.)

Conclusion. Off-site incineration will be eliminated from further analysis. Because the estimated quantities of contaminated soils are significant (i.e., over 10,000 cy), a mobile incinerator is more economical than off-site incineration; on-site incineration provides the same results (i.e., permanent reduction in toxicity, mobility, or volume) at half the total cost. Furthermore, costs for off-site incineration are expected to increase due to the limited number of available facilities and the increased waste volumes anticipated as a result of the 1986 land disposal restrictions.

SC-SOILS-7: VOC REMOVAL/PCB DECHLORINATION

Description. Contaminated soils would be excavated and treated for VOC removal and PCB dechlorination in a two-step process: (1) heating the soils in a batch reactor to drive off VOCs and

FIGURE 9-12
SCREENING OF REMOVAL ALTERNATIVES
SOURCE CONTROL - SOILS
SC-SOILS-6 OFFSITE INCINERATION



Effectiveness

Advantages

- Permanent reduction of existing risks - organic destruction removal efficiency of greater than 99.99%.
- Permanent reduction of toxicity, mobility, and volume.
- Excellent long-term reliability - low potential for replacement alternative.
- Would meet chemical-specific air quality regulations (NAWS 40 CFR 40; DEQE 310 CMR 6.00-8.00).

Disadvantages

- Short-term risk to workers during processing.
- Protection achievement time may be a few years due to the large volume of soils and the limited capacities of permitted facilities (i.e., can accept approximately 100 tons per day.

Implementability

Advantages

- Compliance with ARARS - would meet action-specific and location-specific ARARs.
- Community acceptance likely.
- Technical requirements (i.e., development and design) are minimal. Remedial design responsibilities will consist of excavation and transportation.
- No long-term environmental monitoring responsibilities.
- Would not interfere with ability to perform a future remedial action.
- Consistent with SARAs emphasis on permanent treatment.

Disadvantages

- Only five facilities are permitted in the country to receive PCB wastes > 50 ppm.
- Long distance transportation would be necessary.
- Permitted facilities are currently operating to capacity.
- Federal and state approval unlikely.

Cost

Advantages

- Development and design costs are minimal.
- No five year review costs.
- No long-term environmental monitoring costs.
- Minimal potential for future remedial action costs.

Disadvantages

- Highest cost of all treatment technologies - even higher than on-site incineration.
- Significant incineration cost increases can be expected in the future - current costs are $1400 per ton.

steam; and (2) removing chlorine atoms from PCB molecules through a reaction with an alkali polyethylene glycol (APEG). Either potassium or sodium can be used as the alkali salt. Excavated soils would be placed in a batch reactor. Other solvents (e.g., dimethyl sulfoxide) are sometimes added to the process to increase the reaction rate and the transport rate of PCBs from sediment into reagent. A steam jacket around the reactor would then heat the soil to 150° C. This drives off VOCs and soil moisture; soil moisture inhibits dechlorination of the PCBs. The off-gas would be sent to an afterburner or other treatment device to comply with Massachusetts ARARs. The dechlorination reaction would then proceed after mixing the contaminated soil with the APEG reagent and is completed in one to four hours.

After reaction completion, the slurry is drained and the excess reagent recovered for recycle. The soil is then washed several times using a countercurrent extractor to remove reagent still present in the soil. Treated soil could then be disposed of on-site.

Screening Evaluation. (See Figure 9-13.)

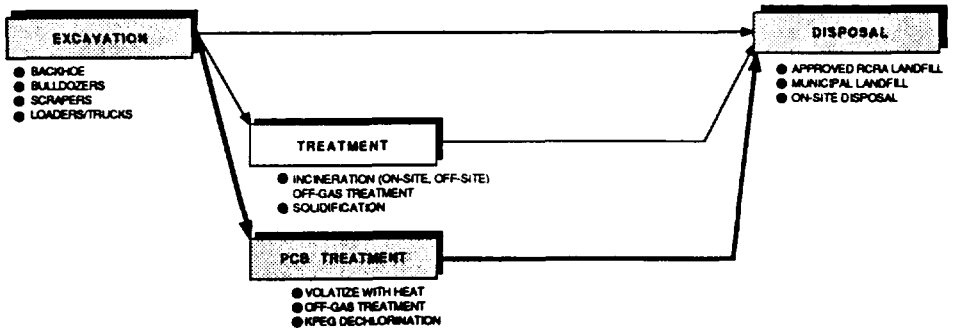
Conclusion. SC-Soils-7 will be eliminated from further analysis. This process would not effectively remove soil PAHs with boiling points higher than 150°C (e.g., BAP). Extensive pilot-testing would have to be performed to evaluate its success. This testing would raise treatment costs above incineration and may not achieve PCB target levels for 10^{-6} present risk level.

SC-SOILS-8: SOLIDIFICATION

Description. Contaminated soils would be excavated, screened, solidified, and disposed of on-site. Solidification of the soils would involve mixing a setting agent (e.g., Portland cement, fly ash, kiln dust, or lime) with the soil to form a hard, durable product of low solubility in which contaminants (e.g., PCBs, VOCs, PAHs, or lead) would be chemically bound and/or entrapped within the solidified mass. The treated end product would be either a solid, monolithic formation or a dry, granular material.

The end product, preferably monolithic rather than granular, would be backfilled on top of the existing ground surface, and an overlying cap would be installed to keep water from ponding on or around the solidified material. A monolith would be more resistant to water erosion than an equivalent mass of granular material because of less surface area. Combining this alternative with SC-Soils-2 (i.e., containment) would be a logical approach.

FIGURE 9-13
SCREENING OF REMOVAL ALTERNATIVES
SOURCE CONTROL - SOILS
SC-SOILS-7
VOC THERMAL AERATION*/PCB DECHLORINATION*



Effectiveness

Advantages

- Permanent reduction in toxicity, mobility, and volume of PCBs/VOCs.
- Residual risk due to biphenyl ether would be minimal - it is not acutely toxic does not bioaccumulate, and is not mutagenic.
- Reliable in the long-term - PCBs are destroyed, VOCs removed.

Disadvantages

- May not achieve risk levels - preliminary studies show residual PCBs of 5 ppm.
- Protection achievement time of approximately 2-3 years.
- Process would not remove SVOCs, PAHs, or lead.
- Moisture (>4%) inhibits process.
- Compliance with ARARs - would have to prove APEG can achieve performance standards required by 40 CFR 761.70 for PCB destruction.

Implementability

Advantages

- Would not interfere with ability to perform future remedial action.
- Consistent with SARAs emphasis on innovative permanent treatment technologies.

Disadvantages

- Limited availability of equipment and specialists - technology is in pilot testing stage of development.
- Short-term reliability must be demonstrated through pilot testing.

Cost

Advantages

- No five year review costs.
- No long-term O&M or environmental monitoring costs.

Disadvantages

- Turnkey operation may not be available - may have to make capital investment for equipment.
- Additional cost related to off-gas treatment.

* INNOVATIVE TECHNOLOGY

In-situ solidification was considered, but was determined unfeasible due to the presence of large debris (e.g., timbers, blocks, and concrete rubble), which would interfere with the mixing process.

Screening Evaluation. (See Figure 9-14.)

Conclusion. Solidification of contaminated soils will be retained for further analysis because it is a treatment technology that is readily available, implementable, and less costly than other treatment technologies. Solidification is effective at immobilizing PCBs and PAHs and will significantly reduce the mobility of these contaminants.

SC-PITS-1: NO-ACTION

The no-action alternative for pits contains the same components as for soils and sediments; therefore, it has been combined with the other two no-action alternatives (i.e., SC-Soils-1 and SC-Sed-1) to create a single no-action alternative (i.e., SC-1).

SC-PITS-2: CONTAINMENT

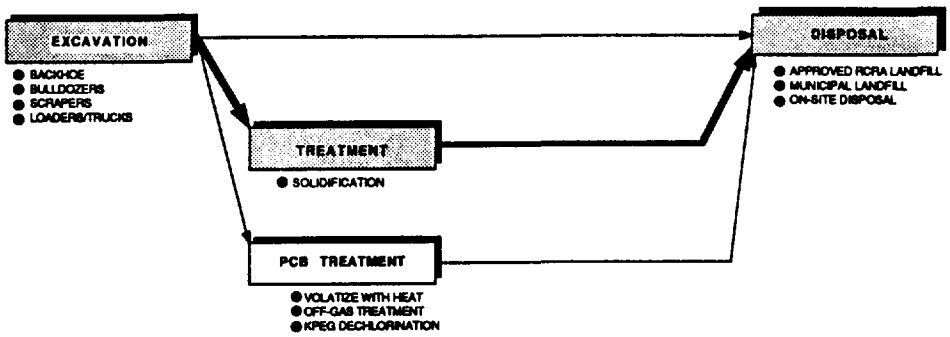
Description. The primary function of the containment alternative would be to eliminate all routes of water influx to the pits. These routes consist of precipitation infiltration through overburden soils, overburden groundwater flow, and bedrock groundwater flow. The containment alternative, therefore, consists of three components: capping, hydraulic barriers, and fracture grouting.

Capping would include installation of a multi-layer cap. The cap would serve to prevent precipitation infiltration into the pits. The cap would include a clay layer and a runoff collection system to draw water off the cap and divert flow off-site.

Hydraulic barriers (i.e., slurry walls and/or sheet piling) would be trenched or driven through the overburden soils (depths ranging from 5 to 10 feet) and set into the bedrock. These barriers are intended to restrict overburden groundwater flow into the pits.

Fracture grouting would be used to seal bedrock fractures that would allow groundwater flow into the pits. However, the large number of fractures in the pits would make sealing all fractures highly doubtful because of technical difficulties in locating all fractures in a highly-fractured medium.

FIGURE 9-14
SCREENING OF REMOVAL ALTERNATIVES
SOURCE CONTROL - SOILS
SC-SOILS-8 SOLIDIFICATION/CONTAINMENT



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Would significantly reduce existing risks. • Would reduce the mobility of PCBs, PAHs and lead. • Protection achievement time - 2 years. • Will comply with Chemical-specific Areas (NAQS-40 CFR 40; DEQE-310 CMR 6.00-8.00). • In conjunction with capping, significant reduction in PCB and PAH risks. • Consistent with future site development (i.e., parking lot, soccer field).	• Fairly established technology - several vendors are readily available to initiate on-site treatment. • Good short-term reliability - vendors perform pilot testing to achieve TCLP criteria. • Federal and State approval likely • Will comply with location-specific wetlands ARARS - (CWA-40 CFR 230; DEQE-310 CMR 10.00)	• Turnkey operation available - less costly than purchasing equipment. • Less costly than other treatment alternatives. • Minimal long-term O&M costs.
Disadvantages	**Disadvantages**	**Disadvantages**
• Short-term risk to workers during excavation. • Residual risk remains on-site - potential for residual risk to increase due to decomposition of solidified mass. • Would not reduce toxicity or volume. • Would have to prove compliance with action-specific TSCA Regulations (40 CFR 761.70) for PCB destruction.	• Solidified mass would complicate future remedial action. • Inconsistent with SARA's preference for permanent remedy.	• Five year review costs. • Environmental monitoring costs.

Screening Evaluation. (See Figure 9-15.)

Conclusion. The combination of the three components (i.e., cap, barriers, grouting) would attempt to form a watertight seal. Since it is technically infeasible to locate all deep fractures, this alternative is not implementable. If a number of fractures remained ungrouted, the pits would still leak. Therefore, this alternative will be eliminated from further evaluation.

SC-PITS-3: IN-SITU BIOLOGICAL

Description. This alternative involves enhancing the ability of indigenous microorganisms to biodegrade the waste constituents of the quarry pits. However, high concentrations of solvents in the quarry pits would preclude using in-situ biodegradation techniques. Solvents such as trichloroethylene (TCE) present in concentrations greater than 10 ppm are believed to be toxic to microbes.

The technology involves installing wells within each pit for the purpose of injecting nutrients to feed the native microbes and to monitor the process over time. Nutrients typically include nitrogen, phosphorus, oxygen (added in the form of hydrogen peroxide), and trace minerals. Monitoring entails the expertise of microbiologists to chart microbial growth, and chemists to track the successful reduction of contaminants.

Groundwater pumping would create a cone of depression in the water table to maintain inflow to the pits. Nutrients would be added to the decontaminated groundwater, which would then be recharged into the aquifer hydraulically upgradient to carry these nutrients to the microbes.

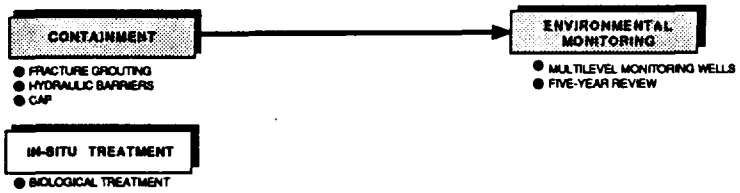
Screening Evaluation. (See Figure 9-16.)

Conclusion. The known presence of chlorinated solvents (i.e., TCE and methylene chloride) in the groundwater precludes the use of in-situ biological restoration. This alternative will be eliminated from further analysis because it is not believed to be effective for the wastes deposited within the quarry pits. In addition, implementing and monitoring this alternative would be difficult and would require highly skilled technicians and scientists.

SC-PITS-4: EXCAVATION/OFF-SITE RCRA LANDFILL

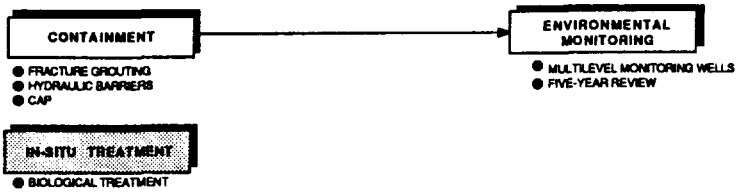
Description. Excavation of the quarry pits and off-site disposal of wastes and debris are the major components of this alternative. Excavation of the pits would be similar to a mining operation and would require heavy equipment and pumps. Cranes would be necessary to lift large objects (e.g., automobiles and timbers) out of the pits. Other conventional

FIGURE 9-15
SCREENING OF NON-REMOVAL ALTERNATIVES
SOURCE CONTROL - PITS
SC-PITS-2 CONTAINMENT



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Short term reduction of existing risks. • Short term reliability in reducing mobility of contaminants	• None.	• Less costly than excavation alternatives.
Disadvantages	**Disadvantages**	**Disadvantages**
• Poor long-term reliability. • Does not reduce magnitude of residual risk. • High potential for alternate remedial action. • Hydraulic barriers will allow leakage due to fractured nature of bedrock. • Hydraulic barriers and grouting would likely need replacement. • Ungrouted fractures would continue to allow leakage from the pits. • Would not reduce the toxicity and volume of contaminants.	• Difficulty expected in installing slurry walls, sheet pile cutains due to large debris in overburden soils. • Difficult to perform O&M. • Administrative feasibility expected to be poor. • Likelihood of community opposition. • Likelihood of federal and state opposition. • Deep bedrock fractures may not be accessible for grouting purposes. • Not consistent with SARAs preference for permanent treatment.	• Development and construction costs expected to be high due to nature or fill material. • Five year review costs. • High potential for future remedial action costs. • O&M costs expected to be high. • Environmental monitoring costs.

FIGURE 9-16
SCREENING OF NON-REMOVAL ALTERNATIVES
SOURCE CONTROL - PITS
SC-PITS-3 IN-SITU BIOLOGICAL *



Effectiveness

Advantages

- Permanent reduction in toxicity, mobility, and volume of biodegradable wastes.
- Magnitude of risk would slowly decrease over time, as biodegradation proceeds.
- No significant risks to workers or the community are expected.
- If successful, would comply with chemical-specific ARARs (SDWA 40 CFR 141.11-141.16; DEQE 314 CMR 6.00) for groundwater in pits.

Disadvantages

- Protection achievement time is unknown.
- Microorganisms would have difficulty in degrading particular waste constituents (e.g., PCBs).
- Contaminant levels are believed to be toxic to microorganisms (e.g., TCE > 10 ppm).
- High potential need for replacement.
- Unknown effectiveness.

Implementability

Advantages

- Vendors are available to install equipment and monitor effectiveness of technology.
- Consistent with SARAs preference for permanent treatment.
- Does not require excavation of pits (in-situ treatment).

Disadvantages

- Poor short-term reliability - microorganisms need time to acclimate to the contaminants.
- Poor long-term reliability - microorganisms have not been shown to breakdown PCBs and TCE in-situ.
- Newly-developed technology requires extensive testing.
- Community and regulatory response uncertain.
- Difficult to implement and control - consists of manual addition of nutrients and microbes.

Cost

Advantages

- Total costs would be less than excavation and treatment alternatives.

Disadvantages

- Continuing operation and maintenance costs for several years until degradation is complete.
- High potential for future remedial action costs.
- Environmental monitoring costs.

* INNOVATIVE TECHNOLOGY

equipment (e.g., backhoes, loaders, bulldozers, and dump trucks) would also be used.

Pumps would be necessary to keep the water level below working zones during excavation. Pumped water is anticipated to be contaminated; it could either be treated in an on-site mobile wastewater treatment unit or pumped into tank trucks for transport to an off-site licensed facility. Due to the large volume of water anticipated, the on-site mobile unit is recommended.

A mobile laboratory would be used to distinguish between contaminated and uncontaminated fill and debris. Uncontaminated fill and debris would be replaced in the pits after excavation. Transfer vehicles of 20- to 30-cy capacity would transport the contaminated materials to a permitted RCRA Subtitle C facility. If sample analyses indicate PCB contamination greater than 50 ppm, only facilities possessing a TSCA PCB permit would be utilized. The three facilities closest to the Sullivan's Ledge site are:

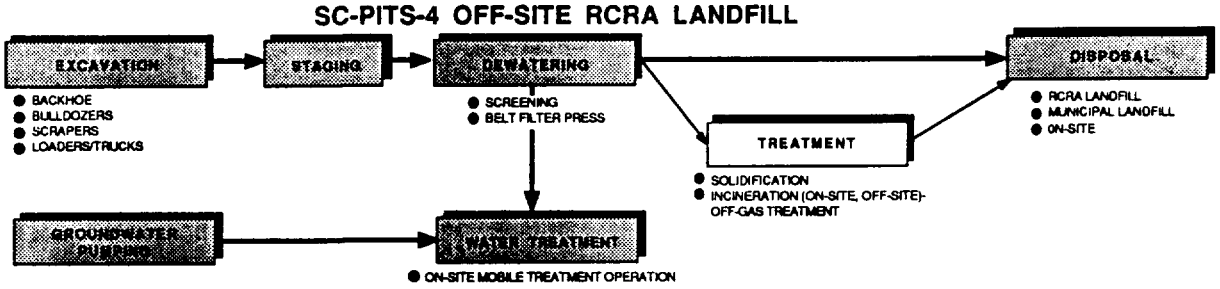
- CECOS International - Niagara Falls, New York
- CECOS International - Williamsburg, Ohio
- SCA Chemical Services - Model City, New York

Automobiles and other metal objects excavated from the pits could go to a salvage dealer or a municipal landfill after decontamination. Decontamination may include a high-pressure water rinse or gritblasting. Large transformer casings would probably require gritblasting.

Screening Evaluation. (See Figure 9-17.)

Conclusion. This alternative will be eliminated from further analysis. Landfilling of hazardous wastes is inconsistent with SARA's emphasis on permanent treatment and reduction of toxicity, mobility, and volume of wastes. Due to the immense volume of wastes, it is also unlikely that enough space in RCRA-permitted disposal facilities is even available. The distance to the nearest RCRA facility would make transportation very costly. In addition, excavation of the uncharacterized waste may pose a significant health risk to the nearby community, therefore making community opposition likely.

FIGURE 9-17
SCREENING OF REMOVAL ALTERNATIVES
SOURCE CONTROL - PITS
SC-PITS-4 OFF-SITE RCRA LANDFILL



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Would eliminate existing risk from site.	• Secure landfill has good short-term reliability.	• No long-term O&M costs after remedial action is complete.
• Secure landfill would reduce mobility of wastes.		• No five year review costs.
• Protection achievement time of 2 to 3 years.		
Disadvantages	**Disadvantages**	**Disadvantages**
• Compliance with ARARS - would not comply with land disposal restrictions - wastes are likely to contain PCBs in excess of 500 ppm.	• Excavation of the pits would require mining techniques, heavy equipment, large pumps, and manpower - availability of such is limited for hazardous waste work.	• Excavation costs, transportation costs and tipping fees would be high considering the volume of the pits.
• Risk not reduced in magnitude - only transferred from one location to another.	• Development, design, and logistics of such a large operation are complex.	• Cost of future liability if the RCRA landfill were to fail.
• Long-term liability for landfilled wastes.	• Federal and state approval is unlikely.	• Additional costs related to treatment of contaminated groundwater.
• No permanent and significant reduction in toxicity or volume.	• Travel distance to nearest RCRA facility (i.e., 500 miles to Model City, NY).	
• Risk to workers and community during excavation - mishap is possible since content of pits is unknown.	• Unlikely that any landfill has available capacity.	
	• Mobile wastewater treatment operation necessary to treat contaminated groundwater pumped from pits during excavation.	
	• Inconsistent with SARA's emphasis on permanent treatment.	

SC-PITS-5: EXCAVATION/SOLIDIFICATION/OFF-SITE RCRA LANDFILL

Description. Complete excavation of the quarry pits, on-site solidification of contaminated fill material, and off-site disposal of solidified material and debris comprise this alternative. Excavation and groundwater pumping/treatment would be performed as in SC-Pits-4.

Large debris would be separated from fill soils prior to solidification. Contaminated fill would be solidified as in SC-Soils-8. Uncontaminated fill, as determined by mobile laboratory analysis, would be stockpiled on-site and replaced in pits after excavation. Metal objects (e.g., automobiles) could be sent to a salvage dealer or a municipal landfill after decontamination, while solidified materials and contaminated debris would have to go to a RCRA facility as in SC-Pits-4.

Screening Evaluation. (See Figure 9-18.)

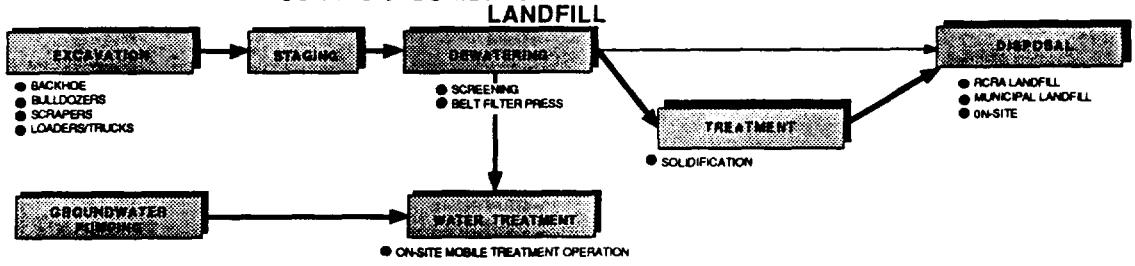
Conclusion. This alternative will be eliminated from further analysis for the same reasons as SC-Pits-4 (i.e., Off-site RCRA Landfill). Landfilling of wastes does not comply with land disposal restrictions nor is it likely that landfill space is available due to the anticipated volume of wastes. Furthermore, pit contents consist of blocks, automobiles, timber, tires, and other bulky objects that cannot be solidified. Primarily, this alternative will be eliminated based on major limitations on its implementability.

SC-PITS-6: EXCAVATION/ON-SITE INCINERATION

Description. Excavation of the pits would proceed as in SC-Pits-4. Contaminated fill material would be incinerated on-site in a mobile unit (see description of SC-Soils-5). Large objects (e.g., timbers, concrete rubble, granite blocks, and junk automobiles) could not be accommodated by the incinerator and may have to be crushed. All metal scraps remaining after incineration could go to a metals salvage facility for reclamation or to a municipal landfill for disposal.

A mobile laboratory would be used to minimize incineration costs by distinguishing between uncontaminated and contaminated materials; uncontaminated materials would not be incinerated. Uncontaminated materials and non-hazardous incineration ash would be stockpiled for later use as fill material for the excavated pits.

FIGURE 9-18
SCREENING OF REMOVAL ALTERNATIVES
SOURCE CONTROL - PITS
SC-PITS-5 SOLIDIFICATION/OFF-SITE RCRA LANDFILL



Effectiveness

Advantages

- Solidified matrix would reduce the mobility of inorganics, PCBs, and some organics - secure landfill would further reduce mobility.
- Permanent reduction of existing risk - no residual risk would remain on-site.

Disadvantages

- Not effective at immobilizing VOCs and some other organics.
- No reduction in toxicity or volume.
- Risk to workers and community during excavation - mishap is possible since contents of pits is unknown.
- Long-term liability for landfilled wastes - residual risk inherent in the solidified matrix.
- Would have to prove compliance with action-specific TSCA regulations (40 CFR 761.70) for PCB distribution.

Implementability

Advantages

- Vendors, equipment are available for contract.
- Good short-term reliability - vendors perform pilot testing to achieve TCLP criteria.

Disadvantages

- Complexity of development, design, and logistical details.
- Different zones of contamination are likely to be uncovered - each would require pilot testing to determine appropriate solidifying agents.
- Fill believed to consist of large, bulky objects (e.g., blocks, timbers, cars, tires) which are not solidifiable.
- Federal, state, local agency approval unlikely.
- Community response uncertain.
- Unlikely that any landfill has available capacity.
- Mobile wastewater treatment operation would be necessary to treat contaminated groundwater pumped from pits during excavation.
- Inconsistent with SARA's preference for permanent treatment.

Cost

Advantages

- No long-term O&M costs after remedial action is complete.
- No five year review costs.

Disadvantages

- Costs for excavation, solidification, and landfilling would be prohibitive considering the volume of the pits.
- Cost of future liability if the RCRA landfill were to fail.
- Additional costs related to groundwater treatment.

Screening Evaluation. (See Figure 9-19.)

Conclusion. On-site incineration will be eliminated from further analysis. The pits are believed to contain a heterogeneous mixture of rubble, automobiles, tires, and other bulky objects which are not amenable to incineration. Test burns would have to be performed continually due to the heterogeneity of the fill, therefore making the process inefficient, costly, and time-consuming. Due to logistical constraints, there are significant disadvantages associated with implementing this alternative.

In addition, excavation would be difficult and may pose a serious health risk to the public. Unsightly piles of excavated debris, coupled with public apprehension toward incinerators, makes community acceptance uncertain.

SC-PITS-7: EXCAVATION/OFF-SITE INCINERATION

Description. Off-site incineration would be conducted and is subject to the same constraints as described in SC-Soils-6, including permit requirements and capacity limitations. SC-Soils-6 lists the five facilities currently holding permits for hazardous waste incineration that could be used to incinerate excavated quarry pit wastes.

During excavation, materials would be characterized as contaminated or uncontaminated. Contaminated materials would be excavated and transported on a continual basis, while uncontaminated materials would be stockpiled for use as future fill material for the fully excavated pits. Bulk wastes would also be stockpiled while awaiting transport to a permitted facility as may be necessary due to the limited acceptance capacities (i.e., 100 to 200 cy per day) of the overloaded facilities. However, stockpiling of contaminated fill would have to be off-site due to space limitations resulting from the excavated pits.

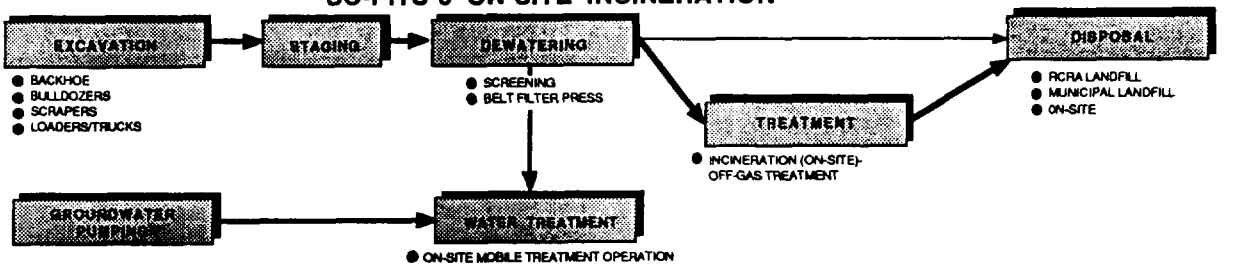
Metal objects (e.g., junk automobiles and transfer casings) would be decontaminated on-site with gritblasting or hydroblasting and sent to either a salvage facility or a municipal landfill.

Screening Evaluation. (See Figure 9-20.)

Conclusion. Off-site incineration will be eliminated from further analysis for the following reasons:

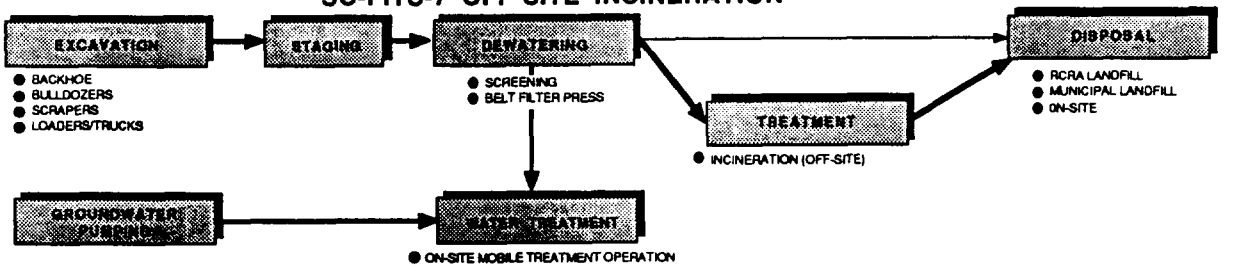
- the pit materials are not amenable to incineration
- excessive excavation, pre-processing, and incineration costs

FIGURE 9-19
SCREENING OF REMOVAL ALTERNATIVES
SOURCE CONTROL - PITS
SC-PITS-6 ON-SITE INCINERATION



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Permanent reduction of existing risk. • Would comply with TSCA ARAR, 40 CFR 761.70. • Permanent reduction of toxicity, mobility, and volume - no organic residuals. • Compliance with ARARs - meets chemical-specific air quality ARARs (NAQS-40 CFR 40; DEQE-310 CMR 6.00-8.00). • Compliance with RCRA and TSCA action-specific ARARs. • Excellent long-term reliability - low potential for replacement alternative.	• Vendors are available to assemble and operate a mobile unit. • Would meet action-specific and location-specific ARARs. • Excellent short-term reliability. • Would not interfere with ability to perform a future remedial action. • Approval from federal agencies likely. • No long-term environmental monitoring responsibilities. • Consistent with SARA's preference for permanent treatment.	• No five year review costs. • No long-term O&M costs after remedial action is complete. • Minimal potential for future remedial action costs.
Disadvantages	**Disadvantages**	**Disadvantages**
• Risk to workers and community during excavation - mishap is possible since content of pits is unknown.	• Excavation of the pits is similar to mining operation - required equipment and manpower are limited in the area. • Complexity of development, design, and logistical details. • Large debris (e.g., timbers, cars) are difficult to incinerate - process not effective for these wastes. • Non-combustible wastes (e.g., cars, blocks, rubble) would have to be decontaminated and disposed on-site. • Ongoing trial burns required - the nonhomogeneity of the fill necessitates frequent trial burns to adjust process variables. • Community response uncertain. • Dewatering of wastes necessary. • Mobile wastewater treatment operation would be necessary to treat contaminated groundwater pumped from pits and effluent from dewatering operations.	• At least one order of magnitude (possible 2 or 3) more costly than in-situ treatment or containment - largely due to excavating the pits and to the total costs of incinerating such a large volume of waste. • Costs are not well defined - vendors quote anywhere from $250 to $500 per ton. • Additional costs related to groundwater treatment, disposal of residuals, off-gas treatment.

FIGURE 9-20
SCREENING OF REMOVAL ALTERNATIVES
SOURCE CONTROL - PITS
SC-PITS-7 OFF-SITE INCINERATION



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Permanent reduction of risk. • Would comply with TSCA ARAR 40 CFR 761.70. • Permanent reduction of toxicity mobility, and volume - no remaining residuals, no potential for future exposure. • Meets chemical-specific air quality ARARS (NAQS-40 CFR 40; DEQE - 310 CMR 6.00 - 8.00)	• Compliance with ARARS - would meet action-specific and location - specific ARARs. • No long-term environmental monitoring responsibilities. • Excellent short-term reliability. • Would not interfere with ability to perform a future remedial action. • Consistent with SARA's preference for permanent treatment.	• No five year review costs. • Minimal potential for future remedial action costs. • No long-term environmental monitoring cost.
Disadvantages	**Disadvantages**	**Disadvantages**
• Protection achievement time of 30 to 50 years - permitted facilities can accept only a limited volume of waste per day (i.e., approximately 100 tons per day). • Would not be effective for a large volume of the fill material (e.g., large blocks, cars). • Concrete rubble would have to be crushed and timbers sectioned to facilitate loading into the incinerator. • Risk to workers and community during excavation - mishap is possible since content of pits is unknown.	• Community response uncertain. • Excavation of the pits is equivalent to a mining operation - required manpower and equipment are limited. • Complexity of development, design, and logistical details. • Non-combustible wastes (e.g., blocks, cars) would have to be decontaminated and hauled off-site. • Federal and state acceptance unlikely - protection achievement time is not favorable. • Only five facilities are permitted in the country to receive PCB wastes and are currently operating to capacity. • Long distance transportation would be necessary. • Dewatering, on-site drumming, and storage would be required. • Mobile wastewater treatment operation would be necessary to treat contaminated groundwater pumped from pits and effluent from dewatering operations.	• Long-term O&M costs to monitor drummed wastes stored on-site. • Highest cost of all pit alternatives - requires excavation, transportation, and costs for off-site incineration. • Significant incineration cost increases can be expected in the future - current costs are $1,400 per ton.

- unfavorable protection achievement time
- likely federal and state opposition to off-site storage of contaminated materials

The non-combustible and heterogeneous nature of fill materials (i.e., mixture of concrete rubble, automobiles, timbers, tires, transformer casing, glass) would restrict the effectiveness of incineration. The high cost of incineration (i.e., $1,400 per ton) as well as pre-processing costs (e.g., excavation, separation, concrete crushing, sawing timbers) would make this alternative economically unattractive; costs are estimated to be in the billions of dollars. The estimated protection achievement time, assuming off-site facilities would accept 200 tons per day, is 30 to 50 years.

SC-SED-1: NO-ACTION

The sediment no-action alternative contains the same components as the no-action alternatives, SC-Soils-1 and SC-Pits-1, and has been combined with them to form a single no-action alternative (i.e., SC-1).

SC-SED-2: CONTAINMENT

Description. Sediment containment would involve placing an earthen cover (i.e., either clay or soil/sand) over contaminated zones in Middle Marsh and dredging the three water hazards located east of the marsh and portions of the unnamed stream. Dredged sediment would be used as initial fill material during installation of a RCRA cap (see SC-Soils-2 and SC-Pits-2) or hauled to a RCRA landfill for disposal, depending on compatibility with preferred SC alternatives.

Capping Middle Marsh would involve the following steps:

- channel the unnamed stream around Middle Marsh
- drain standing water from the marsh
- harvest trees and grub brush
- wash sediments from tree roots with a water spray
- shred tree roots, small trees, and brush
- fill and grade Middle Marsh
- lay sod over the cap to stabilize the fill and reclaim the area as an expansion to the golf course

Continual environmental monitoring would be necessary to identify the migration of capped sediments. Monitoring is

particularly important because the area is known to flood; cycles of flooding and subsidence may uncover contaminated sediments.

Water from decontamination operations may have to be collected and treated. It could be pumped into tanker trucks and transported to an off-site treatment facility (e.g., CECOS of Bristol, Connecticut), or treated on-site, depending on compatibility with the MM alternative.

Dredging the water hazards and the undisturbed, contaminated sections of the unnamed streambed should be performed after capping Middle Marsh. This would ensure removal of both existing contaminated sediment and sediments that are anticipated to migrate to the water hazards during excavation.

Screening Evaluation. (See Figure 9-21.)

Conclusion. The sediment containment alternative will be eliminated from further analysis. A cap would not effectively contain the contaminated sediments because Middle Marsh is subject to periodic flooding. Cycles of flooding and subsidence would cause erosion of the cover, eventually exposing contaminants. In addition, this alternative would have destroyed significant wetland areas, which is inconsistent with EPA's directive on wetlands protection.

SC-SED-3: IN-SITU BIOLOGICAL

Description. The objective of in-situ biological treatment is to reduce PCB concentrations to below target levels without destroying Middle Marsh. The technology involves adding nutrients (e.g., nitrogen, oxygen, phosphorus, and trace minerals) to the sediments to promote a community of microorganisms.

Short-term environmental monitoring would be necessary to document the reduction in PCB concentrations. After reduction of PCBs to below target levels, monitoring would cease.

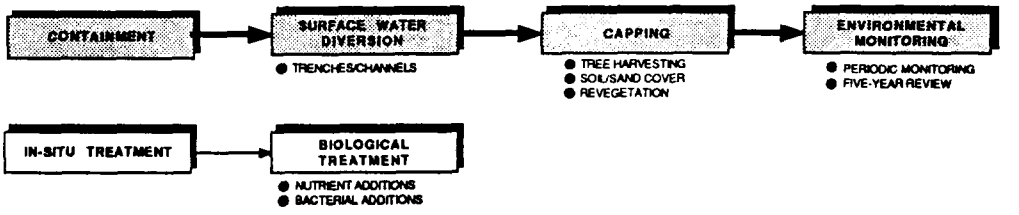
Screening Evaluation. (See Figure 9-22.)

Conclusion. In-situ biological treatment will be eliminated from further analysis. Biodegradation of PCBs is still unproven. This alternative would be difficult to implement and control. In addition, its effectiveness is questionable for PCBs and extensive testing would be required prior to implementation.

SC-SED-4: SEDIMENT REMOVAL/ON-SITE DISPOSAL

Description. This alternative would reduce exposure risks in the unnamed stream, Middle Marsh, and the three water hazards

FIGURE 9-21
SCREENING OF NON-REMOVAL ALTERNATIVES
SOURCE CONTROL - SEDIMENTS
SC-SED-2 CONTAINMENT



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Would reduce existing risks to below target risk levels.	• Easily constructed - contractors are readily available.	• Development and construction costs are lower than treatment alternatives.
• Protection achievement time of a few months.	• Good short-term reliability.	
• Cover would reduce mobility of PCBs.	• Additional remedial actions could be performed without hindrance.	
	• Effectiveness determined by down-stream sediment sampling.	
Disadvantages	**Disadvantages**	**Disadvantages**
• No reduction in toxicity or volume of PCB sediments.	• Compliance with ARARS - not consistent with Executive Order 11988 - the Middle Marsh lies in the floodplain of the unnamed stream.	• Long-term O&M and environmental monitoring costs.
• Minimal risk to workers during tree harvesting and capping.	• Not consistent with Executive Order 11990 - capping would completely destroy the Middle Marsh wetland.	• Five year review costs.
• Increased residual risk magnitude and future exposure risk potential likely due to cover erosion or failure.	• Federal and state opposition likely.	• Potential for future remedial action costs.
• Continual flooding of the Middle Marsh raises doubts over the long-term reliability.	• Community opposition uncertain.	
• High potential for replacement of cap and future remedial action.	• Inconsistent with SARA's preference for permanent treatment.	

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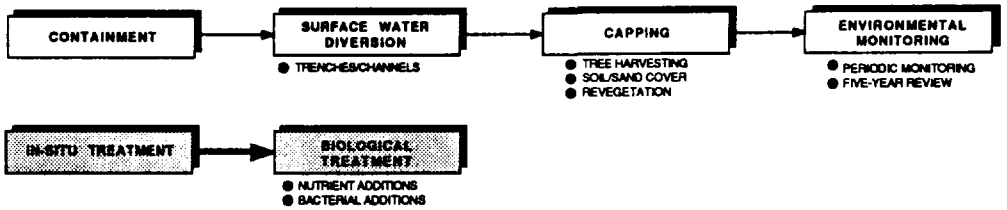
FIGURE 9-22
SCREENING OF NON-REMOVAL ALTERNATIVES
SOURCE CONTROL - SEDIMENTS
SC-SED-3 IN-SITU BIOLOGICAL*



Effectiveness

Advantages

- If successful, permanent reduction of toxicity, mobility, and volume of PCBs with no residual risk.
- Magnitude or risk would be reduced without destroying wetland.
- Permanent solution - if effective no future exposure potential.
- No significant risks to workers or the community during treatment - PCBs remain undisturbed.

Disadvantages

- Innovative technology - requires extensive testing.
- Unknown reliability - in-situ biodegradation of PCBs had not been documented as a treatment technique.
- Unknown time to achieve protection.
- Likelihood of alternative remedial action.

Implementability

Advantages

- Consistent with Executive Order 11990 - protection of wetlands.
- Vendor available to provide services.
- Consistent with SARA's preference for permanent treatment and innovative technologies.

Disadvantages

- Poor short-term reliability - micro-organisms need time (few weeks) to acclimate and time to biodegrade wastes to below target levels.
- Frequent sampling required during active biodegradation (i.e., summer months) until target levels are attained.
- Difficult to implement and control - consists of the manual addition of nutrients and beneficial bacteria.
- Favorable community and regulatory responses uncertain.

Cost

Advantages

- Development, operating, and other capital and short-term costs are less than capping or excavation/disposal options.
- No long-term O&M or environmental monitoring costs.

Disadvantages

- Short-term O&M and environmental monitoring costs until bio-remediation is complete.
- High potential for future remedial actions costs.

* INNOVATIVE TECHNOLOGY

through physical removal of contaminated sediments. Components of this alternative include the following:

- temporarily reroute the unnamed stream around Middle Marsh
- drain standing water from the marsh
- harvest trees and grub brush
- wash sediments from tree roots with a water spray
- collect decontamination water and transport off-site for treatment or treat on-site, depending on compatibility with the preferred MM alternative
- excavate Middle Marsh sediments
- dredge the existing unnamed streambed and the three water hazards where the sediment exceeds the PCB SQC
- stockpile contaminated sediments
- redirect the unnamed stream back through Middle Marsh
- revegetate Middle Marsh

Stockpiled sediments would have to be covered to prevent erosion. Eventually they could be used as initial fill material during the installation of a multi-layered cap (see SC-Soils-2 and SC-PITS-2), provided that soils or pit containment is the preferred alternative.

The decontaminated Middle Marsh could either be restored as a wetland or reclaimed for expansion of the golf course.

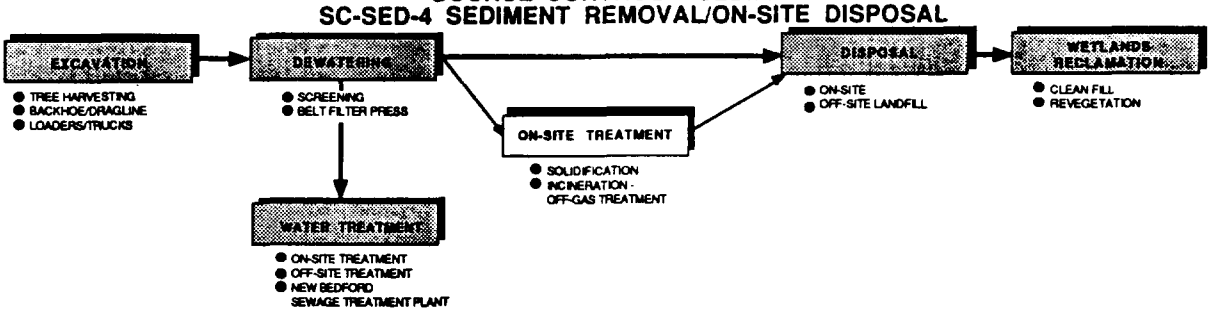
Screening Evaluation. (See Figure 9-23.)

Conclusion. This alternative will be eliminated from further analysis in favor of SC-Sed-5 (i.e., solidification). Unstabilized sediments are subject to erosion, and hence contaminant mobility; stablized sediments are more resistant to erosion thereby reducing contaminant mobility. In addition, the dewatered sediments without a solidifying agent, would have poor bearing capacity and would not be suitable for fill material beneath the cap. Dewatered, unsolidified sediments could result in slumping of the cap and excessive cap maintenance.

SC-SED-5: SOLIDIFICATION/ON-SITE DISPOSAL

Description. This alternative contains the same components as SC-Sed-4, with the addition of a solidification step to reduce the mobility of PCBs. Solidification would apply admixtures

FIGURE 9-23
SCREENING OF REMOVAL ALTERNATIVES
SOURCE CONTROL - SEDIMENTS
SC-SED-4 SEDIMENT REMOVAL/ON-SITE DISPOSAL



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Would reduce existing environmental risk from site. • Multilayer cap would restrict mobility of contaminants. • Shortest protection achievement time amongst sediment alternatives - anticipated to take less than one year.	• Excavation and transport equipment readily available - local contractors could perform work.	• Well defined development and construction costs. • Less costly than other treatment technologies.
Disadvantages	**Disadvantages**	**Disadvantages**
• No permanent or significant reduction of toxicity or volume. • Minimal risk to workers during tree harvesting and excavation. • Ongoing liability for sediments since PCBs would remain intact. • Likelihood for future remedial action.	• Collection and treatment requirements for wastewater resulting from dewatering step. • Wetland restoration required. • Inconsistent with SARAs preference for permanent treatment. • Community opposition possible due to disruption of golf-course activities. • Unconsolidated sediments not suitable for fill material beneath cap.	• Potential for future liability costs if the cap were to fail. • Five year review costs. • Long-term environmental monitoring and O&M costs for cap. • Additional costs related to dewatering.

(e.g., Portland cement, fly ash, kiln dust, and lime) to achieve immobilization of PCBs within the solidified matrix. The final product should be monolithic rather than granular to minimize surface area, thus reducing water erosion. The monoliths would be buried on-site and covered with a multi-layer cap, provided this is compatible with other preferred alternatives.

Screening Evaluation. (See Figure 9-24.)

Conclusion. Solidification/on-site disposal will be retained for detailed analysis as a sediment treatment alternative. Solidification of contaminated sediments would significantly reduce PCB mobility and, together with a multi-layer cap (i.e., SC-Soils-2 and SC-Pits-2), would effectively minimize the existing risk to human health and biota. Solidification of the marsh sediments is feasible because the PCB concentrations are low and any subsequent leaching is anticipated to be insignificant. With the combination of solidification of sediments and capping, there is minimal potential for future remediation.

SC-SED-6: ON-SITE INCINERATION

Description. Contaminated sediments would be excavated/dredged as in SC-Sed-4 (i.e., Removal/On-site Disposal); and incinerated with an on-site facility unit as in SC-Soils-5 (i.e., on-site incineration). Tree roots would be shredded and incinerated along with contaminated sediments.

Excavated/dredged sediments would have to be dewatered to increase thermal efficiency; a belt filter press would be used to dewater to 50-percent solids (by weight). Effluent water would be pumped into a tanker truck and transported to a hazardous waste treatment facility (e.g., CECOS of Bristol, Connecticut) or treated on-site depending on compatibility with the preferred MM alternative.

After incineration is complete, Middle Marsh would be restored as a wetland or graded and sodded for expansion of the golf course.

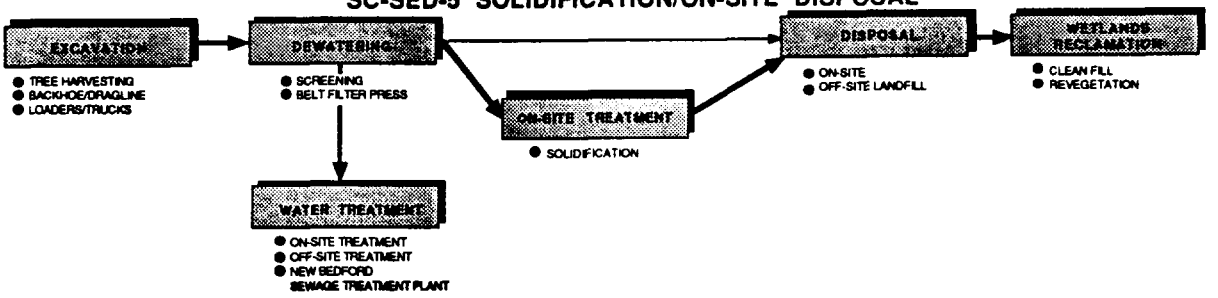
Screening Evaluation. (See Figure 9-25.)

Conclusion. On-site incineration will be retained for detailed analysis. It is a proven technology for PCBs and is consistent with SARA's preference for permanent treatment.

9.3.2 Management of Migration Alternatives

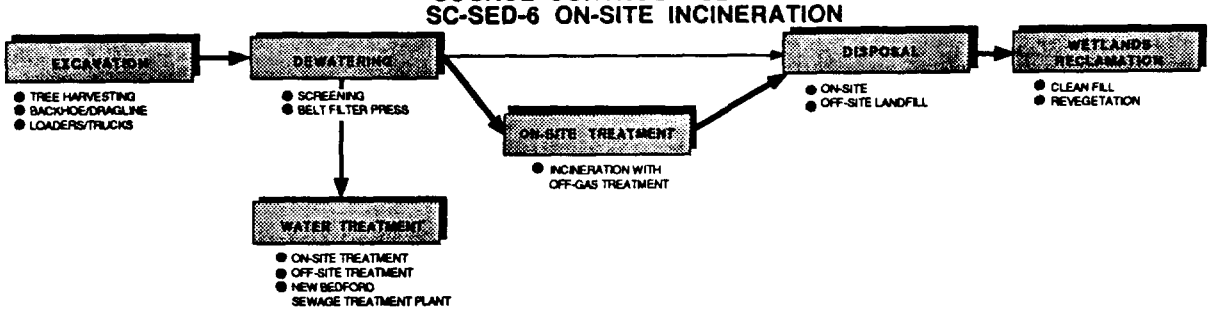
Figures 9-26 through 9-30 present the MM alternatives. As with the SC alternatives, each alternative is first described. The alternative is then screened by using the evaluation matrix, and

FIGURE 9-24
SCREENING OF REMOVAL ALTERNATIVES
SOURCE CONTROL - SEDIMENTS
SC-SED-5 SOLIDIFICATION/ON-SITE DISPOSAL



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Would reduce existing risk to human health and biota. • Solidified matrix would significantly reduce mobility of PCBs; multilayer cap will further reduce PCB mobility. • Minimal protection achievement time - estimated at less than one year. • Double protection of solidification and a multilayer cap minimizes the likelihood of a replacement alternative.	• Vendors and equipment are readily available for contract. • On-site cap would be constructed in RCRA compliance. • Good short-term reliability - vendors would perform pilot testing to achieve TCLP criteria. • Compatible with the soils containment alternative. • Federal and state support likely. • Consistent with SARAs preference for treatment.	• Less costly than incineration. • No five year review of environmental monitoring costs.
Disadvantages	**Disadvantages**	**Disadvantages**
• No reduction in toxicity or volume of PCBs. • Long-term liability for landfilled sediments - residual risk inherent in the solidified matrix. • Would have to prove compliance with action-specific TSCA Regulation (40 CFR 761.70) for PCB treatment.	• Collection and treatment required for wastewater resulting from dewatering step. • Likelihood of community and municipal government opposition due to short-term disruptions on the golf course. • Wetland restoration required.	• Long-term O&M costs for cover. • Additional costs related to dewatering operation.

FIGURE 9-25
SCREENING OF REMOVAL ALTERNATIVES
SOURCE CONTROL - SEDIMENTS
SC-SED-6 ON-SITE INCINERATION



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Permanent reduction of existing risk PCB destruction removal efficiency of 99.9999%. • Permanent reduction of toxicity, mobility, and volume - remaining residuals (i.e., ash) are anticipated to be non-hazardous. • Protection achievement time less than one year. • Would comply with TSCA and RCRA PCB treatment requirements. • Excellent long-term reliability - low potential for replacement alternative.	• Excellent short-term reliability • Technical requirements (i.e., development and design) are minimal - turnkey operation available. • No long-term environmental monitoring responsibilities. • Would not interfere with ability to perform a future remedial action. • Specialists available to perform test burn. • Consistent with SARA's emphasis on permanent treatment.	• Development and design costs are minimal. • No long-term O&M or environmental monitoring costs. • No five year review costs. • Minimal potential for future remedial action costs.
Disadvantages	**Disadvantages**	**Disadvantages**
• PCB redistribution would need to be minimized during excavation activities.	• Compliance with ARARs - not consistent with ARARs protecting wetlands (e.g., Executive Order 11990). • Treatment of dewatering effluent required. • Restoration of wetland required. • Community and regulatory response uncertain.	• Highest total remediation cost among sediment alternatives. • Turnkey costs are not well defined - vendor quotes range from $250 to $500 per ton. • Additional costs related to off-gas treatment and disposal of treated sediment.

a conclusion is made as to whether the alternative will be eliminated or retained for detailed evaluation.

MM-1: NO-ACTION

Description. The no-action alternative will serve as a baseline risk assessment to which the other alternatives are compared. The alternative would include the use of fences and warning signs to protect the public, and initiation of an environmental monitoring program to monitor the extent of contamination migration.

Institutional controls would be implemented and enforced in cooperation with state and local governments. These controls would regulate future groundwater use.

Screening Evaluation. (See Figure 9-26.)

Conclusion. This alternative will be retained for detailed analysis.

MM-2: CONTAINMENT

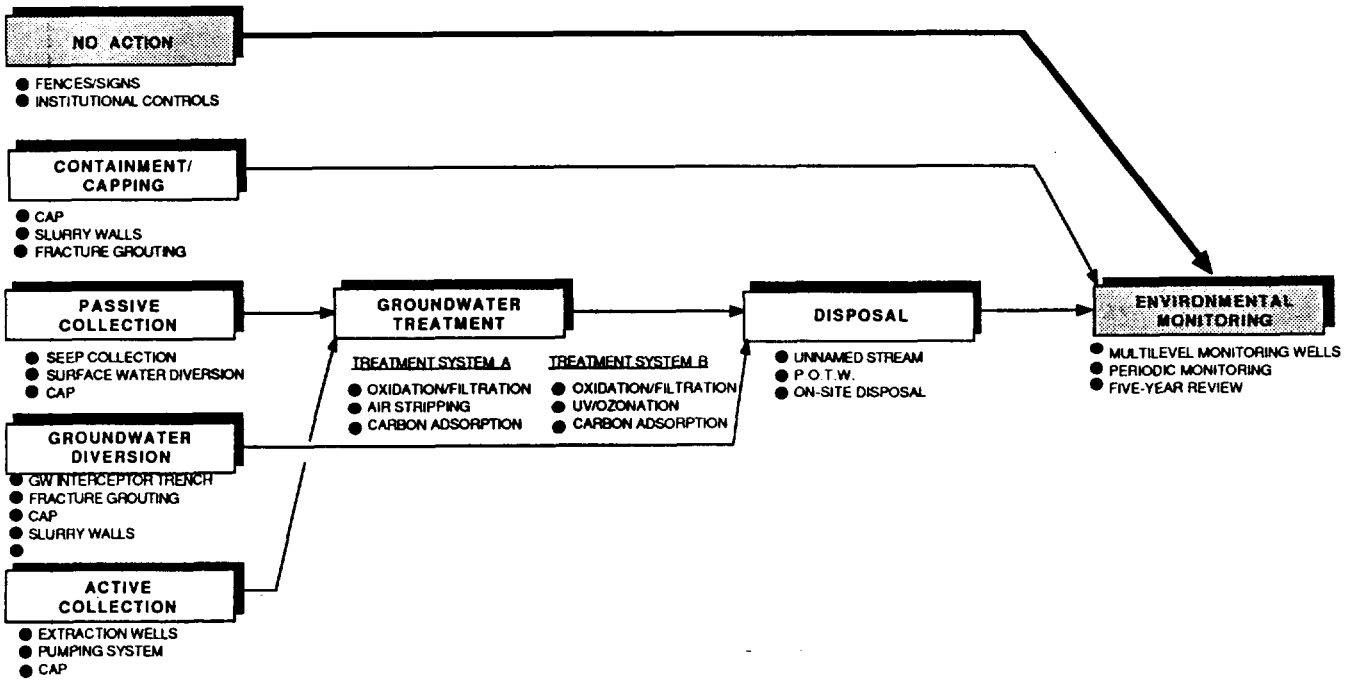
This alternative was eliminated from further consideration during the compatibility evaluation.

MM-3: PASSIVE COLLECTION

Description. The passive collection alternative would collect and treat groundwater discharge along the unnamed stream and the northern edge of Hathaway Road, where it borders the Whaling City Golf Course. To reduce the volume of contaminated water to be treated, two engineering measures would be implemented: (1) the site would be capped with a low-permeability material to reduce surface water infiltration; and (2) the unnamed stream along the eastern portion of the site would be diverted via pipeline or concrete channel into the golf course.

The contaminated water that is collected would be treated to remove dissolved metals, suspended solids, VOCs, and SVOCs. Two options are proposed for water treatment. The first treatment combination consists of a oxidation/filtration process for iron and suspended solids removal; an air stripper for VOC removal; and a carbon adsorption unit for polishing and SVOC removal. The second treatment system is similar to the first, except that an ultraviolet (UV)/ozonation unit would be used in place of an air stripper for removal of organic compounds. Treated effluent would be discharged into the unnamed stream. This alternative would also require the use of an environmental monitoring program.

FIGURE 9-26
SCREENING OF ALTERNATIVES
MANAGEMENT OF MIGRATION
MM-1 NO ACTION



Effectiveness	Implementability	Cost
Advantages	Advantages	Advantages
• None.	• Easy to construct technologies.	• Minimal capital, and operation and maintenance costs.
Disadvantages	Disadvantages	Disadvantages
• Does not reduce existing risk.	• Likelihood of unfavorable community and agency response.	• High potential for future remedial action costs.
• Does not comply with chemical-specific ARARs.	• Does not comply with location-specific ARARs.	• Long-term costs for environment monitoring.
• High potential for future remedial actions.	• Inconsistent with SARA's preference for permanent treatment.	• Costs for 5-year review.
• Does not prevent future exposure to chemicals.		
• Does not permanently and significantly reduce toxicity, mobility, or volume.		

Screening Evaluation. (See Figure 9-27.)

Conclusion. This alternative would provide a reduction of the existing risks associated with groundwater discharge to the unnamed stream, but would not prevent future exposures to contaminated groundwater. It would likely receive a favorable community response because of reduced risks associated with groundwater seeps. This alternative will be retained for detailed analysis.

MM-4: GROUNDWATER DIVERSION

Description. The groundwater diversion alternative would make use of a groundwater interceptor trench to divert the overburden and shallow bedrock groundwater. The interceptor trench would be constructed into the bedrock in an area upgradient of the quarry pits, and would be designed to allow drainage of the intercepted groundwater directly into the golf course area. Chemical analysis of groundwater from the upgradient well (i.e., ECJ-3) indicates that the groundwater in that area is relatively free of organic contaminants. This suggests that the diverted groundwater would not need to be treated prior to discharge. To reduce infiltration of surface water into the quarry pits, a cap constructed with low-permeable materials would be utilized. As with all other alternatives, this alternative would employ the use of a groundwater monitoring program.

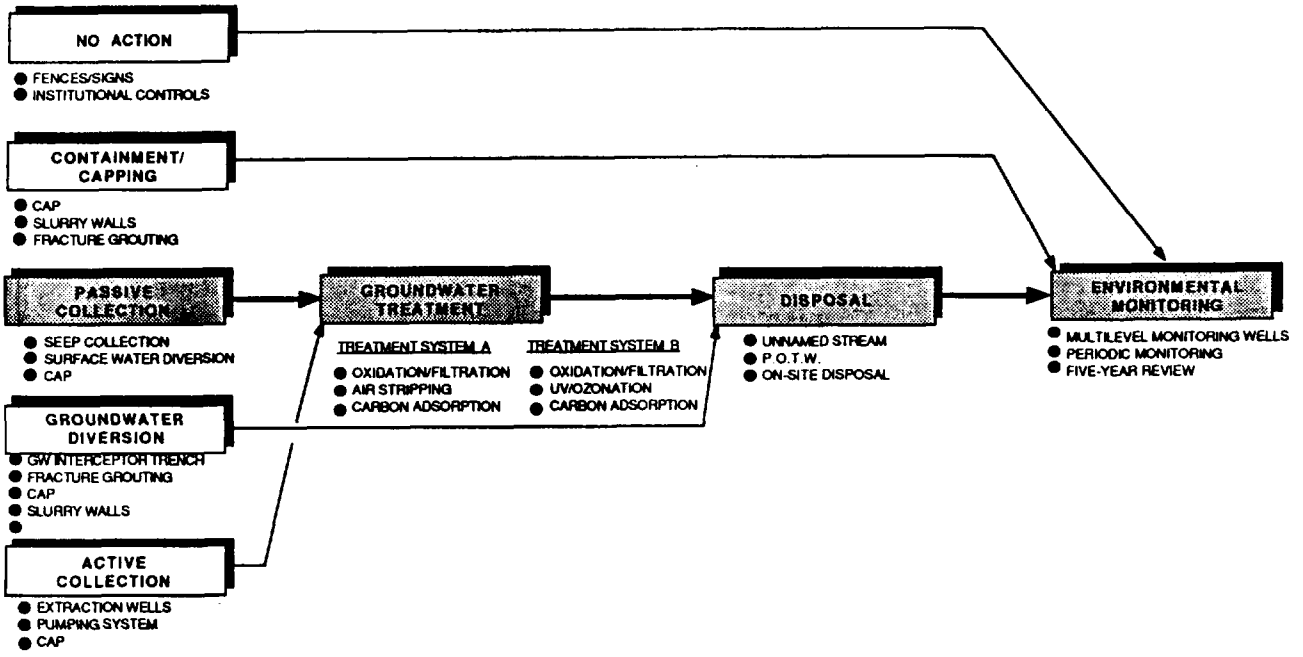
Screening Evaluation. (See Figure 9-28.)

Conclusion. The goal of the groundwater interceptor trench is to lower the water table within the quarry pits, and thus reduce groundwater seepage to the unnamed stream. Based on the information provided in Section 4.2, it is doubtful that this trench would be effective in controlling the groundwater recharge to the pits. The information provided by monitoring wells ECJ-1, ECJ-2, and ECJ-3 indicate that groundwater enters the pits with depth and flows upward in the pits through the overburden and out the seeps. This trench would not be able to collect this water unless the trench is at least 150 feet deep. This is technically infeasible. This alternative will be screened out due to the lack of effectiveness and difficulties in implementation.

MM-5: ACTIVE COLLECTION OF SHALLOW GROUNDWATER

Description. The active collection alternative would employ a series of groundwater extraction wells located along the northern and eastern boundaries of the site. The goal of this alternative is to treat the bedrock groundwater on-site (i.e., less than 150 feet), thereby providing a measure of source

FIGURE 9-27
SCREENING OF ALTERNATIVES
MANAGEMENT OF MIGRATION
MM-3 PASSIVE COLLECTION



Effectiveness

Advantages

- Provides reduction of existing risks associated with seeps discharging to unnamed stream.
- Treatment with air stripping and carbon adsorption (MM-3A) reduces mobility and volume of contaminants.
- Treatment with UV/Ozonation and carbon adsorption (MM-3B) reduces toxicity, mobility and volume of contaminants.
- Multilayer cap provides protection against contact with contaminated surface soil.

Disadvantages

- Does not prevent exposure to residuals.
- Potential need for replacement of treatment units exist.
- Time until full protection is achieved is unknown, therefore, long-term reliability of alternative is in question.
- Does not comply with all chemical-specific ARARs.

Implementability

Advantages

- Good availability of necessary equipment and specialists.
- High technical feasibility and short-term reliability.
- Likelihood of favorable community response.
- Ease of undertaking additional remedial actions, if necessary.
- Compliances with most location-specific ARARs.
- Consistent with SARAs preference for treatment.

Disadvantages

- None

Cost

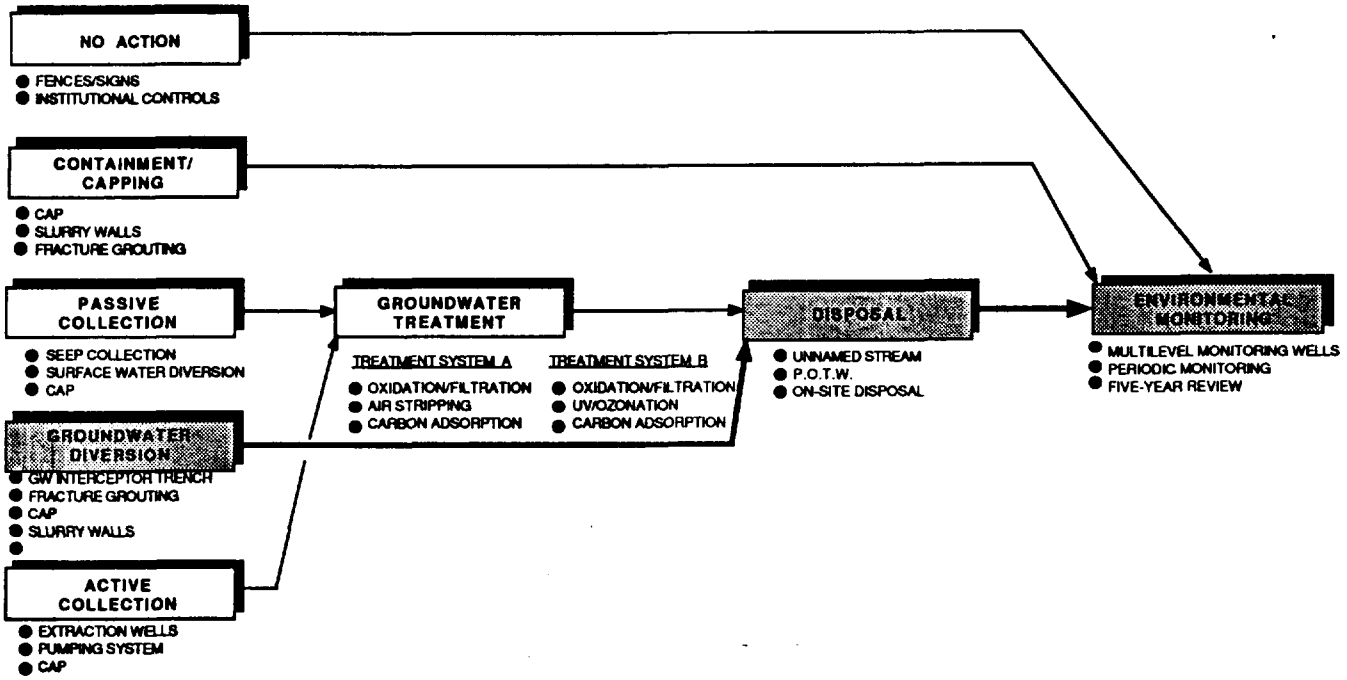
Advantages

- Lower operating and maintenance costs than pump and treat alternative.

Disadvantages

- Treatment operating and maintenance costs will be incurred for an unknown period of time since the time until full protection is achieved is unknown.
- High potential for future remedial action costs since the passive collection system is designed only to collect groundwater discharging to surface water system.
- Costs associated with operation and maintenance of environmental monitoring systems.

FIGURE 9-28
SCREENING OF ALTERNATIVES
MANAGEMENT OF MIGRATION
MM-4 GROUNDWATER DIVERSION



Effectiveness

Advantages

- If successful, would provide reduction of existing risks associated with seeps discharging to unnamed stream.

Disadvantages

- Does not prevent future exposure to residuals.
- Does not provide permanent or significant reduction in toxicity or volume of contaminants since no treatment units are involved.
- Does not comply with all chemical-specific ARARs.
- High potential need for replacement of groundwater interceptor trench.
- Questionable effectiveness in reducing groundwater flow to pits.

Implementability

Advantages

- Good availability of necessary equipment and specialists.

Disadvantages

- Uncertainties associated with the groundwater flow systems within the fractured bedrock.
- Poor technical feasibility and short-term reliability for depths in excess of 50 feet.
- Difficult to implement.
- Would require fracture grouting of bedrock fractures adjacent to the quarry pit.
- Federal, state approval unlikely.

Cost

Advantages

- Negligible operating and maintenance costs associated with groundwater interceptor trench.

Disadvantages

- Large capital investment associated with development and construction of groundwater interceptor trench.
- Good potential for future remedial action costs since alternative provides only a partial solution.
- Costs associated with operation and maintenance of environmental monitoring systems.

control. In addition, an active extraction system located near the periphery of the pits would minimize the threat of future off-site migration of contaminated groundwater and would treat the source of groundwater contamination (pits) to the maximum extent feasible. The system would be designed to eliminate the groundwater discharge to the unnamed stream. Water extracted by the system would be treated by one of the treatment options discussed for Alternative MM-3. This alternative would also include the use of a cap of low-permeable material to reduce surface water infiltration. Reduction of surface water infiltration would decrease the volume of groundwater to be pumped and treated. An environmental monitoring system would be included as a part of this alternative.

Screening Evaluation. (See Figure 9-29.)

Conclusion. This alternative will be retained for detailed analysis. It is technically feasible and will be effective in withdrawing on-site overburden and shallow groundwater plumes. On-site pumping will hydraulically control the quarry pit areas and treat the contaminated groundwater within the quarry pits.

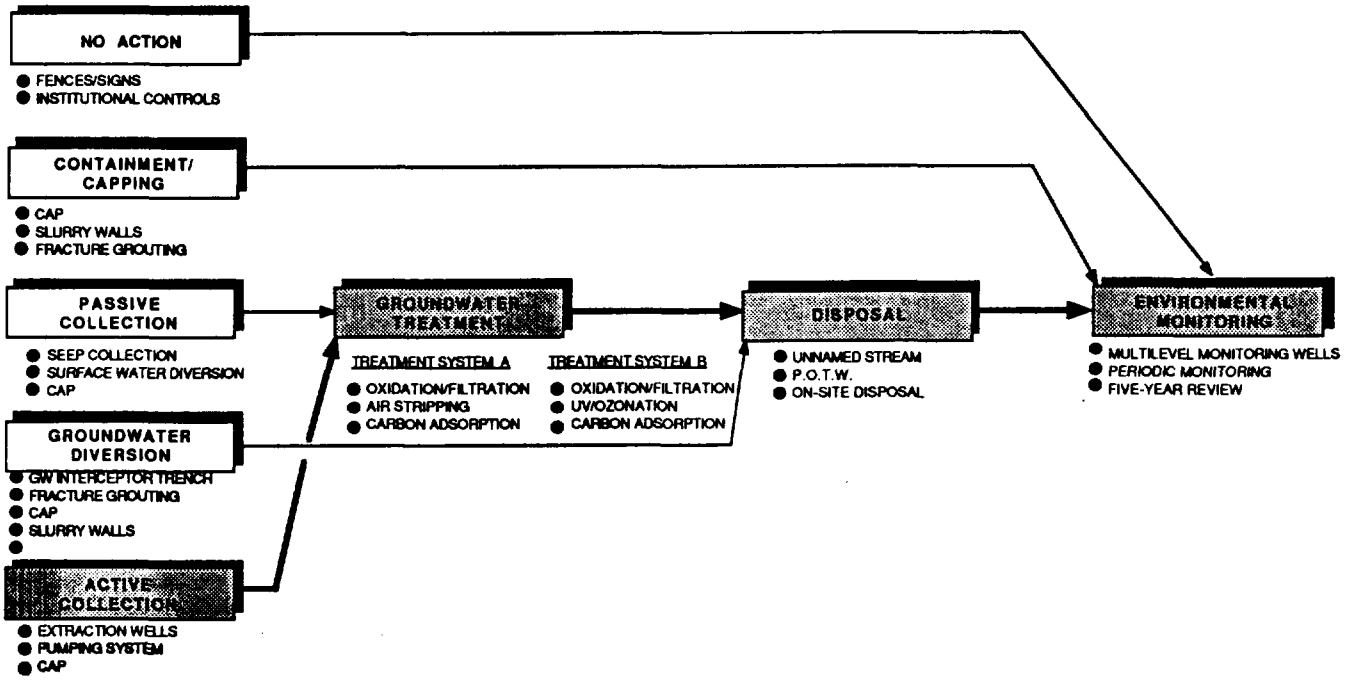
MM-6: ACTIVE COLLECTTION OF DEEP GROUNDWATER IN OFF-SITE BEDROCK FRACTURES

Description. This alternative employs the use of a groundwater extraction system designed to pump deep groundwater from the contaminated off-site bedrock fracture(s). The water extracted from the system would be treated to remove organic contaminants using one of the treatment systems options discussed for Alternative MM-3. The goal of this alternative is to restore the condition of deep groundwater in on- and off-site bedrock fractures. The alternative also includes the use of the multilevel monitoring wells as a component of an environmental monitoring program, which would assess any changes in the migration of contaminants.

Screening Evaluation. (See Figure 9-30.)

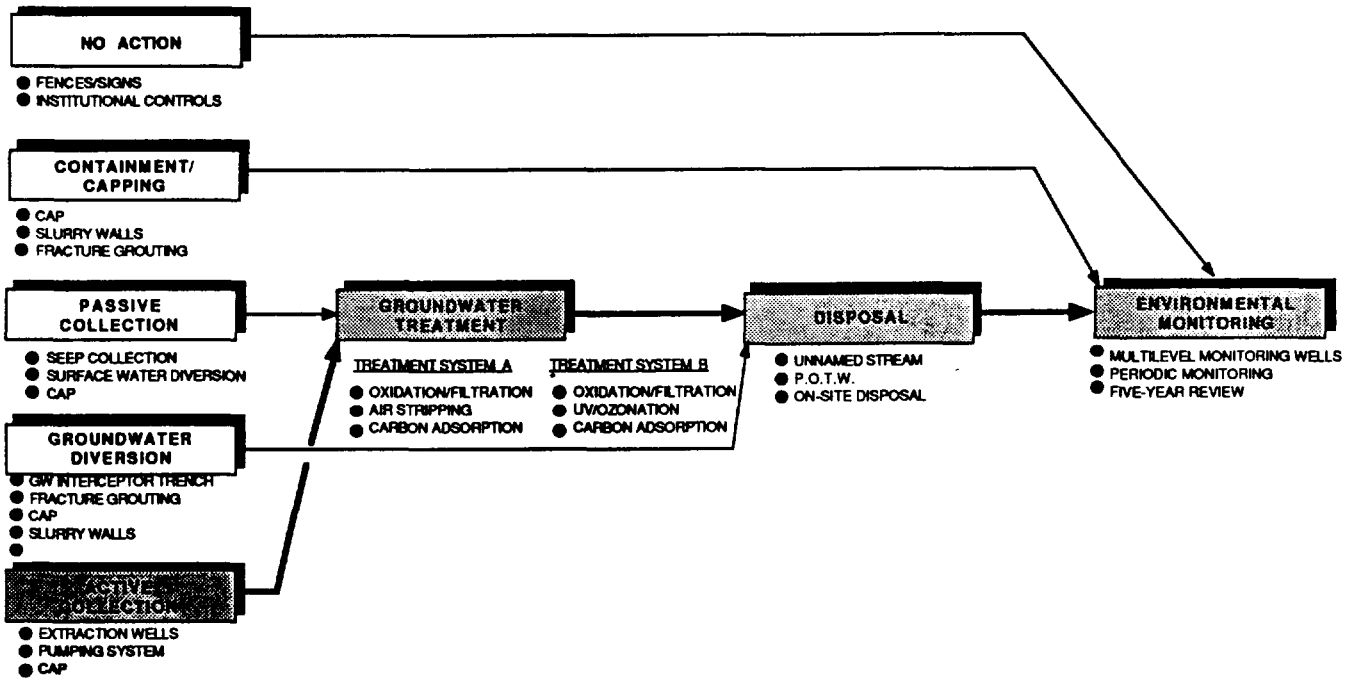
Conclusion. This alternative will be eliminated from further analysis. Additional bedrock fractures may exist in and around the site and in off-site areas; however, their exact locations may be technically infeasible to determine. Furthermore, for successful extraction, DNAPL pockets would have to be intercepted exactly; near misses would not be adequate due to the impermeability of the bedrock and gravity effects on the heavier than water DNAPLs. The ability to locate all fractures and all pockets would be highly unlikely, even if cost was not a concern. If all pockets were not mitigated, DNAPLs would continue to dissolve slowly over time, thereby acting as a chronic source of residual contamination. Recent studies conducted at the University of Ottawa have shown that plume

FIGURE 9-29
SCREENING OF ALTERNATIVES
MANAGEMENT OF MIGRATION
MM-5 ACTIVE COLLECTION



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Provides reduction of existing risk in the shallow groundwater. • Treatment with air stripping and carbon adsorption (MM-5A) reduces mobility and volume of contaminants. • Treatment with UV/Ozonation and carbon adsorption (MM-5B) reduces toxicity, mobility and volume of contaminants. • Most feasible means of minimizing contaminant migration from pits.	• Groundwater treatment operations are technically feasible and are reliable in the short term. • Good availability of necessary equipment and specialists. • UV/Ozonation treatment of groundwater is an innovative technology. • Likelihood of favorable community and regulatory response.	• None.
Disadvantages	**Disadvantages**	**Disadvantages**
• Potential need for replacement of groundwater extraction and treatment components does exist. • Difficult to predict time required to comply with all chemical-specific ARARS	• Difficulty associated with the design and implementation of a groundwater pumping system in fractured bedrock.	• Long-term operation and maintenance costs associated with both the groundwater extraction and treatment systems. • Potential costs associated with replacement of pumping and treatment components. • Potential for future remedial action costs since the pump and treat system will not address cleanup of all bedrock groundwater. • Costs associated with operation and maintenance of environmental monitoring systems.

FIGURE 9-30
SCREENING OF ALTERNATIVES
MANAGEMENT OF MIGRATION
MM-6 ACTIVE COLLECTION
(OFF-SITE BEDROCK FRACTURES)



Effectiveness	Implementability	Cost
Advantages	**Advantages**	**Advantages**
• Provides reduction of existing risks in the specific fractures. • Treatment with air stripping and carbon adsorption reduces mobility and volume of contaminants. • Treatment with UV/ozonation and carbon adsorption reduces toxicity, mobility, and volume of contaminants.	• Treatment technologies are technically feasible and are reliable in the short-term. • Good availability of necessary equipment and specialists. • UV/ozonation treatment of groundwater is an innovative technology.	• None.
Disadvantages	**Disadvantages**	**Disadvantages**
• Time required to provide full protection will be difficult to estimate. Existence of DNAPLs, making effectiveness questionable. • Will not reduce future risks associated with all off-site deep bedrock groundwater. • May not achieve chemical-specific ARARs (e.g., SDWA-40 CRF 141.11-141.16).	• Difficulty associated with the design and implementation of a groundwater pumping system in fractured bedrock. • Lack of information pertaining to contaminant levels and flow patterns of deep groundwater would make it difficult to design a system that would address all contaminated bedrock fractures. • Technically infeasible to locate all deep bedrock fractures.	• Long-term operation and maintenance costs associated with both the groundwater extraction and treatment systems. • Potential costs associated with replacement of pumping and treatment components. • Costs associated with additional site investigation programs which would be required to obtain the information necessary for the design of a deep groundwater pumping system encompassing all bedrock fractures. • Costs associated with O&M and environmental monitoring systems.

expansion will occur to or beyond original plume boundaries once pumping is halted if the source(s) has not been completely eliminated. Based on these possibilities, a waiver is justifiable.

9.4 ALTERNATIVE SCREENING SUMMARY

Table 9-2 summarizes results of the alternatives screening for the SC alternatives. Twenty-one alternatives were developed. One alternative was eliminated and the three no-action alternatives were combined during the compatibility evaluation. Of the 18 alternatives remaining, 11 were eliminated from further analysis during the screening step, leaving seven alternatives to be carried into detailed analysis. To eliminate subsequent confusion in the detailed evaluation of alternatives, the SC alternatives will be renumbered SC-1 through SC-5, as shown below.

The seven alternatives that will be carried into detailed analysis are as follows:

NEW ALTERNATIVE NUMBER	PRIOR ALTERNATIVE NUMBER	ALTERNATIVE DESCRIPTION
SC-1	SC-1	No-action
SC-2	SC-Soils-2	Containment of surface soils
SC-3	SC-Soils-3	In-situ vitrification of surface soils
SC-4	SC-Soils-8	Solidification of surface soils
SC-5	SC-Soils-5	On-site incineration of surface soils
SC-6	SC-SED-6	Removal and on-site incineration of PCB-contaminated sediments
SC-7	SC-SED-5	Removal and solidification of PCB-contaminated sediments

Table 9-3 presents results of the alternatives screening for the MM alternatives. Six alternatives were developed. Alternative MM-2 was eliminated during the compatibility evaluation. Of the five remaining alternatives, two were eliminated during the screening step, leaving three alternatives to be carried into detailed evaluation.

The three remaining alternatives are as follows:

TABLE 9-2

SUMMARY OF SOURCE CONTROL ALTERNATIVES SCREENING
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ALTERNATIVE DEVELOPMENT (SECTION 9.1)		ALTERNATIVE(S) ELIMINATED DURING COMPATIBILITY (SECTION 9.2)	ALTERNATIVES ELIMINATED DURING SCREENING OF (SECTION 9.3)	ALTERNATIVES REMAINING FOR DETAILED EVALUATION
SC-Soils-1	No Action	SC-Soils-1*		SC-1*
SC-Soils-2	Containment			SC-Soils-2
SC-Soils-3	In-situ Vitrification			SC-Soils-3
SC-Soils-4	Off-site RCRA Landfill	SC-Soils-4		
SC-Soils-5	On-site Incineration			SC-Soils-5
SC-Soils-6	Off-site Incineration		SC-Soils-6	
SC-Soils-7	KPEG/Thermal Aeration		SC-Soils-7	
SC-Soils-8	Solidification/on-site Disposal			SC-Soils-8
SC-Pits-1	No Action	SC-Pits-1*		
SC-Pits-2	Containment		SC-Pits-2	
SC-Pits-3	In-situ Biological		SC-Pits-3	
SC-Pits-4	Off-site RCRA Landfill		SC-Pits-4	
SC-Pits-5	Solidification/Off-site Landfill		SC-Pits-5	
SC-Pits-6	On-site Incineration		SC-Pits-6	
SC-Pits-7	Off-site Incineration		SC-Pits-7	
SC-Sed-1	No Action	SC-Sed-1*		
SC-Sed-2	Containment		SC-Sed-2	
SC-Sed-3	In-situ Biological		SC-Sed-3	
SC-Sed-4	Excavation/On-site Disposal		SC-Sed-4	
SC-Sed-5	Solidification/On-site Disposal			SC-Sed-5
SC-Sed-6	On-site Incineration			SC-Sed-6

*Note: SC-Soils-1, SC-Pits-1, SC-Sed-1, Combined to SC-1

TABLE 9-3

SUMMARY OF MANAGEMENT OF MIGRATION ALTERNATIVES SCREENING
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ALTERNATIVE DEVELOPMENT (SECTION 9.1)		ALTERNATIVE ELIMINATED DURING COMPATIBILITY (SECTION 9.2)	ALTERNATIVES ELIMINATED DURING SCREENING OF (SECTION 9.3)	ALTERNATIVES REMAINING FOR DETAILED EVALUATION
MM-1	No Action			MM-1
MM-2	Containment	MM-2		
MM-3	Passive Collection			MM-3
MM-4	Groundwater Diversion		MM-4	
MM-5	Active Collection - Overburden and Bedrock Groundwater			MM-5
MM-6	Action Collection - Deep Bedrock Fracture Groundwater		MM-6	

ALTERNATIVE NUMBER	ALTERNATIVE DESCRIPTION
MM-1	No-action
MM-3	Passive collection of groundwater leachate
MM-5	Pumping and treatment of shallow bedrock groundwater

10.0 DETAILED EVALUATION OF SOURCE CONTROL ALTERNATIVES

The detailed analysis of alternatives is intended to provide decision-makers with sufficient information concerning a range of proposed remedial actions in order to select a single remedy that meets the following CERCLA requirements:

- protective of human health and the environment
- attains ARARs (or provides grounds for invoking a waiver)
- cost-effective
- permanent solution that uses alternative treatment technologies or resource recovery technologies to the maximum extent practicable
- preference for treatment that reduces toxicity, mobility, or volume as a principal element

This section presents a detailed evaluation of SC alternatives that passed through initial screening (see Section 9.0). Seven SC alternatives are evaluated, consisting of a no-action alternative, four soils alternatives, and two sediment alternatives. The SC alternatives are as follows:

Alternative	Alternative Media	Alternative Description
SC-1		No-action
SC-2	soils	Containment of surface soils
SC-3	soils	In-situ vitrification of surface soils
SC-4	soils	Solidification of surface soils
SC-5	soils	On-site incineration of surface soils
SC-6	sediments	Removal and on-site incineration of PCB-contaminated sediments
SC-7	sediments	Removal and solidification of PCB-contaminated sediments

This section also contains a site preparation description of the activities necessary to initiate the SC alternatives.

Each alternative evaluation includes a detailed description emphasizing the technology used, specific components, and proposed design specifications. Anticipated work activities are summarized and graphics are included to depict process flows and site layouts of equipment. The description is followed by an assessment of the following nine evaluation criteria:

- short-term effectiveness
- long-term effectiveness and permanence
- reduction of toxicity, mobility, or volume
- implementability
- cost
- compliance with ARARs
- overall protection of human health and the environment
- state acceptance
- community acceptance

The first five criteria constitute technical, cost, institutional, and risk concerns. Compliance with ARARs and overall protection of human health and the environment are threshold criteria that reflect statutory requirements. The final two criteria, state acceptance and community acceptance, were evaluated on the basis of information available at the time of the detailed analysis.

At present, public perception of the seven SC alternatives is not known. State and community acceptance will be addressed here and will apply to all seven SC alternatives. The assessments are as follows:

- <u>State Acceptance</u>. The lead agency has kept the state informed of progress at the site. State comments will be received after review of the draft FS and will be incorporated into later revisions of this document and the Record of Decision (ROD).

- <u>Community Acceptance</u>. To date, the community has not been informed of proposed remedial actions at the site. The community will be given a 30-day public comment period following the release of the draft final FS to make formal comments. Comments received at that time will be incorporated into the Responsiveness Summary, an integral part of the ROD.

10.1 SITE PREPARATION

10.1.1 Description

Before remediation work begins for alternatives involving treatment of contaminated soil or sediment (i.e., SC-3 through SC-7), several construction tasks must be accomplished. These tasks are grouped together as the Site Preparation Plan. However, site preparation for alternative SC-2 would not be as extensive and will be specifically described in Section 10.3.1.

The site preparation work, depicted in Figure 10-1, includes the establishment of security and controlled access to the site, the connection of light and power utilities, and the furnishing of sanitary facilities. It also includes grading to provide a level surface for the engineer's trailer, the contractor's office, the areas for equipment and materials, and the remediation operational area. In addition, the site preparation plan includes provisions for diverting the unnamed stream and controlling stormwater runoff. Erosion and sediment control measures used during the construction period are also considered part of the Site Preparation Plan.

The site, consisting of about 12 acres, is roughly rectangular in shape and bounded by highways on the south and north, a private motel property on the west, and the unnamed stream on the east. The topography of the site slopes from the southwestern corner to the northeastern corner, with a drop of about 45 feet. The unnamed stream flows northerly and drops about 4.8 feet along the eastern boundary of the site.

About 10 acres of the site contains contaminated soils. Exclusion of the contaminated zones leaves a 100-foot, uncontaminated strip along the west border and a 150- to 400-foot-wide, wedge-shaped, uncontaminated strip along the southern side of the site. The engineer's trailer, the entrance road, and the contractor's area will be located in these clean zones (see Figure 10-1).

10.1.2 Construction Sequence

The contractor's first activities would be to install the security fence and entrance gate. Basic utilities, the contractor's own working area, and the engineer's area then would be established. The next two steps would be to (1) initiate concurrent operations for cleanup of the site; that is, removal of trees, brush, debris, and reclamation of concrete pillars, telephone poles, and cobblestones, and (2) excavate along the unnamed stream and sedimentation pond site.

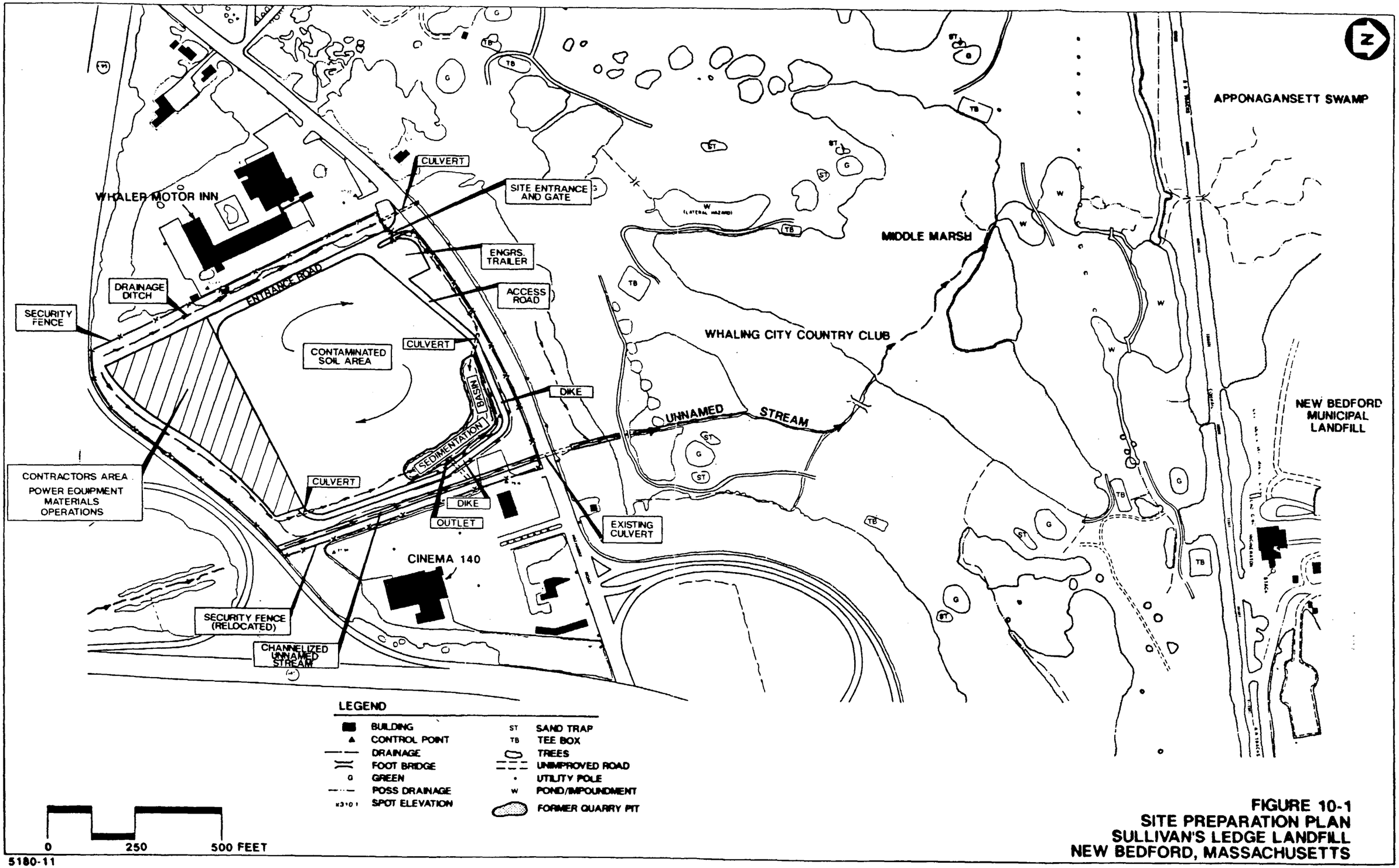


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FIGURE 10-1
SITE PREPARATION PLAN
SULLIVAN'S LEDGE LANDFILL
NEW BEDFORD, MASSACHUSETTS

Contaminated soil zones (i.e., soils posing a carcinogenic risk of 10^{-6} or greater; PCBs above 4.6 ppm, PAHs above 3.1 ppm) are devoid of trees and heavy vegetation; vegetation consists primarily of grasses with some brush. Such areas would be cleared with a brush hog and the vegetation would be shredded or left to decompose in place. Trees and heavy vegetation lying outside designated contamination zones (see Figures 6-3, 6-4, 6-5) would be hauled off-site to the New Bedford Municipal Landfill. Concrete pillars, telephone poles, and cobblestones above ground level have not yet been tested for residual contamination and would be randomly sampled. If PCBs and PAHs are found to be above regulated levels, the pillars, poles, and cobblestones would be decontaminated with an approved physical removal process (i.e., scrub/wash/steam-clean or sand blast/steam-clean) and disposed of on-site. As the owner of the cobblestones, pillars, and poles, the City of New Bedford will be given the opportunity to salvage such materials.

Water handling would be a key factor in the contractor's approach to the excavation and grading. Water-handling includes the following:

- site drainage
- stormwater discharge control
- erosion and sediment control
- unnamed stream diversion

Site Drainage. Adequate drainage would prevent runoff from interfering with construction and remediation activities. Generally, runoff from the site would be carried by new drainage ditches on the northern and southern site boundaries and by overland flow to a new sedimentation basin (described later) constructed in the northeastern corner of the site (see Figure 10-1). Dikes constructed along the northerly side of the site and the easterly side adjoining the unnamed stream would direct the runoff to the sedimentation basin. Stormwater runoff would flow through the sedimentation basin and through an outlet pipe to the unnamed stream.

The Sullivan's Ledge site is part of an approximate 31-acre watershed, which extends beyond the western boundary of the site. Runoff from the off-site watershed would be diverted by a channel constructed across the westerly boundary adjacent to the Whaler Motor Inn, which would drain northerly into a proposed culvert under Hathaway Road, as shown in Figure 10-1. Diverted runoff would flow to the unnamed stream on the northern side of Hathaway Road.

Stormwater Discharge Control. An evaluation of 25-year, 24-hour stormwater runoff rates for existing conditions and post-construction conditions has been made to assure that this project would not result in an increase in runoff to the unnamed stream. This evaluation has used the methodology of The Soil

Conservation Service (SCS) in their TR-55 publication. Runoff Curve Numbers (CN) for existing conditions is estimated to be 86. This value represents open space in urban areas with less than 50-percent grass cover. Previous studies have placed the soils in the project vicinity in hydrologic soil Group C.

For estimating runoff after construction, a cap with a soil profile of various layers covered by a foot of topsoil and grass has been assumed. Corresponding CN values are estimated to be 78 to 80. The decrease in CN values from existing conditions to post-conditions indicates that the 25-year, 24-hour post-construction runoff rates would be reduced below existing runoff rates. Therefore, no attenuation measures would be necessary for this project.

Erosion and Sediment Control. During construction in remediation areas, temporary erosion control measures, such as haybale check dams located in ditches and siltation fences immediately downgradient of excavations, would be installed and maintained. However, it may be impractical to use siltation fencing at all times, and runoff carrying sediment would be transported to the lower end of the site to a sedimentation pond. The pond is sized to provide at least 10-hours detention time for the runoff from a storm frequency of at least twice the duration of the construction period. A five-year, 24-hour duration storm event has been used. A riser at the upstream end of a culvert outlet will detain the runoff until 3 acre-feet have been accumulated. Water over topping the riser will pass through the culvert to the unnamed stream. Perforations in the riser will allow the pond to drain between storms. An estimate of 324 tons of soil loss over the five-year period has been made using the Universal Soil Loss Equation (USLE) with conservative values. The basin has capacity for this volume of sediment. Sediment and water quality will be monitored with time and removed and treated as appropriate. These procedures will minimize additional site soil erosion from impacting the unnamed stream.

The drainage ditches and all earth-grading areas and the remediation area would require special erosion control measures during and after construction. Permanent work areas and diversion ditches would be loamed, seeded, and mulched as soon as grading is completed. Special seed mixtures appropriate to the land use would be used.

Unnamed Stream Diversion. Diversion of the unnamed stream through an excavated channel is part of two MM alternatives (MM-3, MM-5); however, the work, if it is to be conducted, would be performed during the site preparation phase. A channel is needed in either of these alternatives to prevent the flow gradients caused by the collection system from inducing streamwater flow into the collection system. A channel would be

excavated immediately east of and parallel to the unnamed stream. The exact location of the channel will be determined during remedial design. Stream flow would be diverted through the new channel while a concrete lining is constructed in the original streambed. A water-tight concrete lining for the unnamed stream is part of Alternative MM-3 to separate the unnamed stream from the contaminated seep water. The lining of the unnamed stream can be addressed in the site preparation work because construction of the sedimentation pond and dike are similar construction activities. Construction of all water handling activities at the same time would facilitate contracting and help to insure adequate controls are in place prior to remediation.

Because the excavation is in an area that is contaminated with PCBs, the excavated earth would be stockpiled on-site for further treatment. Embankment construction of the dike will be done with clean fill material imported from off-site sources. Alternative MM-3 for the contaminated groundwater also contains a groundwater collection pipe that would be located between the sedimentation pond dike and the concrete-lined channel. It would be prudent to install the groundwater collection pipe as part of site preparation work, if this alternative is chosen as part of the site remedial alternative.

Sediment monitoring of concrete ditch would be needed to determine the adequacy of the sedimentation pond design at capturing eroded soil and additional dredging requirements.

Earthwork and Grading. The site entrance would be off Hathaway Road at the northwestern corner of the site. This location does not interfere with drainage considerations nor with the on-site areas that are contaminated to the greatest extent (see Figure 10-1). A small parcel of land on-site adjacent to the entrance road and Hathaway Road is proposed for the engineer's trailer. A 20-foot-wide entrance road would travel southerly from the entrance on Hathaway Road to a relatively uncontaminated area of about 3 acres along the southern border of the site. This 3-acre area is proposed for the contractor's use and for remedial operations. It slopes significantly and will be terraced. There will be a maximum 3- to 5-foot drop between terraces with a maximum 3-percent slope across the terraces.

Grading generally would direct runoff to the perimeter of the site where drainage ditches would be utilized to carry all runoff from the site to the proposed sedimentation pond located at the northeastern corner. A combination road and dike would serve as an operational road for earth-moving as well as control of surface water runoff. These described areas are shown in Figure 10-1.

The location of the sedimentation pond and its dike are shown in Figure 10-1. With the sedimentation pond completed with its outlet to the concrete-lined unnamed stream, the remainder of the grading work for the remediation efforts could be completed. Gravel surfacing of the roadways within the site, followed by installation of culverts and drainage ditches, would ready the site for the start of remediation work.

Cost. Total site preparation costs are approximately $1.4 million. Table 10-1 presents itemized costs.

10.2 ALTERNATIVE SC-1: NO-ACTION

10.2.1 Description

The objective of the SC no-action alternative is to restrict human access to the site, and to minimize human dermal contact with contaminated soils, sediments, and pit contents. A chainlink fence with warning signs posted at appropriate intervals will be maintained around the perimeter of the site. Warning signs will be in both English and Portuguese because a large population of Portuguese- Americans reside in the New Bedford area. The fence will restrict access to the site. Weekly security visits, consisting of walking the site perimeter, will identify breaches in a timely manner.

An environmental monitoring program will be implemented to assess migration and natural attenuation of soil and sediment contaminants. Monitoring programs will include on-site surface soil sampling, and sediment sampling in the unnamed stream and Middle Marsh. A minimum of 10 soil and sediment samples will be collected annually and analyzed for PCBs, PAHs, and lead. For the 10 sediment samples, analysis will also include total organic carbon (TOC).

Because this alternative will result in contaminants above health-based levels remaining on-site, CERCLA (as amended) requires that the site must be reviewed every five years. Data collected as part of the monitoring program will be evaluated during the 5-year review. Recommendations for potential remedial actions will be formulated at that time.

Institutional controls will need to be implemented to restrict future land development of the site. These controls would be drafted, implemented, and enforced in cooperation with state and local governments.
The major items associated with this alternative are as follows:

- maintain chainlink fence and warning signs

TABLE 10-1

COST ESTIMATE
SITE PREPARATION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ITEM DESCRIPTION	COST
• Clear and Grub Vegetation	27,500
• Dispose Vegetation in Off-site Landfill	20,000
• Sample Above-ground Debris for Residual Contamination	7,200
• Clean and Stack Cobbles	20,000
• Treat Decontamination Water Off-site	3,400
• Decontaminate Concrete Pillars and Telephone Poles	11,400
• Gravel Base for Entrance Road, Operation Road, Laydown Site, Office Trailer Site	98,800
• Grade Contractor Laydown Area, Entrance Road	44,000
• Construct Sedimentation Basin*	97,500
• Clean Backfill Material for Dike, Office Trailer Site	414,000
• Install Culverts (24 in. diameter RCP)	
- Hathaway Road (8 ft. depth)	7,920
- Entrance Road (4 ft. depth)	3,150
- Operations Road (4 ft. depth)	3,150
- Sediment Pond Outlet (10 ft. depth)	4,260
- Flared Ends	840
• Loam, Seed, Fertilize, Mulch	60,000
• Perimeter Fence (6 ft. high, barbed wire, single gate)	45,500
• Power Tie-in	13,000
• Sediment and Water Quality Monitoring	48,000
• Allowance for Level D Hazard	192,980
SUBTOTAL	$1,122,600
CONTINGENCY (25%)	280,700
TOTAL SITE PREPARATION COST	1,403,300

* Not required for non-removal (i.e., ISV).

- establish institutional controls (e.g., deed and land restrictions) limiting site use
- perform weekly security visits
- perform semi-annual site visits
- conduct annual sediment and soil sampling to monitor contaminant concentrations and migration
- conduct educational programs, including public meetings and presentations, to increase public awareness
- perform site review every five years

10.2.2 Short-term Effectiveness. This evaluation criterion addresses the effects of the alternative during the construction and implementation phase of the remedial action. Since this alternative provides only a minimal response action (i.e., fences, warning signs, and environmental monitoring), it is not expected that threats to the community and workers will be encountered. However, workers should follow safe working practices and wear protective clothing. It is anticipated that a period of several weeks will be required to complete installation of the appropriate fence and warning signs.

10.2.3 Long-term Effectiveness and Permanence

The no-action response would result in minimal improvements to human health and environmental risks, but only after decades of natural degradative and dispersion processes. It cannot be assumed that contaminant levels will decrease to levels considered protective of public health; therefore, health risks would not be effectively mitigated.

If managed properly, the combination of controls (i.e., public awareness, security, fence, and warning signs) would effectively keep intruders off the site. Breakdown of controls (e.g., fence breaches, communication barriers) would increase the possibility of exposure to contaminants. However, weekly security visits and timely repairs should be adequate in maintaining the integrity of the security fence.

Environmental risks would be expected to remain because soil erosion from the site will continue to impact the unnamed stream and downstream areas. In addition, the PCB-contaminated sediments in the downstream areas will remain. The potential risks of these sediments were discussed in Section 6.3.

10.2.4 Reduction of Mobility, Toxicity, and Volume

This alternative would not result in any reduction in the mobility, toxicity, or volume of contaminants in the soils, sediments, or pits.

10.2.5 Implementability

Technical Feasibility. Installation of fencing and posting of warning signs are simple construction tasks. Local contractors and necessary materials are readily available. Restricting access to the site would not interfere with the ability to perform future remedial action. Maintenance and repair of the fence and warning signs and establishment of a soil and sediment monitoring program are tasks that are easily implemented.

Administrative Feasibility. Implementation of this alternative would require institutional controls to restrict land use. Considerable long-term institutional management would be associated with this alternative because wastes would remain on-site and five year reviews to be initiated by the lead agency (i.e., EPA) would be necessary every five years. Annual site visits, sampling events, and public educational programs (e.g., public meetings, workshops) would require administrative and regulatory participation.

Availability of Services. Fencing, signs, and security services are locally available in the New Bedford area.

10.2.6 Costs

The total 30-year present worth cost of the SC-1 Alternative is estimated at $209,000 (Table 10-2). This cost includes a present worth capital cost of $34,000, annual operating costs of $8,850 (i.e., weekly security visits; semi-annual site visits; annual sediment sampling and analysis), and six 5-year reviews at a cost of $14,000 each. Sampling and analysis costs assume five samples per year with analysis for PCBs, SVOCs, and metals. The five year review would involve data interpretation, reassessment of risks, and public meetings.

Capital expenditures include installation costs for additional fencing and warning signs to enclose the unnamed stream during the first year. A complete replacement of the site perimeter fence is anticipated during Year 16.

10.2.7 Compliance with ARARS

Under SC-1, the no-action alternative, limited activity (e.g., fences, institutional controls) will take place at the site to attempt to prevent contact with site soils and the pits. As discussed in Section 2.2.3.1, there are no chemical-specific

TABLE 10-2

COST SUMMARY TABLE
SC-1: NO ACTION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

	Cost	Present Worth Cost
CAPITAL COSTS		
• Site Security Fence - Initial Repairs (Year 1)	$ 14,000	$ 14,000
• Site Security Fence Replacement (Year 16)	44,000	20,000
TOTAL CAPITAL COSTS	$ 58,000	
PRESENT WORTH CAPITAL COST - ASSUME 5% DISCOUNT RATE		$ 34,000
ANNUAL OPERATING COSTS		
• Weekly Security Visits	$ 2,500/yr.	
• Semi-annual Site Visits	2,200/yr.	
• Sampling and Analysis (PCBs, SVOCs, Metals)	4,150/yr.	
TOTAL ANNUAL OPERATING COSTS	$ 8,850/yr.	
PRESENT WORTH OPERATING COSTS - ASSUME 30 YR. PERIOD AND 5% DISCOUNT RATE		136,000
FIVE-YEAR REVIEWS		
• Data Analysis and Report Writing	$10,000	
• Public Meetings	4,000	
TOTAL FIVE YEAR REVIEW COSTS	$14,000	
PRESENT WORTH REVIEW COSTS - ASSUME 6 REVIEWS OVER 30 YEAR PERIOD AND 5% DISCOUNT RATE		39,000
PRESENT WORTH OF ALTERNATIVE		$209,000

ARARs for the contaminants found in the soils and sediments at the Sullivan's Ledge site.

Location-specific ARARs for this alternative are the federal and state wetlands regulations: CWA (40 CFR 230) and DEQE Wetlands Protection (310 CMR 10.00), respectively. Although no disturbance occurs to the wetlands areas under this alternative, these ARARs are not expected to be attained because PCB-contaminated sediments will continue to impact the wetland areas. In addition, contaminated soils from the site will continue to erode causing additional PCB loading to the wetlands areas.

Action-specific ARARs associated with this alternative include RCRA regulations pertaining to RCRA facilities, TSCA regulations, OSHA regulations for federal safety standards, and DEQE Hazardous Waste Regulations.

In addition to these regulations, the State of Massachusetts has three separate right-to-know regulations:

- DPW - Hazardous Substance Right to Know (105 CMR 67)
- DOI - Hazardous Substance Right to Know (441 CME 21)
- DEQE - Hazardous Substance Right to Know (310 CMR 33)

These regulations are applicable to the implementation of the site fence and will be attained during remedial action. OSHA requirements would also be met during fence installation.

The no action alternative will not comply with RCRA closure/post-closure regulations requiring the installation of a specially designed final cover.

Table 1 in Appendix F outlines the chemical-, location-, and action-specific ARARs for this alternative and specifies the corresponding remedial actions that will be required to attain the specific ARARs, if the ARAR can be attained.

10.2.8 Overall Protection of Human Health and the Environment

This alternative would not result in a significant improvement to the protection of human health and the environment over baseline conditions as described in the risk assessment. A security fence would only marginally be effective at preventing human exposure to on-site contaminants, and would not prevent exposure to contaminants migrating beyond the site boundary. Terrestrial and aquatic organisms would continue to be exposed to surface soil and sediment contaminants. Exposure levels of

PCBs in sediments may increase as additional PCB soils erode from the site area.

10.3 ALTERNATIVE SC-2: CONTAINMENT

10.3.1 Description

The SC-2 alternative proposes the containment of contaminated surface soils with a multi-layer cap. The cap would serve to reduce erosion caused by precipitation and reduce recharge to the groundwater table via precipitation. The cap is anticipated to meet the following SC remedial response objectives:

- prevent the continued release of hazardous substances to the unnamed stream, Middle Marsh, and Apponagansett Swamp due to surface water runoff
- reduce risks to human health associated with direct contact and accidental ingestion of contaminated soils
- reduce risks to terrestrial life associated with contact with contaminated soils

The cap would be constructed over an 11-acre portion of the site (Figure 10-2). As discussed in the compatibility evaluation, the cap is advantageous to both SC and MM alternatives. As an SC measure, the cap would prevent future migration of and exposure to contaminated surface soils. The cap would be 6.5 to 9 feet in thickness, thereby establishing a significant barrier between contaminated soils and potential receptors (e.g., humans, terrestrial organisms).

The proposed cap would reduce infiltration through the porous overburden soils by approximately 81 percent or 13,000 gpd of precipitation. Such a reduction in infiltration would be advantageous to MM alternatives (i.e., MM-3) since it would reduce seep and groundwater discharges to both the unnamed stream and the tributary north of Hathaway Road (see Section 4.2.4). As a result, contaminant migration via groundwater movement would slow down and treatment volumes would be minimized. Therefore, the cap is an integral component of both SC containment and MM alternatives. The evaluation of the cap will be performed in the SC section; however, it is also incorporated into both MM treatment alternatives (MM-3 and MM-5).

Construction of the cap would involve site preparation, cap installation, and long-term water runoff management. These activities are described in the following sections.

Site Preparation. Contaminated soil zones (i.e., soils posing a carcinogenic risk of 10^{-6} or greater; PCBs above 4.6 ppm, PAHs above 3.1 ppm) are devoid of trees and heavy vegetation;

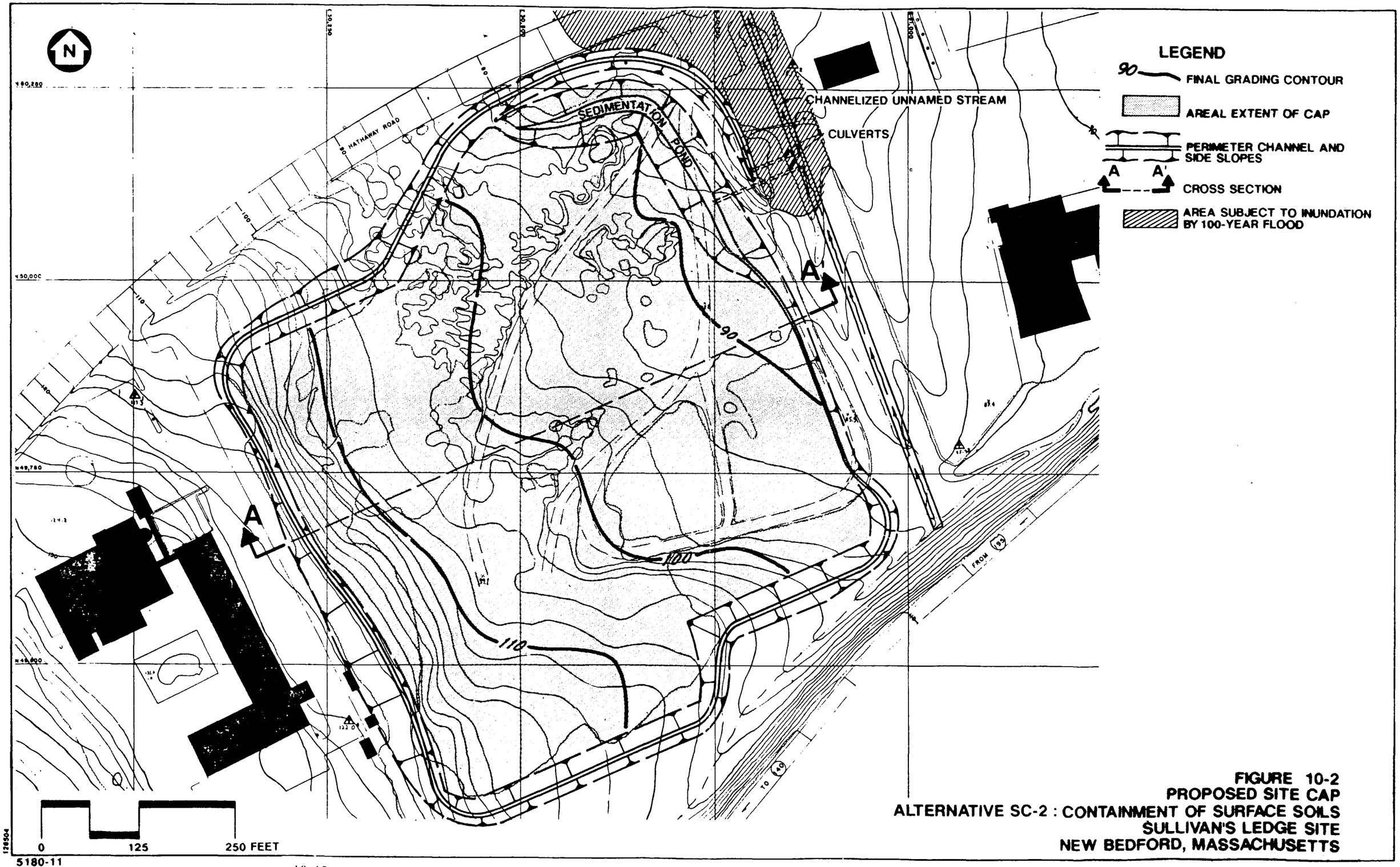


FIGURE 10-2
PROPOSED SITE CAP
ALTERNATIVE SC-2 : CONTAINMENT OF SURFACE SOILS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

5180-11

vegetation consists primarily of grasses with some brush. Such areas would be cleared with a brush hog and vegetation removed.

Trees and heavy vegetation lying outside 10^{-6} carcinogenic risk zones will be assumed non-hazardous. Such trees and vegetation would be cut as close to the ground as possible and stumps left in place to minimize soil disturbance. The stumps would be covered over with clean fill during regrading and left under the cap. Cut vegetation would be hauled off-site to the nearby New Bedford Municipal Landfill.

The City of New Bedford will be given the opportunity to salvage concrete pillars, telephone poles, timbers, and cobblestones. Such materials would be randomly sampled for residual contamination. If they are found to be contaminated, decontamination with an approved physical removal process (i.e., scrub/was/steam-clean or sand blast/steam-clean) would be performed as part of salvage operations.

Monitoring wells not proposed for long-term sampling would be plugged and eventually covered with borrow material. Risers of wells selected for environmental monitoring would be extended to above the surface elevation of the proposed cap.

Site Regrading. Regrading would be performed to contour the rough surface to a 3- to 15-percent initial grade with an estimated 37,000 cy of fill material including solidified soils and/or sediments (if compatible with remedy).

Cap Installation. Cap guidelines are set forth in the EPA document, "Covers for Uncontrolled Hazardous Waste Sites" (EPA/540/2-85/002, September 1985). This document describes a cover system consisting of a vegetative top cover layer, a drainage layer, and a bottom hydraulic barrier. The hydraulic barrier can consist of a 2-foot recompacted clay layer, or a combined system with a 2-foot recompacted clay layer overlain by a synthetic membrane at least 20-mil thick. The proposed cap for the Sullivan's Ledge site would consist of a base of fill material, a 2-foot compacted clay layer, an 18-inch fill buffer layer, a 1-foot sand drainage layer, and a 2-foot vegetative cover. Figure 10-3 presents a typical cross section of the component layers that would be used for the Sullivan's Ledge cover. Figure 10-4 presents cross section A-A', which depicts the cap over the existing site surface. Two feet of a low-permeability clay (1×10^{-7} cm/sec permeability or less) would be placed over the regraded site and compacted. The clay would act to minimize water infiltration to the landfill. Clay is available in limited quantities in the New Bedford area. The 35,000 cy required for the site is presently available from local sand and gravel companies.

To protect the clay layer from the effects of freeze-thaw weather cycles, an 18-inch buffer layer would be installed above the clay layer. This would ensure that the minimum thickness of

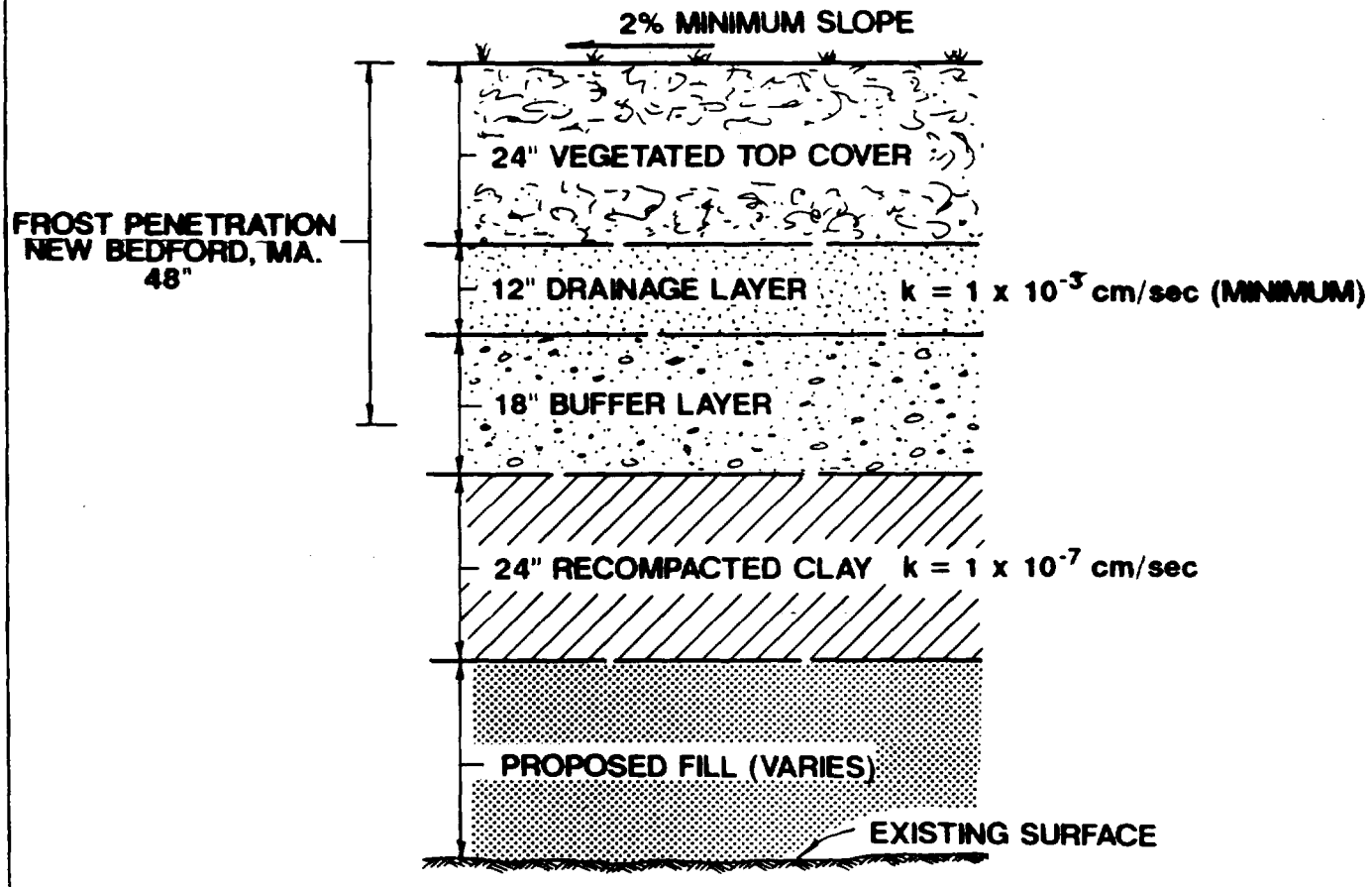
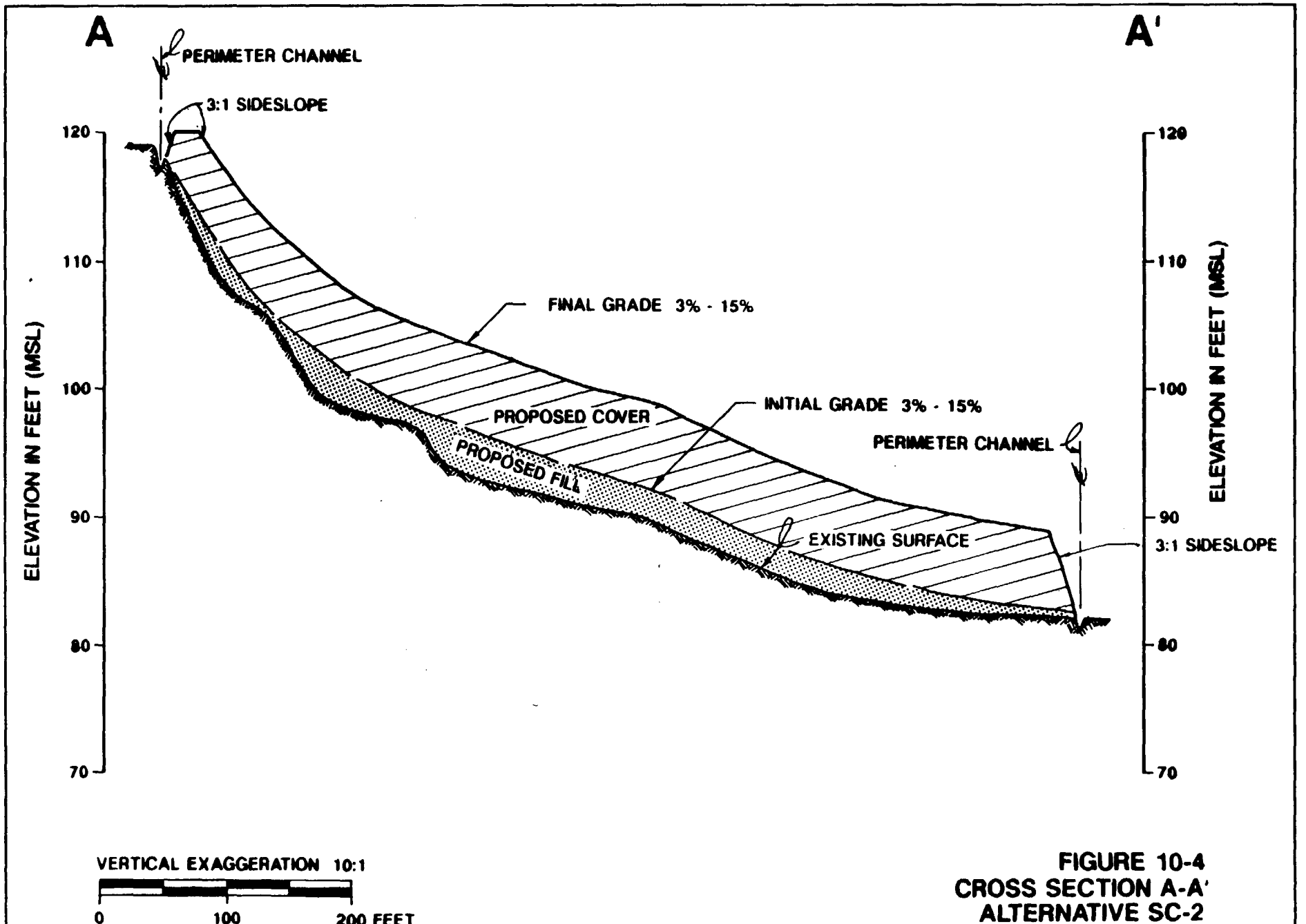


FIGURE 10-3
PROPOSED CAP DESIGN
SC-2 : CONTAINMENT OF SURFACE SOILS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS



NOTE: FOR COVER DETAIL SEE FIGURE 10-3

FIGURE 10-4
CROSS SECTION A-A'
ALTERNATIVE SC-2
CONTAINMENT OF SURFACE SOILS
SULLIVAN'S LEDGE LANDFILL
NEW BEDFORD, MASSACHUSETTS

the soil cover over the clay layer (i.e., vegetative layer, drainage layer, and buffer layer) would be sufficient to cover the clay wholly beneath local frost penetration depths. Based on information provided by the City of New Bedford, the maximum frost depth is approximately 48 inches.

The drainage layer, consisting of 12 inches of sandy soil and exhibiting a saturated conductivity of at least 1×10^{-3} cm/sec, would be placed above the buffer layer. The main function of the drainage layer is to intercept percolation through the vegetative layer and transmit the water along the slopes to the toe of slope for collection in the surface water perimeter channels.

A 24-inch final vegetative covering (consisting of 18 inches of sandy soil overlain by 6 inches of topsoil, and seeded with grass) would be installed to provide stability and minimize erosion of the cap layers. Vegetation would also serve to uptake rainwater for evapotranspiration, thus reducing the amount of water available to percolate through the cover. To establish vegetation, the cover area would be drill- or broadcast-seeded, fertilized, and mulched. Erosion during vegetation establishment would be controlled by applying hay bales or erosion control fabrics. Once established, vegetation (grass) would be mowed at least twice a year.

Surface Water Management System. Prior to vegetation establishment, a majority of the runoff would be channeled to the sedimentation pond in the northeastern corner of the site via a perimeter channel. Eroded material would settle within the pond, and runoff water would be discharged through an outlet pipe to the unnamed stream. Erosion is expected to be minimal following establishment of the vegetation. At this time, the sedimentation pond will be deactivated and will not impound water.

The perimeter channel would be constructed with a minimum 2-percent slope to maintain flow of runoff downgradient. The base of the channel would be lined with sand, and a well-graded stone would be placed to maintain low flow velocities and minimize erosion within the channel.

The northeastern corner of the site has been identified to lie within the 100-year floodplain of the unnamed stream (see Figure 10-2). Site regrading in this area will be limited to backfilling areas where soils have been removed for treatment. Therefore, the 100-year floodplain will not be impacted by this alternative.

10.3.2 Short-term Effectiveness

The public would be at minimal risk during the construction of the cap. Construction activities would be performed to minimize

disturbance of contaminated soils. Such soils would not be excavated, but would be covered with borrow material before construction of the cap proceeds. These procedures would reduce the generation of airborne contaminants sorbed to dust particles, thereby minimizing inhalation risks posed to the community. Furthermore, fugitive dust will be controlled during construction activities by water sprays or dust control chemicals.

Remedial action workers would be at risk via dermal contact with contaminated soils and inhalation of volatilized organics or non-volatiles sorbed to airborne particulates. Workers would be required to have health and safety training and employ proper controls to minimize these risks. Controls would include air monitoring and the use of appropriate personal protective equipment (e.g., gloves, boots, coveralls, respirator). Adherence to health and safety procedures would reliably protect workers during the remedial action.

Construction of the cap may cause resuspension and transport of contaminated soils from the site into the unnamed stream. This could potentially expose aquatic organisms to short-term elevated concentrations of toxicants. Impact of this activity can be minimized by use of silt curtains, sedimentation basins, or other appropriate equipment to prevent dispersal of contaminated sediments. Habitats for terrestrial organisms in the work area will be destroyed during cap construction.

Construction of the cap would take an estimated one to two years. Remedial response objectives would be met upon completion.

10.3.3 Long-term Effectiveness and Permanence

The main concern associated with long-term effectiveness would be the subsidence of underlying materials due to the additional load of the cap. Environmental uncertainties (e.g., severe weather occurrences, annual precipitation, freeze/thaw depths, infiltration of precipitation, contaminant migration beneath the cap) may also affect the useful life of the cap. Periodic site visits would be required to observe the cap for settlement, ponding of liquids, erosion, and invasion by deep-rooted vegetation.

Caps generally have a minimum design life of 20 years, which could extend up to 100 years depending on environmental conditions and the quality of maintenance activities. Therefore, it is difficult to assess the need for replacement after 20 years.

The installation of a cap would contain the contaminated soils and reduce the risks from exposure to this medium. In addition, the cap would prevent the migration of contaminated soils to off-site locations. The cap is also designed to minimize infiltrations of water through the site and, as such, may reduce the flow from several of the current seep areas.

If the cap were to fail, PCBs and PAHs in untreated soil may pose a dermal contact or ingestion exposure risk and may migrate into the unnamed stream. Cap failure may occur from subsidence in time due to the increased weight of the cap over fill materials. Additional groundwater seeps may appear, creating an exposure pathway. However, such seeps would not likely pose a risk to human health since present seeps pose no human health risk, although they could pose a risk to environmental receptors in the unnamed stream. In addition, migration of PCB-contaminated soils could pose a significant ecological threat by increasing concentrations in the sediments of the unnamed stream and wetland areas.

10.3.4 Reduction of Toxicity, Mobility, or Volume

A cap would reduce the mobility of contaminants, but not the toxicity or volume of wastes. The multi-layer cap would be emplaced over contaminated soils, thereby forming a physical barrier to prevent potential exposure and halt further mobility via surface water runoff. Mobility would not be permanently reduced and could pose a future concern as the cap begins to deteriorate.

The cap would also be effective in reducing the migration of groundwater contaminants by reducing precipitation infiltration to the aquifer underlying the site. This is expected to shut off groundwater seeps north of Hathaway Road.

10.3.5 Implementability

Technical Feasibility. Capping is a reliable technology for preventing erosion and reducing infiltration. The proposed cap would reduce infiltration by an estimated 80 to 83 percent as calculated using the Hydrologic Evaluation of Landfill Performance (HELP) model.

Caps can be easily constructed over a variety of terrains and can be completed in a short period of time. The Sullivan's Ledge site has a relatively even surface with a pronounced slope from southwest to northeast, making it ideal for capping. Therefore, no construction difficulties are anticipated.

The performance of a multi-layer cap is generally excellent for the first 20 years of service, after which its integrity becomes

questionable. At that point, site visits and groundwater sampling should increase in frequency.

A future remedial action involving soil removal or groundwater treatment would not be permanently hindered by the cap. Although temporary disruption would occur, the earthen layers of the cap could be excavated and then reconstructed if necessary. Similarly, with sufficient precautions groundwater treatment could be performed as easily with or without the cap in place.

The effectiveness of the cap would be assessed by sampling a number of multi-level and open borehole monitoring wells quarterly for the first two calendar years and annually thereafter. A sufficient number of wells have already been installed and would be used for groundwater monitoring purposes. To check for soil mobility, an annual sediment sampling program would be instituted.

Administrative Feasibility. The site is owned by the City of New Bedford; therefore, coordination would have to be established and maintained with local government authorities, as well as the state. The lead agency (i.e., EPA) is expected to have little trouble coordinating cap construction and long-term maintenance responsibilities with them.

Considerable long-term institutional management would be associated with this alternative because wastes would remain on-site. The lead agency would be required to initiate site reviews every five years. Site visits, sampling events, and public educational programs (e.g., public meetings, workshops) would require administrative and regulatory participation.

Availability of Services and Materials. Cap installation involves well-established construction procedures and local construction firms are available to perform the work. If local contractors are not qualified to work on a CERCLA site due to health and safety considerations, hazardous materials remedial action firms would have to be contracted for such work. Several of these firms are available to perform work in Massachusetts and to bid competitively against each other. Such firms include ACES, O.H. Materials, and Clean Harbors. Two local firms have been identified for materials bidding.

10.3.6 Cost

The total present worth cost for the SC-2 alternative is $2.76 million. This includes an initial capital expenditure of $1.85 million for site preparation and construction of the cap and $904,000 for long-term monitoring, operating, five-year review, and equipment replacement (e.g., fencing, monitoring wells) costs. Table 10-3 summarizes the itemized costs.

TABLE 10-3

COST SUMMARY TABLE
SC-2: CONTAINMENT
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ITEM DESCRIPTION	COST	PRESENT WORTH COST
CAPITAL COSTS		
Site Preparation		
• Clear and Grub Vegetation	$ 27,500	
• Dispose Vegetation in Off-site Landfill	20,000	
• Sample Above-ground Debris for Residual Contamination	7,200	
• Clean and Stack Cobbles	20,000	
• Treat Decontamination Water Off-site	3,400	
• Decontaminate Concrete Pillars	8,200	
• Construct Sedimentation Basin	97,500	
• Install Sediment Pond Outlet	4,300	
• Sediment and Water Quality Monitoring During Construction	48,000	
• Set Initial Grade - Spread and Compact Fill	277,500	
Construct Cap		
• Clay Layer (24 in. thick) - Spread and Compact	338,400	
• Buffer Layer (18 in. fine sand) - Spread and Compact	187,100	
• Drainage Layer (12 in. course sand) - Spread and Compact	118,300	
• Vegetative Cover (18 in. fine sand, 6 in. topsoil) - Spread and Compact	283,200	
• Seed, Fertilize, and Mulch Vegetative Cover	22,000	
• Perimeter Runoff Channel - Excavate and Construct	5,900	
• Security Fence and Warning Signs - Replace 1,000 Feet of Existing Fence and Post Signs	14,000	
SUBTOTAL CAPITAL COSTS	$1,482,500	
CONTINGENCIES (25%)	370,600	
TOTAL CAPITAL COSTS		$1,853,100
MONITORING COSTS		
Equipment		
• Initial Sampling Equipment Purchase - Year 1	$40,500	$40,500
• Sampling Equipment Replacement - Year 11	40,500	23,700
• Multi-level Well Replacement - Year 16	144,000	55,000
• Sampling Equipment Replacement - Year 21	40,500	14,500

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TABLE 10-3 (continued)

Sampling and Analysis		
• Quarterly Groundwater Sampling and Analysis for VOCs (Yrs. 1 - 2)	106,200/yr.	
- Present Worth for 2 yr. period at 5% Discount Rate		197,500
• Annual Groundwater Sampling and Analysis for VOCs (Yrs. 3 - 30)	26,550/yr.	
- Present worth for 27 yr. period at 5% Discount Rate, discounted to base yr.		358,800
• Annual Sediment Sampling and Analysis for PCBs, SVOCs, Metals (Yrs. 1 - 30)	4,150/yr.	
- Present Worth for 30 yr. period at 5% Discount Rate		63,800
ANNUAL OPERATING COSTS		
• Weekly Security Visits	$2,500/yr.	
• Semi-annual Site Visits	2,200/yr.	
• Semi-annual Mowing	1,200/yr.	
TOTAL ANNUAL OPERATING COSTS	5,900/yr.	
PRESENT WORTH - 30 YRS. AT 5% DISCOUNT		$90,700
FIVE YEAR REVIEW COSTS		
• Data Analysis and Report Writing	$10,000	
• Public Meeting	4,000	
TOTAL FIVE YEAR REVIEW COSTS	$14,000	
PRESENT WORTH - ASSUME 6 REVIEWS OVER 30 YRS. AT 5% DISCOUNT		$39,000
EQUIPMENT REPLACEMENT COSTS		
• Site Security Fence (Year 16)	$44,000	$20,200
PRESENT WORTH OF ALTERNATIVE		$2,756,800

10.3.7 Compliance with ARARs

Chemical-specific ARARs for SC-2 include the federal and state regulations pertaining to particulate emissions (CAA 40 CFR 40.0, DEQE 310 CMR 6.00-8.00). These ARARs will be attained during remedial actions by controlling fugitive dust generated from construction equipment with water sprays or chemical dust suppressants. Specific procedures used to abate dust generation will be specified in the remedial design.

Location-specific ARARs for this alternative can be separated into two groups: the federal and state Wetlands Regulations (CWA 40 CFR 230, DEQE 310 CMR 10.00) Facility Location Standards (RCRA 40 CFR 264.18, 990 CMR 1.00). Under Alternative SC-2, site soils would be contained and further erosion of PCB-contaminated site soils would be stopped. This will attain wetland ARARs in part by preventing further contaminant transport to these wetlands areas. Relevant and appropriate federal and state facility location standards (RCRA 40 CFR 264.18, 990 CMR 1.00, respectively) will be attained as the cap will not be constructed within the 100-year floodplain of the unnamed stream.

Action-specific ARARs associated with this alternative include RCRA facility regulations, OSHA safety regulations, and DEQE Hazardous Waste Regulations. In addition, the State of Massachusetts has separate right-to-know regulations, as follows:

- DPW - Hazardous Substance Right to Know (105 CMR 67)
- DOI - Hazardous Substance Right to Know (441 CMR 21)
- DEQE - Hazardous Substance Right to Know (310 CMR 33)

These regulations are applicable to the implementation of the site cap and will be attained during remedial action.

RCRA, OSHA, and DEQE Hazardous Waste ARARs will be attained because the criteria specified in these regulations will be used as standards during remedial design. TSCA regulations will be attained by this alternative because the contaminated soil will not be removed from original disposal site.

Table 2 in Appendix F outlines the chemical-, location-, and action-specific ARARs for this alternative and specifies the corresponding remedial action that will be required to attain the specific ARARs.

10.3.8 Overall Protection of Human Health and the Environment

Capping the site would result in decreased risk to both human health and the environment. The cap would provide a barrier for reducing exposure to both humans and terrestrial organisms, and would prevent the future migration of PCBs off-site.

The cap would also prevent precipitation from recharging the aquifer beneath the site. This is expected to shut off the seeps discharging to the tributary just north of Hathaway Road, thereby effectively reducing any potential risks to aquatic biota in the stream segment north of the site. Risks from groundwater ingestion would not be mitigated by the cap and would remain at 10^{-1}, assuming maximum exposure to on-site groundwater.

10.4 ALTERNATIVE SC-3: IN-SITU VITRIFICATION OF SOILS

10.4.1 Description

The SC-3 alternative involves vitrifying contaminated soil in situ. Treatment quantities are estimated at 6,550 to 68,250 cy for a 10^{-4} to 10^{-6} residual carcinogenic risk level, respectively, with contamination depths ranging from 3 to 9 feet (see Section 6.2.3.2). This alternative would meet the following SC response objectives:

- mitigate the continued release of hazardous substances to the unnamed stream, Middle Marsh, and Apponagansett Swamp
- reduce risks to human health associated with direct contact with and accidental ingestion of contaminated soils
- reduce the volume, toxicity, and mobility of soil contaminants
- reduce risks to terrestrial life associated with direct contact with contaminants in the soils.

Premobilization activities would involve clearing/grubbing of vegetated areas, rough grading of contaminated surface zones to provide a level surface for ISV equipment, and installation of a commercial electrical hook-up to provide a power source. These operations would be performed as part of site preparation work, as discussed in Section 10.1.

ISV of hazardous waste is an innovative technology; currently, the only vendor for this technology is Battelle Pacific Northwest Laboratories (BPNL). Once site preparation is

complete, BPNL would mobilize a fabricated ISV unit on-site. The BPNL unit consists of three process trailers and an off-gas hood (Figure 10-5) and is capable of vitrifying an approximate 625-square-foot area in a single setting, with meltdown proceeding at a rate of four to five tons per hour. Such a system contains the following components (Buelt, et al., 1987):

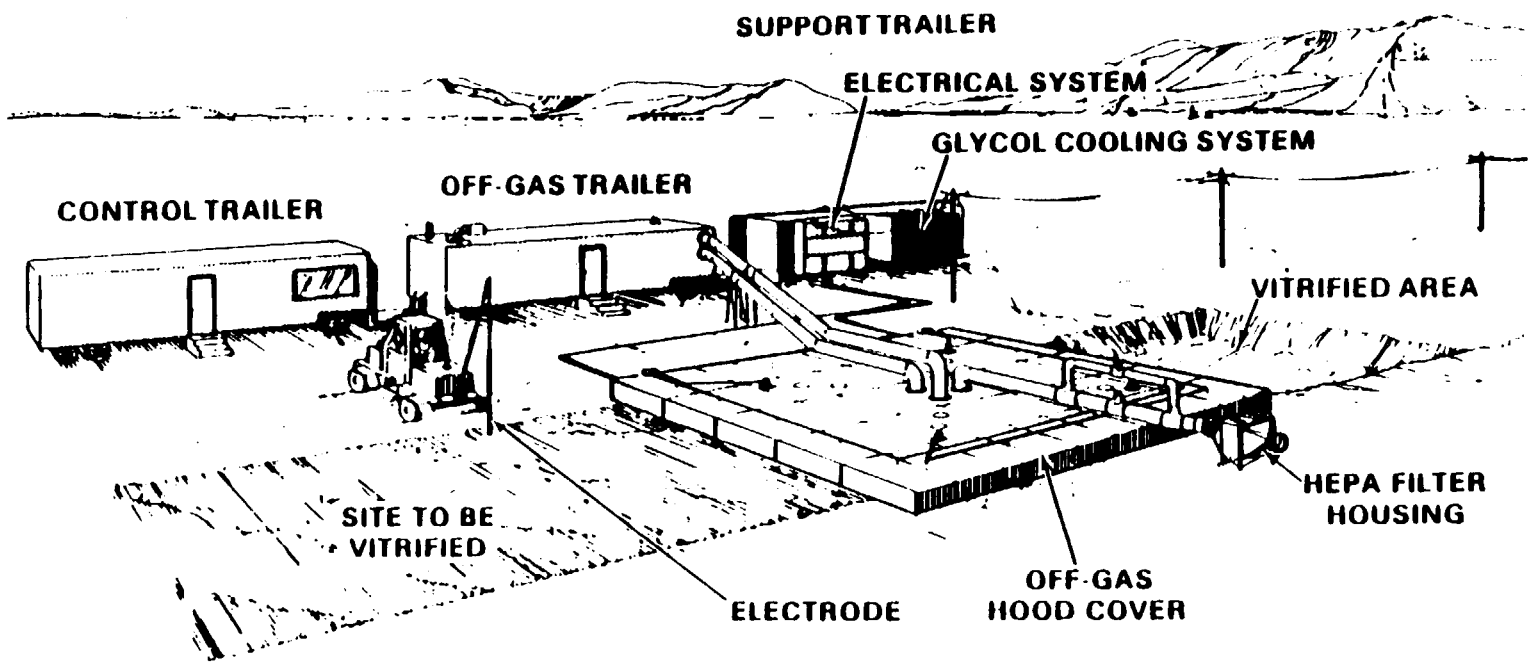
- Power System. Consists of a Scott-Tee transformer connection, which converts three-phase power to two single-phase loads. Multitude voltage taps provide a maximum 3,750 kW power output.
- Off-gas Hood. Stainless steel construction, 550°C skin design temperature. A fiber skirt surrounds the hood and maintains a seal between the hood and the soil surface during processing.
- Off-gas Treatment System. Cools, scrubs, and filters gases exhausted from the hood. Composed of a gas cooler, two wet scrubber systems, two heat exchangers, two process scrub tanks, two scrub solution pumps, a condenser, three mist eliminators, a heater, a particulate air filter, and a blower system.
- Glycol Cooling System. Consists of two fan-cooled radiator systems that remove 1,600 kW at a 38°C ambient temperature.
- Process Control Station. Monitors and controls important process parameters and activates backup equipment during systems failure.
- Off-gas Support Equipment. Provides electrical, water, and air requirements. Equipment includes a transformer, a diesel generator, an air compressor, and a process water supply tank with pump and agitator.

The average processing operation would take 40 to 100 hours for a 3- to 9-foot depth, respectively. Once one sector has been vitrified, the trailers and hood would be moved to the next processing position. Moving takes about 16 hours. Assuming a 70-hour average processing time and a 140-cy average volume per setting, 2 to 6 years would be required to complete site remediation for a 10^{-4} to 10^{-6} target risk level, respectively.

10.4.2 Short-term Effectiveness

The nearby community would not be at risk during on-site processing. Contaminated soils would be treated in situ,

FIGURE 10-5
SCHEMATIC DIAGRAM
ALTERNATIVE SC-3: IN-SITU VITRIFICATION OF SURFACE SOILS



thereby eliminating risks associated with excavation, especially air quality impacts due to contaminated dust particles. Accidental exposure could occur if uncontrolled venting or an off-gas line breach were to occur. In such cases, the continuous monitoring microprocessor would automatically shut down the system to minimize quantities of off-gas released to the atmosphere.

Occupational risks would be posed to workers during the following activities: (1) observing the melt, (2) working in the off-gas treatment trailer, (3) placing the electrodes, (4) placing the hood, and (5) draining and flushing the off-gas system scrub solution tanks. In addition, high voltage lines would pose a danger to on-site personnel. Proper personal protective equipment would be specified for each activity in order to meet OSHA requirements.

The cooling vitrified mass would pose a short-term risk to injury (i.e., burns) for about a year until it completely cools. Accidental injury to workers and unauthorized intruders could be minimized by covering the hot mass with 2 to 3 feet of backfill. Biweekly site observation visits would be necessary during the cooling period (i.e., until approximately one year after treatment) and would be discontinued once temperatures have dropped to below 120°F or other predetermined temperature.

Overall protection achievement time is estimated at 2 to 6 years for a 10^{-4} and 10^{-6} residual carcinogenic risk level, respectively. This assumes that equipment would be fabricated during the site preparation operations. The schedule breakdown is as follows:

- Site preparation — 1 year
- Bench-scale test — 2 months
- Mobilization of ISV equipment — 2 months
- Equipment operation training — 1 month
- Trial run — 2 months
- Full-scale processing — 5 months to 4 years

10.4.3 Long-term Effectiveness and Permanence

The ISV technology has achieved a DRE of greater than 99.9 percent for PCBs and other organic constituents (Buelt, et al., 1987). Residual organics concentrations within the vitrified mass are typically below present instrument detection limits. It is likely that treatment at the Sullivan's Ledge site would attain such performance standards because of favorable site conditions (i.e., the overburden fill is not more than 10 feet deep in contaminated zones and contains 34-percent silicon). Silicon is necessary for a good meltdown.

Some untreated soils would remain on-site; contaminant migration could continue via runoff. This may pose chronic risks to aquatic biota in the unnamed stream, therefore, long-term annual sediment monitoring would be instituted. Long-term monitoring or management of the vitrified mass itself would not be required after cool down is complete as treatment is permanent and irreversible.

The vitrified mass could complicate a future soils remedial action if zones of contamination (either surface or subsurface) initially undetected were determined to require removal and/or treatment. The mass would be difficult to excavate and would pose an almost impenetrable barrier to subsurface soils. Additionally, the mass would hinder future monitoring operations (e.g., test pitting, well installation).

10.4.4 Reduction of Toxicity, Mobility, or Volume

As a permanent treatment technology, ISV satisfied SARA's preference for permanent solutions. ISV would reduce the volume and toxicity of treated soil in direct proportion to processed quantities; preliminary specifications are to treat an estimated 6,550 to 68,250 cy of soil, a risk level reduction of 10^{-4} to 10^{-6}, respectively. Toxicity reductions are anticipated to be greater than 99.99 percent DRE for PCBs and other organics, achieved primarily through volatilization, pyrolysis, and combustion. Volatilized, unreacted organics, and other off-gases would be collected under the hood and eventually destroyed through off-site treatment of scrubber water. ISV would also reduce the mobility of inorganics (e.g., lead) through encapsulation within the glass matrix and significantly reduce mobility of organics.

10.4.5 Implementability

Implementation of ISV processing involves four steps. The first step is the insertion of four electrodes into the overburden soil; one electrode at each of the four corners of a 25- by 25-foot square array. Electrodes would be set into the soil down to bedrock or to a maximum depth of 10 feet and a conductive path created between them by placing a graphite and glass frit mixture on the soil surface. Next, the off-gas hood is set in place over the electrodes and sealed to the soil surface. Lastly, 3,500 kW of electricity is passed through the electrodes to heat the graphite/glass starter path to 3,600°F. This causes the surface soil to melt. Because current is continuously supplied, meltdown proceeds downward, consuming soil and producing a vitrified mass. After power is turned off, meltdown ceases and the vitrified mass cools, eventually forming a chemically inert, stable glass product.

Technical Feasibility. Installation of an electrical hook-up capable of supplying a continuous 3,500 kW would require some cable work along Hathaway Road. Commonwealth Electric of Massachusetts has been contacted to assess the feasibility of installing a commercial hook-up at this site. Commonwealth Electric has visually observed the nearest substation and believes existing equipment can handle the load. However, one mile of transmission line along Hathaway Road would have to be installed to carry the load.

Operational performance may be affected by process controlling factors, the most significant being soil moisture. Saturated soils and/or the uncontrolled influx of overburden groundwater could lead to increased processing time. If necessary, hydraulic barriers or wells could be used to lower the watertable to below the electrode depth. It should be realized that soil moisture is an economic factor, not a process impediment (Buelt, et al., 1987). High moisture content or saturation would not affect the ISV overall performance, but only increase processing times and power requirements.

Downtime is anticipated at 20 percent of total processing time. This would account for regular maintenance and equipment moving time, as well as unplanned shutdowns. During processing, depth sensors mounted below one or more of the electrodes would be used to monitor downward migration of the vitrification zone over time.

Administrative Feasibility. The site is owned by the City of New Bedford; therefore, the lead agency (i.e., EPA) would have to establish and maintain communication with the city as well as the state. EPA has already established good rapport with the city and the state and is expected to have little difficulty coordinating the implementation of ISV technology at the site.

Availability of Services and Materials. Battelle Memorial Institute currently owns exclusive worldwide rights to ISV technology applied to hazardous waste sites. BPNL does not lease equipment or provide turnkey services, but does provide training and technical assistance to initiate startup of purchased units. ISV units are only available through fabrication. Fabrication would take approximately one year. ISV has been demonstrated through field-testing for some applications; however, engineering or pilot-scale tests would have to be performed to adapt ISV technology to specific waste site characteristics and to provide necessary data for process scale-up. BPNL can provide turnkey services for such tests, and can arrange for equipment fabrication of a full-scale unit, mobilize the unit, train equipment operators, and provide continued technical assistance during and after startup.

10.4.6 Cost

Total remedial action costs range from $4.4 million to $29.8 million over a 10^{-4} to 10^{-6} target clean-up range, respectively (Table 10-4).

Equipment charges are based on an initial capital cost of $1.34 million, distributed over the useful life of the equipment. A fixed-charge rate of 0.145 was applied, giving an annual equipment cost of $194,000. The fixed-charge rate is a function of capital, equipment life, tax rates, depreciation, and tax credit allowances (Buelt, et al., 1987). Energy costs assume $0.075 per kilowatt hour, as quoted by Commonwealth Electric Company of Massachusetts, and are the single largest expenditure. Electrode expenditures assume that electrodes are not reusable from setting to setting, but that new electrodes must be used. Costs for wastewater treatment of scrubber water assume a rate of $0.35 per gallon and include transportation to and treatment at CECOS of Bristol, Connecticut.

Short-term monitoring costs assume biweekly site visits for the first year (i.e., during cool down of the vitrified mass). Sampling costs assume five samples per sampling event on an annual basis.

10.4.7 Compliance with ARARs

Chemical-specific ARARs for ISV of the site soils are primarily related to air emissions from the construction activities and from the ISV process. Federal and state regulations pertaining to these air emissions include the federal National Air Quality Standards (40 CFR 40) and the Commonwealth of Massachusetts DEQE - Air Quality Regulation (310 CMR 6.00-8.00). These ARARs will be attained during site remediation by off-gas treatment of the ISV process and fugitive dust control during site preparation activities.

Location-specific ARARs for this alternative can be separated into two groups: the federal and state wetlands regulations (CWA 40 CFR 230, DEQE 310 CMR 10.00) and the federal and state facility location standards (RCRA 40 CFR 264.18, 990 CMR 1.00). Under Alternative SC-3, site soils will be vitrified, preventing further soil erosion from the site. This will attain the wetlands-related ARARs in part by preventing additional PCB loading to wetlands areas.

The facility location standards specify that a hazardous waste facility cannot be constructed within a 100-year floodplain or adjacent to a wetland area. These ARARs will be attained by removing the contaminated soils within the 100-year floodplain of the unnamed stream, spreading the soils over other

TABLE 10-4

COST SUMMARY TABLE
SC-3: IN-SITU VITRIFICATION
OF SURFACE SOILS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

	COSTS		
	10^{-4} RESIDUAL RISK LEVEL	10^{-5} RESIDUAL RISK LEVEL	10^{-6} RESIDUAL RISK LEVEL
CAPITAL COSTS			
• Site Preparation	$1,280,000	$1,280,000	$1,280,000
• Equipment Charges - ISV Unit	$ 73,000	272,000	757,000
• Labor Charges - ISV Support Personnel	$ 658,000	2,450,000	6,825,000
• Electrodes - 4 Per Setting	$ 545,000	2,030,000	5,655,000
• Off-site Treatment of Scrubber Water	$ 9,000	33,000	91,000
• Reconduct Power Line along Hathaway Road	$ 40,000	40,000	40,000
• Energy - Commonwealth Electric Co.	$ 864,000	3,216,000	8,958,000
• Backfill and Revegetate Vitrified Zones	$ 17,000	69,000	194,000
• Biweekly Site Observation Visits for First Year	$ 10,000	10,000	10,000
SUBTOTAL CAPITAL COSTS	$3,496,000	$9,400,000	23,810,000
CONTINGENCIES (25%)	874,000	2,350,000	5,953,000
TOTAL CAPITAL COST	$4,370,000	$11,750,000	$29,763,000
MONITORING COSTS			
• Annual Sediment Sampling - 5 Samples with Analysis for PCBs, SVOCs, Metals	$ 4,150/yr.	$ 4,150/yr.	$ 4,150/yr.
PRESENT WORTH MONITORING COSTS - ASSUME 30 YEAR PERIOD AND 5% DISCOUNT RATE	$64,000	$64,000	$64,000
FIVE YEAR REVIEW COSTS			
• Data Analysis and Report Writing	$10,000/5 yrs.	$10,000/5 yrs.	$10,000/5 yrs.
• Public Meetings	4,000/5 yrs.	4,000/5 yrs.	4,000/5 yrs.
TOTAL FIVE YEAR REVIEW COSTS	$14,000/5 yrs.	$14,000/5 yrs.	$14,000/5 yrs.

TABLE 10-4 (continued)

PRESENT WORTH REVIEW COSTS - ASSUME 6 REVIEWS OVER 30 YEAR PERIOD AND 5% DISCOUNT RATE	39,000	39,000	39,000
PRESENT WORTH OF ALTERNATIVE (Total Capital, Present Worth Monitoring, and Present Worth Review Costs)	$4,473,000	$11,853,000	$29,866,000

contaminated areas, and vitrifying them in-place within the other soils.

Action-specific ARARs pertinent to ISV include RCRA facility and incinerator regulations, TSCA regulations, OSHA safety regulations, the Clean Water Act, and DEQE hazardous waste regulations.

In addition to these regulations, the State of Massachusetts has three separate right-to-know regulations:

- DPW - Hazardous Substance Right to Know (105 CMR 67)
- DOI - Hazardous Substance Right to Know (441 CME 21)
- DEQE - Hazardous Substance Right to Know (310 CMR 331)

The right-to-know regulations are applicable to the implementation of Alternative SC-3 and will be attained during remedial action.

The RCRA, OSHA, CWA, and DEQE hazardous waste regulations will be attained because the requirements specified in these regulations will be used as design standards during remedial design. Under this alternative, placement/disposal would not occur since contaminated soil has not been identified within the 100-year floodplain of the unnamed stream. Thus, no processing of soils is planned within floodplain areas.

ISV is an innovative treatment technology. ISV is believed to comply with TSCA by achieving a level of performance equivalent to incineration. This would need to be verified by pilot tests prior to full-scale implementation.

Table 3 in Appendix F describes the chemical-, location-, and action-specific ARARs for this alternative. Table 3 also specifies the corresponding remedial action required to attain each ARAR.

10.4.8 Overall Protection of Human Health and the Environment

The ISV process will reduce residual carcinogenic risks to less than 10^{-4} (i.e., 463 ppm PCBs, 310 ppm PAHs) and 10^{-6} (i.e., 4.5 ppm PCBs, 3.0 ppm PAHs) depending on the treatment volume. The ISV process combusts organics such as PCBs, PAHs, and VOCs and effectively reduces the mobility of lead. Since PCBs and PAHs are the contaminants of concern in the soils and occur in the highest concentrations, the ISV process will greatly reduce the risks via direct contact and/or ingestion of soils.

The permanent destruction of the on-site soil PCBs would halt further migration to the unnamed stream, Middle Marsh, and Apponagansett Swamp, thereby reducing impacts to the environment.

10.5 ALTERNATIVE SC-4: SOLIDIFICATION OF SURFACE SOILS

10.5.1 Description

The SC-4 alternative proposes to encapsulate soil contaminants within a solidified matrix using a mobile solidification unit. The objective would be to immobilize PCBs, PAHs, lead, and other soil contaminants within the matrix to prevent future migration. The overall process consists of excavation, on-site solidification, and on-site disposal, and is depicted on the alternative component diagram (Figure 10-6). Solidification would be initiated following site preparation.

Solidification of waste material is a fairly established technology, having been in use for approximately 20 years. Recently, solidification has been applied to soils and sediments in bench and pilot scale applications. Its effectiveness in limiting leaching of PCBs and certain metals has been demonstrated in laboratory tests. Hazardous waste applications typically involve blending contaminated soil or sludge with an inorganic cementitious additive such as Portland cement, kiln dust, fly ash, lime, or lime kiln dust to facilitate encapsulation of the hazardous constituents. Encapsulation results from a reaction (i.e., aluminous and siliceous compounds that harden in the presence of lime), whereby the cement-like additive forms chemical crystalline structures. These interlocking structures surround contaminants and, after curing, form stable, impermeable matrices that inhibit contaminant mobility.

On-site solidification operations consist of three standard methods: (1) in-situ mixing for small, easily-mixed quantities; (2) completely mobile, trailer-mounted units with feed rates up to 250 tons per hour for larger-sized jobs (i.e., up to 100,000 tons); and (3) semi-stationary processing plants for large volumes of wastes (i.e., over 100,000 tons). Based on the estimated 6,550 to 68,250 cy of contaminated soils to be treated, a trailer-mounted, mobile unit would be most suitable for the site. The SC-4 alternative, as depicted in the alternative process flow diagram (Figure 10-7), would consist of the following primary components:

- excavate 1,500 tons per day of soil, fill, debris
- screen out an estimated 500 tons per day of bulk debris

FIGURE 10-6
SCHEMATIC OF ALTERNATIVE SC-4
SOLIDIFICATION OF SURFACE SOILS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

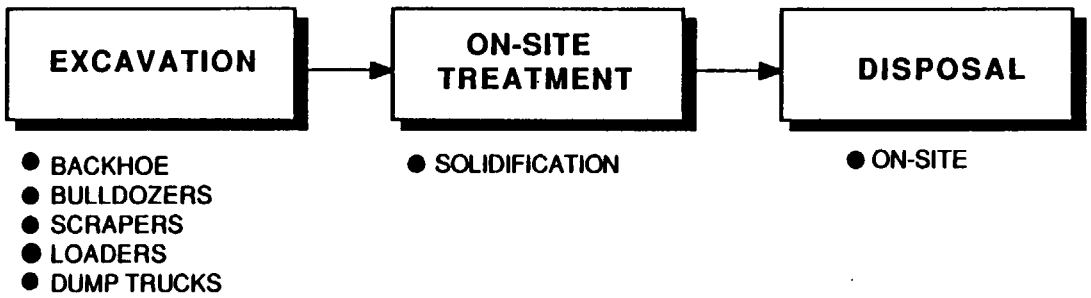
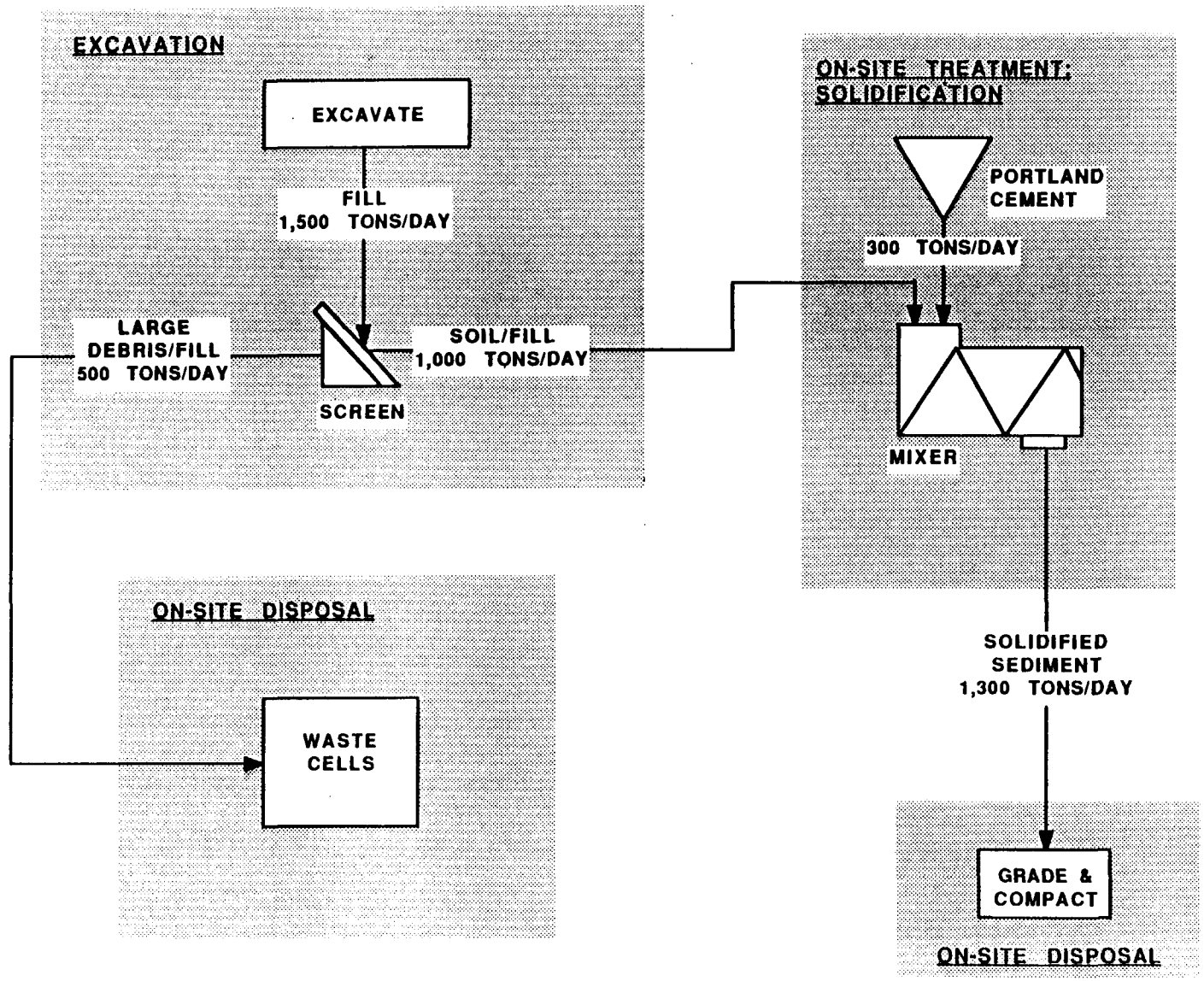


FIGURE 10-7
PROCESS FLOW DIAGRAM
ALTERNATIVE SC-4: SOLIDIFICATION OF SURFACE SOILS



- solidify 1,000 tons per day of loose soil, fill
- grade and compact 1,300 tons per day of treated material
- dispose 500 tons per day of bulk debris within the solidified monolith

Excavation, screening, solidification, and on-site disposal would be performed concurrently. The mobile solidification unit would be located in the contractor's area (see Figure 10-1).

Equipment, such as hydraulic excavators, bulldozers, loaders, and a mechanical screener would be used to perform operations prior to solidification. The screener would remove bulk debris (e.g., boulders, timbers, tires, concrete rubble) that may jam the mixer.

Estimated two-thirds by weight (i.e., 1,000 tons per day) of excavated material is expected to pass through screening. This material would be loaded into waste-feed hoppers with a loader and conveyed to the pug mill solidification mixer. The mixer would combine the feed material with a cementitious admixture to produce a damp, granular, easily handleable, soil-like material. The damp product would likely be stockpiled temporarily while excavated zones are backfilled; it can remain unconsolidated for seven to ten days before hardening. The treated soils would be graded and compacted over the site surface and allowed to cure. Compacted material must be kept above the water table to minimize potential contaminant remobilization. Once cured, the treated soil would resemble a concrete slab and would exhibit increased load bearing characteristics, low permeability coefficients, and low leachability characteristics.

The remaining one-third (i.e., 500 tons per day) of the excavated material would consist of bulk debris. These debris would be contained within waste cells formed out of compacted soilidified product. Individual waste cells could be constructed within excavated zones or on top of the existing ground level. This type of configuration is a procedure used by solidification vendors and would effectively contain bulk debris on-site while eliminating costly (i.e., $425 per cubic yard) off-site disposal.

Additionally, a cap would be placed over the solidified monolith for protection against freeze/thaw and wet/dry cycles and to minimize perception infiltration. The cap would have to be thicker than the frost depth (i.e., approximately 48 inches). A multi-layer cap as depicted in Figures 10-3 and 10-4 would meet such requirements.

Solidification of surface soils is anticipated to meet the following SC response objectives:

- Reduce releases of hazardous substances to the unnamed stream, Middle Marsh, and Apponagansett Swamp.
- Reduce risks to human health associated with direct contact with and accidental ingestion of soil contaminants.
- Reduce the mobility of surface soils contaminants.
- Reduce risks to terrestrial life associated with contact with surface soils.

10.5.2 Short-term Effectiveness

PCBs and PAHs adsorbed to airbone dust particles and VOCs could potentially pose a health risk to the community during excavation. The site soil/fill is devoid of organic matter, has low moisture content and, therefore, is likely to create dust if disturbed. The Whaler Motor Inn, Rosies's Cafe, Whaling City Country Club, and Scrub-a-Dub car wash would be within range of airborne dust particles. Human receptors in these areas would be susceptible to inhalation exposure. On-site workers would also be at risk to airborne contaminant concentrations and to dermal contact with contaminated soils. Potential worker exposure could be controlled through careful planning and adherence to strict health and safety procedures. Inhalation exposure risks could be controlled by instituting dust control measures such as watering down work areas and applying dust suppressants (e.g., magnesium chloride) to haul roads.

On-site soils processing is not anticipated to adversely affect the environment. Surface runoff would be collected in the proposed sedimentation pond, thereby reducing loading to the unnamed stream. Atmospheric dispersion would likely decrease contaminant concentrations to levels which would not impact the surrounding ecosystem.

Soils processing time, including bench-scale testing, mobilization of equipment, excavation, solidification, and on-site disposal is estimated at five to eight months, assuming processing of 1,500 tons per day of excavated fill, soil, and debris. Additionally, site preparation would require one year, and installation of a cap would take one to two years. This sums to a total remediation time of 2.5 to 3.5 years. Individual task breakdowns are as follows:

- site preparation — 1 year
- bench-scale study — 2 months
- mobilization — 1 month
- solidification of soil/fill; on-site disposal of treated product and bulk debris — 1 to 4 months
- Installation of cap — 1 to 2 years

10.5.3 Long-term Effectiveness and Permanence

The long-term effectiveness of the solidified matrix at immobilizing PCBs and PAHs is uncertain largely due to limited available information. A U.S. Army Corps of Engineers'(USACE) study performed on New Bedford Harbor sediments resulted in a 70- to 90-percent PCB leachability reduction for solidified sediments as compared to untreated sediments (Myers, 1987). It is uncertain whether the Sullivan's Ledge soils will behave in a similar fashion to these sediments since differences exist in physical characteristics and contaminant concentrations between the site soils and the tested sediments. Long-term effectiveness will be better understood following bench-scale testing.

Treatment of 6,550 cy of contaminated soil will reduce the residual carcinogenic risk to less than 10^{-4} (i.e., 463 ppm PCBs, 310 ppm PAHs) and treatment of 68,250 cy will reduce the risk to less than 10^{-6} (i.e., 4.5 ppm PCBs, 3.0 ppm PAHs). The cap would further reduce residual risks by isolating both treated and untreated soils, thereby mitigating dermal contact and ingestion exposure risks. In addition, the mobility of on-site soils will be significantly reduced, thus preventing, for all practical purposes, additional PCB loading to the unnamed stream. However, annual sediment monitoring would be performed to detect contaminant releases into the stream.

If the cap were to fail, PCBs and PAHs in untreated soil may pose a dermal contact or ingestion exposure risk and may migrate into the unnamed stream. Cap failure may occur from subsidence in time due to the increased weight of the cap over fill materials. However, if the monolith were to fail, PCBs would be expected to sorb to fine particles and become "immobile for all practical purposes", (Dragun, 1988). PAHs are also expected to sorb to soil particles.

Upholding the integrity of the cap would maintain the long-term effectiveness of the alternative, regardless of the long-term durability of the monolith. The integrity of the monolith and cap is expected to remain for 20 to 30 years.

10.5.4 Reduction of Toxicity, Mobility, and Volume

Solidification is expected to significantly reduce the mobility of PCBs and PAHs, but not the toxicity of the soil. Solidification would also increase the volume of treated soils by 10 to 30 percent. Although, mobility reductions are not expected to be permanent, the integrity of the monolith/cap combination is expected to remain for a minimum of 20 to 30 years.

10.5.5 Implementability

Technical Feasibility. The SC-4 alternative would be implemented by contracting the services of a solidification vendor. Such a vendor would be responsible for the entire soils solidification remedial action, including excavation, screening, solidifying, and on-site disposal of the treated product and debris. Table 10-5 lists 19 vendors who provide full-scale solidification services.

Solidification using a trailer-mounted, mobile unit would be technically feasible at the site. Such units are fully transportable and could be hauled on interstate highways by a tractor-trailer truck. Units are completely self-sufficient and would require no additional construction once brought on-site. Operational reliability has been demonstrated over the past decade through routine operations performed at landfills. Over that time, vendors have developed process controls to maintain a consistent product that achieves performance goals. Prior to full-sale operation, a bench-scale study would be performed to identify and clarify various operating parameters, the most important of which is the appropriate admixture-to-soil ratio. Once determined, an automated weighing system, designed as part of the mobile mixer, would control the admixture feed to maintain the proper mixture.

Monitoring considerations would include monitoring mixer holding times, waste-feed and admixture-feed rates, and testing the end-product against set performance standards. Other short-term monitoring functions would involve routine ambient air monitoring and taking core samples of the monolith as it cures.

Inherent downtime is estimated at 20 percent. However, this downtime is accounted for in design (i.e., assume a 10-hour work day with eight hours operation time) and would not affect performance standards or cause schedule delays.

The initiation of a future remedial action could be complicated by the hardened monolith. The monolith may be difficult to excavate due to its concrete-like nature and may require blasting.

TABLE 10-5

VENDOR LIST: ON-SITE SOLIDIFICATION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

Chemfix Technologies, Inc.
Metairie Center, Suite 620
2424 Edenborn Avenue
Metairie, Louisiana 70001
Attn: John Foster
(504) 831-3600

Chemical Waste Management, Inc.
3003 Butterfield Road
Oak Brook, Illinois
(312) 654-8800

Enreco, Inc.
P.O. Box 1536
Baltimore, Maryland 21203
Attn: Steven Erlanson
(301) 576-8819

Envirite Field Services
600 West Germantown Pike
Suite 221
Plymouth Meeting Executive Campus
Plymouth Meeting, Pennsylvania 19462
(215) 939-0700

Environmental Management and
Engineering, Inc.
1305 21st Street, South
P.O. Box 55953
Birmingham, Alabama 35255
(205) 939-0700

ACES
800 East Eighth Ave.
King of Prussia, Pennsylvania 19406
Attn: John Colussi
(215) 962-0800

Geo-Con, Inc.
P.O. Box 17380
Pittsburgh, PA 15235
Attn: Jeffrey J. Goldin
(412) 856-7700

GSX Chemical Services, Inc.
P.O. Box 210799
121 Executive Center Drive
Congaree Building
Suite 100
Columbia, SC 29221
(803) 798-2993

Haytex International
Corporation
P.O. Box 7313
Alexandria, Virginia 22307
(703) 922-9800

Hazcon, Inc.
P.O. Box 947
Katy, Texas 77492
(713) 391-1085

Haztech
5280 Panola Industrial Boulevard
Decatur, Georgia 30035-4013
(404) 981-9339

International Waste Technologies
807 North Waco
Suite 31
Wichita, Kansas 67203
(316) 262-1338

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TABLE 10-5 (continued)

VENDOR LIST: ON-SITE SOLIDIFICATION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

Lopat Industries, Inc.
1750 Bloomsburg Avenue
Building No. 1
Wanamassa, New Jersey 07712

SolidTek
P.O. Box 888
5371 Cook Road
Morrow, Georgia 30260

Mineral By-Products, Inc.
777 Franklin Road
Marietta, Georgia 30067

Toxic Treatment (USA), Inc.
901 Mariner's Island Boulevard
Suite 315
San Mateo, California 94404
Attn: John Williams
(415) 572-2994

Silicate Technology Corporation
7505 East Main Street
Scottsdale, Arizona 85251
(602) 945-9789

VFL Technology Corporation
42 Lloyd Avenue
Malvern, Pennsylvania 19355
Attn: Emlyn Webber
(215) 296-2233

Soliditech, Inc.
6901 Corporate Drive
Suite 215
Houston, Texas 77072
(713) 778-1800

Administrative Feasibility. The site is owned by the City of New Bedford; therefore, the lead agency (i.e., EPA) would have to establish and maintain communication with the city as well as the state. EPA has already established good rapport with the city and the state and is expected to have little difficulty in coordinating the implementation of the SC-4 alternative. No permits would be required as operations would be performed on-site.

Considerable long-term institutional management would be associated with this alternative because wastes would remain on-site. The lead agency would be required to initiate site reviews every five years. Site visits, sampling events, and public educational programs (e.g., public meeting, workshops) would require administrative and regulatory participation.

Availability of Services and Materials. Turnkey services would be readily available, as indicated by the vendor list presented previously (see Table 10-5). The listed vendors are experienced in remedial action projects and would be responsible for excavation and on-site disposal, as well as solidifying the contaminated soil. Vendors typically request a minimum three-month lead time to schedule the mobilization of a mobile mixing unit. Mobile units are custom-built and would take a year to construct if a unit were not available at the time of implementation.

The vendor would perform a search to determine which cementitious admixtures are locally available and would be responsible for procuring process needs.

10.5.6 Cost

Table 10-6 presents estimated costs to remediate surface soils to an acceptable carcinogenic risk level. Calculated costs range from 2.54 to 8.23 million for a 10^{-4} to 10^{-6} carcinogenic risk level, respectively. Capital costs are calculated on a per/cy basis at $95/cy, the majority of which (i.e., $85/cy) is attributable to solidification. A 25-percent contingency is added to the capital costs to cover both engineering and unforeseen circumstances. A cap would cost an additional $1.85 million.

Annual operating costs are for semi-annual observation visits, semi-annual mowing of the vegetative cover, and annual sediment sampling. These costs are estimated at $7,550 per year.

10.5.7 Compliance with ARARs

Chemical-specific ARARs for solidification of site soils are primarily related to potential air emissions from construction

TABLE 10-6

COST SUMMARY TABLE
SC-4: SOLIDIFICATION OF SURFACE SOILS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

	COSTS		
	10^{-4} RESIDUAL RISK LEVEL	10^{-5} RESIDUAL RISK LEVEL	10^{-6} RESIDUAL RISK LEVEL
CAPITAL COSTS			
• Site Preparation	$1,403,000	$1,403,000	$1,403,000
• Excavate and Screen Surface Soils	$ 61,000	159,000	404,000
• Solidify Soils in Mobile Mixing Unit	$ 408,000	1,505,000	4,259,000
• On-site Disposal - Grade and Compact Treated Soil to Form Monolith	$ 38,000	140,000	394,000
SUBTOTAL CAPITAL COSTS	$1,910,000	$3,207,000	$6,460,000
CONTINGENCIES (25%)	478,000	802,000	1,615,000
TOTAL CAPITAL COSTS	$2,388,000	$4,009,000	$8,075,000
ANNUAL OPERATING COSTS			
• Semi-annual Site Visits	$ 2,200/yr.	$ 2,200/yr.	$ 2,200/yr.
• Semi-annual Mowing	1,200/yr.	1,200/yr.	1,200/yr.
TOTAL ANNUAL COSTS	3,400/yr.	3,400/yr.	3,400/yr.
PRESENT WORTH OPERATING COSTS - ASSUME 30 YEAR PERIOD AND 5% DISCOUNT RATE	$52,000	$52,000	$52,000
MONITORING COSTS			
• Annual Sediment Sampling - 5 samples with analysis for PCBs, SVOCs, Metals	$ 4,150/yr.	$ 4,150/yr.	$ 4,150/yr.
PRESENT WORTH MONITORING COSTS - ASSUME 30 YEAR PERIOD AND 5% DISCOUNT RATE	$64,000	$64,000	$64,000
FIVE YEAR REVIEW COSTS			
• Data Analysis and Report Writing	$10,000/5 yrs.	$10,000/5 yrs.	$10,000/5 yrs.
• Public Meetings	4,000/5 yrs.	4,000/5 yrs.	4,000/5 yrs.
TOTAL FIVE YEAR REVIEW COSTS	$14,000/5 yrs.	$14,000/5 yrs.	$14,000/5 yrs.

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TABLE 10-6 (continued)

PRESENT WORTH REVIEW COSTS - ASSUME 6 REVIEWS OVER 30 YEAR PERIOD AND 5% DISCOUNT RATE	$39,000	$39,000	$39,000
PRESENT WORTH OF ALTERNATIVE (Total Capital, Present Worth Operating, Present Worth Monitoring, and Present Worth Review Costs)	$2,543,000	$4,164,000	$8,230,000

activities and the solidification process. The federal and state regulations pertaining to these air emissions are the Federal National Air Quality Standards (40 CFR 40) and the Commonwealth of Massachusetts DEQE-Air Quality Regulation (310 CMR 6.00-8.00). These ARARs will be attained by fugitive dust control during site preparation and solidification activities.

Location-specific ARARs for this alternative can be separated into two groups: the federal and state Wetlands Regulations (CWA 40 CFR 230, DEQE 310 CMR 10.00) and the federal and state Facility Location Standards (RCRA 40 CFR 264.18, 990 CMR 1.00). Under Alternative SC-4, the site soils will be excavated and solidified, thereby preventing further erosion of contaminated soils from the site. This alternative will attain the wetlands-related ARARs in part by preventing additional PCB loading to the wetlands areas.

Facility location standards specify that a hazardous waste facility cannot be constructed with a 100-year floodplain or adjacent to a wetland area. These ARARs will be attained by removing the contaminated soils within the 100-year floodplain of the unnamed stream, solidifying with the other contaminated areas, and disposing of the solidified soils on-site outside of the 100-year floodplain.

Action-specific ARARs pertinent to solidification of the surface soils include RCRA facility and landfill regulations, TSCA regulations, the OSHA safety regulations, the Clean Water Act, and the DEQE Hazardous Waste Regulations.

In addition to these regulations, the State of Massachusetts has three separate right to know regulations, as follows:

- DPW-Hazardous Substance Right to Know (105 CMR 67)
- DOI-Hazardous Substance Right to Know (441 CMR 21)
- DEQE-Hazardous Substance Right to Know (310 CMR 33)

These regulations are applicable to the implementation of the SC-4 Alternatives and will be attained during remedial action.

RCRA, OSHA, CWA, and DEQE Hazardous Waste Regulation will be attained because the requirement specified in these regulations will be used as standards during remedial design. Since batch solidification processes constitute treatment, RCRA technical standards are relevant and appropriate. The final cover system placed over the solidified material will be designed and maintained according to RCRA closure/post-closure requirements.

Table 4 in Appendix F describes the chemical-, location-, and action-specific ARARs for this alternative. Table 4 also specifies the corresponding remedial action required to attain each ARAR.

10.5.8 Overall Protection of Human Health and Environment

Capping and soil solidification will effectively reduce the mobility of the contaminated soils, thereby reducing exposure to human health and the environment. The impermeable cap will add increased protection to both human health and the environment by isolating contaminated materials from direct contact or ingestion exposure. Aquatic biota would also benefit from the cessation in contaminant transport.

10.6. ALTERNATIVE SC-5: ON-SITE INCINERATION OF SURFACE SOILS

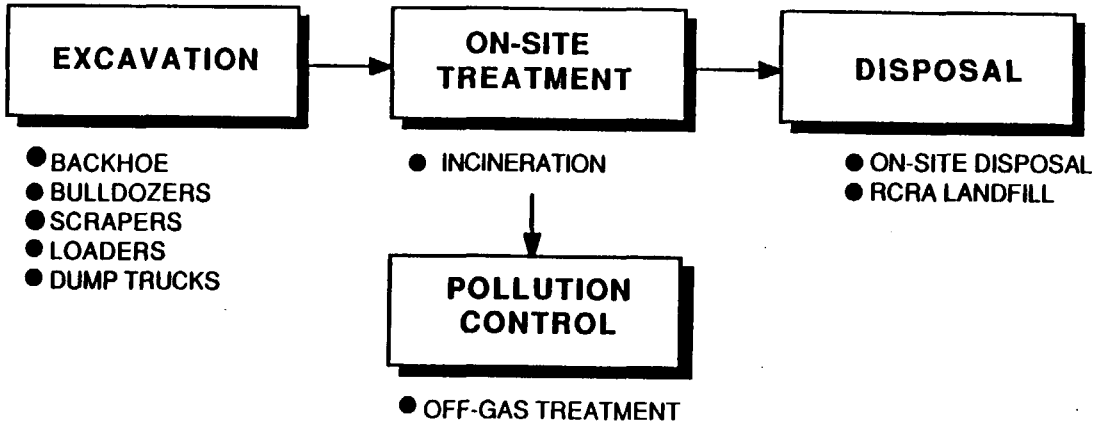
10.6.1 Description

The SC-5 alternative proposes incineration of contaminated soils to thermally destroy PCBs, PAHs, and other organic contaminants. Figure 10-8 presents the alternative component diagram. Between 6,550 to 68,250 cy of soils would be incinerated on-site with a transportable incineration system and would take from one to 3.5 years, respectively, for completion. Mobile incinerators typically process 50 to 150 tons per day. Incineration is a permanent treatment technology and is anticipated to meet the following response objectives:

- reduce releases of hazardous substances to the unnamed stream, Middle Marsh, and Apponagansett Swamp
- reduce human health risks via direct contact with contaminated and accidental ingestion of contaminated soils
- reduce the volume, toxicity, and mobility of soil contaminants
- reduce risks to terrestrial life associated with contact with surface soils

This alternative would involve preparing the site (as discussed in Section 10.1) followed by excavating soils; screening out excavated debris greater than 2 inches in diameter (e.g., granite blocks, tire, timbers); incinerating materials less than 2 inches in diameter; treating incinerator off-gases; and appropriately disposing incinerated soil and debris. The incinerator would be located in the contractor's area (see Figure 10-1)

FIGURE 10-8
SCHEMATIC OF ALTERNATIVE SC-5
ON-SITE INCINERATION OF SURFACE SOILS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS



Excavation and incineration would be performed concurrently. Excavated materials would be hauled to the on-site processing area where they would be screened and separated into two piles: (1) debris and fill greater than 2 inches in diameter; and (2) soil and fill less than 2 inches in diameter. Debris and fill greater than two inches in diameter (i.e., an estimated one-third of excavated material) would either be decontaminated or loaded into long distance haul vehicles and transported to an appropriate RCRA/TSCA landfill, as appropriate, if it were hazardous, or disposed on-site if non-hazardous. Material less than 2 inches in diameter would be incinerated on-site at a rate of 100 tons per day. Figure 10-9 depicts the proposed process design.

On-site incineration would involve one of three currently available technologies: rotary kiln, infrared, or fluidized bed. For the Sullivan's Ledge site, a rotary kiln incinerator is recommended. Rotary kiln incineration is advantageous over the other two configurations because of the higher number of rotary kiln units available, the rotary kiln's ability to handle the widest variety of waste feed characteristics, and the availability of published rotary kiln pilot studies including actual cost information.

A rotary kiln mobile incinerator consists of the following components:

- Solid waste feed system
- Rotary kiln combustion chamber
- Secondary combustion chamber
- Off-gas pollution control system

A dump hopper, conveyor, and kiln feed screws comprise the solid waste feed system. The feed system is designed to process 6 tons per hour of classified soil (i.e., less than 2 inches in diameter) introduced into the hopper with a front-end loader.

The rotary kiln is a cylindrical rotating combustion chamber that is refractory-lined and mounted slightly offset from horizontal. The rotational movement of the kiln provides maximum exposure to combustion air and helps move the feed material through the kiln. The burner is mounted above the feed inlet and is fueled by propane, natural gas, or fuel oil. The incinerator flame dries and heats the feed material to temperatures between 1,600 and 2,600°F; the actual operating temperature is determined by a trial burn. Figure 10-10 presents a schematic of the rotating combustion chamber.

The secondary combustion chamber receives off-gases from the rotary kiln and combusts them at a minimum temperature of 2,100°F. This chamber is stationary, vertically mounted, and

FIGURE 10-9
PROCESS FLOW DIAGRAM
ALTERNATIVE SC-5: ON-SITE INCINERATION OF SURFACE SOILS

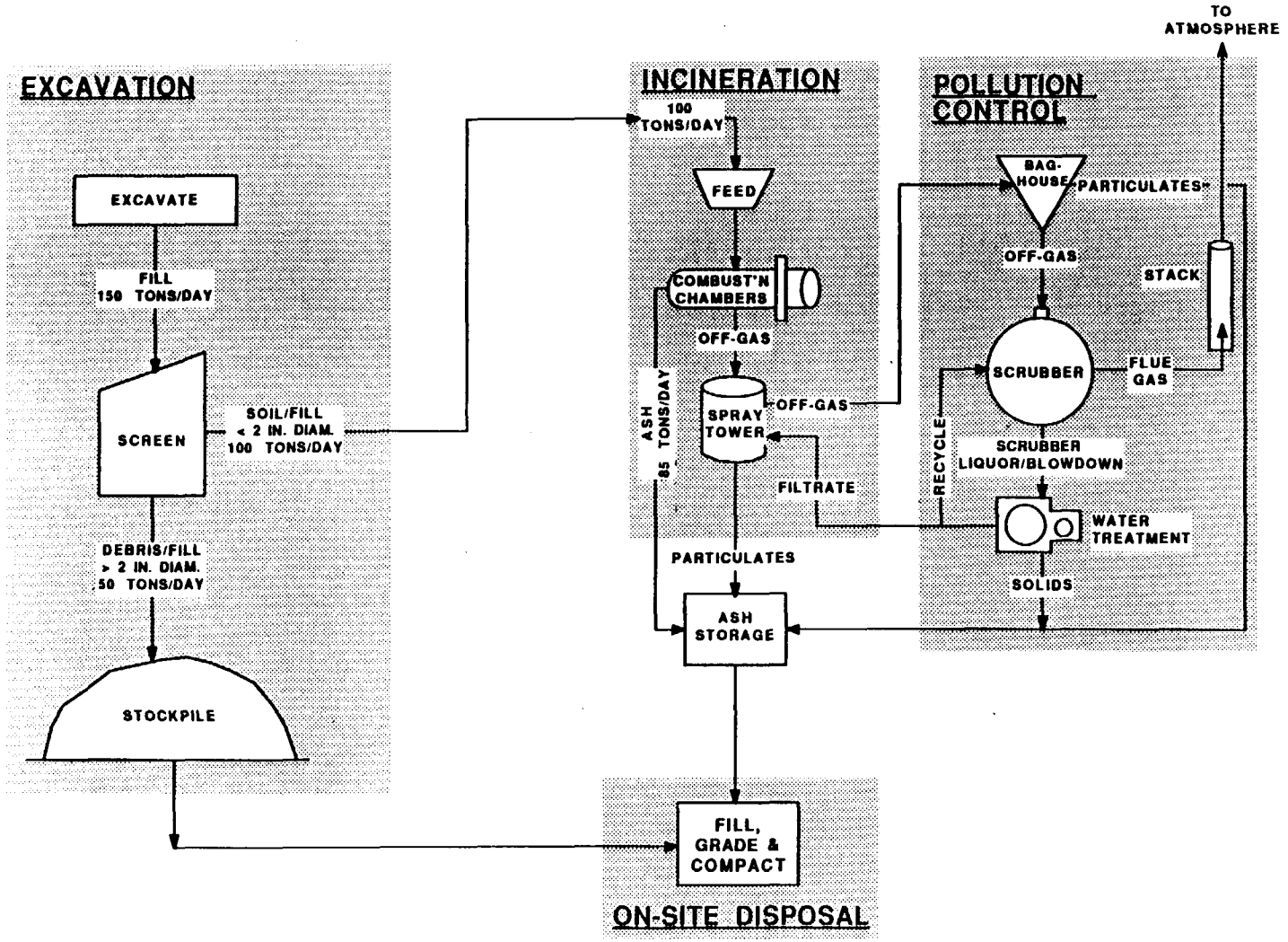
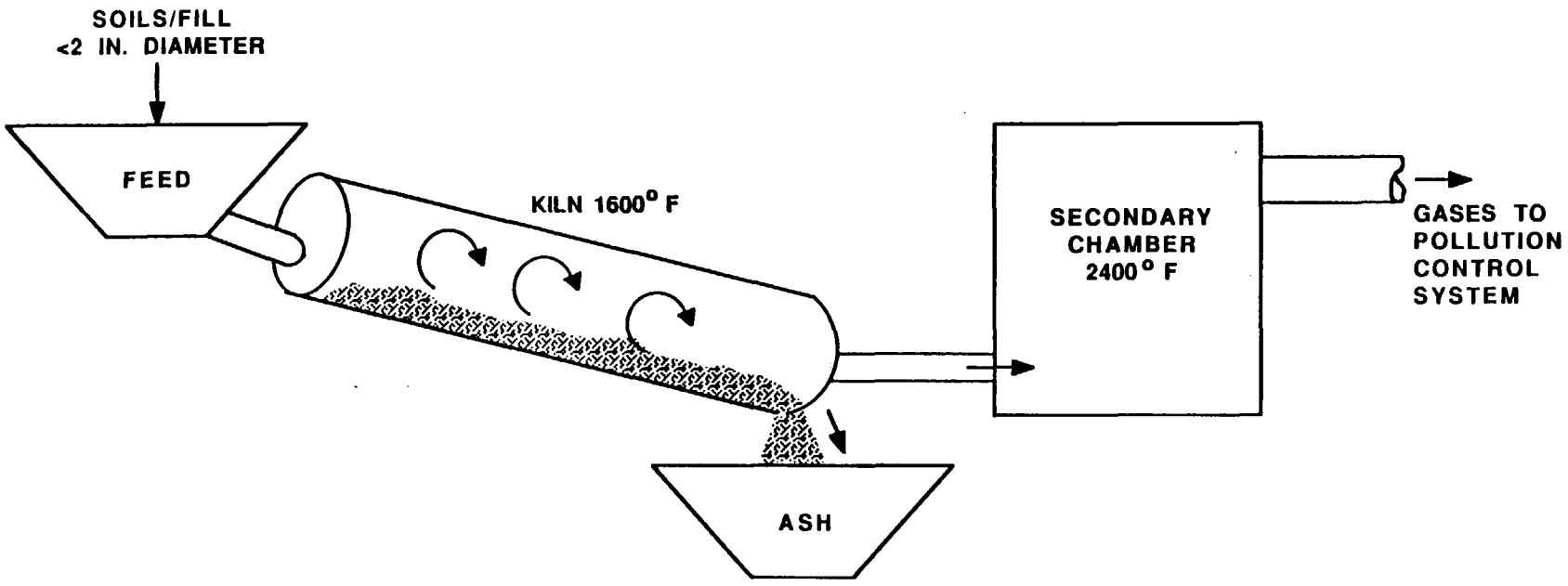


FIGURE 10-10
ROTARY KILN INCINERATOR
SCHEMATIC DIAGRAM



SOURCE: NBH DETAILED ANALYSIS OF REMEDIAL TECH. PP. 6-99

refractory-lined. It is designed with a minimum gas retention time of two seconds.

The off-gas pollution control system is designed to remove particulates and neutralize HCl and consists of a spray tower, baghouse, scrubber, and a scrubber liquor/scrubber blowdown water treatment process. The spray tower functions to reduce the temperature of off-gases to 1,000°F with a water spray. This cooling initiates particulate fallout. Additional particulates are removed as gases pass through a baghouse. The scrubber treats off-gas with a caustic solution to neutralize acidic gas components (i.e., HCl). Scrubber liquor is then treated and reused and scrubber blowdown water is filtered and used as makeup water for ash cooling and dust control. Scrubbergases are sent to a stack and discharged to the atmosphere (Janssen, et al., 1987).

10.6.2 Short-term Effectiveness

Mobile incinerators are equipped with state-of-the-art pollution control equipment. This equipment is necessary to control stack gas emissions to within ambient air quality standards (i.e., National Ambient Air Quality Standards (NAAQS), Massachusetts Ambient Air Levels (MAALs), and Threshold Limit Values (TLVs)). Compliance with air quality standards would minimize inhalation risks to workers and nearby residents to safe levels (as determined by the state and federal government). Furthermore, a trial burn would be performed prior to full scale operation to demonstrate achieval of all ARARs and RCRA and TSCA performance standards. The contracted vendor would be responsible for sampling feed soils, treated soils, scrubber water, baghouse particulates, and stack gas emissions, and providing mass balance calculations based on such measured data. These calculations would be checked by the lead agency before approval to proceed is granted. Based on prior performance testing, a mobile incinerator would comply with ARARs and thus, would not pose an unsafe human health risk to workers or the community.

However, workers involved in soil excavation and decontamination operations could be exposed to contaminants via dermal contact and/or the inhalation of dusts or volatilized organics. To minimize or prevent such exposure, dust control measures and air monitoring for particulates and organic compounds, and personal protection equipment (e.g., respirators, overalls, and gloves) may be required.

Excavation could also lead to increased erosion and subsequent transport of contaminated soils to the unnamed stream, Middle Marsh, and Apponagansett Swamp. Such migration would put increased stress on aquatic biota in these areas. To minimize migration of contaminants and environmental stress, a sedimentation pond would be constructed during site preparation.

Assuming an incinerator throughput of 100 tons per day (i.e., 63 cy) and 20 workdays per month, the SC-5 remedial action would take an estimated 2 to 4.5 years for a residual carcinogenic risk of 10^{-4} (i.e., 464 ppm PCBs, 331 ppm PAHs) to 10^{-6} (i.e., 4.6 ppm PCBs, 3.1 ppm PAHs), respectively. The breakdown is as follows:

- site preparation — 1 year
- mobilization — 2 months
- trial burn — 1 month
- treatment — 4 to 36 months
- demobilization — 1 month

10.6.3 Long-term Effectiveness and Permanence

Incineration is often selected because of its permanence. Residual PCB and PAH concentrations in the treated soils would be less than the 10^{-6} residual concentrations (i.e., 4.6 ppm PCBs, 3.1 ppm PAHs) of the untreated soils. A vegetative cover over the site would stabilize both the treated and untreated soils to reduce erosion and subsequent off-site migration. If soils are treated to an 10^{-6} acceptable human-health based risk level, no long-term management, monitoring, or operation and maintenance functions would be performed. However, annual sediment sampling of the unnamed stream would be performed to assess the long-term mobility of untreated contaminated soils.

10.6.4 Reduction of Toxicity, Mobility, or Volume

Incineration would effectively reduce the toxicity and mobility of treated soils and reduce human health risks from exposure to PCBs and PAHs. Incineration would destroy over 99 percent of initial PCBs and PAHs present in the feed stream. However, untreated materials (i.e., non-combustible bulk debris) and soils could remain tainted with contaminants and could erode from the site into the unnamed stream. Treatment of approximately two-thirds of the total volume of contaminated materials is anticipated. Therefore, the volume of hazardous materials would be decreased by two-thirds since the treated soil would contain less than 1 ppm PCBs and PAHs. The bulk debris screened out prior to incineration may be contaminated with residual PCBs or PAHs and may require RCRA landfilling, or disposal on-site depending upon whether capping is a preferred option.

10.6.5 Implementability

Technical Feasibility. Mobilization of the incinerator would require site preparation as described in Section 10.1 and the assemblage of individual components (e.g., rotary kiln, secondary combustion chamber, air pollution control devices,

stack). The incinerator would be positioned in the designated contractor's area as shown on the site preparation plan (see Figure 10-1).

Approximately 20 truckloads of equipment would have to be assembled during mobilization of the rotary kiln incinerator. Equipment is either trailer- or skid-mounted and pre-piped and pre-wired. The contracted vendor would be responsible for assembling the incinerator and ensuring that it is operable. Approximately three to six weeks would be required to complete assembly. Vendor personnel are trained and experienced in assembly; thus, no difficulties or unknowns are to be expected.

Incineration is a proven technology at permanently destroying organic species including VOCs, PCBs, and PAHs (i.e., soil contaminants of concern). However, a trial burn would be required to demonstrate that the incinerator can achieve the following RCRA and TSCA performance standards:

- particulate emissions not to exceed 0.08 grains/dsft^3
- HCl control efficiency greater than 99 percent
- minimum combustion efficiency of 99.9 percent
- PCB destruction removal efficiency of 99.9999 percent

Operating parameters include DREs, fuel requirements, residence times, and stack gas emissions. Ideally, operating parameter testing could be performed during the bid phase by distributing representative waste samples to participating vendors. In actuality, such testing would probably take place after the bid award, but prior to field mobilization.

Trial burn testing would be performed on-site after mobilization of the incinerator is complete. Trial burn tests would involve spiking contaminated soil with known quantities of representative chemicals (e.g., PCBs, PAHs) in order to demonstrate DREs, fuel requirements, emission levels, and residence times. Previous field tests have demonstrated that rotary kiln units can achieve the previously mentioned performance criteria.

Typical downtime estimates for mobile incinerators are 20 to 30 percent. This time is required for systems maintenance and inspections and would not affect process flow rates.

Incineration systems possess sophisticated monitoring instrumentation to control combustion processes and monitor

stack emissions. Monitoring instruments provide continuous data on the following parameters:

- fuel feed rates and pressures
- waste feed rates
- primary and secondary combustion chamber temperatures
- operating conditions of air pollution control equipment
- flue gas concentrations of O_2, CO_2, and total hydrocarbons
- combustion air flow rates

These data are used to optimize the efficiency of combustion and would be more than adequate in monitoring exposure pathways and in detecting systems failure.

Since the incinerator is limited to a throughput of 100 tons per day, excavation would be limited to 150 tons per day to simplify the logistics associated with stockpiling of materials. Available space would be used for stockpiling of screenings and incinerator ash. An estimated 50 tons per day of bulk debris would be rejected by screening prior to incineration and would require stockpiling. Additionally, the incinerator would generate an estimated 85 tons per day of ash. The bulk debris and incinerator ash would initially be stockpiled separately, but could later be combined for disposal once the debris are decontaminated.

If, after sampling, the incinerator ash is determined to be non-hazardous, it can be replaced in the excavated areas; however, if the incinerator ash is found to contain hazardous components, it may require further treatment (e.g., solidification) or off-site disposal. In this case, storage of the incinerated soils may pose a logistical problem and operation of the incinerator may need to be adjusted to prevent excessive storage of the incinerated soils.

Administrative Feasibility. Mobilization of an incinerator may be a sensitive operation and would have to be coordinated with the City of New Bedford and the Commonwealth of Massachusetts. Coordination would involve formal and informal meetings between the lead agency (EPA), the city, and the state. Coordination would also include public meetings to enhance active communication with the local community.

Availability of Services and Materials. Hazardous waste excavation and incineration services are currently available from several vendors including C-E Raymond, Roy F. Weston, ENSCO, Vesta Technology, and IT Corp. At present, mobile incinerators are readily available and are anticipated to remain so, as more companies purchase units to meet market demands.

10.6.6 Cost

Table 10-7 summarizes cost estimates for incinerating contaminated surface soils. Total remediation costs range from $5.97 to $32.6 million over the 10^{-4} to 10^{-6} target risk levels, respectively. Such costs assume that both ash and untreated, tainted debris would be disposed on-site. If off-site disposal were necessary, costs would increase by an additional $2.7 to $28.5 million over presented costs for the same 10^{-4} to 10^{-6} range.

Present worth was not calculated for the 10^{-4} and 10^{-5} target clean-up levels because incineration would take less than one year to complete. Present worth was calculated for the 10^{-6} target clean-up level, assuming it would take 2.2 years to process 68,250 cy of excavated materials.

10.6.7 Compliance with ARARs

Chemical-specific ARARs for on-site incineration of the contaminated site soils are primarily related to air emissions from the construction activities and the incineration process. The federal and state regulations pertaining to air emissions include Federal National Air Quality Standards (40 CFR 40) and the State of Massachusetts DEQE-Air Quality Regulation (310 CMR 6.00-8.00). These ARARs will be attained during site remediation by off-gas treatment of the incineration gases and fugitive dust control during site preparation activities.

Location-specific ARARs for this alternative can be separated into two groups: the federal and state Wetlands Regulations (CWA 40 CFR 230, DEQE 310 CMR 10.00) and the federal and state Facility Location Standards (RCRA 40 CFR 264.18, 990 CMR 1.00). Under Alternative SC-5, contaminated soils will be excavated and incinerated on-site. This will mitigate further soil erosion from the site. This alternative will in part attain the wetlands-related ARARs by preventing additional PCB contamination of wetlands areas.

The facility location standards specify that a hazardous waste facility cannot be constructed within a 100-year floodplain or adjacent to a wetland area. These ARARs will be attained by removing the contaminated soils within the 100-year floodplain of the unnamed stream, incinerating them on-site, and disposing of the residual ash (treated-soil) on-site. The ash disposal location will be outside the 100-year floodplain.

Action-specific ARARs pertinent to this alternative include RCRA facility and incinerator regulations, TSCA regulations, the OSHA safety regulations, the Clean Water Act, and the DEQE Hazardous Waste Regulation.

TABLE 10-7

COST SUMMARY TABLE
SC-5: ON-SITE INCINERATION OF SURFACE SOILS
WITH ON-SITE DISPOSAL OF ASH/DEBRIS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

	COSTS		
	10^{-4} RESIDUAL RISK LEVEL	10^{-5} RESIDUAL RISK LEVEL	10^{-6} RESIDUAL RISK LEVEL
CAPITAL COSTS			
• Site Preparation	$1,403,000	$1,403,000	$1,403,000
• Mobilization of Incinerator/Trial Burn	$1,000,000	1,000,000	1,000,000
• Excavate Surface Soils and Screen Out Debris	$ 61,000	159,000	404,000
• Incinerate Soils in Rotary Kiln Unit with Off-gas Treatment	$2,208,000	8,142,000	23,023,000
• On-site Disposal of Ash and Debris - Grade, Compact, and Cover	$ 20,000	72,000	203,000
SUBTOTAL CAPITAL COSTS	$4,692,000	$10,776,000	26,033,000
CONTINGENCIES (25%)	1,173,000	2,694,000	6,508,000
TOTAL CAPITAL COSTS	$5,865,000	$13,470,000	$32,541,000
MONITORING COSTS			
• Annual Sediment Sampling - 5 Samples with Analysis for PCBs, SVOCs, Metals	$ 4,150/yr.	$ 4,150/yr.	$ 4,150/yr.
PRESENT WORTH MONITORING COSTS - ASSUME 30 YEAR PERIOD AND 5% DISCOUNT RATE	$64,000	$64,000	$64,000
FIVE YEAR REVIEW COSTS			
• Data Analysis and Report Writing	$10,000/5 yr.	$10,000/5 yr.	$10,000/5 yr.
• Public Meetings	$ 4,000/5 yr.	$ 4,000/5 yr.	$ 4,000/5 yr.
TOTAL FIVE YEAR REVIEW COSTS	$14,000/5 yr.	$14,000/5 yr.	$14,000/5 yr.
PRESENT WORTH REVIEW COSTS - ASSUME 6 REVIEWS OVER 30 YEAR PERIOD AND 5% DISCOUNT RATE	$39,000	$39,000	$39,000
PRESENT WORTH OF ALTERNATIVE (Total Capital, Present Worth Monitoring, and Present Worth Review Costs)	$5,968,000	$13,573,000	$32,644,000

In addition to these regulations, the State of Massachusetts has three separate right-to-know regulations, as follows:

- DPW - Hazardous Substance Right to Know (105 CMR 67)
- DOI - Hazardous Substance Right to Know (441 CMR 21)
- DEQE - Hazardous Substance Right to Know (310 CMR 33)

These regulations are applicable to the implementation of Alternative SC-5 and will be attained during remedial actions.

The RCRA, TSCA, OSHA, CWA, and DEQE Hazardous Waste Regulations will be attained because the requirements specified in these regulations are used as design standards by incinerator manufacturers. The RCRA incinerator standards will be demonstrated during the trial burn. Under this requirement, however, all untreated residues, ash, or process effluents must be removed from the site if the material is tested (EP toxicity testing) and considered a hazardous waste. Special RCRA and TSCA performance standards for incineration of PCBs will be attained.

Table 5 in Appendix F describes the chemical-, location-, and action-specific ARARs for this alternative in greater detail. Table 5 also specifies the corresponding remedial action required to attain each ARAR.

10.6.8 Overall Protection of Human Health and the Environment

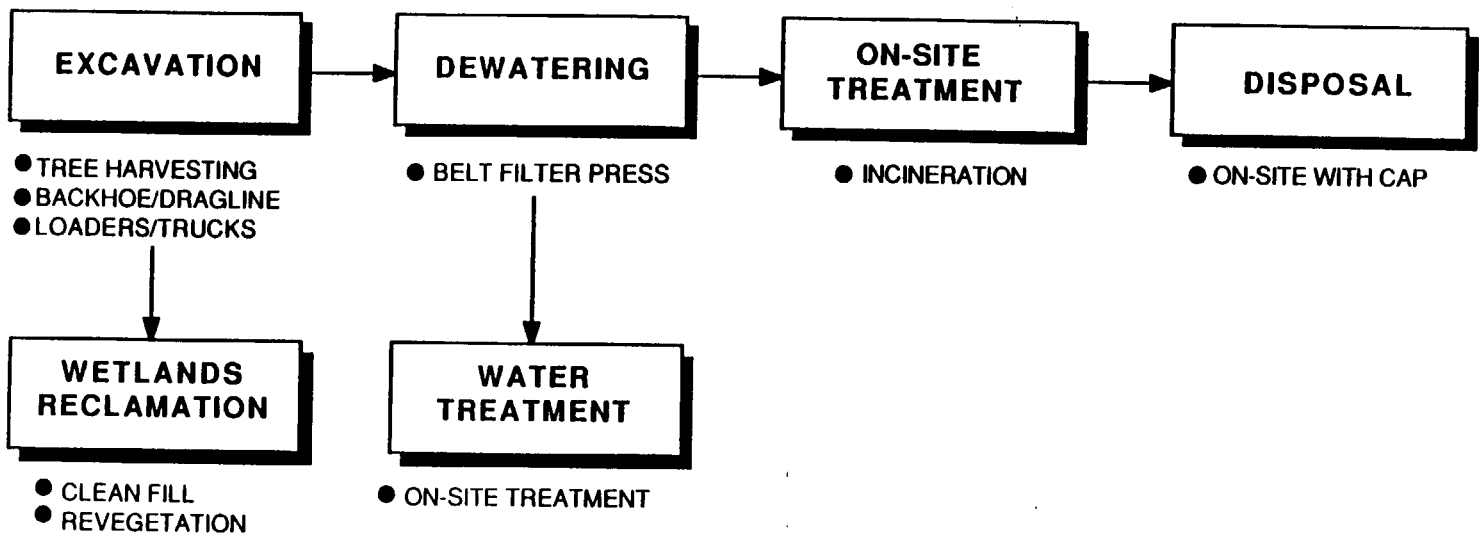
Incineration of PCB- and PAH-contaminated soils would permanently reduce human health risks to a residual carcinogenic risk level less than 10^{-4} (i.e., 463 ppm PCBs, 310 ppm PAHs) and to 10^{-6} (i.e., 4.5 ppm PCBs, 3.0 ppm PAHs). PCB migration to aquatic environments would be reduced as the majority of on-site surface soil PCBs would be destroyed.

10.7 ALTERNATIVE SC-6: REMOVAL AND ON-SITE INCINERATION OF PCB-CONTAMINATED SEDIMENTS

10.7.1 Description

The SC-6 alternative proposes to mitigate off-site PCB exposure risks to aquatic and terrestrial organisms by removing contaminated sediments from their present locations and incinerating them on-site. Figure 10-11 depicts the major components of the alternative. Off-site PCB sediments are defined as those sediments believed to have been contaminated with PCBs originating from the site. Sediment PCB concentrations average between 10 and 20 ppm and have been

FIGURE 10-11
SCHEMATIC OF ALTERNATIVE SC-6
REMOVAL AND ON-SITE INCINERATION OF PCB-CONTAMINATED SEDIMENTS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS



detected in the following areas: (1) southern tributary to the unnamed stream (i.e., the brook along the southern site boundary), (2) unnamed stream, (3) northern tributary to the unnamed stream (i.e., brook north of and parallel to Hathaway Road), (4) Middle Marsh, (5) golf course water hazards, and (6) Apponagansett Swamp. Table 10-8 presents estimated sediment quantities targeted for removal along with sediment criteria values. An estimated 17,300 cy would have to be removed and treated to attain mean value SQCs in the Middle Marsh and Apponagansett Swamp South and upper value SQCs in the unnamed stream and water hazards one and two.

A remedial action comprising the SC-6 alternative would meet the following SC response objectives:

- reduce risks to terrestrial and aquatic life associated with PCB-contaminated sediments
- reduce the mobility of PCB contaminants

Removal of PCB-contaminated Sediment. Sediment removal would involve clearing, grubbing, and excavation. Such operations are typically performed with bulldozers and hydraulic excavators. However, Middle Marsh and Apponagansett Swamp may not support the weight of such equipment. If such is the case, a dragline, crane, and skidders may have to be used to clear trees and brush. Trees and brush would be hauled on-site for shredding. The shredded vegetation would be incinerated with the PCB-contaminated sediment.

The dragline and/or crane would access the marsh by causeways constructed to support the weight of such equipment. Causeways would likely consist of a two to three foot gravel base overlain with one foot of graded and compacted sandy fill. Approximately 1,250 feet of causeways are anticipated in the Middle Marsh as depicted in Figure 10-12. Additionally, 1,100 feet of general purpose haul roads, consisting of six to twelve inches of sandy fill, and 3,050 feet of gravel based haul roads, consisting of one foot of gravel covered with six to twelve inches of fill, would be required to transport cleared vegetation and excavated sediments on-site for processing (see Figure 10-12). Gravel based roads would be constructed around the perimeter of the marsh to provide additional support over the saturated soils.

Excavation is estimated to proceed at 1,500 cy per day (i.e., approximately one-half acre to a depth of 2 feet) with excavated sediment being transported on-site by dump trucks for further processing.

On-site operations would consist of site preparation work (see Section 10.1), dewatering, incineration, and wastewater treatment. The alternative process flow diagram (Figure 10-13)

TABLE 10-8

ESTIMATED REMOVAL QUANTITIES - SEDIMENTS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

Location	Sediment Criteria Value	Removal Quantity*
Middle Marsh	0.8 - 46 ppm	14,000 cu. yd.
Apponagansett Swamp South	15 - 37 ppm	1,400 cu. yd.
Unnamed Stream with Tributaries	0.2 - 1.7 ppm	500 cu. yd.
Water Hazard 1	0.5 - 2.05 ppm	600 cu. yd.
Water Hazard 2	0.5 - 2.05 ppm	800 cu. yd.
TOTAL REMOVAL QUANTITY		17,300 cu. yd.

* Estimate assumes a 2-foot excavation depth in the Middle Marsh, Apponagansett Swamp, and water hazards; and a 1-foot excavation depth in the unnamed stream and its tributaries. However, if sampling indicates residual PCBs above sediment criteria values, additional sediment would be removed until criteria values are satisfied.

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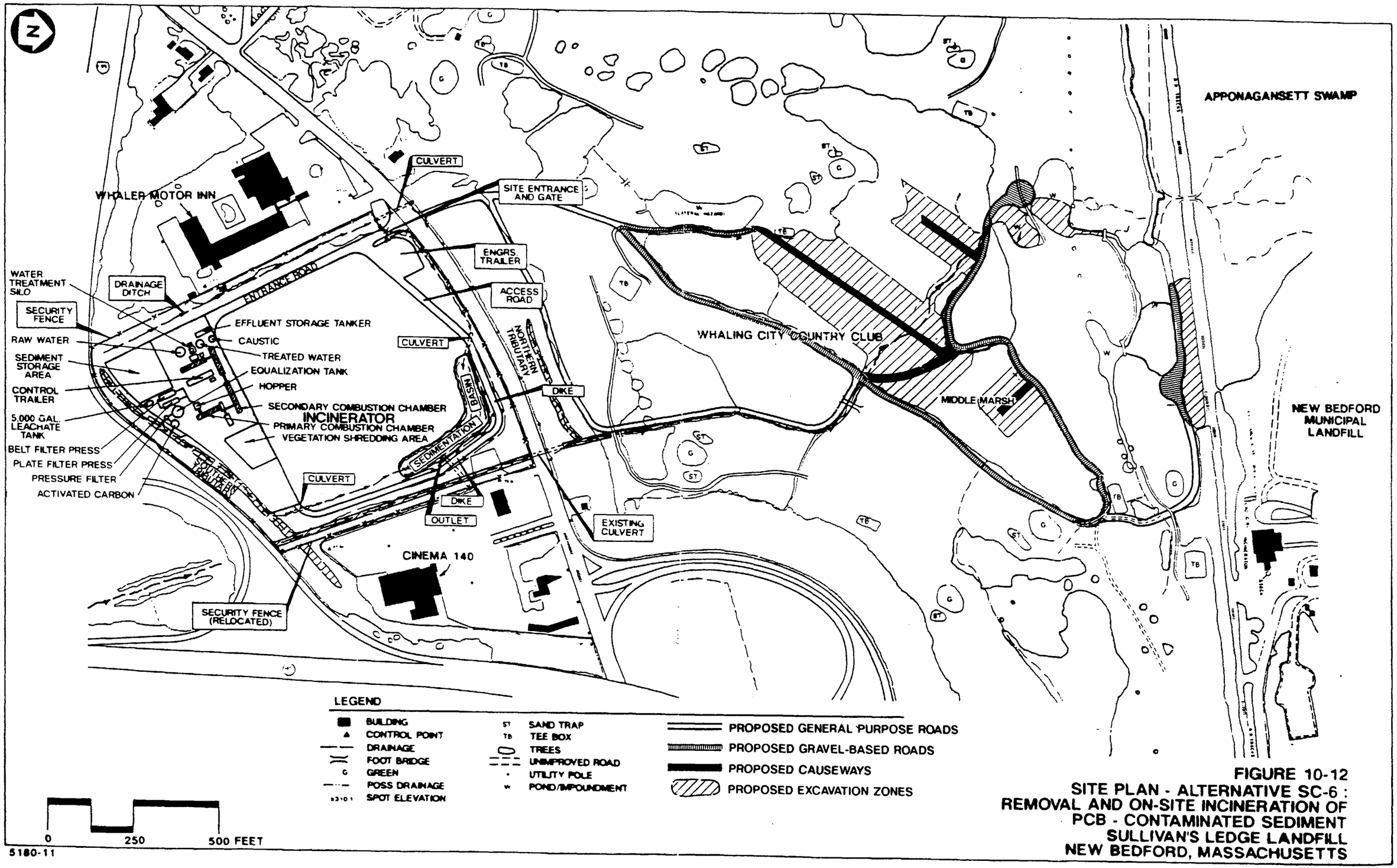
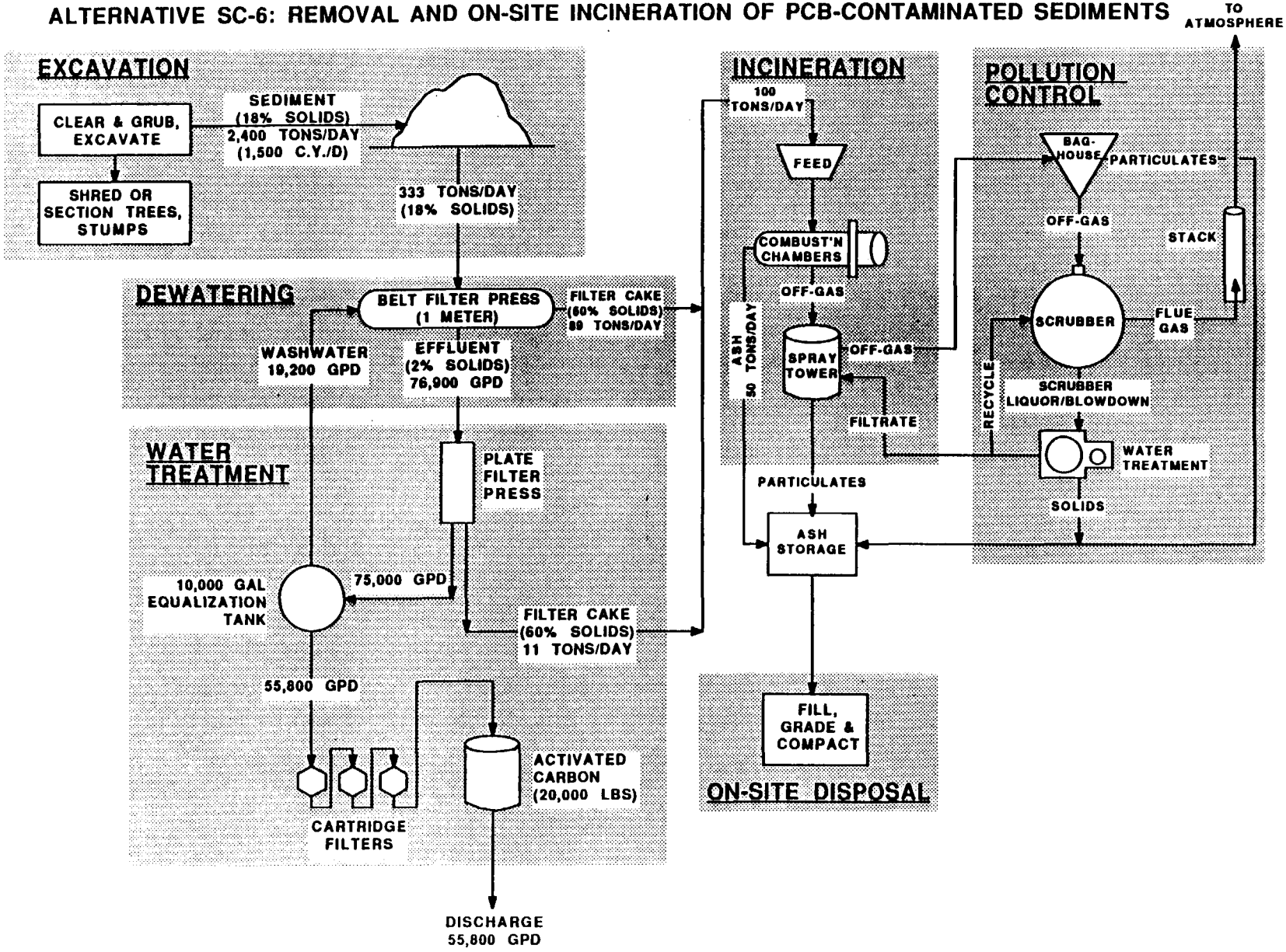


FIGURE 10-12
SITE PLAN - ALTERNATIVE SC-6 :
REMOVAL AND ON-SITE INCINERATION OF
PCB - CONTAMINATED SEDIMENT
SULLIVAN'S LEDGE LANDFILL
NEW BEDFORD, MASSACHUSETTS

FIGURE 10-13
PROCESS FLOW DIAGRAM
ALTERNATIVE SC-6: REMOVAL AND ON-SITE INCINERATION OF PCB-CONTAMINATED SEDIMENTS



depicts the proposed design. The design calls for the incineration of 100 tons per day, which is the maximum capacity of currently available mobile incinerators.

Dewatering. Dewatering would be performed with a 1-meter belt filter press to reduce sediment moisture content from an initial quantity of approximately 80 percent by weight to less than 40 percent. Reducing the moisture content is an economic factor, in that it decreases incineration costs by decreasing combustion-chamber holding times. The filter cake (89 tons per day) would be conveyed to the incinerator, while the liquid filtrate (2-percent solids) would be pumped to the wastewater treatment system.

On-site Incineration. A rotary kiln incinerator is recommended for on-site treatment. Rotary kilns are the most widely available mobile incinerators and the most flexible in terms of waste feed characteristics. The rotary kiln unit would be positioned in the southern portion of the site (see Figure 10-12) and would remain stationary throughout the remedial action. The incinerator and support equipment is described in detail in Alternative SC-5.

Wastewater Treatment. The wastewater treatment system for the belt filter press filtrate is designed to remove aqueous PCBs through carbon adsorption and PCBs sorbed to solids by filtration. Filtration would involve two steps. The first step involves the use of a plate and frame filter press to remove the bulk solids that would not be captured by the belt filter press. The plate and frame press would remove an estimated 11 tons per day (60-percent solids) of sediment. These sediments would be fed into the incinerator with a loader.

The plate and frame press filtrate would still contain between 10 and 20 ppm of suspended solids less than 10 microns in diameter. A cartridge filter would be added to remove these solids. The cartridge system would consist of three filters in series (i.e., 1.0, 0.5, and 0.1 micron) to remove successively smaller particles. Filters would be changed periodically and the wasted filters incinerated.

Aqueous PCBs would be removed by a 20,000-pound carbon adsorption unit; influent aqueous PCB concentrations are anticipated to be 100 to 150 ppb. When sorbed PCBs reach 50 ppm, the carbon would have to be changed. Contaminated carbon would be incinerated in the rotary kiln unit. The treated effluent, with expected PCB concentrations of less than 0.5 ppb, would be discharged to the unnamed stream.

On-site Disposal. Incinerated sediment is expected to have residual PCB concentrations of less than 1 ppm and would be

disposed of on-site. The incinerated sediment would be mixed with site surface soils, graded over the site, and capped with a multi-layer cap or a vegetative cover to provide long-term stability.

Wetlands Restoration. Restoration of Middle Marsh and Apponagansett Swamp would be a reversal of clearing and excavation operations. Clean fill material would be hauled in and distributed throughout the wetlands to replace previously removed sediments and bring the ground level back to original elevations. Causeways in the Middle Marsh would be removed as no longer needed. Excavation and loading operations are likely to have spilled contaminated sediments onto the causeway. Therefore, it is estimated that the top six inches of the causeway would be removed and incinerated on-site. The remainder of causeway materials would be used as fill in restoring the wetlands. A 1-foot peat layer would be mixed with the clean fill and trees planted at twice the original density (100 trees per acre) to account for expected mortality. Additionally, a variety of indigenous wetland plant species would be introduced.

For conceptual design purposes, reconstruction of wetlands would be performed in conjunction with site remediation. Yearly operation and maintenance would also be necessary for several years after construction of wetland areas. The scope of maintenance activities is difficult to predict and generally depends on plant community success in the new wetlands.

10.7.2 Short-term Effectiveness

Primary human receptors at risk during sediments excavation would include workers, golfers, and groundskeepers. Golfers may be more likely to chase golf balls hit into contaminated zones as they would be cleared of vegetation. However, carcinogenic risks are not expected to be elevated above present levels (i.e., 10^{-6} to 10^{-7}) for such human receptors. Health risks to excavation workers would involve a dermal contact hazard. Workers would be required to use dermal protection (e.g., gloves, boots, coveralls) as necessary. Airborne PCBs are not anticipated to be a problem because the wet sediments are not likely to generate dust even when disturbed. Haul roads would be monitored to prevent excessive buildup of spilled sediments.

Excavation is likely to allow surface water migration of PCBs. Migration can be minimized with siltation fences and haybales.

Clearing and grubbing along stream banks and within Middle Marsh and Apponagansett Swamp would destroy terrestrial habitat for small animals (e.g., racoons, rabbits) and excavation would destroy aquatic habitats. These areas would be backfilled and revegetated as previously described.

The rotary kiln incinerator would produce air emissions but is equipped with state-of-the-art pollution control equipment to control stack gas emissions to within ambient air quality standards (i.e., National Ambient Air Quality Standards (NAAQs), Massachusetts Ambient Air Levels (MAALs), and Threshold Limit Values (TLVs)). Compliance with air quality standards would minimize inhalation risks to workers and nearby residents to safe levels (i.e., as determined by the state and federal government). Furthermore, a trial burn would be performed prior to full scale operation to demonstrate achieval of all ARARs and RCRA and TSCA performance standards. The contracted vendor would be responsible for sampling feed soils, treated soils, scrubber water, baghouse particulates, and stack gas emissions, and providing mass balance calculations based on such measured data. These calculations would be checked by the lead agency before approval to proceed is granted. Based on prior performance testing, a mobile incinerator would comply with ARARs and thus, would not pose an unsafe human health risk to workers or the community.

Assuming an incinerator throughput of 100 tons per day (i.e., 63 cy) and 20 work days per month, sediment removal and treatment could be accomplished in one year. An additional year of site preparation work would be required prior to initiation of removal and treatment activities. Initial wetlands restoration activities are anticipated to take three to six months after removal activities are complete and wetlands recovery may take one to two decades. After initial revegatation activities, wetlands restoration would become a passive process, requiring only semi-annual checks for the first five years to observe the recovery process. Replanting is a possibility if initial plantings fail.

The anticipated schedule is as follows:

• site preparation	1 year
• mobilization	2 months
• trial burn	1 month
• treatment	10 months
• demobilization	1 month
• initial wetlands restoration activities	3-6 months

10.7.3 Long-term Effectiveness and Permanence

After excavation, sediment PCB concentrations would be reduced to the upper value SQC in Middle Marsh and Apponagansett Swamp South and mean value SQC in the unnamed stream and water hazards one and two. These levels are considered protective of aquatic biota and pose less than a 10^{-7} human health risk. Incinerated sediments would have residual PCB concentrations less than one ppm and would be disposed of on-site. Because

these levels are protective of human health, no long-term management, monitoring, or operation and maintenance functions would be required.

10.7.4 Reduction of Mobility, Toxicity, and Volume

Incineration is an established technology at permanently reducing the toxicity of contaminated materials. Incineration would combust PCBs in the feed-sediments leaving only trace concentrations of PCBs in the product (i.e., treated sediments). Treatment would also reduce the volume of PCB-contaminated sediments by an estimated 17,300 cy since treated sediments would no longer pose a residual risk, and would irreversibly reduce further PCB mobility by permanently destroying the PCBs.

10.7.5 Implementability

Technical Feasibility. Site preparation and off-site roadway construction procedures are well-established and would not involve unknowns. Construction crews may encounter obstacles posed by golfers trying to continue play through work zones.

The transportable incineration system would have to be assembled on-site from 20 truckloads of component pieces. Assembly would be performed by personnel thoroughly familiar and experienced with such equipment. A trial burn would be necessary to demonstrate that the incinerator can achieve RCRA performance standards for site-specific wastes and conditions.

Typical downtime estimates for mobile incinerators are 20 to 30 percent. This time is required for systems maintenance and equipment inspection and would not jeopardize the process design rate of 100 tons per day.

During excavation, sediment samples would be taken to measure the effectiveness of removal operations at attaining sediment criteria values. Initially, 1 to 2 feet of sediment would be removed from a sector and samples taken. If the samples indicate residual PCBs above criteria values, another 1 to 2 feet would be excavated and more samples taken. The process of excavation followed by sampling would be continued until criteria values are satisfied.

Continuous process monitoring would be performed to maintain high combustion efficiencies during incineration. Sophisticated monitoring instruments would measure the following parameters:

- fuel feed rates and pressures
- waste feed rates
- combustion chamber temperatures

- air pollution control operating conditions
- flue gas concentrations (i.e., O_2, CO_2, total hydrocarbons)
- combustion air flow rates

Wetlands restoration is considered to be technically feasible; however, few wetlands have been successfully restored. Continuous monitoring and periodic plantings are anticipated to be required to restore the wetlands.

Administrative Feasibility. Coordination would have to be maintained between the lead agency (i.e., EPA), the City of New Bedford, and the Commonwealth of Massachusetts. Coordination would involve active communication, including formal and informal meetings among these agencies at critical points in the remedial action process. Meetings would most likely be held prior to site construction to keep all agencies informed of latest developments.

Availability of Services and Materials. Rotary kiln incinerators are currently available from C-E Raymond, Roy F. Weston, ENSCO, Vesta Technology, and IT Corp. Such vendors have experienced specialists available to mobilize, operate, and demobilize equipment. Their specialists are health and safety trained and would decontaminate equipment during demobilization operations. Such firms would also be responsible for excavation operations.

10.7.6 Cost

Table 10-9 summarizes costs for the SC-6 alternative. The present worth for excavating and incinerating 17,300 cy of PCB-contaminated sediment, including wetlands restoration, is $16.1 million. The majority of the cost is due to mobilization and operation of the incinerator. For this reason, this alternative assumes all PCB-contaminated sediments would be treated as it would not be cost effective to remediate smaller volumes. Mobilization would cost $1,000,000, which includes a trial burn, and incineration costs are estimated at $460/cy. Costs for wetlands restoration are estimated to be approximately $350,000 per acre. Costs to restore specific wetland areas are as follows:

WETLAND AREA	ACREAGE	RESTORATION COST
Middle Marsh	4.5 acres	$1,575,000
Apponagansett Swamp South	0.5 acres	$ 175,000

TABLE 10-9

COST SUMMARY TABLE
SC-6: REMOVAL AND ON-SITE INCINERATION
OF PCB-CONTAMINATED SEDIMENTS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ITEM DESCRIPTION	COST
CAPITAL COSTS	
• Site Preparation	$1,403,000
• Clearing and Grubbing - 5 Acres in Middle March and Apponagansett Swamp South	35,000
• Construct Roadways and Causeways to Access Middle Marsh and Apponagansett Swamp South	114,000
• Excavate PCB-contaminated Sediments in Middle Marsh, Apponagansett Swamp South, Unnamed Stream with Tribs, and Water Hazard #1 and 2.	180,000
• Sediment Sampling during Excavation	20,000
• Dewater Sediments with 2-meter Belt Filter Press	125,000
• Water Treatment (i.e., Filtration, Carbon Adsorption) of Belt Press Filtrate	211,000
• Mobilize Incinerator, Run Trial Burn	1,000,000
• Incinerate Sediments and Chipped Vegetation	8,028,000
• On-site Disposal of Ash	28,000
• Wetlands Restoration - 5 Acres in Middle Marsh and Apponagansett Swamp South	1,750,000
• Short-term Wetlands Observation Visits - Semi-annually for 5 years	8,000
SUBTOTAL	12,902,000
CONTINGENCIES (25%)	3,226,000
PRESENT WORTH OF ALTERNATIVE	$16,128,000

These costs are approximate because few wetlands have been successfully restored. Depending on the success of revegetation, these costs could approach $500,000 per acre.

10.7.7 Compliance with ARARs

Chemical-specific ARARs for the removal and on-site incineration of the PCB-contaminated sediments are divided into two media: surface water and air. Massachusetts Surface Water Quality Standards (310 CME 4.00) and Federal AWQC levels are the only surface water ARARs for this alternative. These ARARs will be attained downstream of the sediment excavation areas by erosion/sedimentation control measures (e.g., check dams, silt curtains, hay bales). Federal and state regulations pertaining to air emissions from the incinerator and fugitive dust created by excavation and transportation activities are as follows:

- Federal National Air Quality Standards (40 CFR 40)
- State DEQE Air Quality Regulations (310 CMR 6.00-8.00)

These ARARs will be attained during site remediation by Best Available Control Technologies for treatment of the incinerator air emissions and by fugitive dust control during excavation and construction activities.

Location-specific ARARs for Alternative SC-6 can be divided into two groups: federal and state wetlands regulations and federal and state location standards. In this alternative, the major wetland areas, Middle Marsh, water hazards, and Apponagansett Swamp South will be partially excavated to remove PCB-contaminated sediments in excess of mean or upper value SQCs. Federal location-specific ARARs pertinent to this remedial action include the CWA (40 CFR 230) and the Fish and Wildlife Coordination Act (16 U.S.C. 661). Excavation of the wetland areas would not violate the CWA. Migration of PCBs during excavation does not constitute discharge from a point source as the wetlands are not a "discernible, confined, and discrete conveyance."

The state location-specific ARAR is the DEQE Wetlands Protection (310 CMR 10.00). This regulation requires that any person proposing to do work in or around a wetland area must submit to a conservation commission or DEQE a "request for a determination of applicability." The commission shall issue an order of conditions outlining the steps to be taken to insure the protection of the wetlands, and a certificate of compliance is issued within 21 days following application request. This alternative will remove the PCB contamination from the aforementioned wetland areas; however, temporary destruction would occur. Following excavation, the roads would be removed

and the wetlands revegetated to reestablish wetland habitats and comply with DEQE wetlands protection.

The federal and state Facility Location Standards (RCRA 40 CFR 264.18, 990 CMR 1.00) specify that a hazardous waste facility cannot be constructed within a 100-year floodplain or adjacent to a wetland area. These ARARs will be attained by siting the incinerator on-site and outside the 100-year floodplain of the unnamed stream.

Action-specific ARARs pertinent to incineration of sediments can be divided into three groups:

1. those that deal with the construction and operation of an incinerator (RCRA facility and incinerator regulation, TSCA regulations, DEQE-Hazarous Waste Regulation);

2. those that deal with excavation of wetlands area (CWA 40 CFR R5, 404; NEPA 40 CFR 6); and

3. those that regulate hazardous waste activities or federal work standards (OSHA Federal Safety Standards, Massachusetts Right to Know Regulations).

The ARARs in each group are discussed herein. The RCRA facility regulations and the DEQE Hazardous Waste Regulations will be attained because mobile incinerators are manufactured with state-of-the-art pollution control devices designed according to stringent standards. Furthermore, the incinerator would first have to demonstrate RCRA and TSCA performance standards through a trial burn before it is allowed to operate at full capacity. Incinerated sediment would be tested and disposed on-site if determined to be non-hazardous according to EP toxicity testing. RCRA technical standards would be relevant and appropriate if process residuals fail EP toxicity. In this case, process residuals would be treated and disposed of on-site or disposed of off-site in an appropriate facility.

The ARARs pertaining to the excavation of the wetlands area (CWA, NEPA) will be attained by developing sedimentation control for the downstream areas and by recreating the wetlands areas. Reconstruction and recolonization of wetlands areas is a long-term process and attainment of these ARARs (i.e., CWA 40 CFR 404) will not be immediate.

OSHA regulations and the Massachusetts Right to Know Regulation (DPW 105, CMR 67, DOI 441, CMR 21, 310 CMR 33) will be initiated during the remedial design phase by designing the remedial action to incorporate procedural requirements of these regulations.

Table 6 in Appendix F describes the chemical-, location-, and action-specific ARARs for this alternative in greater detail. Table 6 also outlines the corresponding remedial actions required to attain each ARAR.

10.7.8 Overall Protection of Human Health and the Environment

Removal of sediments in the unnamed stream and water hazards will reduce exposure concentrations of PCBs which presently pose a risk to aquatic organisms. Stream habitat loss to result from this activity is not believed to be significant. The area should become recolonized with benthic macroinvertebrates over time. Terrestrial organisms will return to the area, given that suitable habitat remains. Temporary adverse effects to aquatic and terrestrial organisms are believed to be minimal in comparison to the benefit of removing the PCBs from this area.

Significant temporary habitat destruction would occur as a result of removing Middle Marsh and Apponagansett Swamp sediments. However, long-term benefits of removing PCB-contaminated sediments posing significant chronic risks to aquatic organisms need to be weighed against the short-term impacts of the removal effort itself. Both Middle Marsh and Apponagansett Swamp presently support a large number of benthic macroinvertebrates and provide shelter for mammals, birds, and reptiles. Wetlands restoration would be necessary to mitigate this impact and provide long-term protection of aquatic environment.

This alternative would do little in reducing human health risks since present PCB concentrations are not health-threatening.

10.8 ALTERNATIVE SC-7: REMOVAL AND SOLIDIFICATION OF PCB-CONTAMINATED SEDIMENTS

10.8.1 Description

The SC-7 alternative proposes to mitigate PCB sediment risks to terrestrial and aquatic organisms and humans by removing contaminated sediments from their present locations and solidifying them to prevent future PCB releases. Removal and solidification of PCB sediments would meet the following response objectives:

- Reduce long-term risks to terrestrial and aquatic life associated with PCB-contaminated sediments.
- Reduce the mobility of PCB-contaminated sediments.

Remedial action would involve site preparation, clearing and grubbing wetlands, excavating contaminated sediments,

transporting sediments on-site, dewatering, water treatment, solidifying sediments, and restoring wetlands. Figure 10-14 presents a flow diagram of the major components of the SC-7 alternative. Contaminated sediments are defined as those sediments deposited by surface waters hydraulically connected to the site and contaminated with PCBs believed to have originated from the site. Sediment PCBs range from zero to 118 ppm, averaging 13 ppm, and have been detected in the following locations:

- the brook south of the site (southern tributary)
- the unnamed stream
- the brook north of and parallel to Hathaway Road (northern tributary)
- Middle Marsh
- the golf course water hazards
- Apponagansett Swamp

PCB SQCVs were established for these sediments and would be used as clean-up target levels (see Table 10-8).

Figure 10-15 illustrates a process flow diagram of the SC-7 alternative. The proposed configuration has been designed to process 746 tons, or 470 cy per day (assuming 18 percent solids and a specific gravity of 1.6). The proposed design includes a 2-meter belt filter press, which can process 15 dry tons per hour and a mobile solidification unit specified at 30 tons of sediment per hour.

The proposed design assumes a 1:10 Portland cement-to-sediment ratio, which was selected based on a USACE study. The USACE study showed a 70- to 90-percent PCB mobility reduction in sediments after solidification using a 1:10 ratio. Future pilot-testing during design, including TCLP testing, would be needed to determine the actual admixture-to-sediment ratio, which could be as high as 3:10.

The resulting solidified sediment would be graded over the site surface and compacted. The compacted material would cure to form a hard, low permeability surface that would then be covered to reduce its erosion.

Clearing, Grubbing, and Excavation. Clearing, grubbing, and excavation would require the construction of roadways throughout the golf course (Figure 10-16). The roadways would serve as travel routes for haul vehicles and provide a working platform for excavating equipment (e.g., hydraulic excavators, draglines, cranes).

FIGURE 10-14
SCHEMATIC OF ALTERNATIVE SC-7
SOLIDIFICATION OF PCB-CONTAMINATED SEDIMENTS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

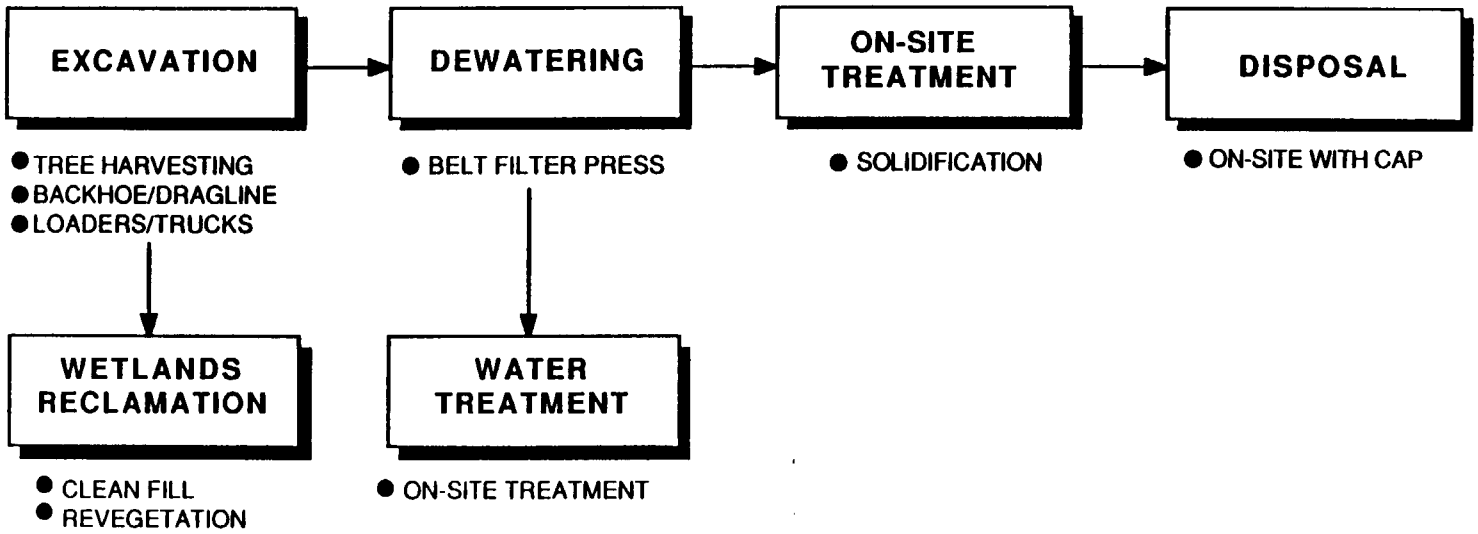
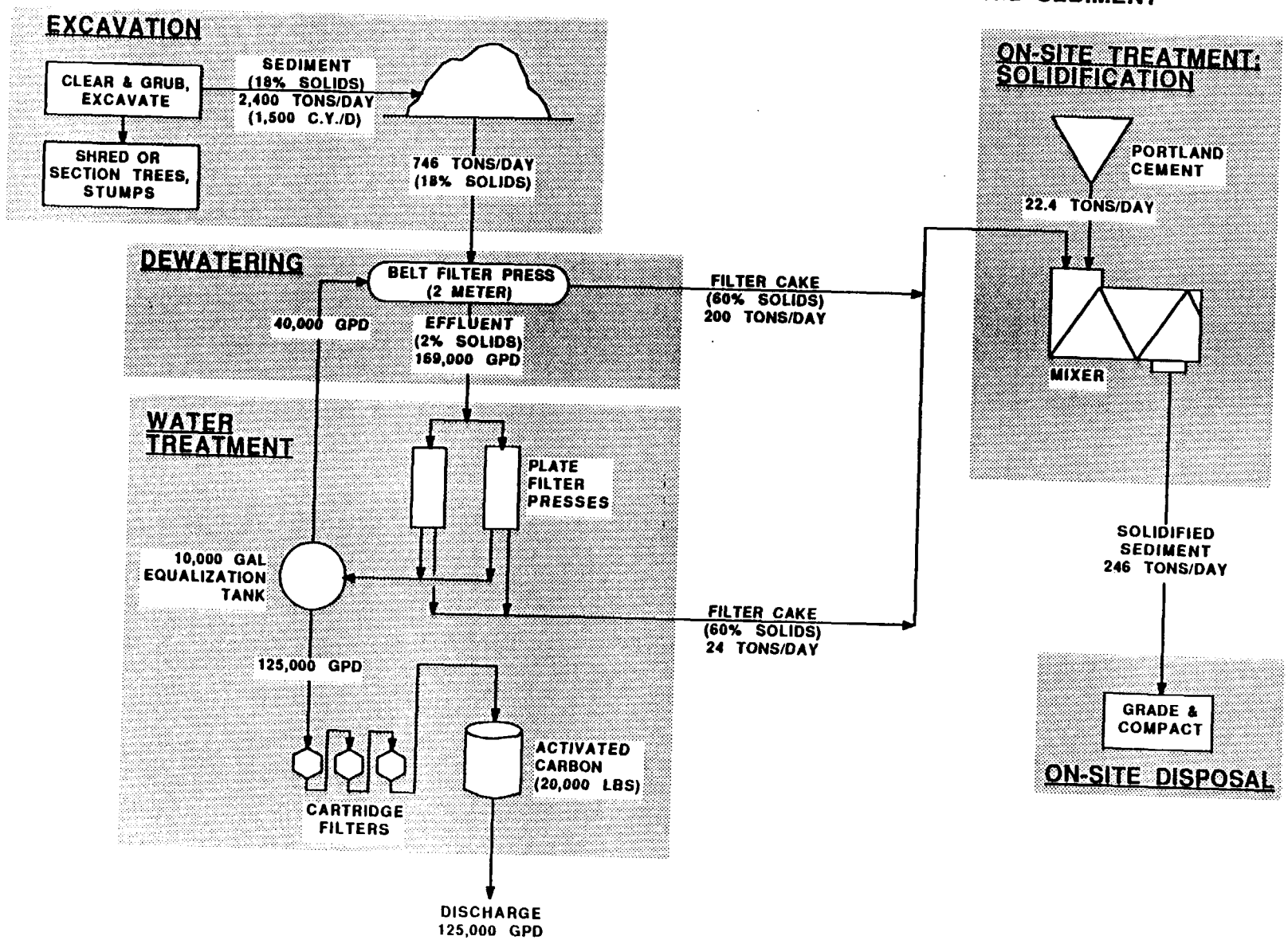


FIGURE 10-15
PROCESS FLOW DIAGRAM
ALTERNATIVE SC-7: REMOVAL AND SOLIDIFICATION OF PCB-CONTAMINATED SEDIMENT



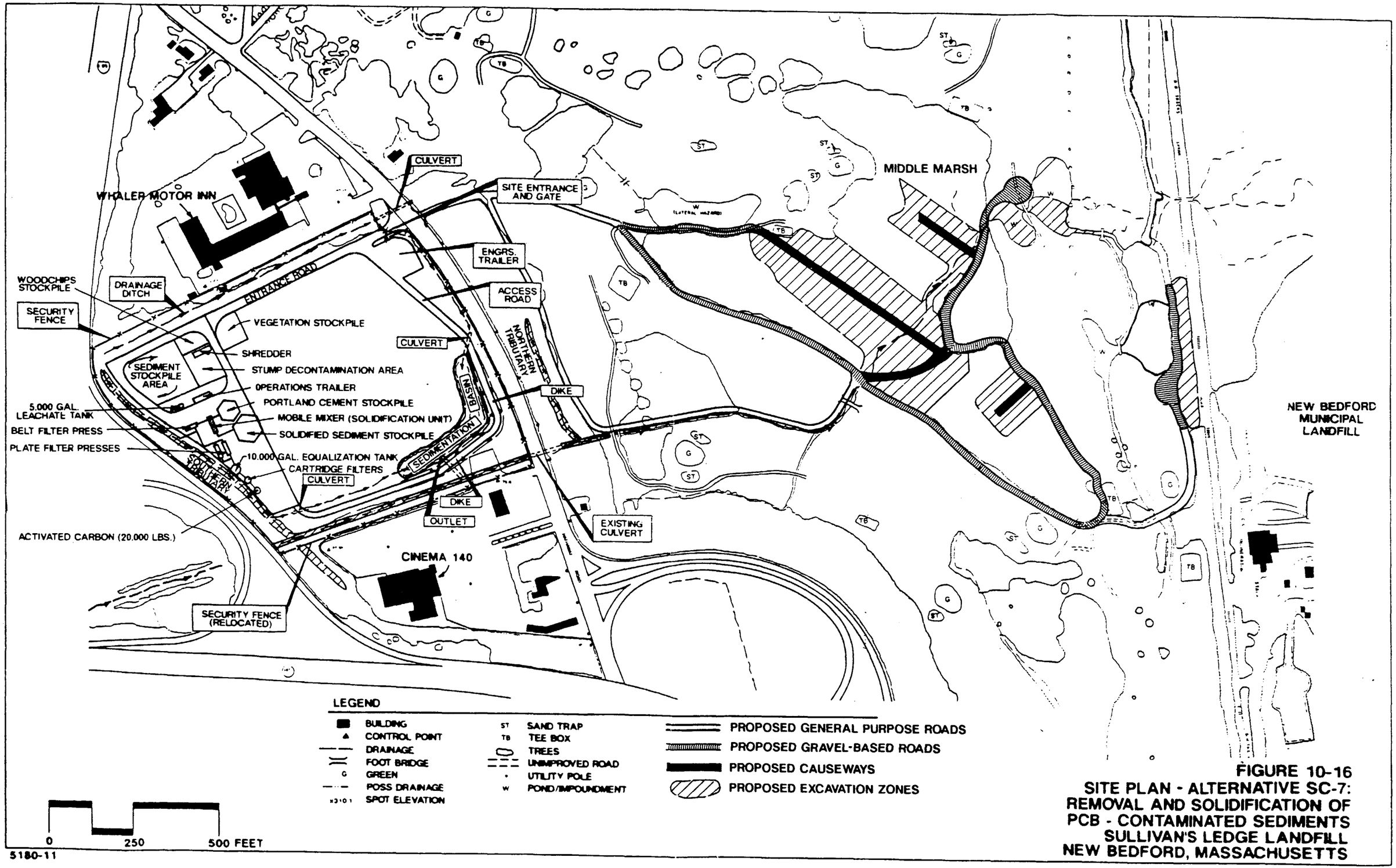


FIGURE 10-16
SITE PLAN - ALTERNATIVE SC-7:
REMOVAL AND SOLIDIFICATION OF
PCB - CONTAMINATED SEDIMENTS
SULLIVAN'S LEDGE LANDFILL
NEW BEDFORD, MASSACHUSETTS

Clearing, grubbing, and excavation are usually performed with bulldozers and backhoes. However, Middle Marsh and Apponagansett Swamp may not support the weight of such equipment. If this is the case, such operations would be performed with a crane equipped with a grapple and a dragline. The dragline and/or crane would access the marsh by causeways constructed to support the weight of such equipment. Causeways would likely consist of a two to three foot gravel base overlain with one foot of graded and compacted sandy fill. Approximately 1,250 feet of causeways are anticipated in the Middle Marsh as depicted in Figure 10-16. Additionally, 1,100 feet of general purpose haul roads, consisting of six to twelve inches of sandy fill, and 3,050 feet of gravel based haul roads, consisting of one foot of gravel covered with six to twelve inches of fill, would be required to transport cleared vegetation and excavated sediments on-site for processing (see Figure 10-16). Gravel based roads would be constructed around the perimeter of the marsh to provide additional support over the saturated soils.

Initially, 1 foot of sediment would be removed from the unnamed stream and its tributaries and 2 feet from Middle Marsh, the water hazards, and Apponagansett Swamp. Remaining sediment would then be tested for residual PCB contamination, and further excavation would be performed as necessary.

Clearing and grubbing would require approximately two months. Excavation would proceed more quickly, requiring only about one month to complete.

Solidification. A trailer-mounted solidification mixer is recommended for the site. Such mobile units can process up to 250 tons per hour and are typically designed with a waste-feed hopper, a feed conveyor, an admixture silo, a pugmill mixer, and a process control cab. The unit is equipped with weighing devices and monitoring instruments that provide continuous feedback to the operator. The operator can adjust process variables such as waste feed rate and admixture feed rate instantaneously to maintain a consistent product. Sediment would be dewatered to 60-percent solids with a 2-meter belt filter press prior to solidification.

Water Treatment. Effluent from dewatering would be treated for solids removal and for aqueous PCB removal. Liquid effluent discharged from the belt filter press would contain approximately 2-percent solids and 100 to 150 ug/l aqueous PCBs. The majority of solids would be removed with mobile plate and frame filter presses that would reduce total suspended solids to below 20 ppm. Each mobile press is capable of processing 10 dry tons of solids per day. The proposed design specifies two plate filter presses to process the design flow rate of 14.3 dry tons

per day. The resulting filter cake would be solidified along with the belt filter press cake, while the filtrate would either be treated and discharged or recycled as washwater for the belt filter press. Seventy-eight percent of the filtrate (125,000 gallons per day) would be passed through a series of cartridge filters and an activated carbon unit before discharge, and 22 percent (40,000 gallons per day) would be recycled to the belt filter press.

The cartridge filters are necessary to remove the suspended solids (20 ppm) remaining in the filtrate. These solids must be removed because they would be too small (i.e., less than 10 microns) to be captured by the activated carbon unit. The treated effluent, with expected PCB concentrations of less than 0.5 ppb, would be discharged into the unnamed stream.

Wetlands Restoration. Wetlands restoration in Middle Marsh and Apponagansett Swamp would be restored as described in Section 10.7.1.

10.8.2 Short-term Effectiveness

Primary human receptors at risk during the remedial action would include neighborhood children, golfers, groundskeepers, and remedial action workers. Golfers may be more likely to chase golf balls hit into contaminated zones which would be cleared of vegetation. However, carcinogenic risks are not expected to be elevated above present levels (i.e., 10^{-6} to 10^{-7}) for such human receptors.

Health risks to remedial action workers would involve a dermal contact hazard. Airborne PCBs are not anticipated to be a problem because the wet sediments are not likely to generate dust even when disturbed. Personal protective equipment would consist of gloves, boots, tyveks, coveralls, etc. Even though respiratory protection is not anticipated, it should be available in case air monitoring indicates such a requirement.

Excavation is likely to allow further migration of PCBs, which may expose aquatic biota to lethal or sublethal concentrations. Migration can be minimized with siltation fences and hay bales.

Clearing and grubbing along stream banks and within Middle Marsh and Apponagansett Swamp would destroy terrestrial habitat for small animals (e.g., racoons, rabbits) and excavation would destroy aquatic habitats. These areas would be backfilled and revegetated with trees and wetland plant species.

Excavation and treatment of PCB-contaminated sediments could be accomplished in 7 months. An additional year of site preparation work would be required prior to initiation of removal and treatment activities. Initial wetlands restoration

activities are anticipated to take 3 to 6 months after removal activities are complete and wetlands recovery may take 1 to 2 decades. After initial revegetation activities, wetlands restoration would become a passive process, requiring only semi-annual checks for the first five years to observe the recovery process. Replanting is a possibility if initial plantings fail. The implementation schedule breakdown is as follows:

• site preparation	1 year
• construction of access roads	1 month
• clearing/grubbing	5 weeks
• bench-scale testing	2 months
• excavating sediments	1 month
• solidifying sediments and disposing on-site	1 month
• curing time	1 month
• initial wetlands restoration activities	3-6 months

10.8.3 Long-term Effectiveness and Permanence

A USACE solidification study on New Bedford Harbor sediments (Myers, 1987) indicated positive results for immobilizing PCBs. The study showed that all admixture (i.e., Portland cement, Portland cement with Firmix, and a silicate-based process) to sediment ratios (except a 1:10 Portland cement to sediment ratio) exceeded the 50 pounds per square inch (psi) compressive strength criterion established by a policy directive for the Office of Solid Waste and Emergency Response (OSWER), and the leachability of PCBs was reduced by 70 to 90 percent. The leach test involved agitating loose granular media and distilled-deionized water in a mechanical shaker for 24 hours. If Sullivan's Ledge sediments behave similarly to the New Bedford Harbor sediments, similar results can be expected.

After excavation, sediment PCB concentrations would be reduced to below the upper value sediment quality criterion in Middle Marsh and Apponagansett Swamp South and the mean value sediment quality criterion in unnamed stream. Such levels are considered protective of aquatic biota and pose less than a 10^{-7} human health risk.

Solidified sediments would be disposed of on-site, thereby long-term controls are required. Long-term management of the monolith and cap would consist of semi-annual site visits and timely maintenance to maintain cap integrity. Environmental monitoring would consist of annual sediment sampling along the unnamed stream as a means of checking the integrity of the cap and the possible migration of disposed sediments.

Sufficient data pertaining to the long-term effectiveness of solidified matrices are not available to assess the potential need for replacement. However, the monolith and cap are expected to be effective for 20 to 30 years, based on proven long-term effectiveness of caps. Semi-annual site visits should be adequate to identify potential problems. Observed damage (e.g., cover erosion) would be corrected in a timely manner to prevent accidental dermal contact and to minimize weathering effects to the monolith.

10.8.4 Reduction of Toxicity, Mobility, and Volume

Solidification would reduce the mobility of PCBs, but would not reduce the toxicity of the treated sediments, and would increase the volume of treated sediments by 10 to 30 percent. The USACE study indicates that PCB leachability reductions of up to 90 percent are achievable. The permanence of mobility reductions would be indirectly assessed by monitoring the sediments in the stream for the presence of PCBs.

10.8.5 Implementability

Technical Feasibility. Implementation of the SC-7 alternative would require the following operations:

- construction of haul roads, perimeter roads, and causeways throughout the golf course
- site preparation
- mobilization of the solidification mixer
- construction of a dewatering and wastewater treatment process

Construction of roadways would be performed to support the movement of heavy equipment around excavation zones. There are three types of roads: (1) haul roads to provide travel between the site and excavation zones; (2) perimeter roads that would serve as both a working base for excavation equipment and a right-of-way for haul vehicles; and (3) causeways that would support excavation equipment in unstable areas of Middle Marsh. Local construction contractors are available in the New Bedford area to construct such roads and causeways. Also, road materials (i.e., gravel, fill) are available for local delivery.

Construction of on-site solidification and water treatment processes would consist of mobilizing individual pieces of equipment and installing pumps, pipes, and conveyors to facilitate continuous flow between such units. Since turnkey services are recommended, it is not likely that coordination

between vendors would be difficult. One to two months can be expected to complete construction and start-up of an efficient unit operation.

Solidified sediment performance standards would have to be established through bench-scale or pilot-scale testing. Testing involves casting 10 to 20 small cylinders using various solidifying agents, admixture to sediment ratios, and combinations of solidifying agents. After curing, the cylinders are tested for unconfined compressive strength, permeability, and leachability (e.g., multiple extraction tests).

Established performance standards would be maintained during full-scale operation through continuous process monitoring. The systems operator would be supplied with continuous readouts of waste feed rate, admixture feed rate, moisture content, and handling characteristics that would allow almost immediate adjustments to maintain a consistent damp granular product. Such quality control standards would enable the solidification mixer to process up to 250 tons per day of stable product.

Full-scale operational time of the mixer would be decreased by an estimated 20 percent. However, this downtime is considered during process design and would not cause schedule delays.

Performance of the water treatment process (i.e., solids and PCB removal) would have to meet and maintain Massachusetts Surface Water Quality Standards to allow discharge of the treated water into the unnamed stream. The proposed treatment process is designed for a final effluent concentration of 0.5 ppb. It would be necessary to periodically sample the effluent to determine the effectiveness of the process.

The initiation of a future remedial action may be hindered by the hardened monolith. The monolith may be difficult to excavate due to its concrete-like nature and may require blasting.

Monitoring considerations would involve monitoring mixer holding times, waste-feed and admixture-feed rates, and testing the end-product against set performance standards. Other short-term monitoring functions would involve taking core samples of the monolith as it cures. Air monitoring would not be required because the sediments are not expected to generate dust.

<u>Administrative Feasibility</u>. Temporary disruption to portions of Middle Marsh and Apponagansett Swamp South, inevitable during excavation, would have to be carefully coordinated with both the City of New Bedford and the Commonwealth of Massachusetts. Coordination would involve formal and informal meetings chaired by the lead agency (EPA).

Considerable long-term institutional management would be associated with the alternative because wastes would remain on-site. The lead agency would be required to initiate site reviews every five years. Site visits, sampling events, and public education programs (e.g., public meetings, workshops) would require administrative and regulatory participation.

Availability of Services and Materials. Turnkey services would be available for on-site solidification. Nineteen vendors have been identified that provide such services (see Table 10-5). Vendors typically request a minimum lead time of three months to schedule the mobilization of a mixing unit because units are custom-built and not readily available. Support equipment (i.e., pressure, belt, and plate and frame filter presses; activated carbon units) would be available for either purchase or lease.

Activated carbon units are available for lease from vendors such as Adsorption Systems, Inc. of Millburn, New Jersey, and Calgon Carbon Corporation of Bridgewater, New Jersey. Final disposal or regeneration of spent carbon would be the responsibility of the vendor as part of the negotiated service award. Plate and frame filter presses would be available under turnkey services from Pressure Filtration Specialists, Inc., of Columbia, South Carolina, and many others. Cartridge filters would have to be purchased and are available from Serfilco of Glenview, Illinois.

10.8.6 Cost

Table 10-10 summarizes costs for the SC-7 alternative. Costs were calculated for three removal scenarios. Scenario 1 would involve excavation and solidification of 1,900 cy of sediment from the unnamed stream (and its tributaries) and the two golfcourse water hazards. Its cost is estimated at $2.78 million. This scenario assumes that removal operations would not require roadway construction since such areas could be excavated during the winter; the frozen ground would provide adequate support for heavy equipment.

Scenario 2 would involve remediating the Middle Marsh and Apponagansett Swamp South to the upper value sediment quality criterion and the unnamed stream to the mean value sediment quality criterion. Sediment volume to be treated is estimated at 14,000 cy. Total remediation cost is estimated at $6.76 million.

Scenario 3 would involve mitigating off-site sediments in excess of lower value sediment quality criteria, including the unnamed stream, the water hazards, Middle Marsh, and Apponagansett Swamp. Total remediation volumes are approximately 67,300 cy and costs would be in excess of $19.8 million.

TABLE 10-10

COST SUMMARY TABLE
SC-7: REMOVAL AND SOLIDIFICATION
OF PCB-CONTAMINATED SEDIMENTS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ITEM DESCRIPTION	COSTS		
	SCENARIO 1	SCENARIO 2	SCENARIO 3
CAPITAL COSTS			
• Site Preparation	$1,403,000	$1,403,000	$ 1,403,000
• Clear and Grub Unnamed Stream, Middle Marsh, Apponagansett Swamp	4,000	35,000	135,000
• Construct Roadways and Causeways to Access Middle Marsh, Apponagansett Swamp	--	114,000	208,000
• Excavate PCB-contaminated Sediments	17,000	180,000	240,000
• Sediment Sampling During Excavation	2,000	20,000	40,000
• Dewater Sediments with 2-meter Belt Filter Press	125,000	125,000	125,000
• Water Treatment of Contaminated Filtrate	132,000	211,000	391,000
• Solidify PCB Sediments	408,000	1,470,000	5,721,000
• On-site Disposal - Grade and Compact Treated Sediment to Form Monolith	36,000	130,000	503,000
• Wetlands Restoration	--	1,750,000	7,000,000
• Short-term Wetlands Observation Visits - Semiannually for 5 Years	8,000	8,000	8,000
SUBTOTAL CAPITAL COSTS	2,135,000	5,321,000	15,774,000
CONTINGENCIES (25%)	534,000	1,330,000	3,944,000
TOTAL CAPITAL COSTS	$2,669,000	$6,651,000	$19,718,000
ANNUAL OPERATING COSTS			
• Semi-annual Site Visits	$ 2,200/yr.	$ 2,200/yr.	$ 2,200/yr.
• Semi-annual Mowing	1,200/yr.	1,200/yr.	1,200/yr.
TOTAL ANNUAL OPERATING COSTS	3,400/yr.	3,400/yr.	3,400/yr.
PRESENT WORTH OPERATING COSTS - ASSUME 30 YEAR PERIOD AND 5% DISCOUNT RATE	52,000	52,000	52,000

TABLE 10-10 (continued)

MONITORING COSTS			
• Annual Sediment Sampling - 5 Samples with PCB Analysis	1,400/yr.	1,400/yr.	1,400/yr.
PRESENT WORTH MONITORING COSTS - ASSUME 30 YEAR PERIOD AND 5% DISCOUNT RATE	$22,000	$22,000	$22,000
FIVE YEAR REVIEW COSTS			
• Data Analysis and Report Writing	10,000/5 yr.	10,000/5 yr.	10,000/5 yr.
• Public Meetings	4,000/5 yr.	4,000/5 yr.	4,000/5 yr.
TOTAL FIVE YEAR REVIEW COSTS	14,000/5 yr.	14,000/5 yr.	14,000/5 yr.
PRESENT WORTH REVIEW COSTS - ASSUME 6 REVIEWS OVER 30 YEAR PERIOD AND 5% DISCOUNT RATE	39,000	39,000	39,000
PRESENT WORTH OF ALTERNATIVE (Total Capital, Present Worth Operating, Present Worth Monitoring, and Present Worth Review Costs)	$2,782,000	$6,764,000	$19,831,000

Costs for wetlands restoration are estimated to be approximately $350,000 per acre. Costs to restore specific wetland areas, as specified in Scenario 2, are as follows:

WETLAND AREA	ACREAGE	RESTORATION COST
Middle Marsh	4.5 acres	$1,575,000
Apponagansett Swamp South	0.5 acres	$ 175,000

These costs are approximate because few wetlands have been successfully restored. Depending on the success of revegetation, these costs could approach $500,000 per acre.

10.8.7 Compliance with ARARs

The chemical-specific ARARs for the removal and on-site solidification of the PCB-contaminated sediments are divided into two media: surface water and air. Massachusetts Surface Water Quality Standards (310 CMR 4.00) and Federal AWQC levels are the surface water ARARs for this alternative. These ARARs will be attained downstream of the sediment excavation area by erosion/sedimentation control measures (e.g., check dams, silt curtains, hay bales). In addition, the effluent from dewatering operations will be discharged in accordance with the Clean Water Act.

Federal and state regulations pertaining to air emissions from the solidification activities and fugitive dust created by excavation and transportation activities are as follows:

- Federal National Air Quality Standards (40 CFR 40)
- State DEQE Air Quality Regulations (310 CMR 6.00-8.00)

These ARARs will be attained during site remediation by fugitive dust control during excavation construction and solidification activities.

Location-specific ARARs for Alternative SC-7 can be divided into two groups: federal and state wetlands regulations and federal and state location standards. In this alternative, the major wetland areas, Middle Marsh, water hazards, and Apponagansett Swamp will be excavated and the PCB-contaminated sediments removed. Federal location-specific ARARs pertinent to this remedial action are the CWA (40 CFR 230) and the Fish and Wildlife Coordination Act (16 USC 661). The state location-specific ARAR is the DEQE Wetlands Protection (310 CMR 10.00). This alternative will remove the PCB contamination from these areas; however, temporary destruction of these wetlands and habitats for aquatic biota will result because vegetation and soils will be removed in the top 2 feet of sediment. Following

excavation, the roads will need to be removed and the wetlands revegetated to reestablish wetland habitats and attain these ARARs.

The federal and state facility location standards (RCRA 40 CFR 264.18, 990 CMR 1.00) specify that a hazardous waste facility cannot be constructed within a 100-year floodplain or adjacent to a wetland area. These ARARs will be attained by siting the solidification unit on-site and outside the 100-year floodplain of the unnamed stream.

Action-specific ARARs pertinent to solidification of sediments can be divided into three groups:

- Those that deal with the construction and operation of a hazardous waste treatment unit (RCRA Facility and Landfill Regulation, TSCA regulations)
- Those that deal with excavation of a wetlands area (CWA 40 CFR R5, 404; NEPA 40 CFR 6)
- Those that regulate hazardous waste activities or federal work standards (OSHA Federal Safety Standards, Massachusetts Right to Know Regulations)

The ARARs in each of these groups are discussed herein. The RCRA Facility Regulations and the DEQE Hazardous Waste Regulations will be attained by using the requirements specified in these regulations as design standards during remedial design. The TSCA regulations are relevant and appropriate for PCB-contaminated sediments in excess of 50 ppm. Although few samples were in excess of 50 ppm, areas that exceed the 50 ppm will be solidified with the other sediments and placed on-site under a cap. This alternative disposal method is based on technical, environmental, and economical considerations and should meet the substantive requirements of TSCA.

The ARARs pertaining to the excavation of the wetlands area (CWA, NEPA) will be attained by developing sedimentation control for the downstream areas and by recreating the wetlands areas. Reconstruction and recolonization of wetlands areas is a long-term process and attainment of these ARARs (i.e., CWA 40 CFR 404) will not be immediate.

OSHA regulations and the Massachusetts Right to Know Regulation (DPW 105, CMR 67, DOI 441, CMR 21, 310 CMR 33) will be initiated during the remedial design phase by designing the remedial action to incorporate procedural requirements of these regulations.

Table 7 in Appendix F describes the chemical-, location-, and action-specific ARARs for this alternative in greater detail.

Table 7 also outlines the corresponding remedial actions required to attain each ARAR.

10.8.8 Overall Protection of Human Health and the Environment

Removal of sediments in the unnamed stream and water hazards will reduce exposure concentrations of PCBs and PAHs which presently pose a risk to aquatic organisms. Further migration of these contaminated sediments into Middle Marsh and Apponagansett Swamp will also be mitigated.

Stream habitat loss resulting from the removal of sediments in unnamed stream and water hazards is not believed to be significant. The area should become colonized again with benthic macroinvertebrates over time. Terrestrial organisms will return to the area, given that suitable habitat remains. Temporary adverse effects to aquatic and terrestrial organisms are thought to be minimal in comparison to the benefit of removing the PCBs from the stream.

Significant temporary habitat destruction would occur as a result of removing Middle Marsh and Apponagansett Swamp sediments. However, long-term benefits of removing PCB-contaminated sediments posing chronic risks to aquatic organisms need to be weighted against the short-term impacts of the removal effort itself. Both Middle Marsh and Apponagansett Swamp presently support a large number of benthic macroinvertebrates and provide shelter for mammals, birds, and reptiles. It is anticipated that sediment removal would result in a deforested area subject to erosion. Wetlands restoration would be necessary to mitigate this impact and provide long-term protection of the aquatic environment.

This alternative would do little in reducing human health risks since present PCB concentrations are not health-threatening.

10.9 SOURCE CONTROL ALTERNATIVES SUMMARY

Table 10-11 presents a brief summary of the detailed analysis of SC alternatives for each of the nine screening criteria.

TABLE 10-11

SOURCE CONTROL ALTERNATIVES SUMMARY TABLE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	SC-1: NO ACTION	SC-2: CONTAINMENT	SC-3: ISV OF SOILS	SC-4: SOLIDIFICATION OF SOILS	SC-5: INCINERATION OF SOILS	SC-6: INCINERATION OF SEDIMENTS	SC-7: SOLIDIFICATION OF SEDIMENTS
1. SHORT-TERM EFFECTIVENESS							
Time Until Implementation is Achieved	No additional time is required to restrict site access as the security fence is already in place.	Cap construction would take 1 to 2 years.	Mitigation would take from 2 to 6 years for a 10^{-4} to 10^{-6} cleanup effort, allowing time for site preparation, equipment fabrication, bench tests, mobilization, operator training, trail run, and full-scale processing.	Mitigation would take less than 1.5 to 2 years to complete, assuming 1 year for site prep and 1 to 4 months for on-site solidification.	Mitigation would take 2 to 4.5 years for a 10^{-4} to 10^{-6} clean-up effort. This allows time for site preparation, mobilization, trial burn, treatment, and demobilization.	Following 1 year of site prep, mitigation of the unnamed stream, water hazards, Middle Marsh, and Apponagansett Swamp would require 1 year (includes excavation and incineration). Initial wetlands restoration activities would take 3 to 6 months.	Mitigation of the unnamed stream, water hazards, Middle Marsh, and Apponagansett Swamp would take 2 years, allowing 1 year for site prep and 1 year for excavation and solidification. Initial wetlands restoration activities would take 3 to 6 months.
Protection of Community During Remedial Action	No additional increase over present risks would be posed.	Dust generated during construction would pose an increased risk via inhalation. However, dust would be minimal since soils would remain largely undisturbed.	Considerable dust would pose inhalation risks during site preparation. ISV Off-gases could pose a risk if accidental release were to occur. Atmospheric dispersion would decrease airborne contaminants to levels protective of human health.	Excavation would generate airborne dust concentrations. Dust would be reduced by soils wetting and/ or chemical dust suppressants.	Excavation would generate significant airborne dust concentrations. Dust would be suppressed by soils wetting or chemical suppressants. Potential air impacts from incinerator controlled by emissions control devices.	Potential air impacts controlled by emissions control devices.	Direct contact hazards to golfers would be controlled by temporary fencing. Concentrations do not pose a human health risk.
Protection of Workers During Remedial Action	No additional increase over present risks would be posed.	Personal protective equipment would control dermal and inhalation exposure pathways.	Personal protective equipment would control dermal and inhalation exposure pathways.	Personal protective equipment would control dermal and inhalation exposure pathways.	Personal protective equipment would control dermal and inhalation exposure pathways.	Personal protective equipment would control dermal and inhalation exposure pathways.	Personal protective equipment would control dermal and inhalation exposure pathways.

TABLE 10-11 (continued)

SOURCE CONTROL ALTERNATIVES SUMMARY TABLE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	SC-1: NO ACTION	SC-2: CONTAINMENT	SC-3: ISV OF SOILS	SC-4: SOLIDIFICATION OF SOILS	SC-5: INCINERATION OF SOILS	SC-6: INCINERATION OF SEDIMENTS	SC-7: SOLIDIFICATION OF SEDIMENTS
Environmental Impacts	Contaminants would continue to be released to the environment via sediment and groundwater transport.	Continued contaminant releases to the unnamed stream would be mitigated. The unnamed stream, Middle Marsh, and Apponagansett Swamp would remain impacted.	Same as SC-2 with addition that mitigation is permanent.	Same as SC-2.	Same as SC-3.	Removal and treatment would mitigate risks to the aquatic biota but would disrupt wetlands in the process.	Same as SC-6.
2. LONG-TERM EFFECTIVENESS AND PERMANENCE							
Magnitude of Residual Risk	Risks would remain as at present.	Contaminant migration via groundwater would continue to pose a 10^{-1} carcinogenic risk. Exposure risks to contaminated soils would be insignificant as long as the integrity of the the cap is maintained.	Residual risk would be permanently reduced to 10^{-4} to 10^{-6} through treatment. Risk would be due to untreated soils. Treated soils would pose no risk provided possible migration is eliminated.	Residual risk would be 10^{-4} to 10^{-6} but could increase if the monolith were to fail, thereby releasing contaminants.	Same as SC-3.	Residual risk would be reduced to levels protective of aquatic biota. Treated sediments would pose no future risk provided possible migration is eliminated.	Residual risk would be reduced to levels protective of aquatic biota. Treated sediments could pose future risk if monolith were to fail.
Adequacy of Controls	The security fence has been effective thus far and is expected to continue to be so.	The multi-layer cap would reduce dermal exposure risks and would prevent the continued release of contaminants to the unnamed stream. Semi-annual walkovers would be necessary to detect cover erosions at a repairable stage.	ISV would mitigate the continued release of contaminants to the unnamed stream. Long-term O&M would not be required as treatment is permanent.	Solidification would mitigate the continued release of hazardous substances to the unnamed stream and reduce dermal exposure risks. Semi-annual walkovers would be necessary to detect cover erosion, ponding, or degradation of the monolith. Sediment sampling would be instituted to check for integrity of cap.	Same as SC-3.	Removal and incineration would permanently destroy sediment PCBs. Long-term controls would not be required.	The solidified monolith would effectively immobilize PCBs. Long-term monitoring would include sediment sampling and semi-annual walkovers to identify ponding, cover erosion, or degradation to the monolith.

TABLE 10-11 (continued)

SOURCE CONTROL ALTERNATIVES SUMMARY TABLE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	SC-1: NO ACTION	SC-2: CONTAINMENT	SC-3: ISV OF SOILS	SC-4: SOLIDIFICATION OF SOILS	SC-5: INCINERATION OF SOILS	SC-6: INCINERATION OF SEDIMENTS	SC-7: SOLIDIFICATION OF SEDIMENTS
Reliability of Controls.	Relies solely on the fence and institutional controls to prevent exposure. Fence would require replacement after 15 years. Residual risk would remain high.	Cap is anticipated to remain intact for 30 years after which its integrity is questionable.	ISV is a permanent treatment technology. After treatment is complete, no further controls would be necessary.	Failure of the monolith is unlikely. Even if the monolith were to degrade, the vegetative cover should prevent contaminant migration due to runoff.	Same as SC-3.	Same as SC-3.	Same as SC-4.
3. REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	No reduction in toxicity, mobility, or volume since no treatment is involved.	Cap would reduce mobility of contaminated soils via surface water runoff.	Complete reduction in toxicity and mobility of treated soils. Treatment is permanent.	Reduction in mobility of treated soils. Leachability is expected to be reduced by 70- to 90-percent.	Same as SC-3.	Complete reduction in toxicity and mobility of treated sediments. Treatment is permanent.	Same as SC-4.
4. IMPLEMENTABILITY							
Technical Feasibility	The security fence and monitoring wells are already in place. Warning signs would have to be put up.	Cap installation would consist of standard construction activities. Monitoring wells are already in place.	Treatment would require fabrication of specialized equipment. Technology is demonstrated.	Treatment would require mobilization of specialized equipment. Technology is demonstrated.	Same as SC-4. In addition, stack monitoring would be necessary.	Same as SC-5.	Same as SC-4.
Administrative Feasibility	No permits would be required.	No permits would be required. Institutional controls are necessary.	No permits would be required.	No permits would be required. Institutional controls are necessary.	No permits would be required.	Right-of-way through the golf course would be required from the City of New Bedford.	Same as SC-6. Institutional controls are necessary.

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TABLE 10-11 (continued)

SOURCE CONTROL ALTERNATIVES SUMMARY TABLE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	SC-1: NO ACTION	SC-2: CONTAINMENT	SC-3: ISV OF SOILS	SC-4: SOLIDIFICATION OF SOILS	SC-5: INCINERATION OF SOILS	SC-6: INCINERATION OF SEDIMENTS	SC-7: SOLIDIFICATION OF SEDIMENTS
Availability of Services and Materials	Services and materials locally available.	Same as SC-1.	Battelle of Richland, WA is available to initiate equipment fabrication and supply specialists to train operators and help with start-up.	Vendor services readily available.	Same as SC-4.	Same as SC-4.	Same as SC-4.
5. COST							
Capital Cost	$ 34,000	$1,853,100	$4.4-29.8 million	$2.4-8.1 million	$5.9-32.5 million	$16.1 million	$2.7-19.7 million
O&M	$175,000	$ 903,700	$103,000	$155,000	$103,000	0	$113,000
Present Worth	$209,000	$2,756,800	$4.5-29.9 million	$2.5-8.2 million	$5.97-32.6 million	$16.1 million	$2.8-19.8 million
6. COMPLIANCE WITH ARARs	Federal and state wetlands regulations would not be met.	Chemical-specific ARARs for groundwater would not be attained.	RCRA incinerator regulations requiring the removal of all wastes, residues, and ash from the site would not be met as the vitrified mass would remain on-site. A waiver is justifiable if the mass passes EP Tox.	A RCRA cap may be required over the solidified monolith to attain ARARs.	RCRA incinerator regulations would not be met since ash would be disposed of on-site. A waiver is justifiable since the ash is expected to pass EP Tox.	Wetland restoration would have to be performed to meet wetlands ARARs. Other compliance is the same as SC-5.	Same as SC-4 with the addition that wetlands restoration would be required to attain wetlands ARARs.
7. OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	The fence would control dermal contact risks with soils. Off-site migration would continue to impact aquatic environments.	The cap would control direct contact and inhalation exposure routes. Groundwater migration would be slowed down as the cap would reduce precipitative infiltration. The environment would benefit from decreased loading.	Risk of direct contact with contaminated soils and continued loading to the aquatic environment would be eliminated.	Same as SC-3, but dermal exposure risks may increase in the future if the solidified monolith fails.	Same as SC-3.	Threats to aquatic biota would be eliminated. Human health risks would be reduced even further from the present risk of 10^{-6}.	Same as SC-6.

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TABLE 10-11 (continued)

SOURCE CONTROL ALTERNATIVES SUMMARY TABLE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	SC-1: NO ACTION	SC-2: CONTAINMENT	SC-3: ISV OF SOILS	SC-4: SOLIDIFICATION OF SOILS	SC-5: INCINERATION OF SOILS	SC-6: INCINERATION OF SEDIMENTS	SC-7: SOLIDIFICATION OF SEDIMENTS
8. STATE ACCEPTANCE	To be incorporated into the ROD.						
9. COMMUNITY ACCEPTANCE	To be incorporated into the Responsiveness Summary of the ROD.						

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11.0 DETAILED EVALUATION OF MANAGEMENT OF MIGRATION ALTERNATIVES

11.1 INTRODUCTION

This section consists of a detailed analysis of the MM alternatives that remain following the screening of remedial alternatives (see Section 9.3.2). The MM alternatives are actions that would provide methods for controlling the movement of contaminants away from the source area.

Alternative MM-1 is the no-action scenario. In this case, no contaminant removal treatment would be instituted at the site. However, a groundwater monitoring program would be implemented to assess any contaminant plume dispersion. Alternative MM-3 (Passive Collection) would involve collection and treatment of overburden groundwater from the northern and eastern boundaries of the site. The last alternative (MM-5) is a groundwater pump and treat scenario that involves pumping groundwater in an area immediately adjacent to the former quarry pits, and treating the water to remove organic contaminants.

The detailed analysis of each MM alternative begins with a description of the conceptual design details developed during the evaluation process. This is followed by an assessment of the alternative with regard to the following criteria:

- short-term effectiveness
- long-term effectiveness and permanence
- reduction of mobility, toxicity, and volume
- implementability
- costs
- compliance with ARARs
- overall protection
- state acceptance
- community acceptance

Each alternative will be evaluated individually with regard to the first seven criteria. The first five criteria constitute technical, institutional, cost, and risk concerns. Compliance with ARARs and overall protection of human health and the environment are criteria that reflect statuory requirements. The final two criteria are evaluated on the basis of information available at the time of the writing of this document.

At the present time, public perception of the three MM alternatives is not known. Therefore, as was done in Section 10, the state and community acceptance sections will be addressed up front, and will apply to all three MM alternatives. The assessments are as follows:

State Acceptance. The state has formally commented on the proposed remedial alternatives. State comments will be received following review of the draft FS and will be incorporated into later revisions of this document.

Community Acceptance. The community has not been informed of the proposed remedial actions evaluated for the site. A public comment period will be scheduled following the release of the draft final FS to allow for comments from the public sector.

Following the evaluations of the MM alternatives is a summary table that compares the major strengths and weaknesses of the alternatives.

11.2 ALTERNATIVE MM-1: NO-ACTION

11.2.1 Description

The minimal no-action alternative for management of groundwater migration at the Sullivan's Ledge site will involve (1) restricting the use of groundwater contaminated by site pollutants; and (2) monitoring distribution and migration of contaminants within the overburden and bedrock groundwater. The following actions are proposed under this alternative:

- Sample multi-level monitoring wells ECJ-1, ECJ-2, ECJ-3, and ECJ-4 on a periodic basis to monitor levels of contaminants in groundwater and to evaluate dispersion of the contaminant plume.
- Sample five of the existing wells constructed during the Phase I field investigation to provide supplemental groundwater information.
- Establish institutional controls limiting the use of on-site groundwater and off-site groundwater within a specified radius of the site.
- Perform site review every five years.
- Conduct educational programs, including public meetings and presentations, to increase public awareness.

The proposed groundwater monitoring program will involve the sampling of the four existing multi-level bedrock wells, selected overburden wells, and five of the existing shallow bedrock wells. In addition, several bedrock wells may need to be installed to asses the effectiveness of the no-action alternative. The four multi- level wells (ECJ-1, ECJ-2, ECJ-3, and ECJ-4) were installed during the Phase II field

investigation, while the five additional wells were installed during the Phase I RI.

During the first two years of the monitoring program, all monitoring wells will be sampled on a quarterly basis in an effort to establish initial groundwater contaminant concentrations. Following the establishment of initial contaminant levels, the monitoring wells will be sampled on an annual basis. Six to eight zones will be sampled in each of the multi-level monitoring wells. The selection of monitoring zones and the five supplemental monitoring wells will be based on the results of previous field investigations and will be updated as new analytical data are obtained.

The groundwater samples collected will be analyzed primarily for VOCs. VOCs were determined to be the major components of contamination in the site groundwater. Therefore, monitoring for VOCs should provide sufficient information to assess contaminant migration. Sampling and analysis only for VOCs will also result in a more cost-effective monitoring program, since collection of large volumes of water from the multi-level monitoring wells is a labor-intensive activity.

CERCLA, as amended, requires that a site be reviewed every five years if contaminants remain on-site following remediation activities. Therefore, a formal 5-year review program will need to be established. Data collected as part of the monitoring program will be evaluated during each of the reviews, and recommendations for potential remedial actions will be formulated.

Institutional controls will need to be implemented to restrict present and future use of groundwater in areas potentially affected by the site. These controls would be developed in cooperation with state and local governments. The actual distance to limit groundwater use around the site will need to be specified at that time.

11.2.2 Short-term Effectiveness

Since this alternative does not provide any level of remediation, it is not expected that threats to the community and workers will be encountered during implementation. No impacts to the environment are anticipated as a result of remedial activities. The monitoring wells selected for use in the program presently exist. Therefore, the time required to implement the alternative will be limited to the time involved in the planning and implementation of a sampling program.

Since there is no current or anticipated short-term exposure to contaminated groundwater beneath the site, there is minimal risk to public health. Implementing this no-action alternative will, therefore, not change baseline risks. Public awareness will

increase the short-term effectiveness of this alternative by preventing future development of the underlying aquifer. Risks associated with future exposure to groundwater are discussed in Section 11.2.3.

This alternative will not result in any improvement to the natural environment over baseline conditions, as described in the Environmental Risk Assessment. Concentrations of metal and organic contaminants in the vicinity of the seeps would be unchanged from baseline levels that are in excess of AWQC and pose a risk to aquatic organisms.

11.2.3 Long-term Effectiveness and Permanence

This alternative will not reduce the potential risks to public health. Although public water is available in the site area and there is no present use of groundwater, the potential exists for future development of the contaminated aquifer for potable and/or household purposes. Contaminant levels in the groundwater currently exceed MCLs, MCLGs, and other health-based criteria. Risks associated with future potential exposure to groundwater are as high as 10^{-1} for maximum exposure to on-site bedrock groundwater. In the absence of remediation, these contaminant levels will remain in excess of appropriate criteria values, and exposure to the groundwater will result in unacceptable risks. Public awareness would increase the long-term effectiveness of this alternative by informing the community of the potential hazards of future groundwater use. However, unfavorable community reaction to leaving the contaminated groundwater untreated may occur.

Aquatic communities exposed to metals and organic toxicants over the long term are expected to continue to be impacted. These impacts affect both number of species and number of organisms (see Section 5.5).

It is anticipated that the existing multilevel monitoring wells will experience an effective lifetime of 10 to 15 years. Therefore, replacement of monitoring wells will be required in Year 16 of the 30-year evaluation period.

11.2.4 Reduction of Mobility, Toxicity, and Volume

This alternative will not result in any reduction in the mobility or toxicity of contaminants in groundwater. The groundwater contaminant plume will continue to disperse, and thus increase the total volume of groundwater impacted by site pollutants.

11.2.5 Implementability

Technical Feasibility. Installation and operation of groundwater monitoring systems is a well-developed technology. However, the contamination that was detected on-site exists

within a fractured bedrock aquifer. Limited information pertaining to the bedrock fracture system is currently available. The present groundwater monitoring system cannot provide a complete picture of the fractured flow system. Migration pathways other than those detected might exist. Additional monitoring wells may be necessary to increase knowledge of the migration pathways and to develop a more intensive groundwater monitoring program.

Administrative Feasibility. The lead agency (EPA) will need to coordinate with the State of Massachusetts and the City of New Bedford to establish institutional controls to regulate installation of water wells within a specified radius of the site. Annual coordination or review should be conducted by both EPA and the state to ensure these controls are being implemented.

Availability of Services and Materials. Availability of necessary equipment and vendors for groundwater monitoring is very good. A significant number of consultants and vendors capable of completing the work is available. Therefore, competitive bidding can be expected.

11.2.6 Cost

The total present worth of the MM-1 alternative is estimated to be about $780,000 for a 30-year period. This cost includes $145,000 for capital and equipment replacement costs; $108,700 per year for operation/maintenance for the first two years; $29,050 per year operation/maintenance for Years 3 to 30; and six 5-year reviews at a cost of $14,000 per review (Table 11-1).

Capital expenditures include the purchase of sampling equipment for use with the multi-level monitoring wells. The equipment includes an electric pressure probe, a pneumatic sampling probe, stainless steel sample collection vessels, and all associated cables, tubing, and reels. The tools are estimated to require replacement following 10 years of service. The cost for two tool replacements is included as part of capital costs.

The service life of each of the multi-level monitoring wells is estimated to be 15 years. Each well will require replacement at a total cost of approximately $36,000 each. Total present worth of replacement of all four wells in Year 16 is calculated to be $55,000. This was determined using a discount rate of 5 percent.

Annual operating costs include costs associated with site security and monitoring of groundwater. The present worth of a groundwater sampling and analysis program is $202,000 during the first two years, when a quarterly sampling is anticipated. During Years 3 to 30, groundwater sampling will take place on an

TABLE 11-1

ALTERNATIVE MM-1
COST SUMMARY TABLE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

Capital Costs		Costs	Present Worth
Year 1	• Sampling Equipment Purchase	$ 40,500	$ 40,500
Year 11	• Sampling Equipment Replacement	40,500	23,680
Year 16	• Multi-level Well Replacement	144,000	54,970
Year 21	• Sampling Equipment Replacement	40,500	14,540
Annual Operating Costs			
Year 1-2	• Quarterly groundwater sampling and analysis for VOCs	106,200/yr	
	• Site Security Visits	2,500/yr	
	TOTAL ANNUAL COST (Year 1 and 2)	108,700/yr	$202,000
Year 3-30	• Annual Groundwater Sampling and analysis for VOCs	26,550/yr	
	• Site Security Visits	2,500/yr	
	TOTAL ANNUAL COST (Year 3 thru 30)	29,050/yr	$393,800
5-Year Review Costs			
	• Data Analysis and Report Writing	10,000/ea	
	• Public Meetings	4,000/ea	
	5-YEAR REVIEW COST	14,000/ea	$ 38,950
	TOTAL PRESENT WORTH		$768,000

annual basis. The present worth of the sampling program for this time period is $393,800.

The 5-year review would include evaluation of analytical data, reassessment of hazards associated with contaminated groundwater, and addressing public comments. Present worth of the six reviews anticipated for the 30-year period is $38,950.

11.2.7 Compliance with ARARs

Under MM-1, the no-action alternative, limited activity will take place at the site to reduce the current and future potential risks of the contaminated groundwater. A groundwater monitoring program will be developed to monitor contaminant migration over time.

The chemical-specific ARARs pertinent to this alternative are the federal Safe Drinking Water Act (SDWA) (40 CFR 141.11 - 141.16), The Clean Water Act (CWA), and the state groundwater and surface water quality standards and drinking water standards (314 CMR 6.00, 310 CMR 22.00). Under the no-action alternative, MCLs and MCLGs will continue to be exceeded for the shallow overburden, bedrock groundwater, and deeper bedrock groundwater, and these ARARs will not be attained. In addition, it is likely that the contaminant plume will continue to migrate off-site, contaminating more groundwater and surface water.

Location-specific ARARs are federal and state wetlands protection regulations, the federal Clean Water Act (CWA 40 CFR 230), and the state DEQE - Wetlands Protection (310 CMR 10.00). Under no-action, the contaminant plume could eventually contaminate the Middle Marsh area. This may result in increased pollution of this area. These ARARs, therefore, will not be attained for the no-action alternative.

Action-specific ARARs associated with this alternative are RCRA regulations pertaining to RCRA facilities, OSHA regulations specifying federal safety standards, and DEQE - Hazardous Waste Regulations. In addition to these regulations, the State of Massachusetts has three separate right-to-know regulations that would be applicable to the groundwater monitoring activities:

- DPW - Hazardous Substance Right-to-Know (105 CMR 67)
- DOI - Hazardous Substance Right-to-Know (441 CMR 21)
- DEQE - Hazardous Substance Right-to-Know (310 CMR 33)

These regulations will be attained during the groundwater monitoring program.

Table 8 in Appendix E outlines the chemical-, location-, and action-specific ARARs for this alternative and specifies the corresponding remedial actions that will be required to attain the ARARs, if the ARARs can be attained.

11.3 ALTERNATIVE MM-3: PASSIVE COLLECTION

11.3.1 Description

The passive collection alternative combines a passive groundwater collection system with a water treatment unit. The goal is to reduce contaminated groundwater discharging to surface water (i.e., the unnamed stream and the tributary north of the Hathaway Road) and collect and treat the contaminated overburden groundwater and portion of the shallow bedrock groundwater. The remedial response objective for this alternative is to minimize the threat posed to public health and the environment from the current and future contamination of the groundwater and surface water caused by groundwater discharge along the unnamed stream.

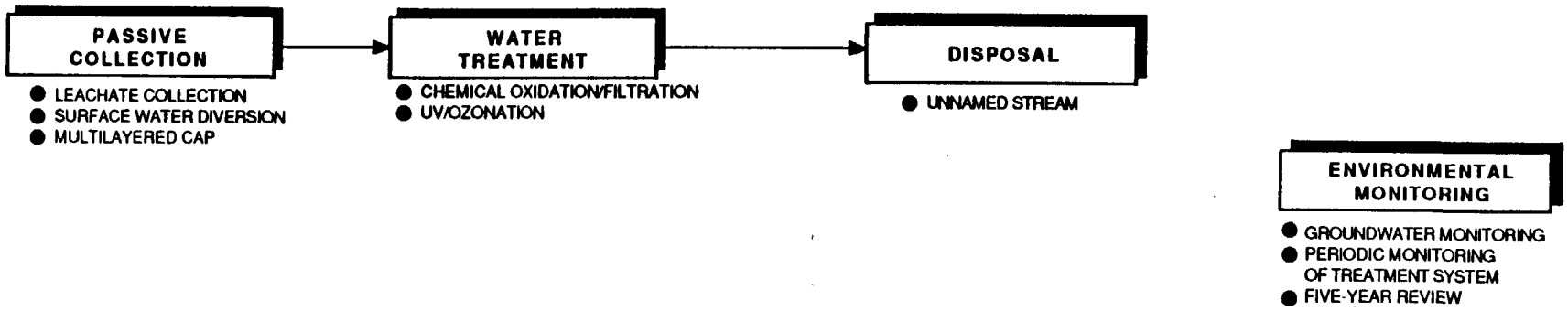
Two designs are proposed for the passive collection system. The first design incorporates an overburden trench constructed at the top of the bedrock surface while the second design calls for a shallow bedrock trench. The primary function of the overburden trench would be to collect overburden groundwater moving north towards the golf course and east to the unnamed stream. This trench would intercept seeps discharging to the unnamed stream and the tributary north of Hathaway Road.

The bedrock trench would be installed 20 feet into bedrock and would collect both overburden and shallow bedrock groundwater. The trench would act as a porous media, providing the least resistance path for migrating groundwater and would cause drawdown to the depth of the trench. Groundwater from both sides (i.e., east and west) of the unnamed stream are likely to discharge to the trench. Additionally, the porosity of the trench may induce upward flow gradients, thereby increasing the zone of influence of the trench.

Groundwater collected in either design would drain to a common sump, where it would be pumped to a treatment unit for water treatment of VOCs. Following treatment, the water would be discharged to appropriate receiving water. A companion feature of this system is a multi-layer cap which would prevent groundwater recharge to the quarry pits by rainwater or streamwater flow. Figure 11-1 provides a schematic diagram of the overall passive groundwater collection and treatment process.

To minimize inflow to the on-site groundwater, a cap would be constructed to shed rainfall and reduce infiltration into the

FIGURE 11-1
SCHEMATIC OF ALTERNATIVE MM-3
PASSIVE COLLECTION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

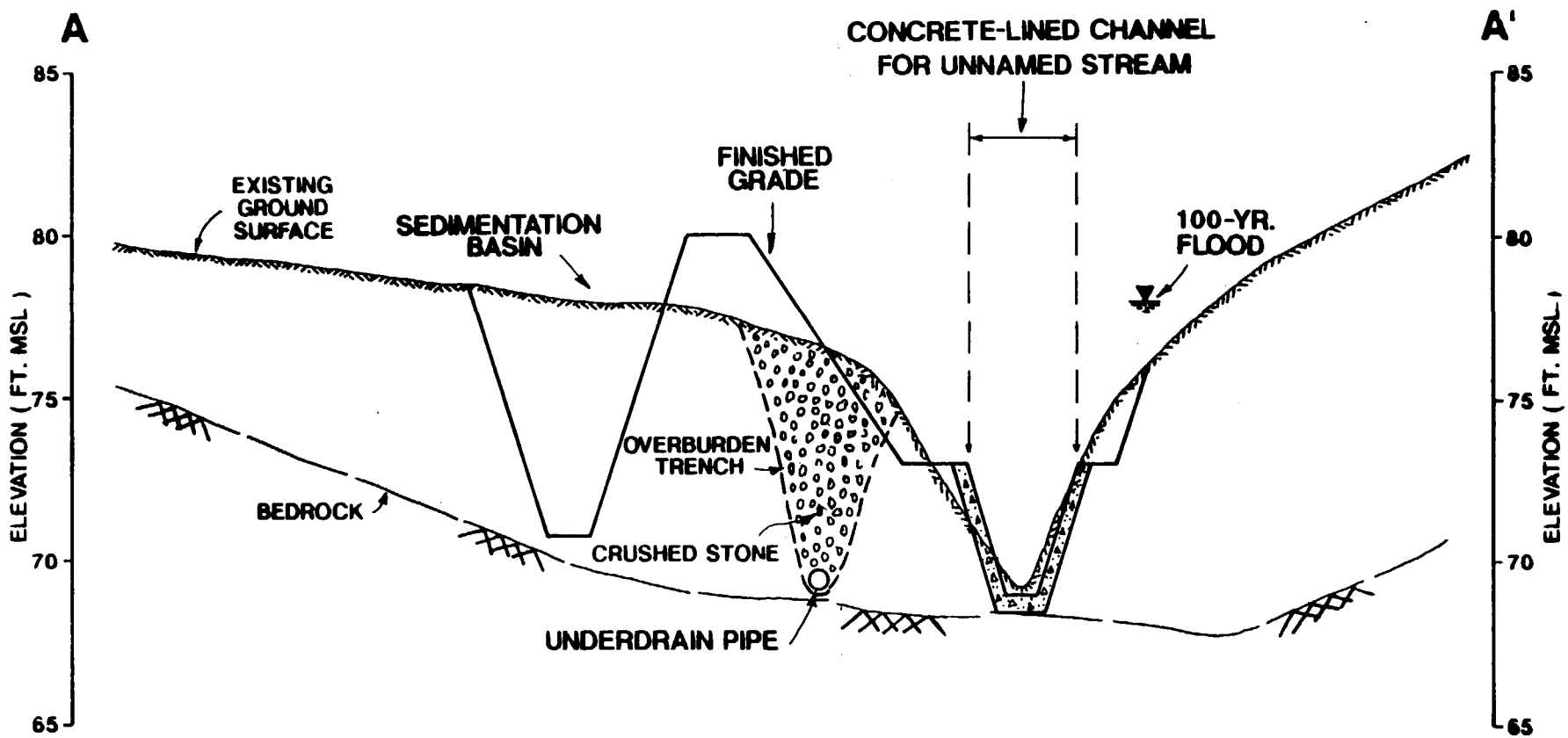


ground (see Section 10.3). Also, the streamflow of the unnamed stream would be carried past the site in a watertight concrete channel to prevent recharge to the groundwater and the underdrain system.

Construction of the key components of the passive collection alternative (i.e., the underdrain pipe, the concrete-lined channel) would occur during site preparation because of the concurrent water-handling requirements. Specifically, lining of the unnamed stream and installation of the underdrain pipe would be undertaken when the sedimentation pond and dike are constructed during the site preparation phase. However, treatment facilities would be constructed after the site development phase is completed. The following paragraphs outline the design and pertinent features of the passive collection alternative. The features include lining of the unnamed stream, the groundwater collection system, and the treatment system.

Lining of the Unnamed Stream. The lining of the unnamed stream is part of the site development work and is one of the first items to be constructed at the site. Initially, it would be necessary to construct a temporary streambed immediately east of the unnamed stream from the I-95 ramp culvert to the Hathaway Road culverts. Material excavated from this trench would be stored on-site for later treatment, or regraded for cap fill material. After the unnamed stream flow is diverted through this relocated streambed, excavation and construction of a concrete-lined channel would occur. The concrete channel would be about 4 feet deep and 20 feet wide, and would be trapezoidal in shape with 2:1 (horizontal:vertical) side slopes. Channel capacity, computed by Mannings equation, would be adequate to handle flood flows of 100-year record without overtopping. The two existing 4-foot-diameter pipe culverts under Hathaway Road and the 6-foot-diameter culvert to the rear of the carwash have capacities less than the proposed concrete-lined channel. The control and major influence on flooding in the area will, therefore, continue to be the existing culverts. Flow in the proposed concrete channel will be less than 1 foot deep during normal dry weather conditions.

Construction of the lined channel will begin with the temporary relocation of the unnamed stream through an excavated channel. While stream flow is diverted, the existing streambed would be excavated to remove contaminated sediments and would be refilled with new bedding material for the concrete lining. After completing the concrete lining, the unnamed stream would be directed back into its new channel. A cross section through this area of construction is shown in Figures 11-2A and 11-2B, which locate the temporary bypass channel and the final



HORIZONTAL SCALE

0 50 100 FEET

VERTICAL SCALE 1"=5'

FIGURE 11-2A
SECTION A-A'
THROUGH CONCRETE-LINED CHANNEL
AND OVERBURDEN TRENCH
SULLIVANS LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

EC JORDAN CO.

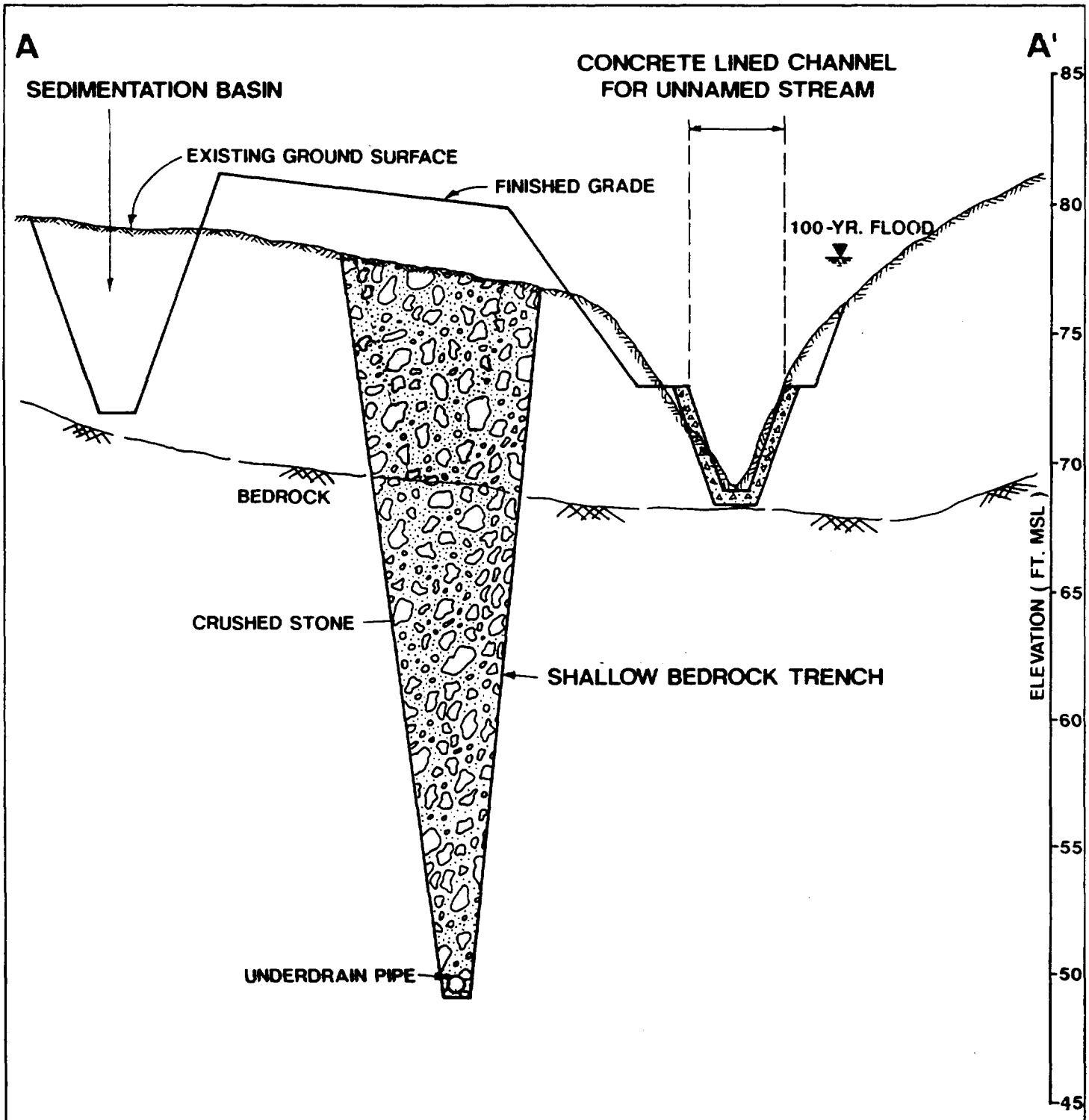


FIGURE 11-2B
SECTION A-A'
THROUGH CONCRETE-LINED CHANNEL
AND BEDROCK TRENCH
SULLIVANS LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

E.C.JORDAN CO.

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concrete lining. The location and extent of the channel is shown in Figure 11-3.

Underdrain Pipe. Groundwater collection pipes would be installed downgradient of the site, and parallel to the eastern and northern boundaries within the overburden or bedrock trench. Along the easterly side of the site, the groundwater collection pipe would be 12-inch perforated PVC, and would be installed in the excavated bypass channel immediately above the bedrock profile (see Figure 11-2A) for the overburden trench or 20 feet into the bedrock structure (see Figure 11-2B) for the bedrock trench. The pipe would be enclosed in a graded-stone envelope wrapped in geotextile fabric to prevent migration of fines into the drain system. The pipe would intercept overburden and/or shallow bedrock groundwater along the easterly side of the site and discharge by gravity to a collection point north of Hathaway Road and adjacent to the unnamed stream (Figure 11-3). The 12-inch underdrain pipe would extend to the southern side of the site to intercept a seep and contaminated overburden groundwater adjacent to the I-95 ramp. The estimated flow rate for either design scenario is approximated at 35 gpm (Section 4.2.4). The exact flowrate will need to be determined during remedial design. The 12-inch pipe will be installed at a slope of about 1 percent.

The north underdrain pipe will run from the collection point westerly, along the southern edge of Hathaway Road, to intercept seeps and groundwater flow. If sufficient room does not exist on the southern side of Hathaway Road, then the inclusion pipe will be located immediately north of Hathaway Road. Estimated flow rates for this line are 6 gpm, and a 6-inch underdrain pipe approximately 500 feet in length will be used. The preferred and alternate location of the pipe is also shown in Figure 11-3. Manholes will be constructed at key points on the collection line for the purpose of monitoring the rate of groundwater flow and to serve as access for sampling.

Groundwater collected from both the eastern and northern branchlines will drain to a submersible wet well pump station, as shown in Figure 11-3. The submersible pump station would be provided with two identical pumps, each sized to handle the expected groundwater flow. The station would feature an explosion-proof design and the pumps would be mounted on non-sparking rails for easy removal. Contaminated groundwater would be pumped through a force main to a water treatment station.

Water Treatment. The total flow rate of groundwater anticipated to be collected by either underdrain system is approximated at 40 gpm. This number was calculated using flow data obtained October 8, 1986, for the unnamed stream and for the small stream

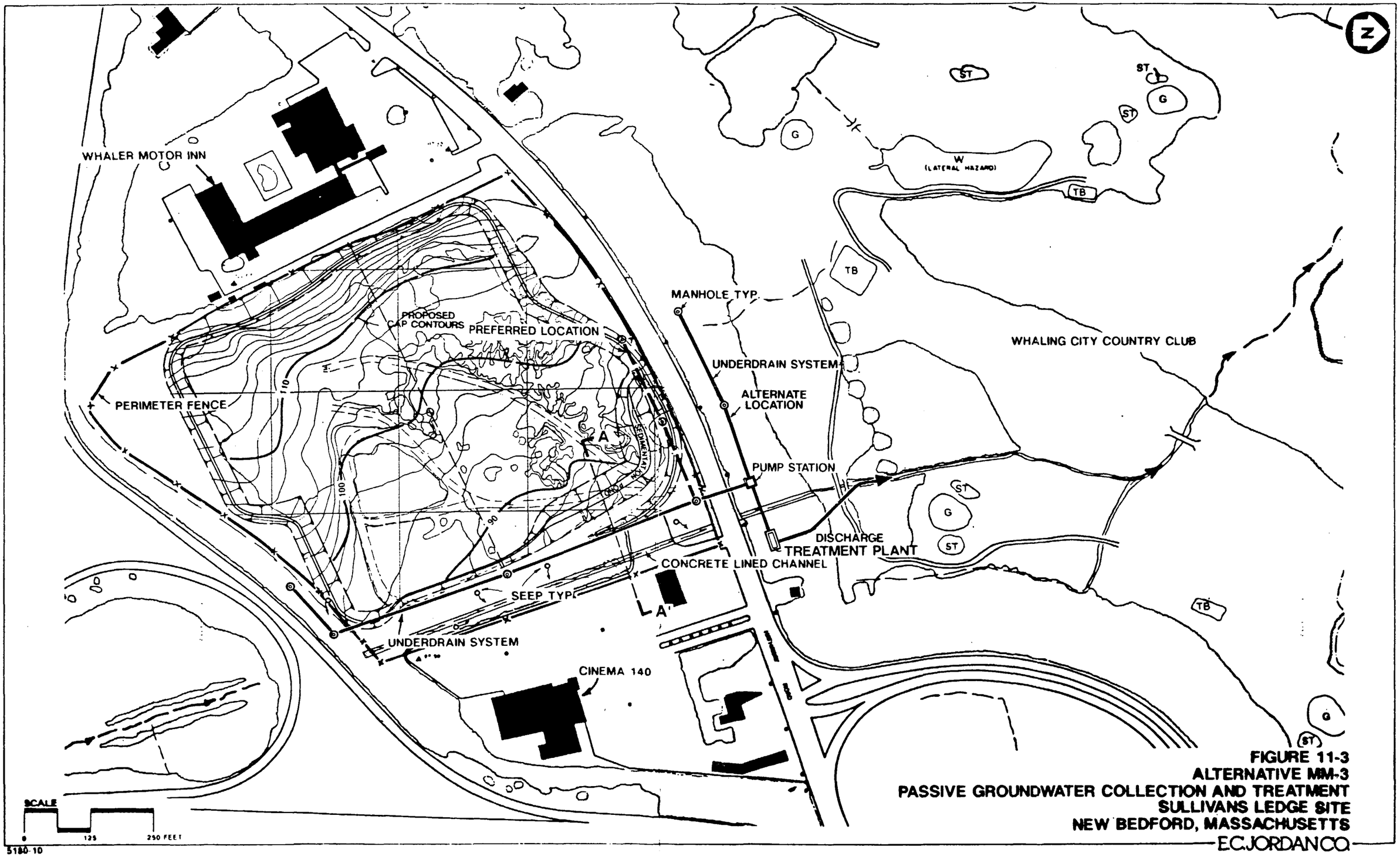

FIGURE 11-3
ALTERNATIVE MM-3
PASSIVE GROUNDWATER COLLECTION AND TREATMENT
SULLIVANS LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

E.C. JORDAN CO.

north of Hathaway Road (NUS, 1987). The increase in stream flow for the unnamed stream along the site border was found to be 50,000 gpd, while the flow in the stream north of Hathaway Road was 9,000 gpd. Hence, total flow can be expected to be 59,000 gpd or about 40-gpm. The 40-gpm flow rate will need to be verified during remedial design, especially if the bedrock trench is selected. This is because the extent of induced groundwater upward flow gradients cannot be determined at this time.

The contaminant concentration levels used to size treatment components were determined using analytical data collected during the Phase I RI (NUS, 1987) and the Phase II RI (see Section 5.4). Average seepage water chemistry is summarized in Table 11-2. Organic contaminants are primarily VOCs, and dissolved iron is present in relatively high concentrations (43 mg/l). Three treatment systems capable of organic contaminant removal were evaluated: air-stripping combined with granular activated carbon (GAC), UV/ozonation, and GAC alone.

Air-stripping/GAC. The air-stripping/GAC option consists of a combination of an air stripper for VOC removal followed by a GAC for polishing and removal of unstrippable compounds. A diagram of the proposed treatment scheme is depicted in Figure 11-4. The first step of the treatment process is to pump groundwater to an equalization tank. Equalization is necessary to provide a more evenly distributed flow through the treatment units. Pre-treatment for iron removal is anticipated to be required.

Application of chemical oxidants (i.e., potassium permanganate or chlorine), combined with aeration and followed by filtration, is a commonly used method for iron removal (Figure 11-5). Solids produced during the oxidation step must be concentrated and dewatered prior to disposal. Sludge produced from this step is anticipated to be hazardous and would be disposed off-site at a RCRA landfill.

Following iron removal, the water will be pumped to an air-stripping tower and sprayed onto a bed of high surface area/volume packing material. A blower will provide a counter-current flow of fresh air through the packed bed to enhance volatilization of organic components. Stripping efficiency for individual organic compounds is dependent on vapor-liquid equilibrium distribution and the mass transfer coefficient. Generally, compounds with higher vapor pressure and low solubility in water are more efficiently stripped.

The air stripper will only remove the VOCs. SVOCs found in the water will require removal by contacting with GAC. The GAC unit proposed for treatment includes the use of two carbon vessels operating in series. Each vessel will hold about 3,000 pounds of activated carbon. Effluent from the GAC units will be pumped to a sump, and will ultimately be discharged to surface water.

TABLE 11-2

CHEMICAL ANALYSIS OF SEEPAGE WATER
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

LEACHATE CHEMICALS	APPROXIMATE CONCENTRATION
volatile organics*	400 μg/ℓ
semivolatile organics+	50 μg/ℓ
sodium	52 mg/ℓ
calcium	48 mg/ℓ
iron	43 mg/ℓ
magnesium	11 mg/ℓ
potassium	6 mg/ℓ
manganese	1.1 mg/ℓ
barium	0.56 mg/ℓ
aluminum	0.2 mg/ℓ
cyanide	0.04 mg/ℓ
zinc	0.035 mg/ℓ
lead	0.01 mg/ℓ

*Volatile organics are primarily 1,2-dichloroethylene, benzene, chlorobenzene, xylenes, and vinyl chloride.

+Semivolatile organics are primarily n-nitrosodiphenylamine, 1,3-dichlorobenzene, and naphthalene.

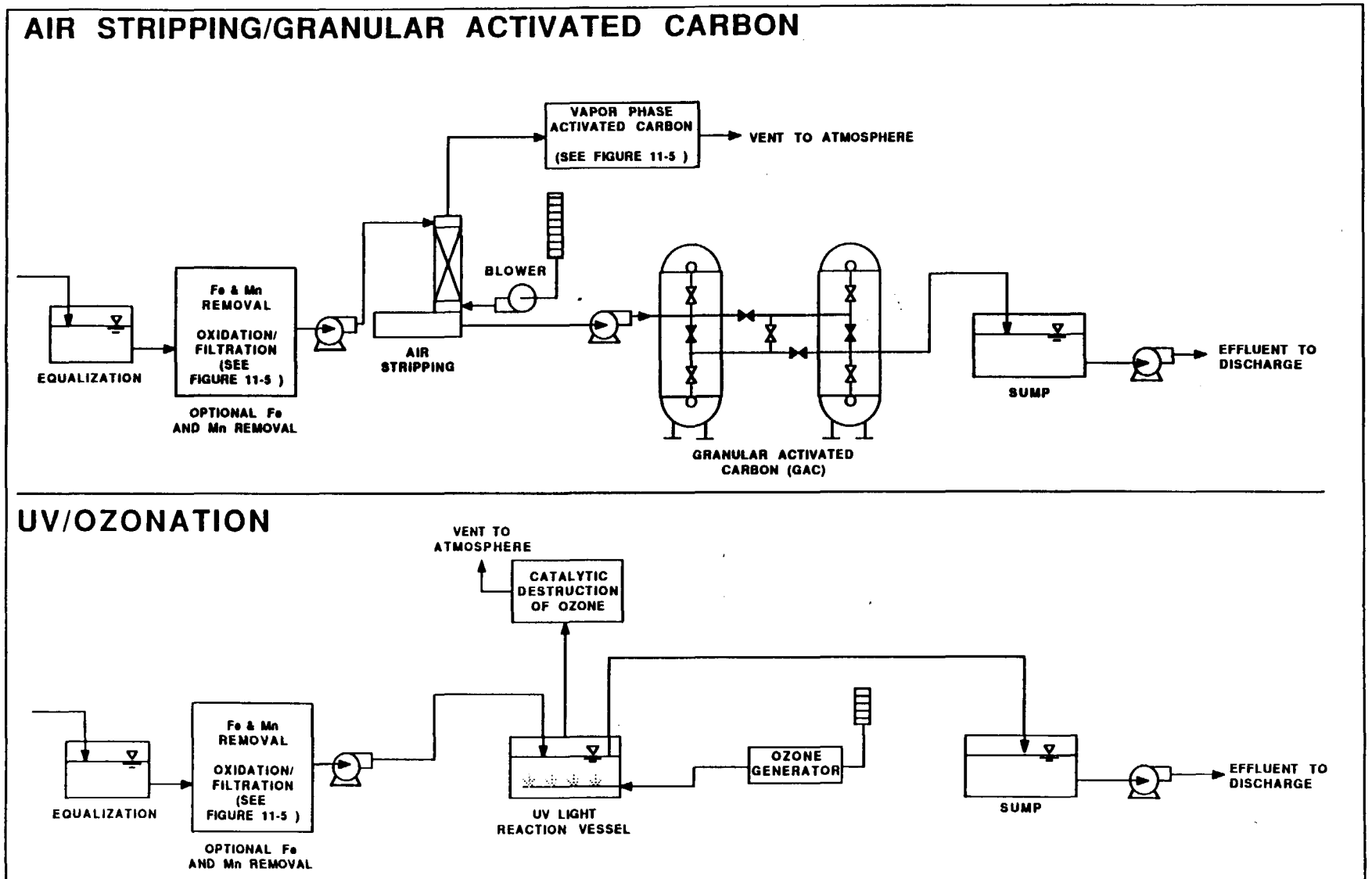

FIGURE 11-4
WATER TREATMENT UNITS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

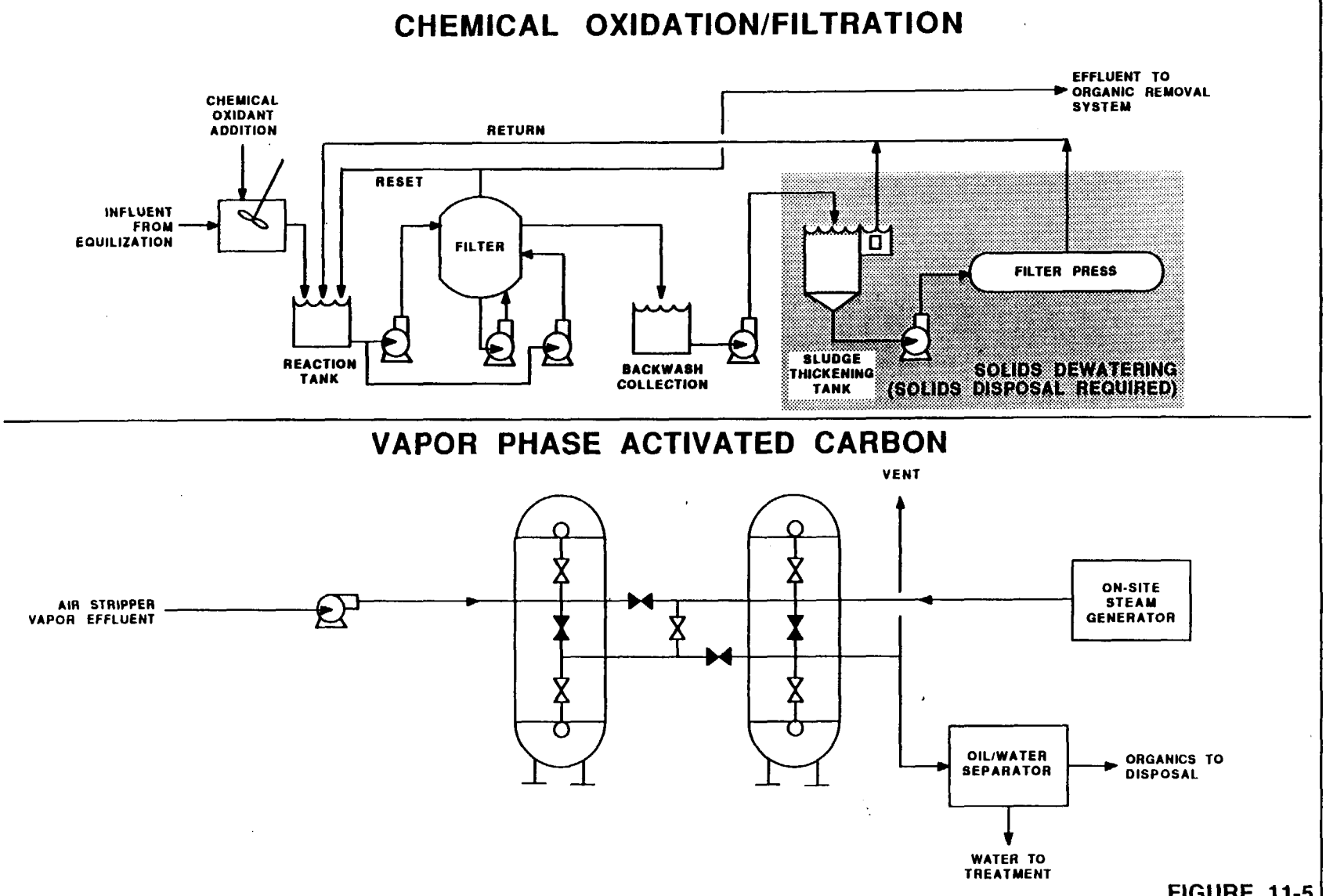

FIGURE 11-5
IRON REMOVAL AND OFFGAS TREATMENT UNITS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

Spent GAC could be regenerated, landfilled, or incinerated. Its fate will be determined as part of the vendor contract, under which the vendor would be responsible for its ultimate treatment or disposal.

Treatment of off-gas emissions from stripping units is required by Massachusetts Regulation 310 CMR 7.02(2)(a)(6). This regulation states that the Best Available Control Technology (BACT) will be implemented to control direct ventilation of contaminated exhaust streams from strippers. Massachusetts DEQE has determined BACT for aeration systems to be vapor phase carbon absorption or other technologies that will result in equivalent emissions reduction. Therefore, to comply with this ARAR, a vapor phase carbon absorption system for air-stripper off-gases has been proposed.

The vapor phase carbon system for off-gas treatment would be one of two types. The spent carbon could either be transported off-site for regeneration or disposal, or it could be regenerated on-site. If economies demonstrate that the carbon should be regenerated on-site, a system using steam to raise the bed temperature and sweep the organics from the bed would be used. Organics separated from the steam condensate would be drummed prior to off-site disposal. The contaminated water could be recirculated as feed to the air stripper. A typical installation (see Figure 11-5) requires low-pressure steam, cooling water, and power.

<u>UV/Ozonation</u>. The second water treatment option consists of the use of a UV Photolysis/Ozonation system for removal of organic compounds (see Figure 11-4). UV/Ozonation is an innovative treatment technology that uses a combination of UV light and a mixture of ozone and hydrogen peroxide to chemically oxidize organic compounds in water.

The UV/Ozonation system consists of a baffled reactor vessel within which UV bulbs are mounted. A predetermined mixture of ozone (generated on-site) and hydrogen peroxide is introduced into the reactor. The combination of the ozone and hydrogen peroxide in the presence of the UV light significantly enhances the oxidation rate for many organic compounds. Residual ozone could be used to enhance the iron precipitation process. If not required, a catalytic unit within a manifold attached to the reactor collects any residual ozone from the process and converts it to oxygen.

The overall treatment setup is similar to the air-stripping/GAC system. An equalization tank and an iron removal system will precede the UV/Ozonation unit. Removal of iron prior to treatment with UV/Ozonation is especially important. The high concentration of dissolved iron (43 ppm) measured in seepage water would interfere with the UV/Ozonation process because dissolved iron would be oxidized and would precipitate within

the reaction vessel. The iron precipitate will reduce penetration of the UV light and diminish the overall ability of the system to oxidize organic compounds. The chemical oxidation/filtration system discussed previously for iron removal should provide a relatively iron-free, nonturbid water for the UV/Ozonation treatment unit. UV/Ozonation is a destruction technology and, therefore, with the exception of metal sludge generated during iron removal, will not require any disposal of concentrated contaminants (e.g., such as spent carbon).

GAC. The third treatment option uses GAC for removal of both VOCs and SVOCs. The process of adsorption onto GAC involves contacting the contaminated groundwater with the carbon, usually by flow through a series of packed bed reactors. The activated carbon adsorbs organic contaminants by a surface attraction phenomenon, whereby the organic molecules are attracted to the internal pores of the carbon granules. When the pores are saturated with organics, the carbon is spent, and must be replaced with virgin or regenerated carbon.

The set-up for this process will be similar to those discussed previously for air-stripping and UV/Ozonation. The collected groundwater will first be pumped to an equalization tank. The water will then be pumped to an oxidation/filtration unit for removal of dissolved iron and suspended solids. This is an important step in the process because the GAC process is sensitive to high levels of suspended solids that could clog the contactors.

Following filtration, the water will be pumped through a series of two contactors. The vessels would be about 4 feet in diameter and about 8 feet in height. Each would hold approximately 3,000 pounds of carbon. The system will be run in series operation. When the first bed is spent, the second bed becomes the primary contactor. The first is then recharged with "clean" carbon, and is put back online as the secondary contactor. Spent carbon from this operation would most likely be regenerated off-site or disposed of at a landfill.

Off-site Treatment. Another option that was considered for disposal of collected groundwater consisted of treatment off-site. Three locations were considered. Two are publicly-owned treatment works (POTW): the Greater Lawrence Sanitary District, located in North Andover, Massachusetts; and the Upper Blackstone Water Pollution Abatement District, located in Millbury, Massachusetts. The third facility is a private treatment works owned by CECOS International, located in Bristol, Connecticut. The New Bedford POTW was not considered because it currently has only primary treatment and is not able to accept contaminated groundwater from a hazardous waste site.

The treatment facilities were given information pertaining to the chemistry and estimated flow rates of the groundwater (see Table 11-2). The flow rate was assumed to be 40 gpm. A total volume of 57,600 gallons, or the equivalent of twelve 5,000-gallon-capacity tractor trailers, would need to be shipped off-site each day.

The Greater Lawrence facility indicated that they would not be in a position to accept any contaminated groundwater from the Sullivan's Ledge site until at least 1990, following expansion of the facility. A cost estimate for treatment at this facility revealed that $8,650 per day, or $3.15 million annually, would be required to transport and dispose of the contaminated groundwater. Costs for treatment at the CECOS facility were estimated to be $20,000 per day, or $7.29 million annually. However, a representative from CECOS indicated that the POTW's current capacity would be unable to handle the estimated flows from the Sullivan's Ledge site.

The extremely high costs, large number of trucks required daily, and general uncertainty associated with off-site treatment of large volumes of contaminated liquid preclude the use of these facilities as a feasible alternative.

The proposed treatment systems will be capable of treating water containing the contaminants measured in the seeps. However, the types and concentrations of contaminants in the seeps do not necessarily indicate which chemicals will be found in the water collected by the passive collection system. The actual contaminant levels and flows will not be known until the passive collection system is installed and begins operation. Following construction of the collection system, a reevaluation of treatment systems should be performed. This approach to design will allow bench- and pilot-scale testing to be made on the actual groundwater collected. A more accurate assessment and design of a treatment facility could be made at that time.

11.3.2 Short-term Effectiveness

Implementation of the passive collection alternative should not result in any short-term adverse impacts to public health. Proper precautions during construction of the collection system, diversion channel, and cap should be taken to ensure worker safety. Workers should follow safe work practices and wear protective clothing. Construction activity is not expected to impact the health of the general public, because there are no residents in close proximity to the site. However, blasting during construction of the bedrock trench will likely endanger normal operation of the adjacent car wash, and has the potential of precipitating structural damage. For maximum safety, operations should be halted during blasting within a safe radius of the car wash. Atmospheric dispersion of any fugitive dust or volatilized chemicals generated during construction

should dilute dust and/or chemical concentrations downwind to levels which do not impact public health.

Construction of the concrete channel may cause resuspension and transport of contamination from stream sediments. Impact in stream segments north of Hathaway Road of this alternative can be minimized by the use of silt curtains, booms, or other appropriate equipment to prevent dispersal of contaminated sediments. Habitat for terrestrial organisms around the stream area will be disrupted or destroyed by activity and clearing of the area for construction of the concrete ditch. Mitigative measures necessary for this alternative include mitigation of damage to shrubs and trees during construction of the channel, and revegetating affected areas following construction. This will reduce disruption of terrestrial habitat and erosion into the stream.

The passive collection system will begin protecting against the threats associated with the contaminated seeps immediately following construction and implementation of the treatment units.

An implementation timeline for construction of the passive collection and treatment system will be as follows:

Construction of passive collection system, and lining of unnamed stream	8 to 12 months
Pilot-scale tests; and water treatment unit design, construction, and startup	8 months
Total completion time	16 to 20 months

Construction of the treatment units will be able to take place during or prior to construction of the cap.

11.3.3 Long-term Effectiveness and Permanence

The installation of a passive collection system will enable the collection and treatment of contaminated overburden and/or shallow bedrock groundwater. In addition, measures will be taken to reduce the amount of groundwater to be treated; these include capping the site and diverting the stream. Either passive collection system design will result in the effective elimination of seeps and reduction of risks associated with direct human contact to seepage water and sediments.

The future contaminant levels in deep bedrock groundwater will not be reduced to levels considered protective of public

health. Therefore, risks associated with groundwater use will not be effectively mitigated by this alternative.

Public awareness would increase the effectiveness of this alternative by informing the community of the potential hazards of future groundwater use. Favorable community reaction to eliminating the seep areas is likely. However, unfavorable reactions to leaving contaminated deep bedrock groundwater untreated may occur.

Permanent stream habitat loss will result from diversion of the stream into a concrete channel. Monitoring of waterborne contaminant levels after remedial actions will document that exposure concentrations have decreased or are decreasing to below AWQC levels.

The appropriate water treatment unit should be capable of meeting the performance specifications if properly operated and maintained. Sampling of the treatment system's influent and effluent will be performed on a periodic basis to ensure system performance.

Certain components of the treatment systems, such as reactors, pumps, controls, and filtration units, will possess limited service life. An average service life of 10 to 15 years can be expected of these components. Therefore, if the alternative is expected to be in service for time periods longer than 15 years, replacement of worn out equipment will be necessary.

11.3.4 Reduction of Mobility, Toxicity, and Volume

Overall, the passive collection alternative will result in reduction of the mobility of contaminants carried by seep water, overburden groundwater, and/or shallow bedrock groundwater. However, each of the proposed treatment systems will provide unique levels of reduction in contaminant toxicity and volume. The following summarizes the extent of reduction in toxicity and volume of organic contaminants.

PROPOSED TREATMENT	ASSESSMENT OF TOXICITY AND VOLUME REDUCTION
• Air Stripping with GAC Polishing (without off-gas treatment)	• Does not reduce either toxicity or volume, but instead transfers contaminants to atmosphere. Regeneration of GAC would result in some reduction of toxicity and volume of organics.

• Air Stripping with GAC Polishing (with off-gas treatment)	• Reduces volume of contaminants by concentrating organics with on-site GAC regeneration. Off-site incineration of concentrated organics would result in toxicity reduction.
• UV/Ozonation	• Reduces both toxicity and volume through complete oxidation of organic compounds.
• GAC Treatment	• Reduces volume of contaminants by concentration within the carbon. Off-site carbon regeneration would reduce toxicity.

Residuals from the treatment processes include spent carbon from GAC operations, concentrated organics from air-stripper off-gas treatment, and a metal-hydroxide sludge from the iron-removal process. Each residual would require disposal. The carbon would be regenerated at an off-site facility, or would be disposed of in a landfill. The concentrated organics would be reclaimed or incinerated at an off-site facility. The metal-hydroxide sludge would require disposal in an approved disposal facility.

11.3.5 Implementability

Technical Feasibility. Difficulties encountered during construction of the passive collection system constructed in the overburden are expected to be minimal. Some water-handling precautions will be necessary to complete the work. Groundwater and stream flows may require pumping and diversion. Presently, the actual elevation and profiles of the bedrock surface below the location of the proposed collection system are unknown. Bedrock elevation information would be confirmed during construction, and any adjustments would be made at that time.

The passive collection system constructed in the bedrock will be more difficult to construct. The overburden will need to be removed along the length of the trench. The bedrock will need to be drilled and blasted to the 20 foot depths. Precautions will need to be taken during blasting of the bedrock near the adjacent car wash and along Hathaway Road. It is anticipated that the car wash will need to be shut down during blasting within 100 feet of the structure. Prior to reopening, the building will need to be inspected for structural damage, some

of which is anticipated. In addition, Hathaway Road will need to be closed during the blasting of the northern trench. Once the trench is blasted, the rock will be removed by a backhoe and crushed on-site for the trench drain fill material.

Water handling precautions will be required during construction. Pumping of the contaminated groundwater and diversion of the unnamed stream will be vital to completing this work. Temporary water-storage/treatment will be needed for the water pumped from the construction area.

The proposed treatment systems are all technically feasible. Air-stripping and treatment with GAC are well-proven technologies. Much work has been done with these technologies and they could be easily adapted to the specific application required for water treatment. Technologies required for iron removal are also well-developed, and have been used extensively in the water and wastewater treatment industries.

Destruction of organic compounds using the UV/Ozonation process is an innovative, less-developed technology. However, this technology has been used in a variety of applications ranging from treatment of chemical and electronic manufacturers' wastewater to treatment of groundwater contaminated with chlorinated hydrocarbons.

Only limited work has been done relating to treatment of off-gas from air-stripping used to remove VOCs from groundwater. Generally, the off-gases contain very low concentrations of organics. Treatment of dilute concentrations of contaminants in an airstream is a very inefficient operation.

Monitoring of the collection and treatment system would be necessary to continually assess its integrity and performance. Sampling manholes would be installed on the underdrain pipeline to provide access to the system. Sampling of the treatment system's influent and effluent would be performed on a routine basis to assess system performance.

A program to monitor the extent of groundwater contamination would also be developed. This monitoring program would incorporate the use of the existing multi-level monitoring wells, and would be similar to the program developed for the no-action alternative.

Administrative Feasibility. The lead agency (EPA) will need to coordinate with the State of Massachusetts and the City of New Bedford to establish institutional controls to regulate installation of water wells within a specified radius of the

site. City water will be available to new residents within this area. Annual coordination or review should be conducted by both EPA and the state to ensure that these controls are being implemented.

Permits would not be required to discharge treated water to local surface waters, but permit requirements would need to be attained during operation of the treatment plant.

Availability of Services and Materials. Technologies necessary for construction and operation of underdrain systems are time-tested and within the capabilities of a great number of contractors locally and within the region.

The technologies considered for the water treatment components are widely available and sufficiently demonstrated for the specific application. The off-gas treatment systems are generally less-developed, and would require additional development prior to application. A recent EPA report (EPA, 1987b) indicated that, of 177 air-strippers identified in the study, only 17 were equipped with air emissions controls. Of the 17, 12 utilized GAC units. In most cases, however, the treatment system flow rates were much greater than those anticipated for the proposed collection and treatment system.

11.3.6 Cost

The costs analysis for the passive collection and treatment alternative includes development of capital costs associated with design and construction of the collection and treatment systems; annual costs associated with treatment system operation/maintenance; and annual costs of the groundwater monitoring program.

Development of this alternative included comparison of four treatment processes for removal of organic compounds. The treatment processes include air-stripping/GAC; air-stripping/GAC with off-gas treatment; GAC alone; and UV/Ozonation. Each proposed treatment system will require iron removal for optimum operation of the organic treatment units. Table 11-3 compares capital and operating costs of the four treatment systems.

The air-stripping/GAC system without off-gas treatment has both the lowest capital expenditure and the lowest operational cost. However, this treatment system does not comply with the

Table 11-3
SHALLOW GROUNDWATER TREATMENT SYSTEMS COSTS COMPARISON
ALTERNATIVE MM-3
SULLIVANS LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

AIR STRIPPING / GAC		AIR STRIPPING / GAC (Emission control using vapor phase carbon)		GRANULAR ACTIVATED CARBON (GAC)		UV / OZONATION	
CAPITAL		CAPITAL		CAPITAL		CAPITAL	
• air stripper	$ 13,000	• air stripper	$ 13,000	• GAC contactors	$ 50,000	• UV/ozonation unit	$ 110,000
• equilization tanks	15,000	• equilization tanks	15,000	• equilization tanks	15,000	• equilization tanks	15,000
• pumps and controls	13,000	• pumps and controls	13,000	• pumps and controls	13,000	• pumps and controls	13,000
• piping - electrical	7,000	• piping - electrical	7,000	• piping - electrical	7,000	• piping - electrical	5,000
• GAC contactors	35,000	• GAC contactors	35,000	• iron removal		• iron removal	
• iron removal		• vapor phase carbon		- chemical feed	9,000	- chemical feed	9,000
- chemical feed	9,000	- carbon contactors	30,000	- filtration unit	23,900	- filtration unit	23,900
- filtration unit	23,900	- carbon regeneration equipment	25,000	- pumps, accessories	6,000	- pumps, accessories	6,000
- pumps, accessories	6,000	• iron removal		- filter press	12,300	- filter press	12,300
- filter press	12,300	- chemical feed	9,000	• force main	7,500	• force main	7,500
• force main	7,500	- filtration unit	23,900	• discharge main	10,000	• discharge main	10,000
• discharge main	10,000	- pumps, accessories	6,000	• building	10,000	• building	12,000
• building	12,000	- filter press	12,300	• miscellaneous (10%)	16,370	• miscellaneous (10%)	22,370
• miscellaneous (10%)	16,370	• force main	7,500				
		• discharge main	10,000				
		• building	15,000				
		• miscellaneous (10%)	22,170				
TOTAL CAPITAL COST	$ 180,070	TOTAL CAPITAL COST	$ 243,870	TOTAL CAPITAL COST	$ 180,070	TOTAL CAPITAL COST	$ 246,070

Table 11-3 (cont.)
SHALLOW GROUNDWATER TREATMENT SYSTEMS COSTS COMPARISON
ALTERNATIVE MM-3
SULLIVANS LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

AIR STRIPPING / GAC		AIR STRIPPING / GAC (Emission control using vapor phase carbon)		GRANULAR ACTIVATED CARBON (GAC)		UV / OZONATION	
ANNUAL OPERATING COSTS		ANNUAL OPERATING COSTS		ANNUAL OPERATING COSTS		ANNUAL OPERATING COSTS	
• chemicals	$ 11,250	• chemicals	$ 11,250	• chemicals	$ 11,250	• chemicals	
• disposal of residues	6,000	• disposal of residues		• disposal of residues	6,000	- UV/ozonation	$ 10,100
• carbon costs	3,500	- iron residuals	6,000	• carbon costs	23,200	- iron oxidation	11,250
• electrical	6,000	- organic liquids	80	• electrical	4,500	• disposal of residues	6,000
• operator	29,200	• carbon costs		• operator	29,200	• electrical	4,500
• maintenance (5% of capital)	9,004	- aqueous phase	3,500	• maintenance (5% of capital)	9,004	• operator	29,200
		- vapor phase	3,000			• maintenance (5% of capital)	12,304
		• electrical	6,000				
		• fuel (preheater and steam generator)	3,650				
		• operator	29,200				
		• maintenance (5% of capital)	12,194				
TOTAL ANNUAL COSTS	$ 64,954	TOTAL ANNUAL COSTS	$ 74,874	TOTAL ANNUAL COSTS	$ 83,154	TOTAL ANNUAL COSTS	$ 73,354
PRESENT WORTH OF O&M (30 yrs @ 5%)	$1,000,000	PRESENT WORTH OF O&M (30 yrs @ 5%)	$1,150,000	PRESENT WORTH OF O&M (30 yrs @ 5%)	$1,280,000	PRESENT WORTH OF O&M (30 yrs @ 5%)	$1,150,000
TOTAL PRESENT WORTH (30 yrs @ 5%)	$1,180,000	TOTAL PRESENT WORTH (30 yrs @ 5%)	$1,390,000	TOTAL PRESENT WORTH (30 yrs @ 5%)	$1,460,000	TOTAL PRESENT WORTH (30 yrs @ 5%)	$1,370,000

Massachusetts Air Quality ARAR regarding treatment of off-gases from an air-stripping unit. Therefore, this system will not be considered further. Costs for this treatment process are included only for comparison. The GAC system has the lowest capital outlay, but requires the largest costs for operation. However, the present worth of the treatment is the greatest of the four. Treatment with GAC also creates the greatest volume of spent carbon, which would require off-site regeneration or disposal.

The two remaining treatment systems are near equal in cost. The UV/Ozonation system requires a slightly higher capital outlay, but costs less to operate and maintain than the air-stripping/ GAC system with off-gas treatment. The UV/Ozonation unit is a permanent treatment technology and does not produce residuals (e.g., the spent carbon and concentrated organics produced by the air-stripping/GAC system). However, the iron-removal process used in both processes will produce a metal-hydroxide sludge, which will require disposal.

The UV/ozonation unit will be retained as the treatment process for this alternative. It is an innovative and permanent destruction technology and has costs comparable with more well-developed treatment methods.

Table 11-4 contains a breakdown of the costs associated with the construction and operation of the passive collection and treatment alternative. Total capital for the collection and treatment system to collect the overburden groundwater is $769,000. Total capital costs for the bedrock collection system is $907,000; the difference between the two systems is for the additional costs required to blast, excavate, and backfill the deeper trench. This includes $246,070 for construction of an iron-removal and UV/Ozonation system.

Twenty-five percent of the capital cost is added as a contingency to cover costs associated with engineering and other unforeseen circumstances.

Long-term costs associated with operation/maintenance of the system are summarized in this table. These include costs for operation of a treatment system, for groundwater and treatment system monitoring, and 5-year review costs. They also include costs for replacement of the monitoring wells and the water treatment system. For replacement, it was assumed that both the monitoring wells and the treatment system would have service lives of 15 years. The total present worth of the overburden system alternative is $2,950,000, and for the bedrock system is $3,084,000. This was computed for a 30-year period, assuming a discount rate of 5 percent.

TABLE 11-4
ALTERNATIVE MM-3 COST ESTIMATE
PASSIVE COLLECTION AND TREATMENT
FOR IRON REMOVAL FOLLOWED BY UV/OZONATION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ITEM DESCRIPTION	OVERBURDEN SYSTEM COST	BEDROCK SYSTEM COST
CAPITAL COSTS		
• bypass channel excavation - stockpile material on-site	$ 6,000	$ 6,000
• remove existing 72"-diameter concrete culvert (adjacent to carwash)	3,500	3,500
• site clearing, grading of streambed	30,000	30,000
• construction of concrete lining (8"-thick, mesh-reinforced, 20'-wide)	117,500	117,500
• construction of overburden underdrain system (12"-diameter perforated pipe, 10'-deep trench, crushed rock and filter fabric around pipe)	129,750	129,750
• additional capital costs for construction of bedrock underdrain system (drilling and blasting of bedrock, excavation, crushing of rock, additional water handling)		100,000
• pump station	12,000	12,000
• engineering and design (10%)	30,000	40,000
• iron-removal system and UV/ozonation unit (see Table 11-3 for details)	246,070	246,000
• sampling equipment purchase costs (Year 1)	40,500	40,500
• contingency (25% of all costs)	154,000	182,000
TOTAL CAPITAL COSTS FOR OVERBURDEN PASSIVE COLLECTION SYSTEM	$769,000	
TOTAL CAPITAL COSTS FOR BEDROCK PASSIVE COLLECTION SYSTEM		$907,000

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TABLE 11-4 (continued)
ALTERNATIVE MM-3 COST ESTIMATE
PASSIVE COLLECTION AND TREATMENT
FOR IRON REMOVAL FOLLOWED BY UV/OZONATION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ITEM DESCRIPTION	COST	PRESENT WORTH
EQUIPMENT REPLACEMENT COSTS		
• sampling equipment replacement costs (Years 11 and 12)	40,500	38,220
• monitoring well replacement costs (Year 16)	120,000	54,970
• treatment system replacement costs (Year 16)	246,070	113,310
PRESENT WORTH OF EQUIPMENT REPLACEMENT (30 years @ 5%)	---	$ 206,500
OPERATING AND MAINTENANCE (O&M) COSTS		
• annual O&M costs for water treatment (see Table 11-3 for details)	$ 73,354	$1,150,000
• annual cost of treatment performance evaluation (monthly sampling of treatment unit influent and effluent)	12,000	185,000
• annual groundwater sampling and analysis cost (Years 1 and 2, quarterly sampling)	108,700	202,000
• annual groundwater sampling and analysis costs (Years 3 to 30, annual sampling)	29,050	394,000
• 5-year review costs	14,000	39,000
PRESENT WORTH OF ANNUAL AND 5-YEAR EXPENDITURES (30 years @5%)	---	$1,970,000
PRESENT WORTH OF ALTERNATIVE (OVERBURDEN SYSTEM)	---	$2,950,000
PRESENT WORTH OF ALTERNATIVE (BEDROCK SYSTEM)	---	$3,084,000

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11.3.7 Compliance with ARARs

Chemical-specific ARARs pertaining to Alternative MM-3 can be separated into three groups: federal and state drinking water and groundwater standards; state surface water quality standards; and federal and state air regulations.

The first group of chemical-specific ARARs for Alternative MM-3 consists of federal and state regulations pertaining to drinking water (SDWA 40 CFR 141.16, DEQE - Drinking Water Standards 310 CMR 22.00) and state groundwater quality standards (314 CMR 6.00). These ARARs will be attained for the off-site overburden groundwater and the upper portion of the bedrock groundwater because this water will be collected in the passive collection system and treated. These ARARs will not be attained for the majority of the contaminated bedrock groundwater both on- and off-site.

An ARAR waiver may be justified for not extracting the contaminated bedrock groundwater because it may be technically impracticable from an engineering perspective. Historically, the quarry pits have been used for disposal of solvents and flammable liquids. In 1968, the largest quarry pit was filled to overflowing and a culvert was installed to the northernmost quarry pit to allow continued liquid dumping (NUS, 1987). This implies that the quarry pits received a substantial volume of industrial waste liquids. Many common solvents found at the Sullivan's Ledge site, such as trichloroethene are heavier than water and could have moved downward into bedrock fractures with only limited influence from groundwater flow. These solvents have the potential to remain in bedrock fractures as a dense, non-aqueous, phase liquid (DNAPL) and slowly dissolve over time, thus acting as a long term residual source of groundwater contamination. Locating the DNAPL in the quarry pits and in an unknown array of bedrock fractures (where DNAPLs may exist) would be difficult and costly. Therefore, if significant DNAPLs are actually present in the quarry pits or bedrock fractures around the site, it may not be technically feasible to effectively remove them unless they can be exactly located and pumping wells can be placed to intercept them.

Pumping and treating the contaminated groundwater will be successful as long as pumping continues. The potential exists that additional groundwater contamination will result when the pumps are turned off as the DNAPL continues to go into solution. A passive collection system, will also not attain the chemical-specific ARARs in bedrock groundwater. However, the potential existence of DNAPL in the bedrock fractures may make the permanent restoration of this groundwater technically infeasible.

In addition to the impracticability of locating and pumping DNAPL, should such wastes exist, there are two other limitations to attaining ARARs in contaminated bedrock groundwater. These are:

- The contents of the waste pits are unknown and could contain waste sources (e.g., drums) that may release contaminants into groundwater for an indeterminate time.

- There are limitations to the extent that bedrock fractures can be located and groundwater extraction wells placed to effectively remove all contaminated groundwater in bedrock.

The second group of chemical-specific ARARs consists of the Massachusetts surface water quality standards. These requirements will be attained by controlling the discharge from the water treatment system.

The last group of chemical-specific ARARs consists of federal and state air regulations. These regulations will be attained during construction activities by controlling fugitive dust emissions. In addition, if air-stripping is reconsidered for groundwater treatment, vapor phase carbon adsorption will be used to attain the state ARAR, DEQE - Air Pollution (310 CMR 7.00).

Location-specific ARARs for Alternative MM-3 are the federal and state facility siting regulations (RCRA Location Standard 40 CFR 264.18 and Hazardous Waste Facility Siting regulation 990 CMR 1.00). These ARARs will be attained by siting the water treatment system outside the 100-year floodplain of the unnamed stream.

Action-specific ARARs for this alternative are separated into four groups. The first group consists of federal and state regulations pertaining to hazardous waste operations (RCRA 40 CFR 264.1 - 264.120, DEQE - Hazardous Waste Phases I and II 310 CMR 30.00). The regulations will be attained because the specifications set forth in these regulations will be used as design standards during remedial design.

The second group of action-specific ARARs consists of safety regulations: federal OSHA regulations and the three separate state right-to-know regulations. These regulations will be attained during the remedial action.

The third group of action-specific ARARs consists of federal and state regulations pertaining to discharge requirements. These regulations are:

- CWA - National Pollutant Discharge Elimination System (40 CFR 122.125)

- Massachusetts Department of Water Pollution Control (MDWPC) - Water Discharge Permits (314 CMR 1.00-7.00)

- MDWPC - Supplemental Requirements for Hazardous Waste Management Facilities (314 CMR 8.00 - 29.00)

These requirements will be attained for the discharge of the water treatment plant into the unnamed stream.

Table 9 in Appendix E outlines the chemical-, location-, and action-specific ARARs for this alternative in greater detail. In addition, the corresponding remedial action(s) required to attain the ARAR is outlined.

11.3.8 Overall Protection of Public Health and Environment

Public health and environmental risks associated with contaminants present in seeps along the unnamed stream will be reduced. This will be accomplished by collection and treatment of groundwater discharging along the downgradient borders of the site. This alternative provides only a partial site cleanup, and will not provide any measure of cleanup to deep bedrock groundwater affected by site contamination.

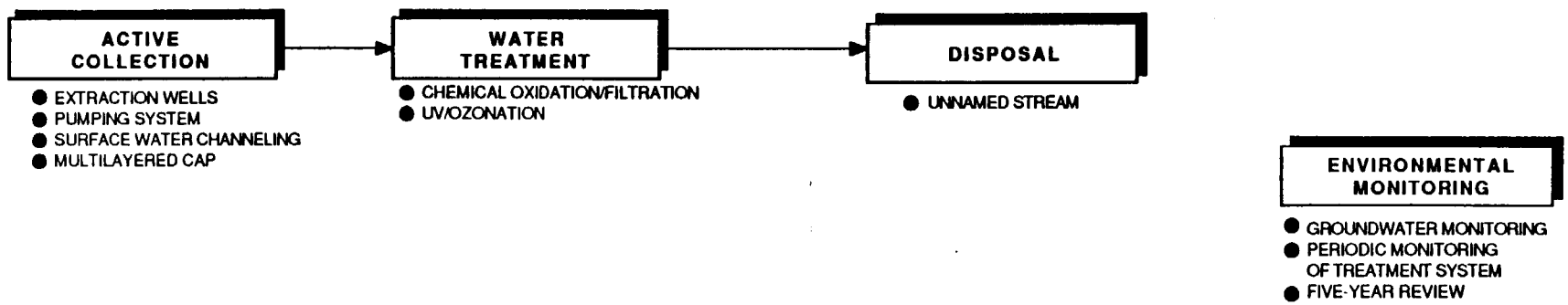
11.4 ALTERNATIVE MM-5: ACTIVE COLLECTION

11.4.1 Description

Contaminants, principally VOCs, are present in groundwater beneath and downgradient of the Sullivan's Ledge site. The contaminants are distributed in the overburden and bedrock groundwater flow systems, and were detected at a distance of up to 800 feet north of the site. The maximum observed depth of VOC distribution in a bedrock fracture was at 225 feet in a downgradient multi-level monitoring well. Alternative MM-5 proposes active collection and treatment to mitigate groundwater contamination. Figure 11-6 depicts major components of this alternative.

A groundwater extraction and treatment system was developed for the pump and treatment alternative being considered for remediation at the site. A set of wells, located on-site at the downgradient end of the landfill or quarry pits, conceptually designed to accomplish three long-term objectives: (1) prevent further migration of groundwater contamination from the quarry pits in the upper 150 feet of the bedrock groundwater flow system; (2) remove contaminated groundwater located in and immediately adjacent to the quarry pits; and (3) provide flushing of groundwater through the pits to encourage continued removal of contaminants at the site.

FIGURE 11-6
SCHEMATIC OF ALTERNATIVE MM-5
ACTIVE COLLECTION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS



Two additional measures (site capping and channeling of the streambed) will need to be incorporated into the design of the groundwater pump and treat alternative. These measures will be employed to reduce water infiltration into the site surface. Details pertaining to the design and construction of the cap are discussed in Section 10.3. Channeling of the unnamed stream in a concrete-lined channel is evaluated in Section 11.3.

Because of the existence of DNAPLs in the pits and the complicated nature of the groundwater flow system, wells are anticipated to operate on a long-term basis.

Groundwater Extraction System. It is anticipated that the groundwater extraction system will include a total of six pumping wells as shown in Figure 11-7. The wells are spaced approximately 150 to 200 feet apart and are placed to cut off flow leaving the downgradient end of the quarry pits. Regional flow will move into and through the pits to encourage flushing of contaminants from the source. Since it is suspected that the quarry pits are approximately 150 feet deep, the extraction wells are specified at a depth of 200 feet below ground surface. The wells will be a minimum of 6 inches in diameter and will be screened the entire depth to intercept fractures hydraulically connected to the quarry pits.

Groundwater will be pumped from the wells using a submersible pump rated up to 10 gpm (1/2 h.p. motor; 1 kw power use). For the purpose of this alternative evaluation, each well is anticipated to provide a minimum of 5 gpm, yielding a total of 30 gpm for the six extraction wells. Given the long-term pumping and unknown chemical constituents in the quarry pits, the wells and pumps should be constructed with stainless steel materials to minimize the potential for chemical deterioration. The flow from the wells will be piped underground to a small building, where flows will be metered and well operation will be automatically controlled (Figure 11-7). Treatment will be applied to the cumulative discharge from the instrumentation/control buildings. The pipeline between the wells and to the building is estimated at 2,100 linear feet and can be constructed using plastic materials. The pipeline will be buried 5 to 6 feet below ground surface to avoid freezing in the winter. No bedrock is expected to be encountered along the route of the pipeline excavation.

The submersible pump in the extraction wells will depress the water table and create inward seepage gradients into and through the quarry pits as groundwater is withdrawn. Under natural flow gradients, the estimated volume of groundwater moving in the bedrock downgradient from the quarry pits could be captured by two wells pumping at 10 gpm. However, to encourage groundwater

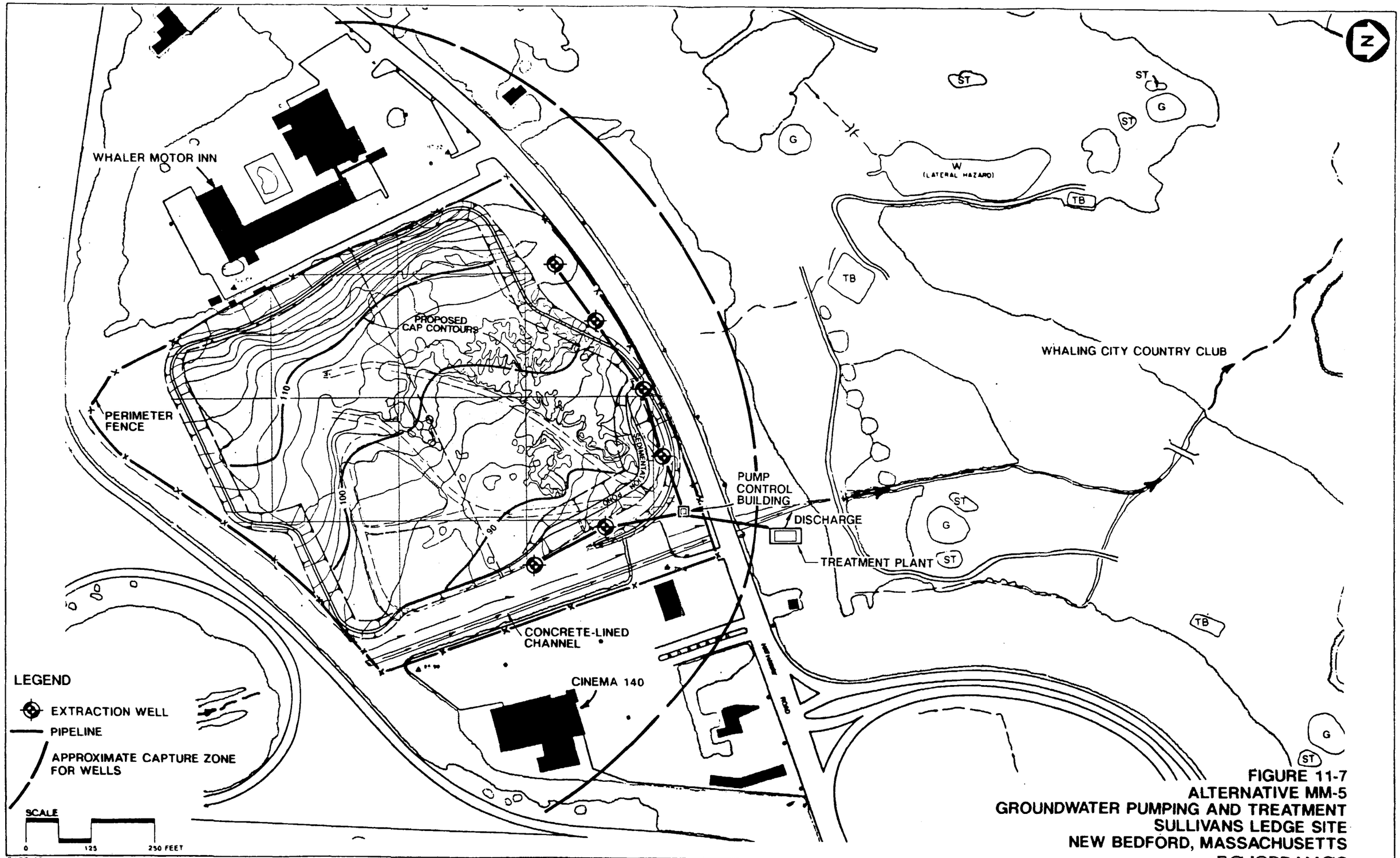


FIGURE 11-7
ALTERNATIVE MM-5
GROUNDWATER PUMPING AND TREATMENT
SULLIVANS LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

E.C. JORDAN CO.

flushing through the pits, an extraction system yielding 30 to 60 gpm has been selected. The combined pumping of all six on-site extraction wells is expected to produce a capture zone that extends up to 500 feet to the east and west beyond the site boundaries (see Figure 11-7). At the cumulative pumping rate of 30 gpm, it is estimated that the equivalent of one pore volume of groundwater will be removed from the quarry pits in six to seven years. After the first drainable pore volume has been removed, drawdown in the quarry pits is likely to remain below the top of the bedrock. Therefore, seepage to nearby ditches will be terminated and further off-site migration in surface water should be remediated. Multiple pore volumes may be extracted through successive years of pumping in increments of six to seven years. The total number of pore volumes needed to flush contaminants from the source is undetermined.

The assumptions made to develop the on-site extraction system are as follows:

1. The extraction wells will be located near enough to the quarry pits to intercept multiple fractures (historically created by quarrying) and, thereby, have good hydraulic connection to groundwater in the pits. Additional test borings may be required to locate the edge of the pits.

2. An estimated 100 million gallons occur in one pore volume of storage (i.e., using a porosity of 0.5) in all pits combined, using an average depth of 150 feet and total area of 180,000 square feet. This compares with a figure of 180 million gallons reported by NUS.

3. Approximately six to seven years of pumping at 30 gpm are needed to remove one pore volume from the pits. After the first pore volume is removed, an upper zone of the pits will be dewatered as drawdown develops in the system.

4. Because of the uncertainty of locating bedrock fractures, the pumping system is not developed to intercept DNAPL if present in the fractures of the bedrock formation.

5. The analysis of groundwater flow and pumping effectiveness is based on a Theis solution technique using available hydraulic conductivity data, seepage gradients, assumed porosity, and storage terms. The pumping alternative described previously represents a conceptual design approach that can be implemented at the site. However, additional hydraulic information will be needed to finalize the number of wells, placement, and pumping rates for the extraction system design.

Groundwater Treatment System. The groundwater treatment units proposed for this alternative are the same systems as those discussed previously for Alternative MM-3 (passive collection). They include for treatment of organic compounds an air-stripping GAC system with and without emission control, GAC alone, and UV/Ozonation. An oxidation/filtration system is provided for removal of dissolved iron. Each treatment system is discussed in Section 11.3.1.

The conceptual design of each treatment unit and the resulting cost estimate were based on mean concentrations of contaminants measured in bedrock wells during the Phase II RI. These mean contaminant levels are summarized in Table 5-9 for the ECJ multi-level bedrock wells and in Table 5-7 for all other bedrock wells.

The major organic contaminants found in site groundwater (ECJ wells) and their associated mean concentrations are trichloroethene, 24,000 ppb; 1,2-dichloroethene, 4,400 ppb; vinyl chloride, 125 ppb; toluene, 978 ppb; ethylbenzene, 395 ppb; styrene, 591 ppb; and 4-methyl-2-pentanone, 440 ppb. Mean iron concentrations range from 2,350 ppb in multi-level wells (ECJ) to 18,500 ppb in other bedrock wells. Although iron levels are not as high in groundwater as they are in seep water, they are high enough to indicate that iron may need to be removed prior to treatment for organic contaminants. Therefore, in order to provide the best water treatment available, an iron removal system will be incorporated into each of the proposed treatment schemes. Figures 11-3 and 11-4 are schematics of the proposed treatment systems.

The total flow from the proposed on-site extraction systems is estimated to be a minimum of 30 gpm and a maximum of 60 gpm. To be conservative, the treatment systems were sized and costed for a 60 gpm maximum pumping rate (i.e., 10 gpm per well for six wells).

An evaluation of the four systems proposed for treatment of contaminated groundwater was performed. This analysis was similar for the water treatment system analysis discussed in Section 11.3.1. Conclusions drawn from this evaluation indicate that a water treatment system consisting of an oxidation/filtration unit for iron removal and a UV/ozonation unit for organic removal would best fit the conditions anticipated with the groundwater extraction system. A cost comparison of possible treatment units (see Section 11.4.6) also revealed that UV/ozonation would be the most cost-effective approach for groundwater treatment.

The treatment system would be located along the northern edge of Hathaway Road, just east of the unnamed stream (see Figure 11-7). The location is a wooded area that borders the Whaling

City Country Club. Treated water from the facility would be discharged directly to the unnamed stream. Appropriate discharge standards would be attained.

11.4.2 Short-term Effectiveness

Installing a pump and treat system should not result in any short-term adverse impacts to public health. However, since this alternative requires the installation of groundwater wells and construction of a treatment system and cap, precautions should be taken to ensure worker safety. Workers should follow safe work practices and wear adequate protective clothing. The construction activity is not expected to release VOCs in concentrations posing a risk to downwind receptors due to dilution and atmospheric dispersion. In addition, the use of water sprays or dust-suppressant chemicals will control dust generation.

Protection from risks associated with the contaminated groundwater discharge along the unnamed stream will begin following construction and startup of the pumping and treatment systems. Installation of the extraction wells will coincide with construction of the site cap. Following well installation, pump tests will need to be performed on the well system to verify that proposed flow rates can be realized. Extraction of water during the pump tests will provide an ideal opportunity to run pilot-scale tests with the UV/ozonation system. These tests will provide the information necessary for proper operation of the treatment units. Ultrox International (Santa Ana, California), a vendor of UV/ozonation systems, has portable treatment systems available for pilot-testing. Following the pilot-testing activity, the treatment units will be designed, constructed, and put into operation.

The implementation timeline will be as follows:

Construction of site cap	12 to 24 months
Well installation; pump tests; and treatment system pilot-testing and design	8 to 10 months
Treatment system construction and startup	6 to 8 months
Total completion time	26 to 42 months

11.4.3 Long-term Effectiveness and Permanence

Pumping and treating contaminated groundwater at this site is designed to eliminate groundwater discharge at the seep locations. This alternative will, therefore, effectively reduce the public health risks associated with direct contact exposure

to groundwater presently discharging to the unnamed stream and tributary north of Hathaway Road. Favorable community reaction to these results is expected.

Since this alternative will treat on-site overburden and bedrock groundwater, it will reduce to some extent future potential risks associated with groundwater use. However, since this alternative is limited to treating only the on-site groundwater, it will not effectively reduce contaminant concentrations in the deeper off-site bedrock groundwater. Since this alternative relies on natural attenuation and dilution to reduce contaminant concentrations in off-site groundwater in bedrock fractures, it may not effectively reduce contaminant concentrations to levels protective of public health. Contaminant concentrations in both on- and off-site groundwater would need to be reduced to effectively reduce the future potential risks associated with drinking contaminated groundwater.

This action would benefit the aquatic environment by mitigating the source of metal and organic contamination to the stream and wetland areas. Cessation of seep flow to the stream would result in the lowering of ambient levels of silver, cyanide, copper, mercury, nickel, chlorobenzene, and BEHP in the unnamed stream water.

Discharge of treated groundwater to the unnamed stream will not impact the aquatic environment, provided water quality standards are met. Monitoring of effluent contaminant levels is necessary after treatment and prior to discharge.

The treatment unit will be designed using results of the pilot-scale studies performed during groundwater pump tests. An appropriately designed treatment unit should be capable of meeting the performance specifications if properly operated and maintained. Sampling of the treatment system's influent and effluent will be performed on a periodic basis to ensure system performance.

Certain components of the treatment systems (e.g., reactors, pumps, controls, and filtration units) will possess limited service life. An average service life of 10 to 15 years can be expected of these components. Therefore, if the alternative is expected to be in service for longer than 15 years, replacement of worn-out equipment will be necessary.

11.4.4 Reduction of Mobility, Toxicity, and Volume

One of the goals of the groundwater extraction system is to reduce movement of contaminants off-site through groundwater flow. Therefore, a correctly designed and operated extraction system will reduce mobility of contaminated groundwater. The

UV/ozonation treatment system is a destruction process. It will, therefore, provide the greatest possible reduction in both volume and toxicity of organic contaminants.

Residuals from the treatment processes include a metal-hydroxide sludge from the iron removal process. This sludge would require disposal in an approved off-site disposal facility.

11.4.5 Implementability

Technical Feasibility. Extraction systems have been commonly used in the past for removal of contaminated groundwater. Few difficulties are expected to be encountered during construction and operation of the system.

Technologies required for iron removal are well-developed and have been used extensively in the water and wastewater treatment industries. Destruction of organic compounds using the UV/ozonation process is an innovative, less-developed technology. However, this technology has been used in a variety of applications ranging from treatment of chemical and electronic manufacturers' wastewater to treatment of groundwater contaminated with chlorinated hydrocarbons.

Monitoring of the extraction and treatment system would be necessary to assess its integrity and performance. Sampling of the treatment system's influent and effluent would be performed on a routine basis to assess system performance.

A program to monitor the effectiveness of the system's ability to control migration of contaminated groundwater would also be developed. This monitoring program would incorporate the use of the existing multi-level monitoring wells, and would be similar to the program developed for the no-action alternative.

Administrative Feasibility. The lead agency (EPA) will need to coordinate with the State of Massachusetts and the City of New Bedford to establish institutional controls to regulate installation of water wells within a specified radius of the site. City water is available to new residents. Annual coordination or review should be conducted by both EPA and the state to ensure those controls are being implemented.

Permits would not be required to discharge treated water to local surface water. Applicable permit requirements, however, would need to be attained during the operation of the groundwater treatment unit.

Availability of Services and Materials. Technologies necessary for construction and installation of groundwater extraction systems are time-tested and within the capabilities of a large number of consultants and contractors within the region.

The technologies considered for water treatment operations are widely available and sufficiently demonstrated for this specific application. UV/ozonation equipment is available from Ultrox of Sana Ana, California and SolarChem of Ontario, Canada, as well as others. Off-gas treatment systems are generally less proven and might require additional development prior to application.

11.4.6 Cost

The cost analyses for the groundwater pump and treat alternative include development of capital costs associated with the design and construction of the extraction and treatment systems; construction costs associated with roadways and stream diversion; annual costs associated with operation/maintenance of the treatment systems; and annual costs of the groundwater monitoring program.

Table 11-5 is a comparison of the capital and operation/maintenance costs for the four treatment systems evaluated in this alternative. Capital costs for the GAC system were the lowest, and those for the UV/ozonation system were the highest. The reverse is true for operation/maintenance costs. GAC operation/maintenance costs are the highest, while those for UV/ozonation are the lowest. A present worth analysis, which assumes that the system is in operation for 30 years, reveals that the UV/ozonation system would have the lowest overall costs, while GAC would be highest. Air-stripping/GAC without off-gas treatment is a close second to UV/ozonation. However, Massachusetts air quality regulations dictate off-gas treatment. This alternative, therefore, will not be considered further. Results of the cost analysis, combined with the fact that the UV/ozonation system is an innovative destruction technology, makes this treatment the best available for the purposes intended.

Table 11-6 contains a breakdown of costs associated with the construction and operation of the groundwater treatment alternative. Total capital for the alternative is $1,112,000. This includes $378,070 for construction of an iron-removal and UV/ozonation system. A 25-percent contingency factor is added to cover costs associated with engineering and other unforeseen circumstances.

Long-term costs associated with operation/maintenance of the overall system are also summarized in Table 11-6. These include costs for operation of the treatment system, groundwater and

Table 11-5
GROUNDWATER TREATMENT SYSTEMS COSTS COMPARISON
ALTERNATIVE MM-5
SULLIVANS LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

AIR STRIPPING / GAC		AIR STRIPPING / GAC (Emission control using vapor phase carbon)		GRANULAR ACTIVATED CARBON (GAC)		UV / OZONATION	
CAPITAL		CAPITAL		CAPITAL		CAPITAL	
• air stripper	$ 60,000	• air stripper	$ 60,000	• GAC contactors	$ 100,000	• UV/ozonation unit	$ 225,000
• equilization tanks	15,000	• equilization tanks	15,000	• equilization tanks	15,000	• equilization tanks	15,000
• pumps and controls	16,000	• pumps and controls	16,000	• pumps and controls	16,000	• pumps and controls	16,000
• piping - electrical	7,000	• piping - electrical	7,000	• piping - electrical	7,000	• piping - electrical	7,000
• GAC contactors	70,000	• GAC contactors	70,000	• iron removal		• iron removal	
• iron removal		• vapor phase carbon		- chemical feed	9,000	- chemical feed	9,000
- chemical feed	9,000	- carbon contactors	30,000	- filtration unit	23,900	- filtration unit	23,900
- filtration unit	23,900	- carbon regeneration equipment	25,000	- pumps, accessories	6,000	- pumps, accessories	6,000
- pumps, accessories	6,000	• iron removal		- filter press	12,300	- filter press	12,300
- filter press	12,300	- chemical feed	9,000	• force main	7,500	• force main	7,500
• force main	7,500	- filtration unit	23,900	• discharge main	10,000	• discharge main	10,000
• discharge main	10,000	- pumps, accessories	6,000	• building	10,000	• building	12,000
• building	12,000	- filter press	12,300	• miscellaneous (10%)	21,670	• miscellaneous (10%)	34,370
• miscellaneous (10%)	24,870	• force main	7,500				
		• discharge main	10,000				
		• building	15,000				
		• miscellaneous (10%)	30,670				
TOTAL CAPITAL COST	$ 273,570	TOTAL CAPITAL COST	$ 337,370	TOTAL CAPITAL COST	$ 238,370	TOTAL CAPITAL COST	$ 378,070

Table 11-5 (cont.)
GROUNDWATER TREATMENT SYSTEMS COSTS COMPARISON
ALTERNATIVE MM-5
SULLIVANS LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

AIR STRIPPING / GAC		AIR STRIPPING / GAC (Emission control using vapor phase carbon)		GRANULAR ACTIVATED CARBON (GAC)		UV / OZONATION	
ANNUAL OPERATING COSTS		ANNUAL OPERATING COSTS		ANNUAL OPERATING COSTS		ANNUAL OPERATING COSTS	
• chemicals	$ 7,100	• chemicals	$ 7,100	• chemicals	$ 7,100	• chemicals	
• disposal of residues	3,200	• disposal of residues		• disposal of residues	3,200	- UV/ozonation	$ 25,860
• carbon costs	32,000	- iron residuals	3,200	• carbon costs	104,000	- iron oxidation	7,100
• electrical	11,515	- organic liquids	8,400	• electrical	4,500	• disposal of residues	3,200
• operator	29,200	• carbon costs		• operator	29,200	• electrical	5,200
• maintenance		- aqueous phase	32,000	• maintenance		• operator	29,200
(5% of capital)	13,679	- vapor phase	3,000	(5% of capital)	11,919	• maintenance	
		• electrical	11,515			(5% of capital)	18,904
		• fuel (preheater and					
		- steam generator)	7,300				
		• operator	29,200				
		• maintenance					
		(5% of capital)	16,869				
TOTAL ANNUAL COSTS	$ 96,694	TOTAL ANNUAL COSTS	$ 118,584	TOTAL ANNUAL COSTS	$ 159,919	TOTAL ANNUAL COSTS	$ 89,464
PRESENT WORTH OF O&M (30 yrs @ 5%)	$1,490,000	PRESENT WORTH OF O&M (30 yrs @ 5%)	$1,820,000	PRESENT WORTH OF O&M (30 yrs @ 5%)	$2,460,000	PRESENT WORTH OF O&M (30 yrs @ 5%)	$1,380,000
TOTAL PRESENT WORTH (30 yrs @ 5%)	$1,760,000	TOTAL PRESENT WORTH (30 yrs @ 5%)	$2,160,000	TOTAL PRESENT WORTH (30 yrs @ 5%)	$2,700,000	TOTAL PRESENT WORTH (30 yrs @ 5%)	$1,750,000

TABLE 11-6
ALTERNATIVE MM-5 COST ESTIMATE
GROUNDWATER PUMPING AND TREATMENT
FOR IRON REMOVAL FOLLOWED BY UV/OZONATION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ITEM DESCRIPTION	COST
CAPITAL COSTS	
• Extraction system	
- pumping wells (6 200-ft stainless steel wells with pumps)	$ 202,500
- pipeline, electrical, and trenching (2,100 ft)	42,000
- instrumentation/control building	12,000
• temporary stream diversion and construction of concrete-lined streambed (8"-thick, mesh-reinforced, 20'-wide)	157,000
• roads/access construction	10,000
• engineering and design (10%)	42,000
• field oversight, extraction well pump tests	46,000
• iron-removal system and UV/ozonation unit (see Table 11-5 for details)	378,070
• contingency (25%)	222,000
TOTAL CAPITAL COSTS	$1,112,000

TABLE 11-6 (cont.)
ALTERNATIVE MM-5 COST ESTIMATE
GROUNDWATER PUMPING AND TREATMENT
FOR IRON REMOVAL FOLLOWED BY UV/OZONATION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

ITEM DESCRIPTION	COST	PRESENT WORTH
EQUIPMENT REPLACEMENT COSTS		
• sampling equipment purchase and replacement costs (Years 1, 11, and 21)	$ 40,500	$ 78,720
• treatment system and monitoring well replacement costs (Year 16)	498,070	228,180
• submersible pump replacement costs (Years 6, 11, 16, 21, and 26)	16,500	40,100
PRESENT WORTH OF EQUIPMENT REPLACEMENT (30 years @ 5%)	---	$ 347,000
OPERATING AND MAINTENANCE (O&M) COSTS		
• annual O&M costs for water treatment (see Table 11-5 for details)	$ 89,464	$1,375,250
• annual O&M costs for pumping wells	10,300	158,000
• annual cost of treatment performance evaluation (monthly sampling of treatment unit influent and effluent)	12,000	185,000
• annual groundwater sampling and analysis cost (Years 1 and 2, quarterly sampling)	108,700	202,000
• annual groundwater sampling and analysis costs (Years 3 to 30, annual sampling)	29,050	393,800
• 5-year review costs	14,000	38,950
PRESENT WORTH OF ANNUAL AND 5-YEAR EXPENDITURES (30 years @5%)	---	$2,353,000
PRESENT WORTH OF ALTERNATIVE	---	$3,812,000

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treatment system monitoring, and 5-year review costs. Costs are also included for replacement of monitoring wells and replacement of the water treatment system. It was assumed that both the monitoring wells and the treatment system would have service lives of 15 years. The total present worth of the alternative is $3,812,000. This was computed for a 30-year period, assuming a discount rate of 5 percent.

11.4.7 Compliance with ARARs

Chemical-specific ARARs pertaining to Alternative MM-5 can be divided into three groups: federal and state drinking water and groundwater standards; state surface water quality standards; and federal and state air regulations.

The first group of chemical-specific ARARs consists of federal and state regulations pertaining to drinking water (SDWA 40 CFR 141.11-141.16, DEQE - Drinking Water Standards 310 CMR 22.00) and state groundwater quality standards. It is not known when these ARARs will be attained for the on-site bedrock groundwater (less than 150 feet). Periodic groundwater monitoring will be conducted to assess the attainment of these standards. These ARARs will not be attained for off-site, deep bedrock fracture contamination. A technical impracticability waiver could be applied for this groundwater for the same reasoning as outlined for Alternative MM-3 (see Section 11.3.7).

The second group of chemical-specific ARARs consists of Massachusetts surface water quality standards. These requirements will be attained by controlling the groundwater treament system effluent contaminant levels discharge to meet Massachusetts discharge criteria at the discharge point.

The last group of chemical-specific ARARs consists of federal and state air regulations. These regulations will be attained during construction activities by controlling fugitive dust emissions. In addition, if air-stripping is reconsidered for groundwater treatment, then vapor-phase carbon adsorption will be used to attain the state ARAR, DEQE - Air Pollution (310 CMR 7.00).

Location-specific ARARs for Alternative MM-5 are federal and state facility siting regulations (RCRA Location Standard 40 CFR 264.18, Hazardous Waste Facility Siting Regulation 990 CMR 1.00). These regulations will be attained by siting the groundwater treatment facility outside the 100-year floodplain of the unnamed stream.

Action-specific ARARs for this alternative are separated into four groups. The first group consists of federal and state regulations pertaining to hazardous waste operations (RCRA 40 CFR 264.1 - 264.120, DEQE - Hazardous Waste Phases I and II

310 CMR 30.00). The regulations will be attained because the specifications set forth in these regulations will be used as design standards during remedial design.

The second group of action-specific ARARs consists of safety regulations: federal OSHA regulations and the three separate state right-to-know regulations. These regulations will be attained during the remedial action.

The third group of action-specific ARARs consists of federal and state regulations pertaining to discharge requirements. These regulations are as follows:

- CWA - National Pollutant Discharge Elimination System (40 CFR 122.125)
- MDWPC - Water Discharge Permits (314 CMR 1.00-7.00)
- MDWPC - Supplemental Requirements for Hazardous Waste Management Facilities (314 CMR 8.00 - 29.00)

These requirements will be attained for the discharge of the groundwater treatment plant into the unnamed stream.

Table 10 in Appendix E outlines the chemical-, location-, and action-specific ARARs for this alternative in greater detail. In addition, the corresponding remedial action(s) required to attain the ARAR is outlined.

11.4.8 Overall Protection of Public Health and Environment

Public health and environmental risks associated with contaminants present in seeps along the unnamed stream will be reduced. This will be accomplished by groundwater pumping, which will lower the water table and effectively shut off seepage to the unnamed stream.

This alternative will also reduce contamination in the shallow off-site groundwater. This should reduce any potential and future risks associated with the shallow off-site groundwater. This alternative will also improve the quality of on-site groundwater and thus, reduce public health risks.

Protection of human health will not occur for the contaminated groundwater located in deep bedrock fractures. Although there is no current exposure associated with this groundwater, the future risks will remain.

11.5 MANAGEMENT OF MIGRATION ALTERNATIVES SUMMARY

Table 11-7 presents a brief summary of the detailed analysis of MM alternatives for each of the nine screening criteria.

TABLE 11-7

MANAGEMENT OF MIGRATION ALTERNATIVES
SUMMARY TABLE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	MM-1: NO ACTION	MM-3: PASSIVE COLLECTION AND TREATMENT	MM-5: ACTIVE COLLECTION AND TREATMENT
1. SHORT-TERM EFFECTIVENESS			
• Time until implementation is achieved	No additional time is required to restrict site access as the security fence is already in place.	Installation of the passive collection system would take 6 to 9 months, pilot testing and treatment unit design and and construction would take 12 to 15 months for a total initiation time of 1.5 to 2 years. System's operational time frame has been estimated at a minimum of 30 years.	2.2 to 3.5 years would be required to initiate start-up. System's operational time frame has been estimated at a minimum of 30 years.
• Protection of community during remedial action	Not applicable - no further construction would be required. Baseline risks to the public would be unchanged.	Short-term adverse impacts to public health are not expected as there are no residents in close proximity to the site. Atmospheric dispersion of fugitive dust or volatilized organics generated during construction will dilute airborne contaminants to levels that do not impact public health. Also, mitigative measures (e.g., dust control) will be taken.	Same as MM-3.
• Protection of workers during remedial action	Not applicable - no further construction would be required.	Workers would be trained in health and safety procedures and would use proper personal protective equipment against dermal and inhalation exposure pathways.	Same as MM-3.
• Environmental impacts	Contaminants would continue to migrate in overburden and bedrock aquifers. Groundwater seeps would continue to load contaminants into the unnamed stream.	Construction activities in the unnamed stream would cause short-term resuspension of PCB sediments that could impact aquatic biota and destroy habitat for terrestrial organisms. Use of silt curtains would reduce impacts, and revegetating cleared areas would restore terrestrial habitats. Dredging of stream would occur subsequent to construction activities.	Same as MM-3.

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TABLE 11-7 (continued)

MANAGEMENT OF MIGRATION ALTERNATIVES
SUMMARY TABLE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	MM-1: NO ACTION	MM-3: PASSIVE COLLECTION AND TREATMENT	MM-5: ACTIVE COLLECTION AND TREATMENT
2. LONG-TERM EFFECTIVENESS AND PERMANENCE			
• Magnitude of residual risk	Baseline public health and environmental risks would remain as at present.	Contaminated groundwater in bedrock fracture zones would continue to pose a 10^{-1} public health risk for maximum exposure. Spent carbon would have high organics concentrations. Public health risk will also exist for off-site bedrock groundwater.	Groundwater in bedrock fracture zones would continue to pose a 10^{-1} risk for maximum exposure. Spent carbon would have organics concentrations. Extraction immediately adjacent to the quarry pits would reduce concentrations of soluble contaminants within and being released from the pits. This alternative attempts to treat the source of the groundwater contamination. DNAPLs may still be left in the pits, however. DNAPLs have the potential for acting as a long-term source.
• Adequacy of controls	No action will have no effect on controlling groundwater transport or groundwater discharge into the unnamed stream. No action would rely on institutional controls to restrict well installation within a specified radius of the site.	The cap would reduce seeps discharging to surface waters and recharge to the site aquifer. Groundwater collection and treatment would improve the overburden and/or shallow bedrock aquifer but would do little in mitigating bedrock aquifer contamination. Institutional controls would regulate well installation.	Groundwater pumping would create a cone of depression north and east of the quarry pits. This would result in eliminating seep discharges. Contaminant migration would continue within bedrock fractures. The cap would reduce recharge to the site aquifer. Institutional controls would regulate well installation.
• Reliability of controls	Institutional controls would be necessary to control groundwater use.	Treatment system equipment would have limited service lives. Pumps would require replacement every few years, while major treatment components (e.g., stripping tower, UV/ozone reactor, carbon unit, monitoring wells) are expected to last 10 to 15 years.	Same as MM-3.
3. REDUCTION OF TOXICITY, MOBILITY, OR VOLUME	No reduction in TMV would be realized since treatment is not involved.	The collection and treatment system would reduce the toxicity of 40 gpm of contaminated overburden and/or shallow bedrock groundwater and would reduce the volume of contaminated water by preventing loading and mobility into the unnamed stream. MM-3 will not mitigate MTV for the quarry pits.	The extraction and treatment system would reduce the toxicity of 30-60 gpm of contaminated overburden and/or shallow bedrock groundwater. The extraction wells would reduce the mobility of groundwater contaminants and would reduce the mobility and volume of contaminated surface water by shutting off seeps discharging to the unnamed stream. Deep groundwater extraction would reduce the mobility of soluble contaminants within the pits and would reduce the overall toxicity of materials within the pits by removing such soluble contaminants.

TABLE 11-7 (continued)

MANAGEMENT OF MIGRATION ALTERNATIVES
SUMMARY TABLE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	MM-1: NO ACTION	MM-3: PASSIVE COLLECTION AND TREATMENT	MM-5: ACTIVE COLLECTION AND TREATMENT
4. IMPLEMENTABILITY			
• Technical feasibility	Required equipment (e.g., fence, groundwater monitoring wells) is already in place.	The treatment system would require pilot testing to determine operating parameters. Treatment technologies are well-proven with the exception of an off-gas emissions control device for the air stripper.	Extraction systems are a proven technology. A hydrogeological investigation would be necessary to correctly position wells outside the quarry pits and at the leading edge of the contaminant plume. The treatment system would require pilot testing to determine operating parameters. Treatment technologies are well-proven with the exception of an off-gas emissions control device for the air stripper.
• Administrative Feasibility	No permits would be required as no additional construction would be performed. Institutional controls would have to be coordinated with the City of New Bedford and the State of Massachusetts.	Rights-of-way to the golf course would be required through the City of New Bedford. Institutional controls would have to be coordinated with the city and the state. Easements for private properties may also be needed.	Same as MM-3.
• Availability of services and materials	Groundwater sampling could be contracted within the state.	Construction services required to install the underdrain system could be contracted locally. Water treatment equipment is widely available within the wastewater industry. Emissions control equipment may not be available as the technology is not fully developed.	Design and installation of the extraction system is within the capabilities of several remediation consultants located in Massachusetts. Technologies considered for groundwater treatment are widely available within the wastewater industry. Emissions control equipment may not be available as the technology is not fully developed.
5. COST	Present Worth of Alternative - $768,000	Present worth of alternative - Overburden trench - 2,950,000 Bedrock trench - 3,084,000	Present Worth of Alternative - $3,812,000
6. COMPLIANCE WITH ARARs	SDWA and Massachusetts DEQE groundwater quality and drinking water standards would not be met as MCLs/MCLGs will continue to be exceeded. Other ARARs that would not be met include: - CWA - DEQE Wetlands Protection	ARARs that may not be met include: - SDWA and DEQE groundwater quality and drinking water standards for shallow and deep bedrock groundwater. A waiver for contaminated groundwater in fractures may justifiable due to technical impracticability.	SWDA and DEQE groundwater quality and drinking water standards for deep bedrock groundwater would not be met. A waiver for non aqueous phase liquids may be justifiable due to technical impracticability.

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TABLE 11-7 (continued)

MANAGEMENT OF MIGRATION ALTERNATIVES
SUMMARY TABLE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	MM-1: NO ACTION	MM-3: PASSIVE COLLECTION AND TREATMENT	MM-5: ACTIVE COLLECTION AND TREATMENT
7. OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	Groundwater would continue to seep into the unnamed stream causing impact to aquatic biota and the contaminant plume would continue to migrate down-gradient. Therefore, public health exposure to contaminated groundwater would be a chronic risk.	Continued contaminant discharge to the unnamed stream would be mitigated which will relieve stress to aquatic biota. The groundwater plume would continue to migrate downgradient. Therefore, public health exposure to contaminated ground-water would be a continuing risk.	Seeps to the unnamed stream would be eliminated which will relieve stress to aquatic biota. Enhanced flushing of the pits will reduce long-term risks associated with the pits. However, non-aqueous phase liquids may pose a potential risk to downgradient well users; bedrock fractures may act as a migration route.
8. STATE ACCEPTANCE	To be addressed in the ROD.	To be addressed in the ROD.	To be addressed in the ROD.
9. COMMUNITY ACCEPTANCE	To be addressed in the Responsiveness Summary of the ROD.	To be addressed in the Responsiveness Summary of the ROD.	To be addressed in the Responsiveness Summary of the ROD.

12.0 SULLIVAN'S LEDGE SITE ALTERNATIVES

12.1 DEVELOPMENT OF SITE ALTERNATIVES

At the Sullivan's Ledge site, interaction between the source areas and groundwater are not significant; that is, SC alternatives will have minimal effect on the groundwater and surface water. As outlined in Section 5.0, contamination in the soils is predominantly PCBs and PAHs, while VOCs constitute the major groundwater pollutant. However, one SC alternative (SC-2: Containment) will affect the groundwater and surface water. This alternative is an exception and was discussed in Section 10.3.1. Because of the lack of interaction between the two types of alternatives, the development of site alternatives has been delayed until after the detailed analysis of alternatives. This approach allows greater flexibility in developing alternatives and simplifies the analyses of site alternatives.

Table 12-1 presents the development of site alternatives. Eight site alternatives were developed which range from no-action to treatment as a principal element for the soils, sediment, and groundwater. In developing the site alternatives, each SC alternative was subdivided into specific areas or contamination levels. For example, the site soils were divided into soils that exceed the 10^{-4} present risk level, 10^{-5} present risk level, and 10^{-6} present risk level. This allows a range of soil volumes and areas that could be treated. Similarly, the PCB-contaminated sediment areas were divided into four areas: the unnamed stream, Middle Marsh, water hazards, and Apponagansett Swamp. Site alternatives were developed by combining alternatives that would logically be used together (e.g., incineration of the soils with incineration of the sediments). In this way, a total of eight logical, feasible site alternatives were developed that address the contamination at the Sullivan's Ledge site with varying degrees of treatment and associated effectiveness, implementability, and costs. The eight site alternatives are as follows:

- SA-1 No-action
- SA-2 Containment/Passive Groundwater Collection with Bedrock Trench and Treatment
- SA-3 Containment/Active Groundwater Collection and Treatment
- SA-4 Solidification of 10^{-4} Present Risk Soils, 10^{-5} Present Risk Surface Soils, Unnamed Stream Sediments, Water Hazard Sediments/Containment/ Passive Groundwater Collection with Bedrock Trench and Treatment

		SITE ALTERNATIVES							
		SA-1	SA-2	SA-3	SA-4	SA-5	SA-6	SA-7	SA-8
		NO ACTION	SOURCE CONTAINMENT - PASSIVE GROUNDWATER CONTROLS	SOURCE CONTAINMENT WITH ACTIVE GROUNDWATER CONTROLS	TREATMENT WITH SOURCE CONTAINMENT -PASSIVE GROUNDWATER CONTROLS (10^{-4})	TREATMENT WITH SOURCE CONTAINMENT AND ACTIVE GROUNDWATER CONTROLS (10^{-5})	TREATMENT WITH SOURCE CONTAINMENT -PASSIVE GROUNDWATER CONTROLS (10^{-6})	TREATMENT AS A PRINCIPAL ELEMENT, SOURCE CONTAINMENT WITH ACTIVE GOUNDWATER CONTROLS (10^{-6})	TREATMENT AS A PRINCIPAL ELEMENT (10^{-6})
SOURCE CONTROL ALTERNATIVES	SC-1 NO ACTION								
	-Soils	✦							
	-Pits	✦	✦		✦		✦		
	-Sediments	✦	✦	✦					
	SC-2 CONTAINMENT		✦	✦	✦	✦		✦	✦
	SC-3 IN-SITU VITRIFICATION OF SOILS								
	-All soil to 10^{-4}								
	-All soil to 10^{-6}						✦		
	SC-4 SOLIDIFICATION OF SOILS								
	-All soil to 10^{-4}				✦				
	-Surface soil to 10^{-6}				✦				
	-All soil to 10^{-6}					✦		✦	
	SC-5 ON-SITE INCINERATION OF SOILS								
	-All soil to 10^{-4}								
	-All soil to 10^{-6}								✦
	SC-6 ON-SITE INCINERATION OF SEDIMENTS								
	-Unnamed stream								
	-Water hazards								
	-Middle Marsh								
	-Apponagansett Swamp								
	-All PCB-contaminated sediments								✦
	SC-7 SOLIDIFICATION OF SEDIMENTS								
	-Unnamed stream				✦	✦		✦	
	-Water hazards				✦	✦		✦	
	-Middle Marsh							✦	
	-Apponagansett Swamp South							✦	
	-All PCB-contaminated sediment						✦		
MANAGEMENT OF MIGRATION ALTERNATIVES	MM-1 NO-ACTION	✦							
	MM-3 PASSIVE COLLECTION AND TREATMENT		✦		✦	✦	✦		
	MM-5 ACTIVE COLLECTION AND TREATMENT			✦		✦		✦	✦

TABLE 12-1
DEVELOPMENT OF SITE ALTERNATIVES
SULLIVAN'S LEDGE SITE

- SA-5 Solidification of 10^{-5} Present Risk Soils, Middle Marsh Sediments, Unnamed Stream Sediments, Water Hazard Sediments/Containment/Active Groundwater Collection and Treatment/Passive Groundwater Collection with the Overburden Trench and Treatment

- SA-6 ISV of All Soils to 10^{-6} Present Risk Level/Solidification of all PCB-contaminated Sediments/Passive Groundwater Collection Utilizing the Bedrock Trench and Treatment

- SA-7 Solidification of all Soils to 10^{-6} Present Risk Level/Solidification of all PCB-contaminated Sediments in the Unnamed Stream, Middle Marsh, and Water Hazards/Containment/Active Groundwater Collection and Treatment

- SA-8 On-site Incineration of all Soils to 10^{-6} Present Risk Level/On-site Incineration of all PCB-contaminated Sediments/Containment/Active Groundwater Collection and Treatment

Each site alternative is described in more detail in the following sections. An evaluation of the nine criteria are summarized in tabular form for each alternative. The information used to develop these summary tables was presented in Sections 10.0 and 11.0. Lastly, site alternative costs are summarized for each site alternative. These cost summaries include capital costs, operating/maintenance costs, present worth analysis, and cost sensitivity analysis for the factor expected to have the greatest impact on the alternative costs.

12.2 ALTERNATIVE SA-1

Alternative SA-1 is the no-action alternative. A true no-action alternative is not believed to be prudent for this site as there are present risks associated with the site soils, on-site groundwater, and off-site groundwater. Institutional controls will be needed to maintain the site fence and regulate the installation of private wells within a specified radius of the site. Educational programs will also be required to inform the public of the risks associated with the site contaminants. Because this alternative does not treat the contamination found at the site, long-term environmental monitoring of the surface soils, sediments, surface water, and groundwater will be required to determine changes in contaminant loadings and/or distribution. Five-year reviews will also be required as specified in SARA. For costing purposes, this alternative is expected to have a 30-year life.

12.2.1 Evaluation Summary

Table 12-2 provides a summary of the criteria evaluation for the SA-1 alternative.

12.2.2 Cost Summary

A summary of costs associated with Alternative SA-1, No-action, is presented in Table 12-3. Capital costs for this alternative include costs for repairs to the existing site fence and cost for purchase of sampling equipment for the multi-level monitoring wells. Total capital costs are $54,500. Present worth for replacement of monitoring wells, sampling equipment, and the site fence is $113,390. This replacement is necessary because the alternative is expected to have a 30-year life. Operating costs for this alternative include those costs associated with groundwater, surface water, surface soil, and sediment monitoring; site security; and five-year reviews. The total present worth of the operating costs is $1.0 million. This is computed for a 30-year period at a 5-percent discount rate. Total present worth of the alternative is estimated at $1.2 million.

The present worth costs associated with Alternative SA-1 are graphically represented as a pie chart in Figure 12-1. Each of the pie charts representing alternative costs has an "exploded section of the pie". This "exploded" section is the cost component selected for cost sensitivity analysis. The present worth of the groundwater, surface water, and sediment monitoring program is the major expenditure for this alternative. The groundwater monitoring program includes quarterly sampling for the first two years, followed by annual sampling in Years 2 through 30. Since the cost of the monitoring program is the major cost component, the alternative will be most sensitive to any changes in this cost. Figure 12-2 is a bar diagram that shows how changes in the monitoring program during Years 2 through 30 effect the total present worth of the alternative. If the sampling program in Years 2 through 30 were changed from an annual event to a quarterly event (i.e., every three months), the total present worth of the alternative would increase from about $1.0 million to over $2.0 million. Alternatively, if the program were changed to a sampling event taking place every five years, the present worth of the alternative would only decrease to about $800,000.

12.3 ALTERNATIVE SA-2

Alternative SA-2 is a containment alternative. Under this alternative, an impermeable cap will be placed on the site and a passive groundwater collection system will be installed to collect the seep and overburden groundwater discharge. This alternative is a combination of SC-2 and MM-3.

TABLE 12-2

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-1
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
1. Short-term Effectiveness	
• Time until implementation is achieved	A fence is already in place to protect human receptors from being exposed to site surface soils. Groundwater and sediment risk protection would not be achieved.
• Protection of community during remedial action	Not applicable.
• Protection of workers during remedial action	Not applicable.
• Environmental impact	Implementation would not cause an impact, but neither would it mitigate future releases via surface water runoff or groundwater. The unnamed stream, Middle Marsh, and Apponagansett Swamp would remain stressed by PCBs.
2. Long-term Effectiveness and Permanence	
• Magnitude of residual risks	Risks would remain as outlined in Section 6.2.2.
• Adequacy of controls	If the fence is maintained and groundwater use restrictions are followed, controls would attempt to prevent human exposure to contaminants.
• Reliability of controls	In order to be effective, institutional controls would require strict adherence and enforcement. However, such controls would not prevent continued PCB, VOC loading to the unnamed stream. The fence is anticipated to need replacement after 15 years.
3. Reduction of Toxicity, Mobility, or Volume	No reduction in toxicity, mobility, or volume would be realized since treatment would not be employed.

TABLE 12-2 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-1
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
4. Implementability	
• Technical feasibility	A security fence and an adequate number of monitoring wells are already in place. Further construction activities would not be necessary unless additional well installations are deemed necessary.
• Administrative feasibility	Institutional controls to regulate well installation would need to be implemented with state and city officials.
• Availability of services and materials	Local security agencies are available to perform weekly security checks.
5. Cost	Present worth of alternative = $1,186,440 (See Table 12-3)
6. Compliance with ARARs	The following ARARs would not be met: - Safe Drinking Water Act (SDWA) - Massachusetts Water Quality Standards - Clean Water Act (CWA) - RCRA Closure/Post-closure Requirements
7. Overall Protection of Human Health and the Environment	If properly managed, security and institutional controls would prevent the worst-case present use health exposure scenarios (i.e., ingestion of site soils or groundwater) but would not reduce on-site risks to terrestrial animals. Off-site sediment and seep contamination do not pose a threat to human health but would continue to stress aquatic biota. Groundwater risks to human health would remain at 10^{-1} for maximum exposure, but compliance with groundwater restrictions would control public risks.
8. State Acceptance	The state does not support this alternative because it does not comply with the Massachusetts Contingency Plan (MCP) which emphasizes permanent treatment.
9. Community Acceptance	To be addressed following the public comment period.

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TABLE 12-3

COST SUMMARY TABLE
SA-1: NO ACTION
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CAPITAL COSTS	
• Repairs to Site Fence (Year 1)	$ 14,000
• Sampling Equipment Purchase (Year 1)	40,500
TOTAL CAPITAL COSTS	$ 54,500
EQUIPMENT REPLACEMENT COSTS	PRESENT WORTH
• Sampling Equipment Replacement (Years 11 and 21)	38,220
• Multi-level Monitoring Well Replacement (Year 16)	54,970
• Site Security Fence Replacement (Year 16)	20,200
PRESENT WORTH OF REPLACEMENT COSTS	$ 113,390
OPERATING COSTS	
• Groundwater Sampling and Analysis	
- Years 1 and 2, Quarterly Sampling	197,350
- Years 3 through 30, Annual Sampling	360,000
• Soil Sampling and Analysis (30 years @ 5%)	221,600
• Sediment Sampling and Analysis (30 years @ 5%)	63,800
• Surface Water Sampling and Analysis (30 years @ 5%)	98,400
• Annual Site Security Visits (30 years @ 5%)	38,450
• 5-Year Review - Public Meetings (30 years @ 5%)	38,950
PRESENT WORTH OF O&M	$1,018,550
PRESENT WORTH OF ALTERNATIVE	$1,186,440

Note: Additional cost details are located in:

- Table 10-2 for Alternative SC-1.
- Table 11-1 for Alternative MM-1.

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FIGURE 12-1: ALT. SA-1
TOTAL PRESENT WORTH: $1,186,000

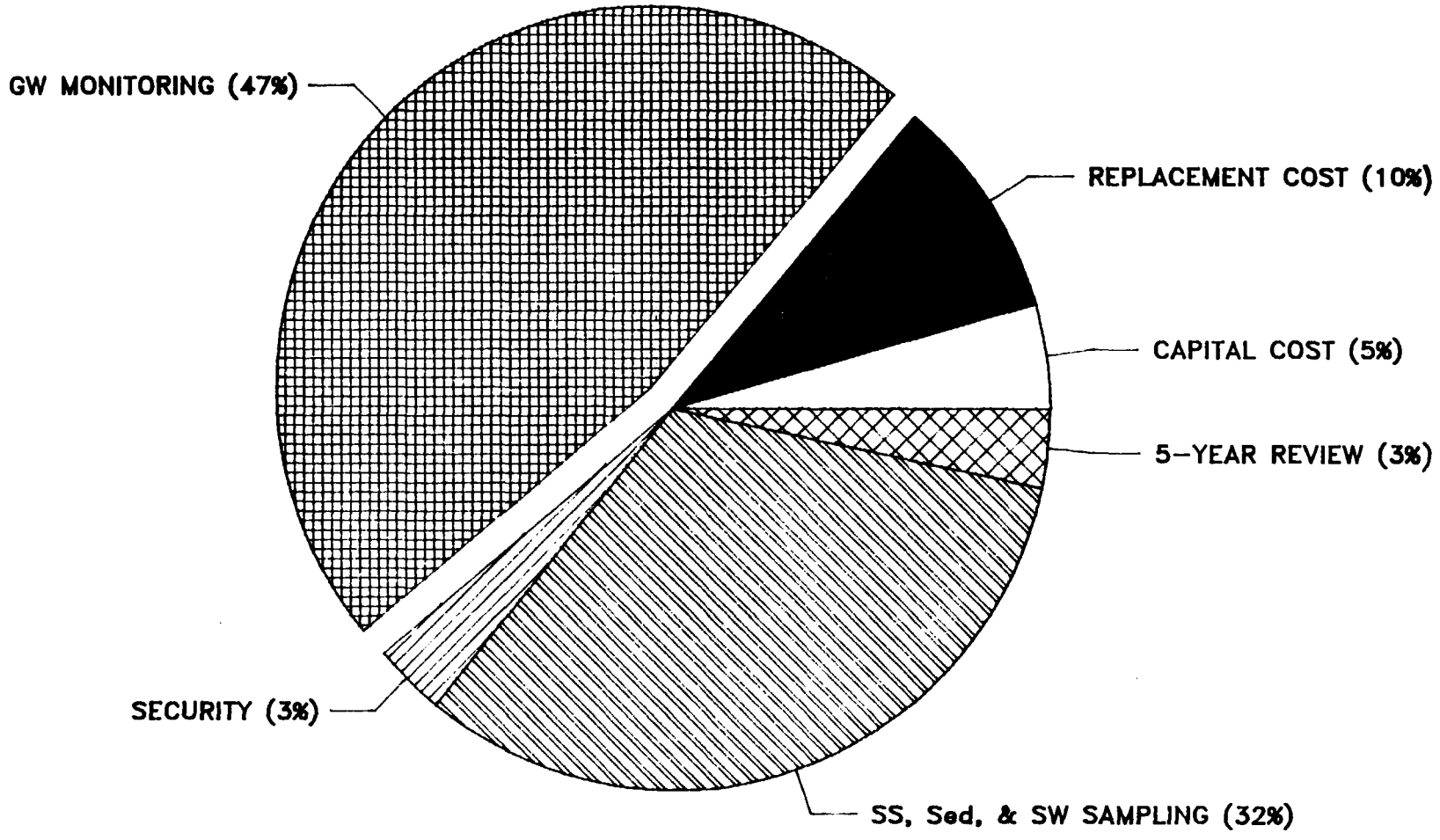
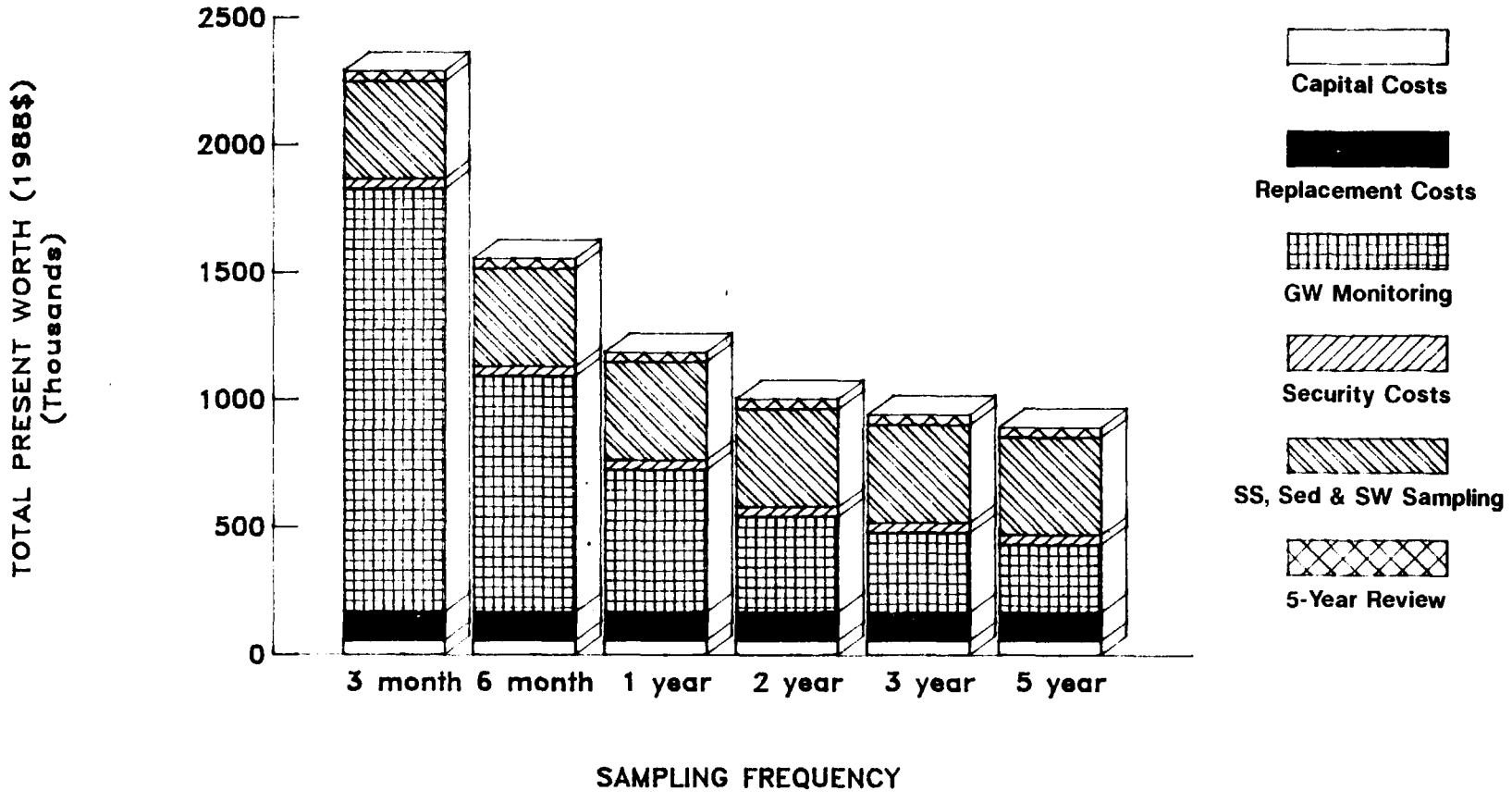


FIGURE 12-2: ALT. SA-1 Cost Sensitivity

GROUNDWATER SAMPLING FREQUENCY: YR 2-28



The first activities at the site would be the installation of the utilities, construction trailer, and offices. Prior to construction of the cap, the unnamed stream would be diverted and the concrete-lined channel would be constructed. Following channel construction, the unnamed stream would be relocated to the newly constructed channel and the bedrock passive collection system would be installed. Clearing and grubbing of the site along with the removal of the cobbles would occur during the relocation of the unnamed stream. Construction of the cap would occur concurrently with the construction of the treatment system. Pilot tests would be conducted on the collected groundwater prior to the final design and installation of the treatment system.

Following cap construction, the site will be refenced and revegetated. A fence will also be constructed around the treatment plant. An environmental monitoring program will be instituted to document the effects of the cap and the collection system.

This alternative is expected to take approximately two years from the onset of construction. It will be effective in reducing the risks associated with the site soils, seeps and the shallow overburden groundwater. This alternative will also mitigate the continued PCB sediment loading to the unnamed stream, Middle Marsh, water hazards, and Apponagansett Swamp. This alternative does not address the deep groundwater contamination and institutional controls will still be required to regulate the installation of drinking water wells within a specified radius of the site. Environmental risk posed by the affected water bodies and wetland areas will not be reduced.

For cost purposes, the life of this alternative is estimated at 30 years. Aesthetically, the Sullivan's Ledge site will become a 10-acre grassed area.

12.3.1 Evaluation Summary

A summary of the 9-criteria evaluation for alternative SA-2 is located in Table 12-4.

12.3.2 Cost Summary

A summary of costs associated with Alternative SA-2 is contained in Table 12-5. Capital costs for this program include costs for construction of a cap, an underdrain system, and a water treatment system. Total capital costs for this alternative are $2.7 million. Replacement of the water treatment system and site fence will be required after 15 years. Total costs associated with equipment replacement are $267,000. Operating/ maintenance costs for this alternative (computed for 30 years

TABLE 12-4

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-2
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
1. Short-term Effectiveness	
• Time until implementation is achieved	Two years would be required to clear the site, install the passive collection and treatment systems, and construct the multi-layer cap.
• Protection of community during remedial action	Dust-control measures would be initiated to minimize the generation of airborne contaminants during construction activities. Atmosphere dispersion would dilute contaminant concentrations to levels that do not impact public health.
• Protection of workers during remedial action	A 40-hour health and safety training course would be required of all workers. Personal protective equipment would be needed to prevent dermal or inhalation exposure during clearing, grubbing, and construction of the cap.
• Environmental impacts	Minimal air quality impacts can be expected during capping operations due to airborne dust particles and volatilized organics. Erosion control would prevent additional sedimentation to Middle Marsh and Apponagansett Swamp.
2. Long-term Effectiveness and Permanence	
• Magnitude of residual risks	Contaminated soils would remain untreated but the cap should reduce exposure risks for an estimated 20 to 30 years. PCB sediment concentrations would remain at present levels (i.e., averaging between 10 and 20 ppm) and would continue to pose risks to environmental receptors. Bedrock groundwater risks would remain at 4.6×10^{-1} for exposure to maximum concentrations.

TABLE 12-4 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-2
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
• Adequacy of controls	Cap would reduce exposure risks to untreated soils, while the collection and treatment system would reduce loading to surface waters. The cap would also reduce recharge to the site aquifer, thereby shutting off seeps north of Hathaway Road. Underdrain pipes would collect contaminated overburden and shallow bedrock groundwater. The water treatment system would remove harmful contaminants before discharge back into the environment. Deep bedrock groundwater would not be mitigated; therefore, contaminant plume migration monitoring would be necessary. Daily checks would be required to maintain the efficiency of the treatment system while semi-annual checks of the cap and groundwater and sediment monitoring would be performed. Adequate controls are not proposed for mitigation of environmental risks for sediments.
• Reliability of controls	The multi-layer cap would be effective for at least 30 years provided that routine maintenance is performed as scheduled. The water treatment system would run unattended with only daily checks, adjustments, and maintenance. Treatment equipment would require periodic replacement, having typical service lines of 5 to 10 years. Multi-level sampling wells are anticipated to require replacement after 15 years. In order to be effective, institutional controls would require strict adherence and enforcement.
3. <u>Reduction of Toxicity, Mobility, or Volume</u>	Cap would reduce contaminant mobility by mitigating soils erosion and by decreasing seep volumes. Treatment would reduce the toxicity of 58,000 gpd of collected groundwater. The volume of on-site waste would not be reduced and neither would TMV of bedrock groundwater. Sediments of affected water bodies and wetland areas would not be remediated, therefore no reduction of TMV of sediment PCBs would occur.

TABLE 12-4 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-2
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
4. Implementability	
• Technical feasibility	Cap would entail standard construction activities. Design of treatment system would require treatability studies. Once designed, construction would consist of procuring and assembling the required component process. Start-up may require component pieces and assistance of technical specialists.
• Administrative feasibility	Rights-of-way to the golf course would have to be obtained from the City of New Bedford to install an underdrain pipe and the treatment system north of Hathaway Road. Institutional controls to regulate private well installation within a specified radius to the site would need to be implemented with state and city officials.
• Availability of services and materials	Construction services are locally available and treatment equipment is available through a number of wastewater equipment vendors.
5. Cost	Present worth of alternative = $5,063,400 (See Table 12-5).
6. Compliance with ARARs	The following ARARs would not be met: - SDWA - DEQE Water Quality Standards MCLs/MCLGs would not be attained in bedrock groundwater. A technical infeasibility waiver may be justifiable.
7. Overall Protection of Human Health and the Environment	The cap would reduce present use exposure risks associated with site surface soils and the collection and treatment system would reduce risks associated with both surface water and overburden groundwater. Sediment PCBs would continue to stress the aquatic environment, but continued loading would be mitigated. Bedrock groundwater would continue to pose a high risk.
8. State Acceptance	The state does not favor a containment/ passive collection system. The state favors a more active treatment alternative.

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TABLE 12-4 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-2
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
9. Community Acceptance	To be addressed after the public comment period.

TABLE 12-5

COST SUMMARY TABLE
ALTERNATIVE SA-2
SOURCE CONTAINMENT,
PASSIVE GROUNDWATER CONTROLS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CAPITAL COSTS	
• Site preparation	$ 513,600
• Cap Construction	968,900
• Passive Collection System Construction (Bedrock Trench)	409,000
• Water Treatment System (oxidation/filtration - iron removal) (UV/ozonation - organic removal)	246,000
• Contingency (25%)	534,400
TOTAL CAPITAL COSTS	$2,671,900
EQUIPMENT REPLACEMENT COSTS	PRESENT WORTH
• Treatment System, Monitoring Wells, and Sampling Equipment Replacement (see Table 11-4)	$ 247,000
• Site Security Fence Replacement (Year 16)	20,200
PRESENT WORTH OF REPLACEMENT COSTS	$ 267,200
OPERATING AND MAINTENANCE (O&M) COSTS (For 30-Year Period)	
• Water Treatment O&M	$1,335,000
• Groundwater and Sediment Monitoring Program	659,600
• Site Security	72,250
• Cap Maintenance	18,500
• 5-Year Review - Public Meetings	38,950
PRESENT WORTH OF O&M COSTS	$2,124,300
PRESENT WORTH OF ALTERNATIVE	$5,063,400

Note: Additional cost details are located in:

- Table 10-3 for Alternative SC-2.
- Table 11-4 for Alternative MM-3.

and discounted at 5 percent) are about $2.1 million. Operating/maintenance costs include expenses associated with water treatment, groundwater and sediment monitoring, site security, cap maintenance, and 5-year reviews. The total present worth of this alternative is $5,063,400.

A pictorial representation of the costs for Alternative SA-2 is presented in Figure 12-3. This figure indicates that the major costs components are those associated with cap construction and water treatment operating/maintenance. Cap construction costs are based on an actual cap design (Alternative SC-2) and are thought to be well-developed. The costs for water treatment, on the other hand, are based on the seepage water chemistry, and have a much higher degree of uncertainty. These treatment costs, therefore, are selected as the component for the cost-sensitivity analysis. Figure 12-4 contains the results of that cost sensitivity. The analysis revealed that a doubling (100-percent increase) in water treatment operating/maintenance costs would increase the total present worth of the alternative from $5 million to approximately $6.5 million.

12.4 ALTERNATIVE SA-3

Alternative SA-3 is also a containment alternative and is similar to SA-2. In SA-3, however, the active collection system is used in place of the passive groundwater collection system. Pumping of groundwater will lower the water table and reduce further groundwater discharge to the unnamed stream and its tributaries. This alternative is a combination of SC-2 and MM-5.

The first site activities would be the installation of the utilities, construction trailer, and offices. Prior to cap construction, the unnamed stream would be diverted and a concrete-lined channel installed. The unnamed stream needs to be channelized under this alternative because the extraction well system will influence the unnamed stream and could pull the water into the ground as the unnamed stream passes the eastern site boundary. This would create excessive water to treat and may impact the downstream wetland.

Site clearing, grubbing, and cobblestone removal would take place at the same time as the relocation of the unnamed stream. Following the channelization of the unnamed stream and site clearing, the cap would be constructed. Cap construction will again occur concurrently with the groundwater treatment system construction. The groundwater wells and associated piping will be installed following cap construction, but prior to topsoiling and revegetation. Topsoil distribution, revegetation, and fence installation complete the site activities for this alternative. An environmental monitoring program will be installed to

FIGURE 12-3: ALT. SA-2
TOTAL PRESENT WORTH: $5,063,000

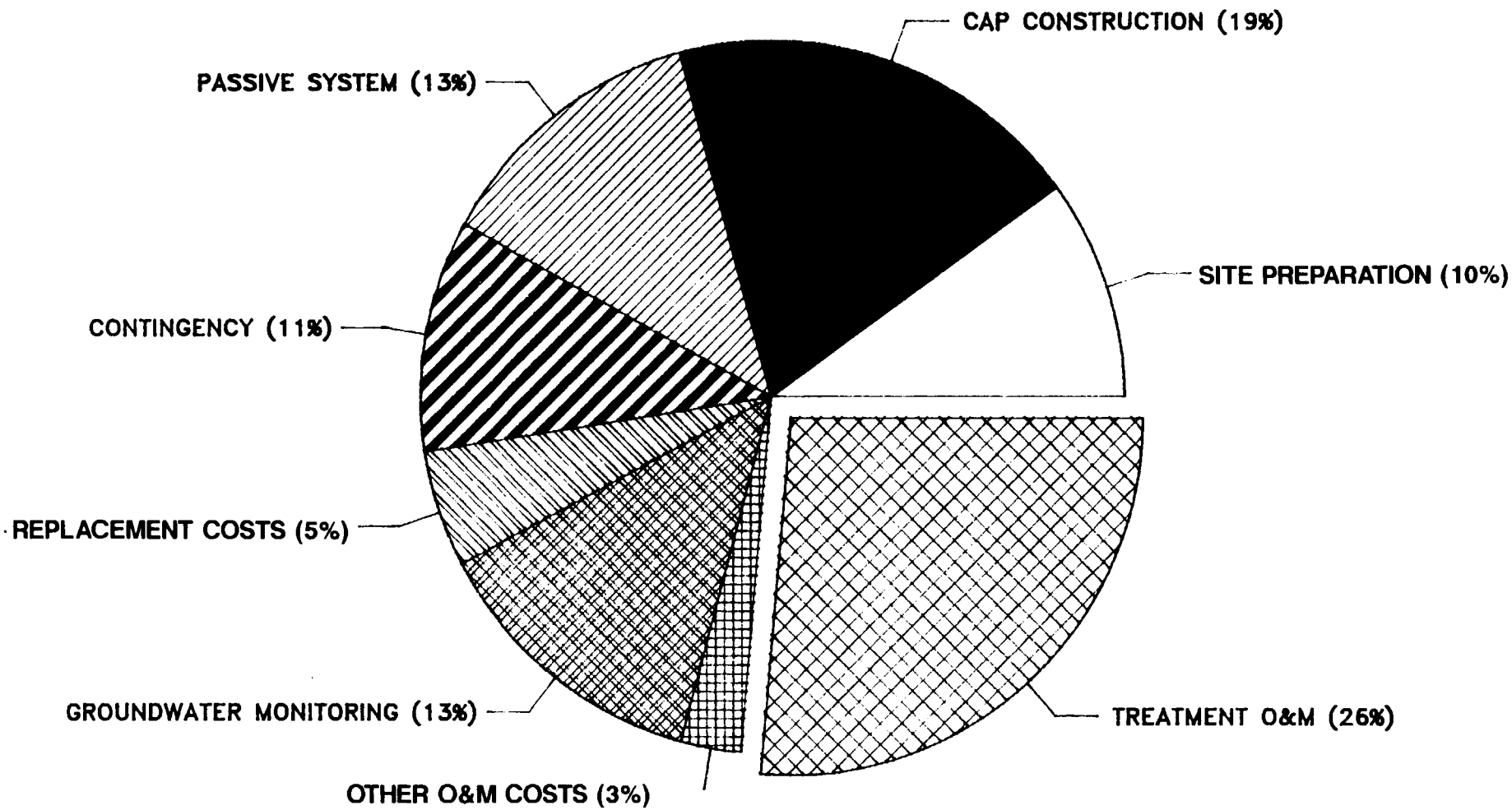
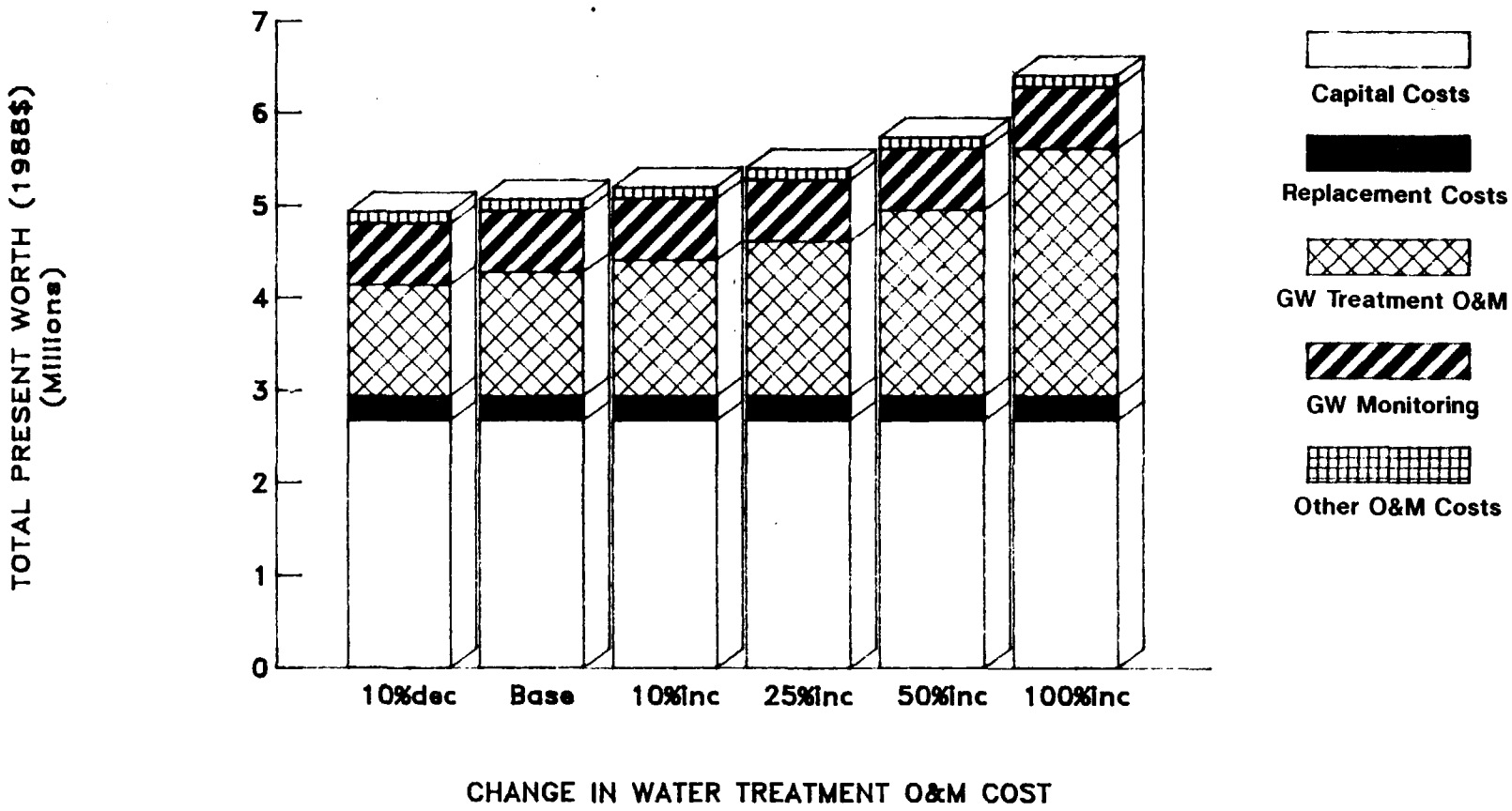


FIGURE 12-4: ALT. SA-2 Cost Sensitivity

UNCERTAINTY IN WATER TREATMENT O&M COST



determine the effectiveness of the groundwater extraction wells and treatment system.

This alternative is expected to take approximately three years from construction onset. This alternative will be effective in eliminating the risks associated with the site soils and seeps. This alternative should also reduce the risks associated with the on-site shallow bedrock groundwater; however, this will need to be monitored to verify this assumption. This alternative does not address on-site or off-site contamination in the deep bedrock fractures. Institutional controls would still be required to regulate the installation of drinking water wells within a specified radius of the site.

Under this alternative, contamination within the quarry pits will be hydraulically controlled to reduce future groundwater release. In addition, PCB sediment loading to the unnamed stream, Middle Marsh, water hazards, and Apponagansett Swamp will be stopped. However, this alternative does not propose to address existing PCB-contaminated sediments in water bodies and affected wetland areas and the respective risk to environmental receptors.

For cost purposes, the life of this alternative is anticipated to be 30 years. Aesthetically, the Sullivan's Ledge site will become an open grassy area.

12.4.1 Evaluation Summary

A summary of the 9-criteria evaluation is summarized for Alternative SA-3 in Table 12-6.

12.4.2 Cost Summary

Alternative SA-3 is nearly identical to Alternative SA-2. The exception is that a groundwater extraction and treatment system is used instead of the passive collection system. Table 12-7 summarizes the costs for this alternative. The capital costs associated with construction of the cap, extraction system, and treatment system total $2,952,500. Replacement of the treatment system and site fence will be about $367,000, and the present worth of operating/maintenance costs over a 30-year period will be $2,507,600. The total present worth of the alternative is $5,827,300.

Alternative costs are depicted graphically in Figure 12-5. Cap construction and water treatment operation/maintenance are the major components of this alternative. A cost-sensitivity analysis was performed on the water treatment costs because it was believed that these costs contain the greatest degree of uncertainty. The cost sensitivity analysis results for this

TABLE 12-6

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-3
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
1. Short-term Effectiveness	
• Time until implementation is achieved	Three years would be required to install the groundwater extraction and treatment systems, line the unnamed stream, and construct the multi-layer cap.
• Protection of community during remedial action	Dust control measures, emissions control equipment, and atmospheric dispersion would prevent airborne contaminant concentrations from impacting public health.
• Protection of workers during remedial action	All workers would be trained in health and safety procedures and safe working practices. Workers would utilize proper personal protective equipment (e.g., gloves, boots, tyveks, respirators) to reduce dermal and inhalation exposure risks. The greatest risks would be posed during extraction well installation and clearing and grubbing.
• Environmental impacts	Minimal air quality impacts can be expected during capping operations due to airborne dust particles and volatilized organics. Erosion control would prevent additional PCB loading to Middle Marsh and Apponagansett Swamp.
2. Long-term Effectiveness and Permanence	
• Magnitude of residual risk	Contaminated soil would remain untreated, but mobility and dermal exposure potential would be considerably reduced by the cap. PCB sediments would also remain untreated. Groundwater contamination in bedrock fractures would remain at a 4.6×10^{-1} risk level for exposure to maximum concentrations.

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TABLE 12-6 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-3
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
• Adequacy of controls	The cap would effectively reduce present use exposure by isolating soil beneath several layers of material. Groundwater extraction and treatment would contain the contaminant plume, limit groundwater migration from the pits, and provide flushing of groundwater through pits, but would not treat contaminants in deep bedrock fractures. Institutional controls would still be necessary to protect downgradient receptors from groundwater risks.
• Reliability of controls	The cap should remain effective for at least 30 years provided that maintenance is performed as scheduled. Certain equipment of the groundwater treatment system would have a limited service life and would require replacement. Complete replacement of all treatment equipment is expected in Year 16. In order to be effective, institutional controls would require strict adherence and enforcements.
3. <u>Reduction of Toxicity, Mobility, or Volume</u>	Soils would not be treated; thus, no reduction in TV would be realized. The cap would reduce the mobility of contaminated soils. Groundwater extraction and treatment would reduce the TMV of the contaminant plume. No reduction of TMV of contaminated sediments would occur as a result of the alternative. As groundwater is flushed through the pits, extracted and treated, the toxicity of the pits would be decreased.
4. <u>Implementability</u>	
• Technical feasibility	The groundwater treatment system would require pilot-scale testing to determine design parameters. Further characterization of the hydrogeology of the site (i.e., pump tests) would be required to properly position extraction wells.

TABLE 12-6 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-3
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
• Administrative feasibility	Activities would have to be coordinated with the City of New Bedford to obtain property north of Hathaway Road for the treatment system. Installation of off-site wells would require rights-of-way to the golf course. Institutional controls to regulate well installation within a specified radius of the site would need to be implemented with state and city officials.
• Availability of services and materials	Construction requirements can be contracted locally. Groundwater extraction well and treatment equipment and specialists are readily available within the wastewater treatment industry.
5. Cost	Present worth of alternative = $5,827,300 (See Table 12-7).
6. Compliance with ARARs	The SDWA and Massachusetts Water Quality Standards would not be attained in bedrock and groundwater fracture zones but a waiver may be applied due to technical impracticability.
7. Overall Protection of Human Health and the Environment	The cap would reduce present use exposure to contaminated soils and would stop continued PCB loading into the unnamed stream. Groundwater extraction and treatment would create a cone of depression which would reduce seepage to surface waters. Downgradient receptors may still be at risk since extraction would not mitigate fracture migration. Aquatic biota would still be stressed by sediment PCBs. Sediment PCBs are not threatening to human health.
8. State Acceptance	The state favors active groundwater treatment over the passive collection system, however, the state also prefers soil treatment, which is not included in this alternative.
9. Community Acceptance	To be addressed following the public comment period.

TABLE 12-7

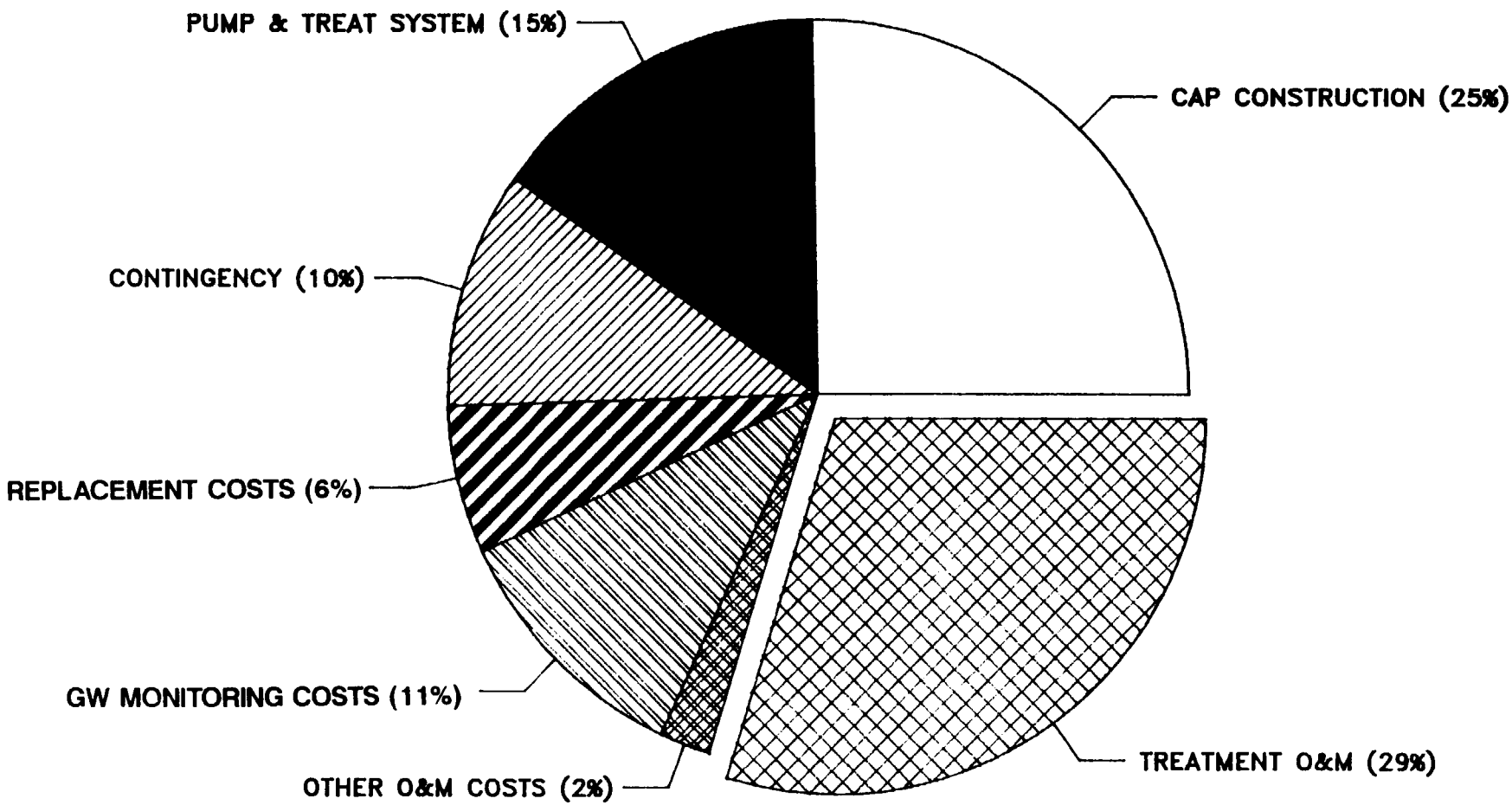
COST SUMMARY TABLE
ALTERNATIVE SA-3
SOURCE CONTAINMENT,
ACTIVE GROUNDWATER CONTROLS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CAPITAL COSTS	
• Site Preparation	$ 513,600
• Cap Construction	968,900
• Groundwater Extraction System	501,500
• Water Treatment System (oxidation/filtration - iron removal) (UV/ozonation - organic removal)	378,000
• Contingency (25%)	590,500
TOTAL CAPITAL COSTS	$2,952,500
EQUIPMENT REPLACEMENT COSTS	PRESENT WORTH
• Treatment System, Submersible Pumps, Monitoring Wells, and Sampling Equipment Replacement (see Table 11-6)	$ 347,000
• Site Security Fence Replacement (Year 16)	20,200
PRESENT WORTH OF REPLACEMENT COSTS	$ 367,200
OPERATING AND MAINTENANCE (O&M) COSTS (For 30-Year Period)	
• Water Treatment O&M	$1,560,000
• Extraction System O&M	158,300
• Groundwater and Sediment Monitoring Program	659,600
• Site Security	72,250
• Cap Maintenance	18,500
• 5-year Review - Public Meetings	38,950
PRESENT WORTH OF O&M COSTS	$2,507,600
PRESENT WORTH OF ALTERNATIVE	$5,827,300

Note: Additional cost details are located in:

- Table 10-3 for Alternative SC-2.
- Table 11-6 for Alternative MM-5.

FIGURE 12-5: ALT. SA-3
TOTAL PRESENT WORTH: $5,827,000



alternative are depicted in Figure 12-6. A 100-percent increase in costs associated with groundwater treatment operation would increase the total present worth of the alternative from $5.8 million to almost $8 million.

The only difference between Alternative SA-3 and Alternative SA-2 is the type of groundwater treatment. Substitution of the passive collection system in Alternative SA-2 to an active extraction and treatment system in SA-3 results in an increase in total present worth of about $900,000.

12.5 ALTERNATIVE SA-4

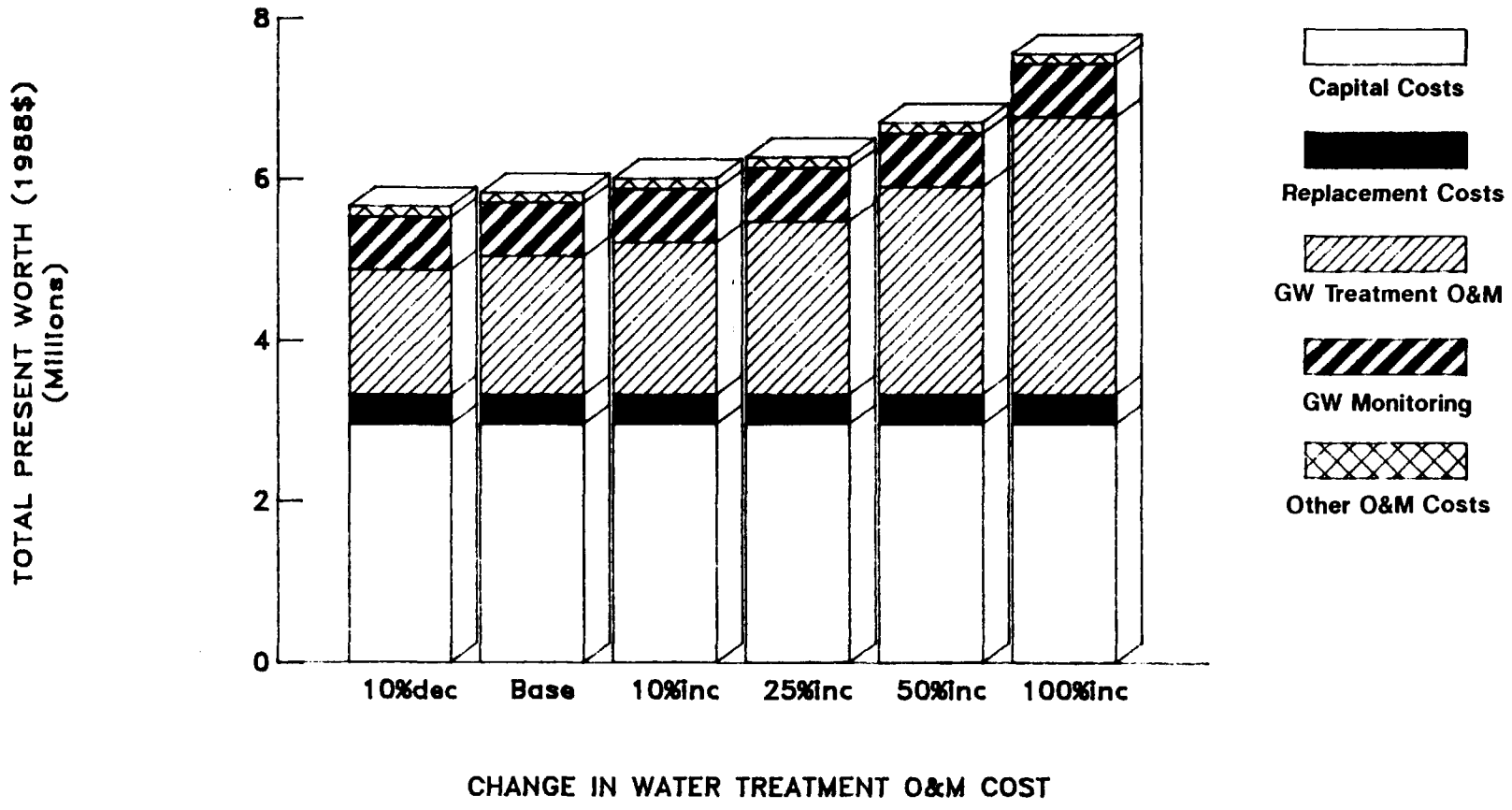
This alternative combines limited treatment of site soils with SC-2, the containment alternative and MM-3, passive bedrock collection and treatment of groundwater. The rationale behind this alternative is that it incorporates SARA's preference for treatment. Under this alternative, the more highly contaminated soils beneath overlying surface soils will be remediated to a 10^{-4} risk level, while surface soils will be remediated to a 10^{-5} risk level. Remediation will involve excavation and solidification so that any potential future risks associated with mobility of the contaminated soils are minimized. Also, PCB-contaminated sediments would be removed from the unnamed stream and the four water hazards and solidified on-site. These two areas are the easiest to access, require the least remediation, and will not result in wetlands habitat loss. All solidified soils and sediment would be compacted on-site as fill material and excavated soil areas would be backfilled with clean fill material prior to installation of the cap. Solidified materials would be placed such that they would remain above the water table.

Site activities would proceed as follows. First, site preparation activities would occur, including establishment of utilities and roads, clearing and grubbing of site vegetation; decontamination and removal of the cobblestones, concrete pillars, and telephone poles; and construction of a sedimentation pond and bedrock passive collection system. Concurrent with these on-site activities would be the relocation of the unnamed stream and construction of the concrete-lined channel.

Once site preparation activities have occurred, a solidification unit(s) will be mobilized and on-site surface soils will be excavated and solidified. Temporary roads will be constructed on the golf course and the sediments from the unnamed stream and water hazards will be excavated and solidified on-site. The solidified soils and sediments will be compacted for cap fill. After all treatment activities have been completed, the cap will be constructed on-site.

FIGURE 12-6: ALT. SA-3 Cost Sensitivity

UNCERTAINTY OF WATER TREATMENT O&M COST



Concurrent with the solidification process, the groundwater treatment system will be constructed north of Hathaway Road and water treatment pilot tests will be performed. The treatment system is expected to be operational upon completion of the cap. An environmental monitoring program will be initiated to determine the effectiveness of the remedial actions.

The time required to implement and construct this alternative is estimated at 2 to 3 years. This alternative will eliminate risks posed by the site soils, seeps, and overburden groundwater. In addition, the mobility of PCB soils and sediments will be reduced by solidification and disposal below an impermeable cap. The volume of contaminated material, however, will increase, but this is inconsequential because the material will be used for fill material and will be placed below the multi-layered cap. This alternative also reduces risks from PCB- contaminated sediments by removing a portion of the contaminated sediments and by preventing future PCB sediment-loading to the stream and marsh habitats.

This alternative does not address the deeper groundwater contamination discussed in Section 5.0, nor does it mitigate contamination in the pits. Institutional controls will still be required to regulate the installation of private wells within a specified radius of the site.

For cost purposes, the life of this alternative is anticipated to be 30 years. Aesthetically, the Sullivan's Ledge site will become an open grassy area.

12.5.1 Evaluation Summary

Table 12-8 contains a summary of the 9-criteria evaluation that was performed for SA-4.

12.5.2 Cost Summary

Alternative SA-4 combines a minimum of soil and sediment treatment with passive collection and treatment of the overburden and shallow bedrock groundwater. Costs for this site alternative are summarized in Table 12-9. The capital costs for this alternative total $5,894,000. These include costs associated with site preparation, soil and sediment treatment, cap construction, and construction of the passive groundwater collection and treatment system. Replacement of the treatment system and site fence would be required in Year 15; the present worth of these expenditures would be $267,200. Operating/ maintenance costs would be incurred for water treatment, groundwater monitoring, site security, cap maintenance, and 5-year reviews. Total present worth of operating/maintenance costs is about $2.1 million. Total present worth of the alternative is $8.3 million.

TABLE 12-8

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-4
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
1. Short-term Effectiveness	
• Time until implementation is achieved	Achievement time is estimated at 2 to 3 years. Component time requirements are as follows: - 1 year for site preparation, passive collection system construction, and lining of unnamed stream. - 3 months for excavation and solidification. - 1 year for cap and treatment system construction.
• Protection of community during remedial action	Dust control measures would be initiated to minimize the generation of airborne contaminants during excavation, solidification, and construction activities. Atmospheric dispersion would dilute contaminant concentrations to levels that do not impact public health.
• Protection of workers during remedial action	A 40-hour health and safety training course would be required of all workers. Personal protective equipment would be needed to prevent dermal or inhalation exposure during excavation, solidification, capping, and installation of passive collection system.
• Environmental Impacts	Minimal air quality impacts can be expected during excavation and solidification operations due to airborne dust particles and volatilized organics. Excavation of the unnamed stream and water hazards would cause resuspension and transport of PCB-contaminated sediments which may impact downstream biota. Therefore, mitigative measures will be instituted. Middle Marsh and Apponagansett Swamp would remain stressed by sediment PCBs but additional PCB loading would be mitigated.

TABLE 12-8 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-4
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
2. Long-term Effectiveness and Permanence	
• Magnitude of residual risks	Contaminated soil risks would be reduced through solidification. PCB concentrations in the unnamed stream and water hazards would be reduced to appropriate sediment quality criteria. PCBs in Middle Marsh and Apponagansett Swamp would remain at present levels (i.e., average between 10 and 20 ppm). Bedrock groundwater risks would remain at 4.6×10^{-1} for exposure to maximum concentration.
• Adequacy of controls	Solidification and capping would mitigate exposure pathways to on-site soils, unnamed stream, and water hazard sediments. Both solidification and capping are established technologies. The bedrock aquifer would not be mitigated and continued groundwater contaminant migration may complicate a future remedial action. Groundwater use restrictions would control unauthorized well installations and monitoring would track the contaminant plume.
• Reliability of controls	The monolith and cap would be effective for at least 30 years. The treatment system would run unattended with daily checks, adjustments, and maintenance. Component pieces would require periodic replacement, having typical service lives of 5 to 10 years. Multi-level sampling wells are anticipated to require replacement after 15 years. In order to be effective, institutional controls would require strict adherence and enforcement.
3. Reduction of Toxicity, Mobility, or Volume	Solidification would reduce mobility of 13,100 cubic yards of contaminated soils and 1,900 cubic yards of PCB sediments. Treatment would reduce the toxicity of 40 gpm of collected groundwater. Groundwater collection would prevent loading to the unnamed stream, thereby reducing contamination in the surface water. No

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TABLE 12-8 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-4
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
	reduction in TMV of bedrock aquifers, quarry pits, or PCB-contaminated sediments in Middle Marsh and Apponagansett Swamp.
4. Implementability	
• Technical feasibility	Both solidification design and groundwater treatment design would require bench-scale and/or pilot scale studies to determine design parameters, but would not require further technical development. Solidification treatment would require mobilization of specialized equipment and specialists to facilitate processing. Assemblage and start-up of the groundwater treatment system would require wastewater treatment specialists. Installation of the cap and collection system would involve standard construction activities.
• Administrative feasibility	Construction activities would have to be coordinated with the City of New Bedford in order to obtain rights-of-way north of Hathaway Road. Institutional controls to regulate well installation would need to be coordinated with state and city officials.
• Availability of services and materials	Construction requirements can be contracted locally. Solidification equipment and specialists can be contracted through any of 19 identified vendors. Water treatment equipment, specialists and operators are also widely available in the wastewater industry.
5. Cost	Present worth of alternatives = $8,285,500 (See Table 12-9).
6. Compliance with ARARs	SDWA and Massachusetts Drinking Water Standards would not be attained in bedrock groundwater. A technical impracticality waiver may be justifiable.

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TABLE 12-8 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-4
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
7. Overall Protection of Human Health and the Environment	Solidification of surface soils would reduce human health risks. The cap would reduce these risks even further by isolating untreated soils under several layers of material. Groundwater collection and treatment would minimize risks to aquatic biota by reducing toxic loading to surface water. PCB sediment risks in the unnamed stream would be mitigated to levels protective of aquatic biota, but PCB sediments would continue to stress biota in Middle Marsh and Apponagansett Swamp. Contaminant migration within bedrock fracture zones may continue.
8. State Acceptance	State acceptance is not anticipated for this alternative because it does not incorporate an active groundwater remediation system.
9. Community Acceptance	To be addressed after the public comment period.

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TABLE 12-9

COST SUMMARY TABLE
ALTERNATIVE SA-4
TREATMENT WITH SOURCE CONTAINMENT,
PASSIVE GROUNDWATER CONTROLS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CAPITAL COSTS	
• Site Preparation	$1,403,300
• Excavation, Solidification, and On-site Disposal of All Soils to 10^{-4} and Surface Soils to 10^{-5} (13,100 Cubic Yards)	964,000
• Excavation, Dewatering, Water Treatment of Filtrate, Solidification, and On-site Disposal of Sediments from Unnamed Stream and Golf Course Water Hazards (1,900 Cubic Yards)	724,000
• Cap Construction	968,900
• Passive Collection System Construction (Bedrock Trench)	409,000
• Water Treatment System (oxidation/filtration - iron removal) (UV/ozonation - organic removal)	246,000
• Contingency (25%)	1,178,800
TOTAL CAPITAL COSTS	$5,894,000
EQUIPMENT REPLACEMENT COSTS	PRESENT WORTH
• Treatment System, Monitoring Wells, and Sampling Equipment Replacement (see Table 11-4)	$ 247,000
• Site Security Fence Replacement	20,200
PRESENT WORTH OF REPLACEMENT COSTS	$ 267,200
OPERATING AND MAINTENANCE (O&M) COSTS (For 30-Year Period)	
• Water Treatment O&M	$1,335,000
• Groundwater and Sediment Monitoring Program	659,600
• Site Security	72,250
• Cap Maintenance	18,500
• 5-Year Review - Public Meetings	38,950
PRESENT WORTH OF O&M COSTS	$2,124,300
PRESENT WORTH OF ALTERNATIVE	$8,285,500

Note: Additional cost details are located in:
- Table 10-3 for Alternative SC-2.
- Table 10-6 for Alternative SC-4.
- Table 10-10 for Alternative SC-7.
- Table 11-4 for Alternative MM-3.

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Figure 12-7 is a pie-chart showing the breakdown of costs for Alternative SA-4. Costs for this alternative are well-balanced among soil and sediment treatment, site containment (cap), and passive collection and treatment of groundwater.

Volumes of sediment selected for treatment are generally more accurate than volumes of contaminated soil. This is because sediment volumes are calculated from well-defined locations (e.g., streambed, water hazards, Middle Marsh), while the soil volumes are calculated from site contaminant maps interpreted from test pit soil chemical analysis. This provides a greater uncertainty associated with the volumes of soil selected for treatment. Therefore, changes in contaminated soil volumes were selected as a variable for cost sensitivity. Results of this analysis, shown in graphic form in Figure 12-8, indicate that even a 100-percent increase in soil volumes would have only a minimal effect on the total present worth of the alternative, increasing it to about $9.5 million. Any changes in present worth costs due to uncertainty associated with water treatment costs would be similar to those observed in the cost sensitivity for Alternative SA-2 (see Section 12.3.2).

12.6 ALTERNATIVE SA-5

In this alternative, the active groundwater extraction system would be used to significantly reduce the contaminated groundwater within and adjacent to the quarry pits. After this time, an overburden passive collection system would collect and treat groundwater. The rationale behind this alternative is that a short-term active pump-and-treat system is utilized to extract volumes of the highly contaminated groundwater from the quarry pit. The groundwater remaining may not meet MCLs and may become further contaminated by any DNAPL that may exist in the pits. Groundwater would then be collected by the passive collection system to prevent contaminated discharge into surface waters. The disadvantage with this scenario is that it requires capital costs for both the extraction wells and the underdrain system pipes. The advantage is that long-term operating/ maintenance costs of the pumping system are avoided.

Solidification would be used to treat on-site soils and PCB-contaminated sediments. Soil treatment would be to a 10^{-5} residual risk level. Sediment in the Middle Marsh and Apponagansett Swamp South would be mitigated to upper value SQCs, while those in the unnamed stream and Water Hazards 1 and 2 would be mitigated to mean value SQCs. Treatment volumes for soils and sediments are estimated at 24,200 and 1,900 cy, respectively.

Site activities would proceed as outlined under SA-4. Site preparation, stream diversion, and installation of the

FIGURE 12-7: ALT. SA-4
TOTAL PRESENT WORTH: $8,285,000

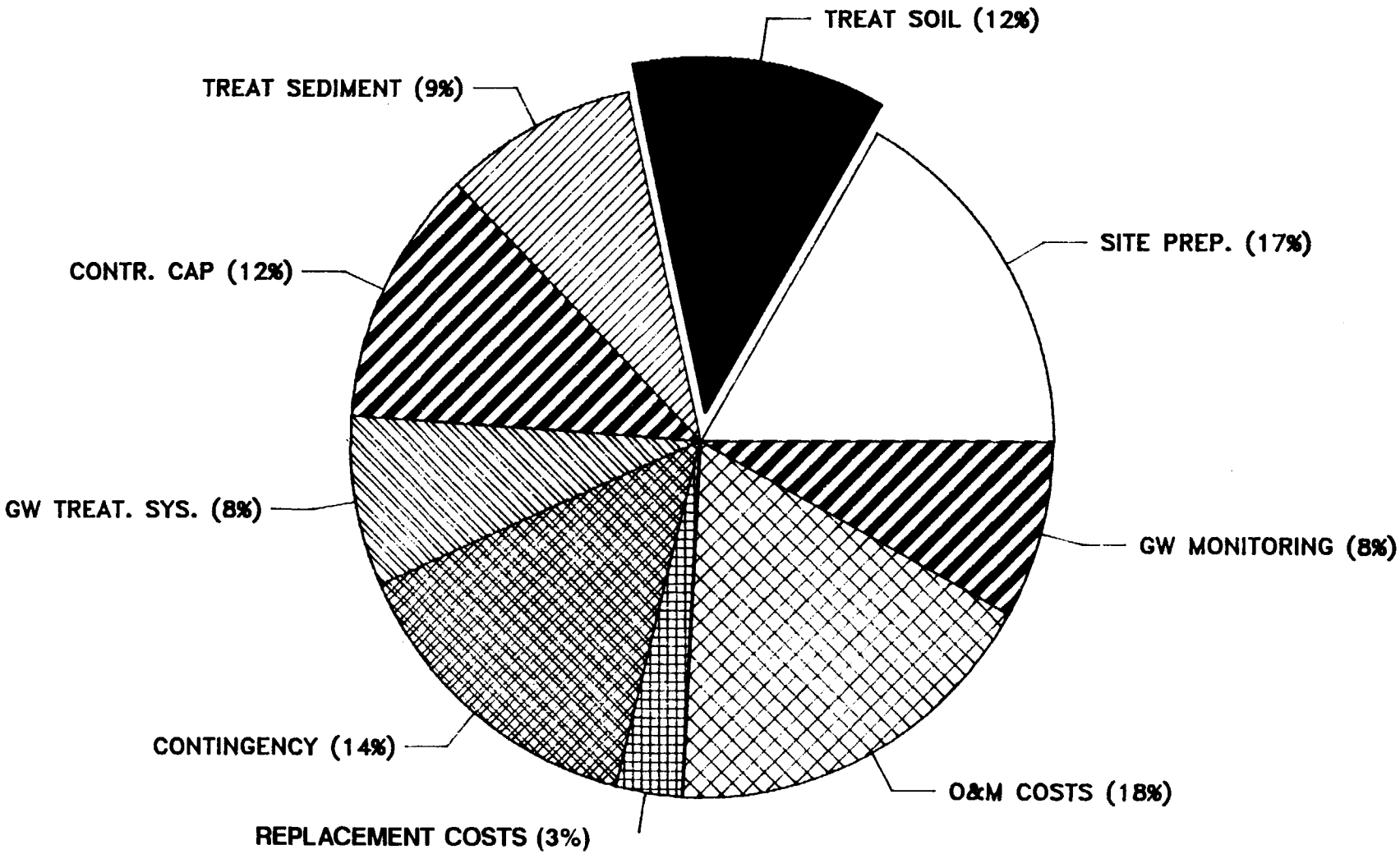
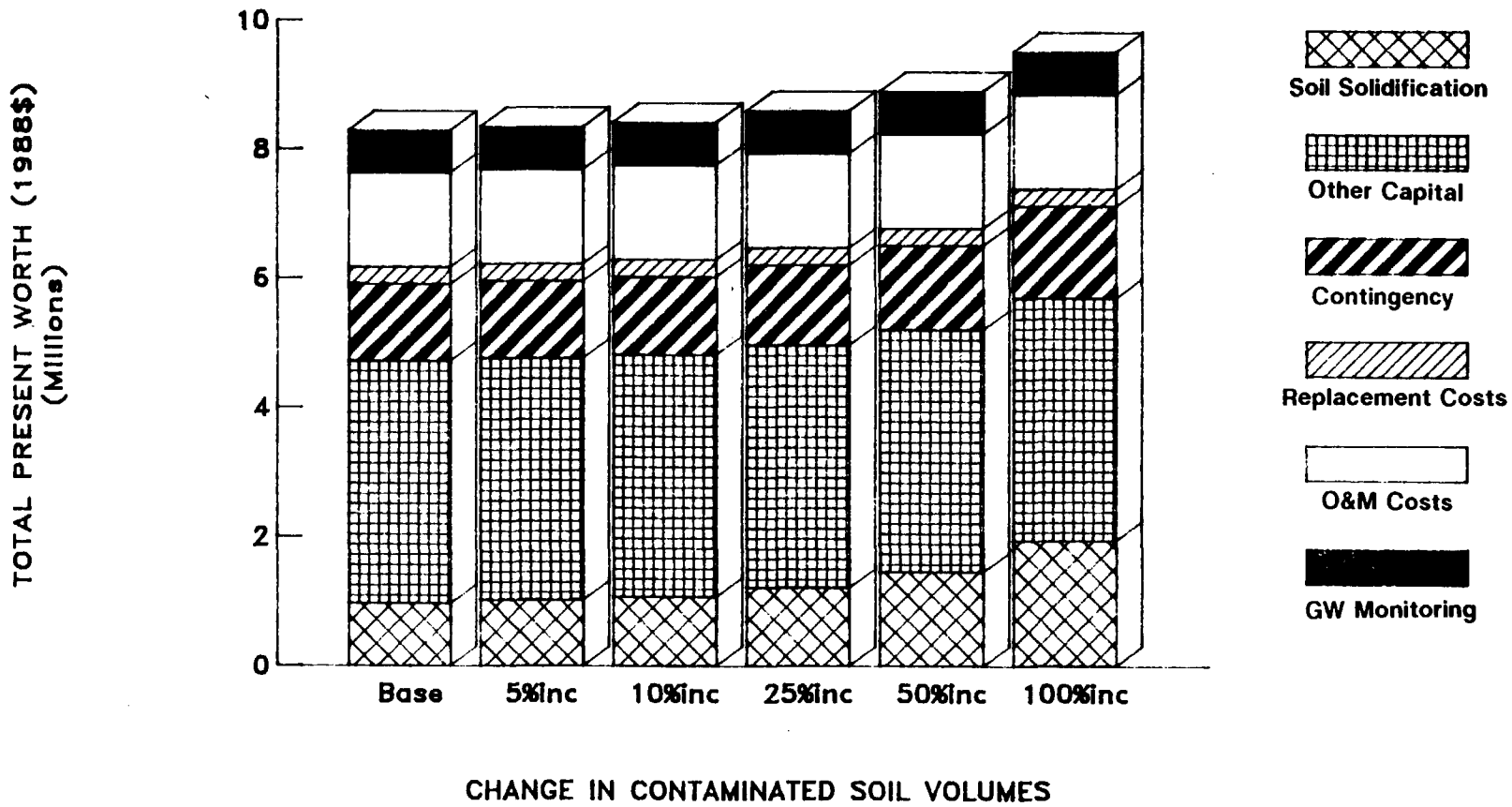


FIGURE 12-8: ALT. SA4 Cost Sensitivity

UNCERTAINTY OF CONTAMINATED SOIL VOLUME



overburden underdrain pipe would occur initially. Solidification of soils and sediments and construction of the groundwater treatment system would occur next. The cap would be constructed following solidification and the wells would be installed prior to topsoil placement and revegetation. Fences would be constructed around the cap and treatment plant. Environmental monitoring would be conducted to determine the effectiveness of the remedial actions and to determine when the pumping system would be discontinued and the passive collection system connected. It is assumed that the treatment system installed for the groundwater extraction wells is more than adequate for the groundwater collected by the underdrain system. This appears to be a safe assumption. Future thought may be given to discharging the passively collected groundwater into the New Bedford sewer system when the new New Bedford Wastewater Treatment plant is constructed and on-line.

This alternative will take approximately three years to implement. It will mitigate the risks posed by the surface soils, seeps, overburden groundwater, and sediments in the unnamed stream, water hazards, Middle Marsh, and Apponagansett Swamp South. In addition, this alternative should reduce the risks associated with the contaminated groundwater within and adjacent to the quarry pits. Because this alternative does not address off-site groundwater contamination, groundwater contamination may pose a chronic risk. Institutional controls will be required to regulate the installation of private wells within a specified radius of the site.

As with the other alternatives, the life of this alternative is anticipated to be 30 years.

12.6.1 Evaluation Summary

A summary of the 9-criteria evaluation for this alternative is located in Table 12-10.

12.6.2 Cost Summary

This alternative is similar to Alternative SA-4, except that the active collection system would be used for a limited period of time. After shutdown of the active collection system, the passive collection system would be put into operation. Table 12-11 summarizes the costs associated with this alternative. The major cost variation of this alterative when compared to Alternative SA-4 is the larger capital costs associated with construction of both the passive collection system and the groundwater extraction system.

Total capital cost of this alternative is $7,636,250. This includes all costs associated with site preparation, treatment of soils and sediments, cap construction, wetlands restoration,

TABLE 12-10

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-5
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
1. Short-term Effectiveness	
• Time until implementation is achieved	Implementation time is estimated at 2 to 3 years. Component time requirements are as follows: - 1 year for site preparation, lining the unnamed stream, installation of overburden trench - 6 months for soils and sediments solidification - 1 year for capping, well installation, and treatment system construction
• Protection of community during remedial action	Dust control measures, emissions control equipment, and atmospheric dispersion would prevent airborne contaminant concentrations from impacting public health.
• Protection of workers during remedial action	A 40-hour health and safety training course would be required of all workers. Personal protective equipment would be needed to prevent dermal or inhalation exposure during excavation, solidification, and capping operations.
• Environmental impacts	Minimal air quality impacts can be expected during excavation and solidification operations due to airborne dust particles and volatilized organics. Excavation of the unnamed stream and water hazards may cause resuspension and transport of PCB sediments which may impact downstream biota. Therefore, mitigative measures will be instituted. Excavation of wetlands would cause loss of habitat.
2. Long-term Effectiveness and Permanence	
• Magnitude of residual risk	Treatment would reduce soils present use exposure risks and the cap would then cover the solidified monolith and untreated soils to reduce exposure risks even further.

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TABLE 12-10 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-5
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
	Treatment would improve the condition of the on-site overburden aquifer with time. Bedrock fracture groundwater would continue to pose risks as high as 10^{-1} for exposure to maximum concentration.
• Adequacy of controls	Solidification would immobilize soil and sediment contaminants. The cap would create an effective barrier to exposure with and mobility of untreated soils. Groundwater migration in off-site fractures is expected to continue, even during extraction. Institutional controls would still be necessary.
• Reliability of controls	The monolith and cap would be effective for 30 years or more. Groundwater treatment support equipment (e.g., pumps) have limited service lives and are expected to require periodic replacement. Major treatment components (e.g., UV/ozonation) would require one replacement over the 30-year design period. In order to be effective, institutional controls would require strict adherence and enforcement.
3. Reduction of Toxicity, Mobility, or Volume	Solidification would reduce the mobility of 24,200 cubic yards of contaminated soils and 1,900 cubic yards of PCB sediments. Groundwater extraction and treatment would reduce the TMV of the contaminant plume while pumping and treatment occurs.
4. Implementability	
• Technical feasibility	Neither solidification nor groundwater treatment would require further technical development, but both would require bench scale and/or pilot scale testing to determine design parameters. Further characterization of the hydrogeology of the site may be required to properly position extraction wells.

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TABLE 12-10 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-5
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
• Administrative feasibility	Construction activities would have to be coordinated with the City of New Bedford to obtain rights-of-way to the golf course. Institutional controls to regulate well installation would need to be implemented with state and city officials.
• Availability of services	Construction requirements can be obtained locally. Solidification equipment and specialists can be contracted through any of 19 identified vendors. Groundwater extraction well, and treatment equipment are readily available within the wastewater treatment industry.
5. Cost	Present worth of alternative = $10,047,500 (See Table 12-11).
6. Compliance with ARARs	SDWA and Massachusetts Drinking Water Standards would not be attained in bedrock fracture zones. A waiver may be justifiable due to technical impracticability.
7. Overall Protection of Human Health and the Environment	Solidification of soils and sediments would mitigate risks to human receptors and biota habitating in the unnamed stream. Capping would reduce dermal exposure risks to untreated soils and would stop continued PCB loading into the unnamed stream. Groundwater extraction and treatment would mitigate the seeps and overburden and shallow bedrock groundwater. Contaminated groundwater fracture migration may continue. Groundwater collection and treatment would minimize risks to aquatic biota by reducing toxic loading to surface water.
8. State Acceptance	This alternative is anticipated to be accepted by the state as it involves both groundwater and soils treatment.
9. Community Acceptance	To be addressed following the public comment period.

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TABLE 12-11

COST SUMMARY TABLE
ALTERNATIVE SA-5
TREATMENT WITH SOURCE CONTAINMENT,
ACTIVE GROUNDWATER CONTROLS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CAPITAL COSTS	
• Site Preparation	$ 1,403,300
• Excavation, Screening, Solidification, and On-site Disposal of All Soils to 10^{-5} (Estimated 24,200 cy)	1,804,000
• Excavation, Dewatering, Solidification, and On-site Disposal of Sediments from Unnamed Stream, Water Hazards 1 and 2, (Estimated 1,900 cy)	724,000
• Wetlands Restoration	
• Cap Construction	968,900
• Groundwater Extraction System Construction	501,500
• Passive Collection System Construction (Overburden Trench)	329,000
• Water Treatment System (oxidation/filtration - iron removal) (UV/ozonation - organic removal)	378,300
• Contingency (25%)	1,527,250
TOTAL CAPITAL COSTS	$7,636,250
EQUIPMENT REPLACEMENT COSTS	PRESENT WORTH
• Water Treatment System, Monitoring Wells, and Sampling Equipment Replacement (see Table 11-4)	$ 247,000
• Submersible Pump Replacement (Year 6)	12,300
• Site Security Fence Replacement	20,200
PRESENT WORTH OF REPLACEMENT COSTS	$ 279,500
OPERATING AND MAINTENANCE (O&M) COSTS (For 30-Year Period)	
• Groundwater Treatment O&M (Years 1-10)	$ 691,000
• Extraction System O&M (Years 1-10)	79,100
• Water Treatment O&M (Years 10-30)	572,400
• Groundwater and Sediments Monitoring Program	659,600
• Site Security	72,250
• Cap Maintenance	18,500
• 5-Year Review - Public Meetings	38,950
PRESENT WORTH OF O&M COSTS	$ 2,131,800
PRESENT WORTH OF ALTERNATIVE	$10,047,550

Note: Additional cost details are located in:
- Table 10-3 for Alternative SC-2.
- Table 10-6 for Alternative SC-4.
- Table 10-10 for Alternative SC-7.
- Table 11-4 for Alternative MM-3.
- Table 11-6 for Alternative MM-5.

and construction of both the passive collection and groundwater extraction and treatment systems. Total present worth of operating/maintenance for this alternative is about $2.1 million. This assumes operation of the groundwater extraction and treatment systems for Years 1 through 10, and the passive collection and treatment systems for Years 10 through 30. Total present worth of the alternative is $10,047,550.

Figure 12-9 is a pie chart showing the breakdown of costs for Alternative SA-5. Only subtle differences in costs between this alternative and Alternative SA-4 (see Figure 12-7) are evident. The cost-sensitivity analysis for this alternative considers the effects that changes in soil volumes have on alternative costs. A doubling of soil volumes produces only a minimal change in alternative costs (see Figure 12-10).

12.7 ALTERNATIVE SA-6

Alternative SA-6 is a treatment alternative utilizing an innovative technology, ISV. In this alternative, all site soils up to a 10^{-6} present risk level would be vitrified in-situ. In addition, PCB-contaminated sediments above lower value SQCs in the unnamed stream, Middle Marsh, water hazards, and Apponagansett Swamp would be removed and solidified on-site. The solidified sediments would remain on-site and would be placed adjacent to or graded over the vitrified soil and covered with soil to prevent direct contact. The passive collection system would also be installed to collect and treat the contaminated overburden groundwater and shallow bedrock water. The passive system will use a bedrock trench set 25 feet into bedrock.

The first site activity would be the setup of the construction trailers, offices, and utilities to power the vitrification unit. Site clearing, grubbing, and removal of the cobblestones would occur concurrently with the channelization of the unnamed stream. Following these activities, the site drainage system, sedimentation pond, and passive collection system would be installed. The contaminated soil excavated from the sedimentation pond area would be redistributed over soils to be vitrified. ISV of the site soils would then commence.

While the soils are being vitrified on-site, sediment removal and treatment activities will begin, including bench studies for solidification. Middle Marsh and Apponagansett Swamp will be cleared and grubbed and haul roads constructed. Pilot tests will be performed on the passively collected groundwater and construction of the water treatment plant will be initiated.

Excavation and solidification of sediments will begin following the completion of ISV. Vitrified areas that are cooling will first be covered with one to two feet of fill. The solidified sediment will be compacted adjacent to the vitrified areas and

FIGURE 12-9: ALT. SA-5
TOTAL PRESENT WORTH: $10,048,000

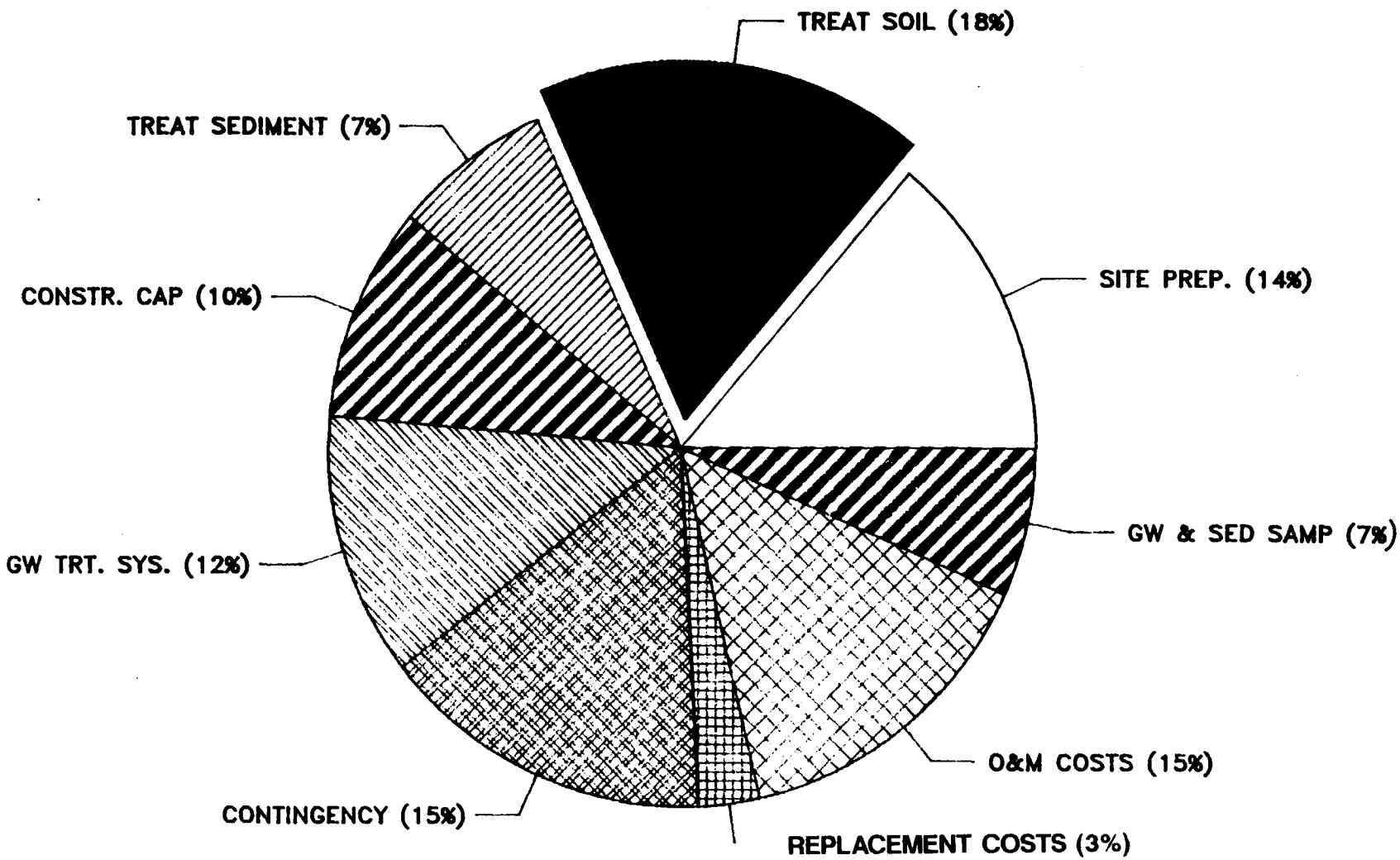
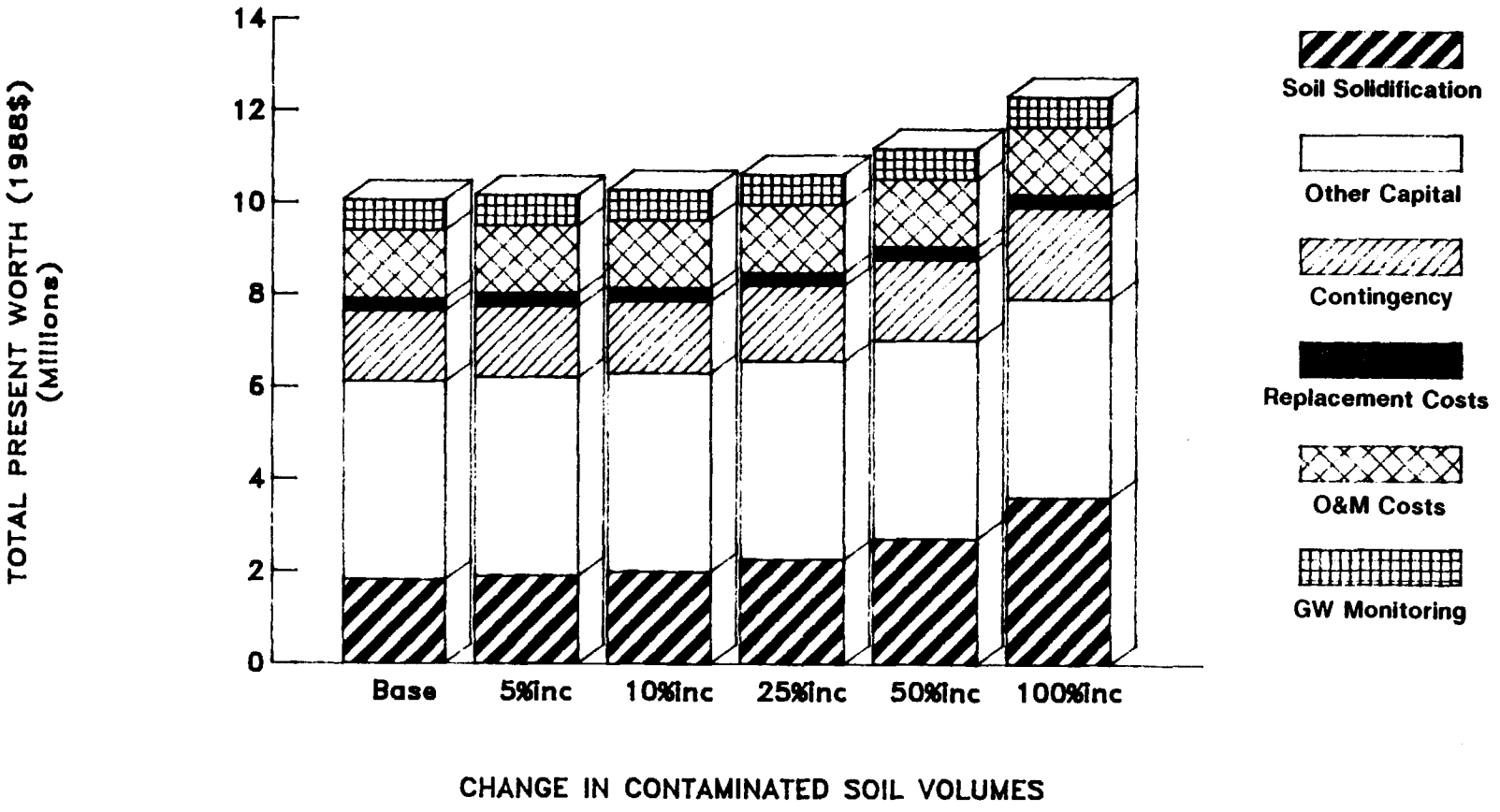


FIGURE 12-10: ALT. SA5 Cost Sensitivity

UNCERTAINTY OF CONTAMINATED SOIL VOLUME



covered with soil to prevent any direct contact risk. Startup of the water treatment system and initial wetlands revegetation will complete the construction phase of this alternative. Both the site and treatment system will be fenced.

The time required to complete the remedial action is estimated to be three years. This alternative embodies SARA's preference for permanent treatment by destroying the majority of the PCBs and PAHs on-site and by reducing the mobility of the PCB-contaminated sediments. Risks associated with the site soils, sediments, and seeps will be reduced. As with the other alternatives, institutional controls will be needed to prevent private well installation within a specified area of the site.

For cost purposes, it is assumed that the passive collection and treatment system will operate for 30 years. The site following treatment will not be capable of supporting vegetation without substantial fill. Future uses of the site have not been evaluated in detail.

12.7.1 Evaluation Summary

Table 12-12 contains a summary of the 9-criteria evaluation for alternative SA-6.

12.7.2 Cost Summary

Alternative SA-6 makes use of ISV of contaminated site soils and solidification of all PCB- contaminated sediments. The MM alternative selected for this site alternative is passive collection and treatment of groundwater. Table 12-13 summarizes alternative costs. ISV of soils ($19.8 million), solidification of sediments ($7.32 million), and a 25-percent contingency ($9.95 million) sum to a majority of the $48.9 million capital costs. The remaining capital costs are the result of site preparation, cap construction, wetlands restoration, and construction of the passive collection and treatment systems. Equipment replacement costs amount to $267,200, and the present worth of operating/ maintenance costs are $2.1 million. Total present worth of this alternative is $51,308,000.

Figure 12-11 is a graphical presentation of costs for Alternative SA-6. Costs for treatment of contaminated site soil by ISV contribute to more than half the total alternative cost. This portion of the alternative "pie" was used in the cost-sensitivity analysis. Two separate analyses were performed: (1) changes in contaminated soil volumes, and (2) changes in electrical power rates. The second analysis is appropriate because the ISV process uses electricity as its primary energy source. A 100-percent increase in soil volumes will result in a cost increase from $51 million to nearly $85 million (Figure 12-12). This is a substantial cost increase. Figure 12-13 contains results of the cost sensitivity performed

TABLE 12-12

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-6
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
1. Short-term Effectiveness	
• Time until implementation is achieved	Remedial completion time is estimated at 3 years. Component time requirements are as follows: - 1 year for site preparation, passive collection system construction, and lining of the unnamed stream - 2 years to solidify sediments and vitrify soils
• Protection of community during remedial action	Dust control measures and atmospheric dispersion of airborne contaminants would maintain conditions which do not impact public health. Off-gas treatment during ISV would reduce inhalation risks to acceptable levels.
• Protection of workers during remedial action	A 40-hour health and safety training course would be required of all on-site workers. Workers would follow safe work practices including use of personal protective equipment to comply with all OSHA requirements. Potential hazards would be posed to workers while observing the melt, working in the off-gas treatment trailer, installing the electrodes, and draining the off-gas scrub solution.
• Environmental impacts	Excavation of PCB sediments may cause loss of habitat in Middle Marsh and Apponagansett Swamp. Erosion control may prevent additional PCB loading due to resuspension during excavation. Restoration of wetlands is proposed, but may take a decade or more.

TABLE 12-12 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-6
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
2. Long-term Effectiveness and Permanence	
• Magnitude of residual risk	Residual risks would be as follows: - 10^{-6} for on-site surface soils - No risk for off-site sediments - No risk for surface waters - 4.6×10^{-1} for bedrock groundwater for maximum concentration exposure
• Adequacy of controls	A security fence would prevent exposure to untreated site soils while institutional controls would be used to restrict installation of wells within a specified radius of the site. Long-term groundwater and sediment monitoring would be necessary to track the movement of contaminants in known bedrock fractures and in surface runoff.
• Reliability of controls	Solidified sediments may begin leaching contaminants after several decades. Component pieces of the groundwater treatment system would require periodic replacement. Such equipment have typical service lives of 5 to 10 years. Sampling wells are anticipated to require replacement after 15 years, and new wells may need to be installed. In order to be effective, institutional controls would require strict adherence and enforcement.
3. Reduction of Toxicity, Mobility, or Volume	ISV would permanently reduce the toxicity and mobility of treated soils and would reduce the volume of contaminated site soils by over 20,000 cubic yards. Treatment would reduce the toxicity of 40 gpm of contaminated groundwater to below MCLs, while preventing contamination of the unnamed stream. Solidification would reduce the mobility of 67,300 cubic yards of sediment.

TABLE 12-12 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-6
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
4. Implementability	
• Technical feasibility	None of the associated technologies would require further technical development, but would require trial or pilot-testing to determine design or operating parameters. ISV would require the fabrication of a full-scale unit and technical specialists to train operators and help with start-up. Solidification would be performed by an experienced vendor, and assemblage and start-up of the water treatment system would require wastewater treatment specialists.
• Administrative feasibility	Construction activities would have to be coordinated with the City of New Bedford in order to obtain rights-of-way to the golf course. Institutional controls to regulate well installation would need to be implemented with state and city officials.
• Availability of services and materials	Construction requirements can be contracted locally. BPNL at Richland, WA, is the sole contractor for ISV technology. Nineteen vendors have been identified to provide turnkey solidification services. Groundwater treatment equipment and specialists are widely available in the wastewater industry.
5. Cost	Present worth of alternative = $51,308,000 (See Table 12-13).
6. Compliance with ARARs	The following ARARs would not be met: - SDWA - Massachusetts Drinking Water Standards MCLs/MCLGs would not be attained in bedrock groundwater. A technical infeasibility waiver may be justifiable.

TABLE 12-12 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-6
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
7. Overall Protection of Human Health and the Environment	ISV treatment would effectively reduce risks posed by surface soils to 10^{-6}. Solidification would reduce threats to aquatic biota, and groundwater collection and treatment would reduce contaminant loading to surface waters. Migration of contaminants within bedrock would continue to pose a serious human health threat.
8. State Acceptance	State acceptance for this alternative is not expected because it does not actively treat the contaminated bedrock groundwater.
9. Community Acceptance	To be addressed after the public comment period.

TABLE 12-13

COST SUMMARY TABLE
ALTERNATIVE SA-6
TREATMENT OF SOURCE
PASSIVE GROUNDWATER CONTROLS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CAPITAL COSTS	
• Site Preparation	$ 1,280,000
• In-situ Vitrification of all Soils to 10^{-6} Clean-up Level (Includes all Equipment, Labor, Energy, Scrubber Water Treatment, Backfilling, and Short-term Site Visit Costs)	22,530,000
• Excavation, Dewatering, Solidification, and On-site Disposal of PCB-contaminated Sediments (67,300 Cubic Yards)	7,363,000
• Wetlands Restoration	7,000,000
• Cap Construction	305,200
• Passive Collection System Construction (Bedrock Trench)	409,000
• Water Treatment System (oxidation/filtration - iron removal) (UV/ozonation - organic removal)	246,000
• Contingency (25%)	9,783,300
TOTAL CAPITAL COSTS	$48,916,500
EQUIPMENT REPLACEMENT COSTS	PRESENT WORTH
• Treatment System, Monitoring Wells, and Sampling Equipment Replacement (see Table 11-4)	$ 247,000
• Site Security Fence Replacement	20,200
PRESENT WORTH OF REPLACEMENT COSTS	$ 267,200
OPERATING AND MAINTENANCE (O&M) COSTS (For 30-Year Period)	
• Water Treatment O&M	$ 1,335,000
• Groundwater and Sediment Monitoring Program	659,600
• Site Security	72,250
• Cap Maintenance	18,500
• 5-Year Review - Public Meetings	38,950
PRESENT WORTH OF O&M COSTS	$ 2,124,300
PRESENT WORTH OF ALTERNATIVE	$51,308,000

Note: Additional cost details are located in:
- Table 10-3 for Alternative SC-2.
- Table 10-4 for Alternative SC-3.
- Table 10-10 for Alternative SC-7.
- Table 11-4 for Alternative MM-3.

FIGURE 12-11: ALT. SA-6
TOTAL PRESENT WORTH: $51,308,000

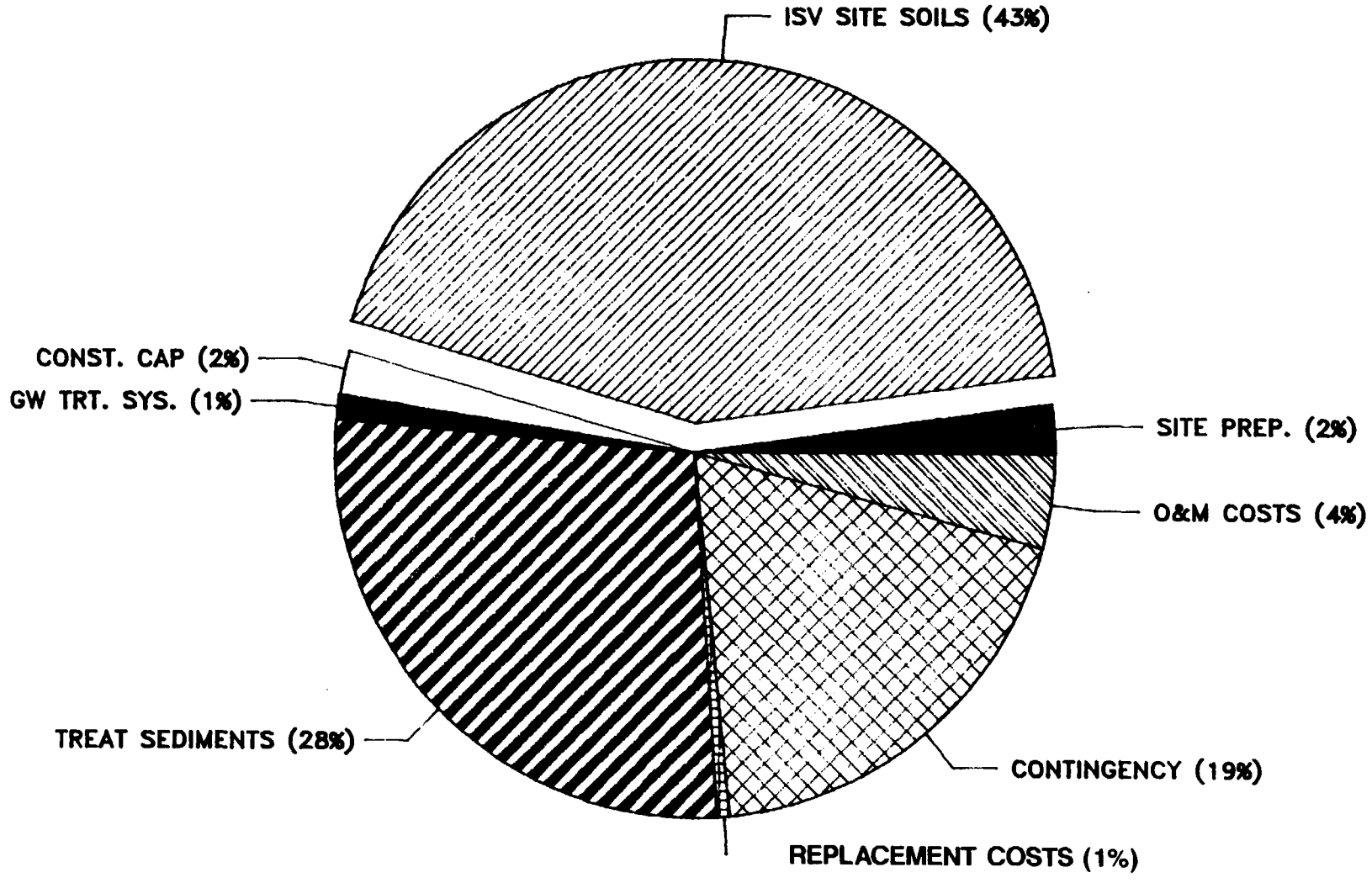


FIGURE 12-12: ALT. SA6 Cost Sensitivity

UNCERTAINTY OF CONTAMINATED SOIL VOLUME

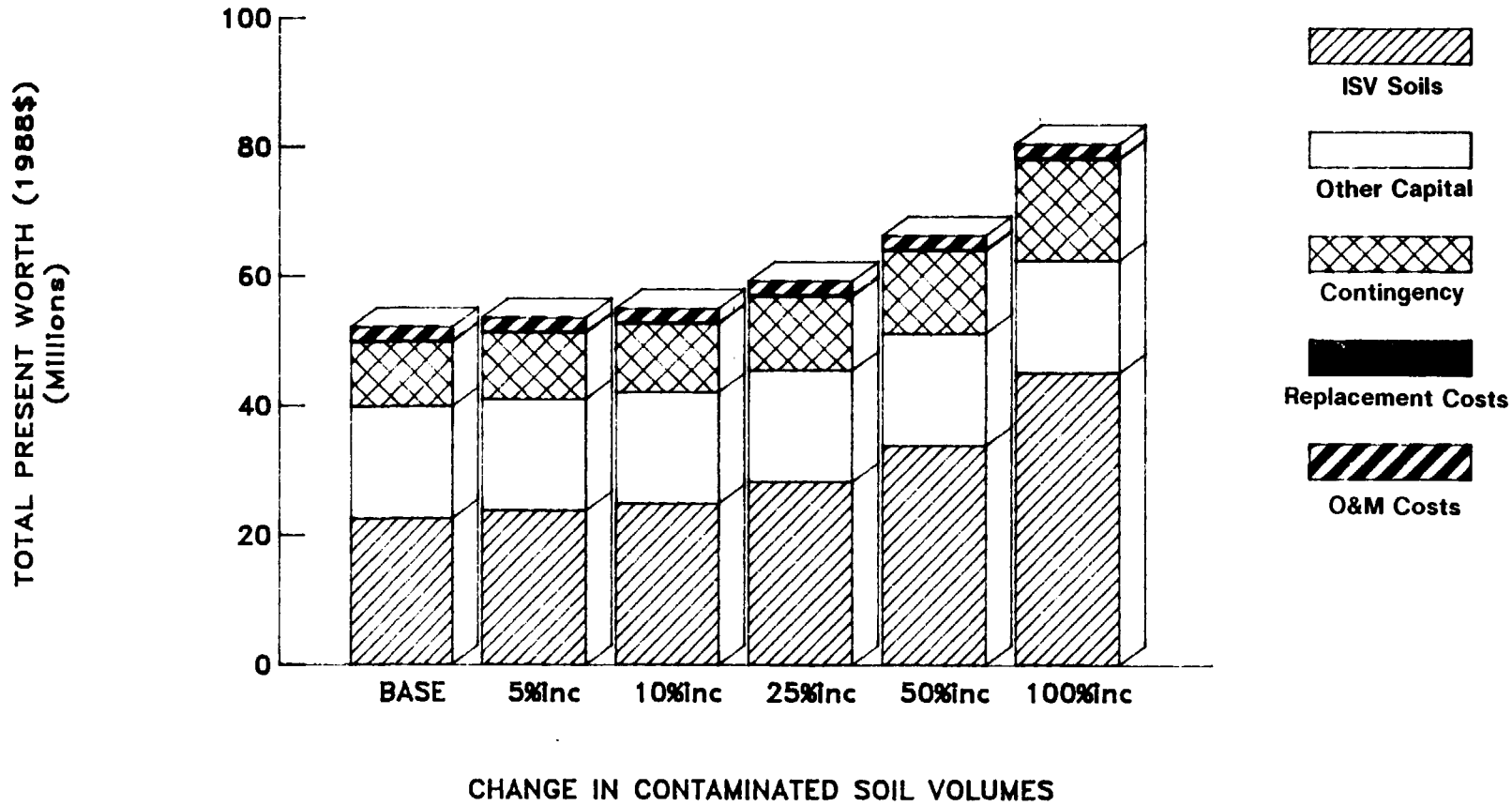
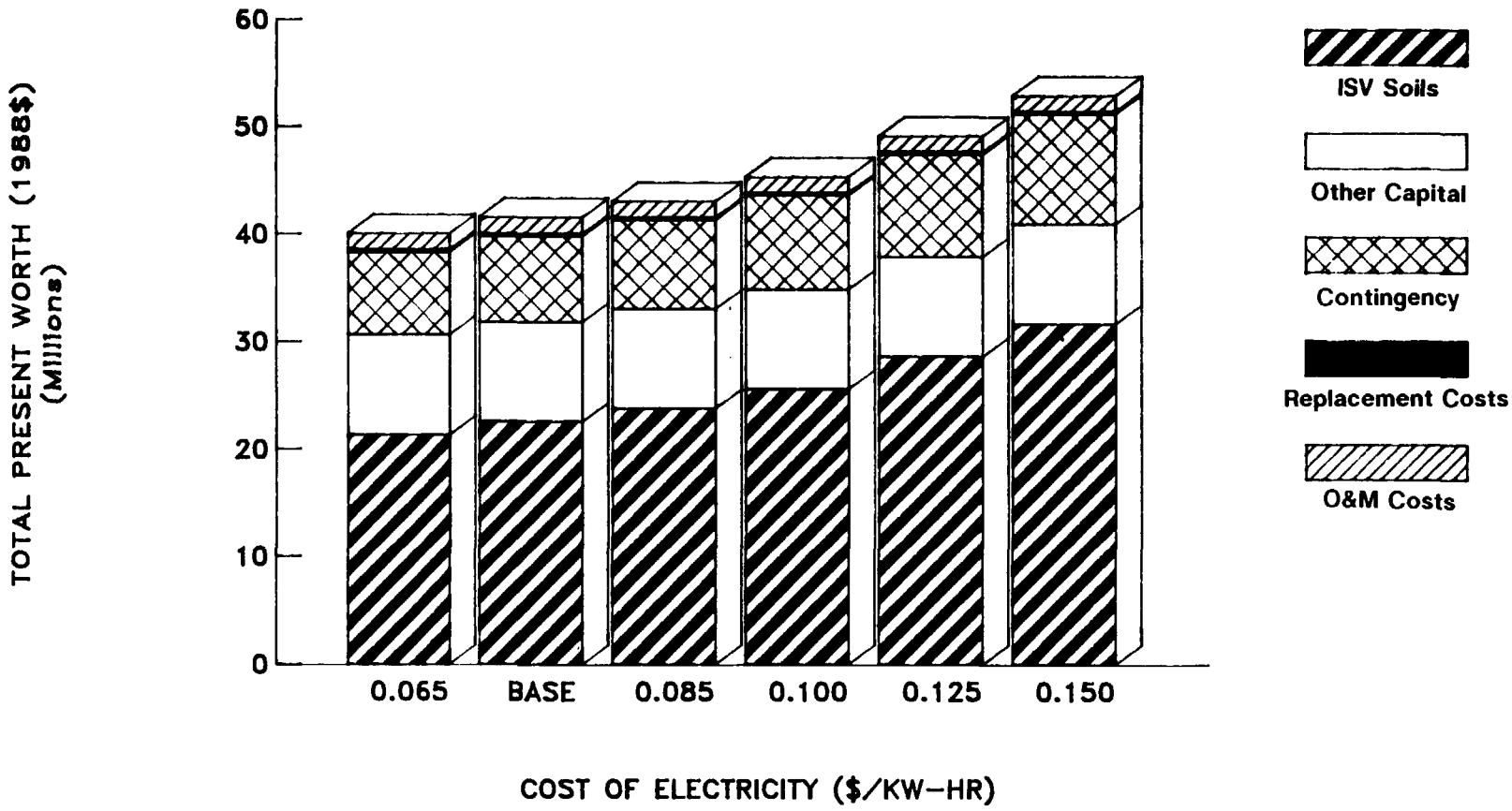


FIGURE 12-13: ALT. SA6 Cost Sensitivity

EFFECTS OF ELECTRIC RATES ON COST



using changes in electrical costs as the variable. The results indicate that a doubling of power costs from $0.075 to $0.150 per kilowatt hour would result in an overall cost increase of about $10 million. Effects on costs due to changes in electric rates are not as substantial as those due to soil volume changes. However, a combination of the two could be significant.

12.8 ALTERNATIVE SA-7

This alternative has treatment as its principal element for site soils; sediments in the unnamed stream, Middle Marsh, water hazards, and Apponagansett Swamp South; and on-site bedrock groundwater (less than 150 feet). Solidification would be used for both the soils and sediments and the solidified material would serve as the base for the multi-layer cap. Soils would be treated to 10^{-6}, the unnamed stream and Water Hazards 1 and 2 to mean value SQCs, and the Middle Marsh and Apponagansett Swamp to upper value SQCs. A groundwater extraction system would pump on-site contaminated groundwater from deep bedrock wells immediately downgradient of the pits. Pumped water would be treated by UV/ozonation.

Site activities would be as follows:

- set up construction trailers, offices, utilities
- clear and grub site; clear and grub Middle Marsh
- relocate unnamed stream, construct concrete-lined channel
- construct on-site sedimentation pond and off-site haul roads
- excavate and solidify on-site soils, initiate construction of groundwater treatment plant
- excavate and solidify sediments
- construct impermeable cap, reconstruct wetlands
- install wells with associated piping
- topsoil and vegetate cap area
- complete groundwater treatment plant construction and fence area

The time required to complete implementation and remediation using this alternative would be approximately three years. The mobility of soil and sedimentary contaminants would be reduced

by solidification and subsequent placement under a site cap. UV/ozonation is a permanent destruction technology and would significantly reduce the contaminant levels in the collected groundwater. This alternative would be effective in hydraulically controlling the groundwater in the area near the quarry pits as long as the extraction system remains operational. As with the other alternatives, institutional controls will be needed to regulate private well installation within specified radius of the site.

For cost purposes, it is assumed that the active collection system will be operated for a period of 30 years with routine groundwater monitoring to document its effectiveness. Approximately five pit volumes of water will be flushed through the pits during the 30-year period.

When revegetated, the site will be an open grassed area.

12.8.1 Evaluation Summary

Table 12-14 contains a summary of the 9-criteria evaluation for alternative SA-7.

12.8.2 Cost Summary

Alternative SA-7 combines solidification of contaminated soils and sediments with active groundwater extraction and treatment. Total capital costs are about $15,200,000 (Table 12-15). These include costs for site preparation, solidification and on-site disposal of soils and sediments, wetlands restoration, cap construction, and construction of a groundwater pump and treat system. Twenty-five percent of capital is added as a contingency factor. Replacement of the groundwater treatment system, submersible pumps, and monitoring wells will need to take place in Year 15. The present worth of these replacement costs is $367,200. The present worth of operating/maintenance costs for the 30-year period is $2,507,600. These include costs for water treatment, operating/maintenance, extraction system operation, and a groundwater and sediment monitoring program.

Figure 12-14 is a graphic representation of costs for Alternative SA-7. The largest component of the total costs is that which is associated with the solidification of contaminated site soils. As noted earlier, the uncertainty associated with the calculations of soil volumes is of greatest interest for cost-sensitivity analysis. The results of the cost-sensitivity analysis are presented in Figure 12-15. A doubling of soil volumes would increase overall alternative costs from $18.1 to approximately $25 million.

TABLE 12-14

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-7
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
1. Short-term Effectiveness	
• Time until implementation is achieved	Remedial completion time is estimated at 3 years. Component time requirements are as follows: - 1 year for site preparation, lining the unnamed stream - 1 year to solidify soils and sediments - 1 year for capping and installation of the extraction and treatment system
• Protection of community during remedial action	Dust control measures, emissions control equipment, and atmospheric dispersion would prevent airborne contaminant concentrations from impacting public health.
• Protection of workers during remedial action	A 40-hour health and safety training course would be required of all workers. Personal protective equipment would be needed to prevent dermal or inhalation exposure during excavation, solidification, well installation, and capping operations.
• Environmental impacts	Minimal air quality impacts can be expected during excavation, solidification, and capping due to airborne dust particles and volatilized organics. Sediment removal would impact Middle Marsh but restoration is proposed. Excavation and construction activities in the unnamed stream would cause resuspension and transport of PCB sediments, which may impact downstream biota. Mitigative measures are therefore proposed.
2. Long-term Effectiveness and Performance	
• Magnitude of residual risks	Contaminated groundwater would continue to migrate in bedrock fracture zones. Soil risks would be reduced to 10^{-6} and sediment risks would be reduced to levels protective of aquatic biota.

TABLE 12-14 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-7
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
• Adequacy of controls	Capping in conjunction with solidification would effectively immobilize contaminated sediments and soils. Groundwater extraction and treatment would treat the contaminant plume, but would not stop migration within bedrock fractures. Institutional controls would still be necessary to protect downgradient receptors from groundwater exposure.
• Reliability of controls	The cap should remain effective for 30 years or more, provided that maintenance is performed as scheduled. Groundwater extraction pumps are likely to require replacement every few years and major groundwater treatment components (e.g., UV/ozone reactor) would require replacement once during the 30-year treatment period. Daily operation checks and routine maintenance would be necessary to maintain treatment efficiency. In order to be effective, institutional controls would require strict adherence and enforcement.
3. Reduction of Toxicity, Mobility, and Volume	Solidification would reduce the mobility of 68,250 cubic yards of contaminated soils and 17,300 cubic yards of PCB sediments. Groundwater extraction and treatment would reduce the toxicity and volume of the contaminant plume by 30-60 gpm, and mobility of the plume would be constrained by pumping.
4. Implementability	
• Technical feasibility	Solidification and groundwater treatment would not require further technical development, but would require bench-scale testing to determine design parameters. Further characterization of the hydrogeology of the site would be required to properly position extraction wells. Solidification would require specialized equipment and the procurement of an estimated 40,000 tons of a cementitious admixture (e.g., Portland cement).

TABLE 12-14 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-7
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
• Administrative feasibility	Construction activities would have to be coordinated with the City of New Bedford to obtain rights-of-way to the golf course. Institutional controls to regulate well installation would need to be implemented with state and city officials.
• Availability of service and materials	Construction requirements can be contracted locally. Solidification equipment and specialists can be contracted through numerous vendors. Groundwater extraction and treatment equipment are readily available within the wastewater treatment industry.
5. Cost	Present worth of alternative = $18,115,900 (See Table 12-15).
6. Compliance with ARARs	Restoration of Middle Marsh would have to be performed to meet wetlands protection ARARs. SDWA and Massachusetts Drinking Water Standards would not be attained in bedrock fracture zones. A waiver may be justifiable due to technical impracticability.
7. Overall Protection of Human Health and the Environment	Solidification of soils and sediments with capping would mitigate risks to human receptors and aquatic biota. Groundwater extraction and treatment would contain shallow bedrock contamination, but contaminants in bedrock fractures would remain a potential future risk. Institutional controls (e.g., alternate drinking water supplies, well installation restrictions) would attempt to control the remaining groundwater risk.
8. State Acceptance	The state is in favor of this alternative because it incorporates pumping and treating of the bedrock groundwater.

TABLE 12-14 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-7
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
9. Community Acceptance	To be addressed following the public comment period.

TABLE 12-15

COST SUMMARY TABLE
ALTERNATIVE SA-7
TREATMENT AS A PRINCIPAL ELEMENT
SOURCE CONTAINMENT
ACTIVE GROUNDWATER CONTROLS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CAPITAL COSTS	
• Site Preparation	$ 1,403,300
• Excavation, Screening, Solidification, and On-site Disposal of All Soils to 10^{-6} Target Level (68,250 Cubic Yards)	5,031,000
• Excavation, Dewatering, Solidification, and On-site Disposal of Sediments from Unnamed Stream, Water Hazards 1 and 2, Middle Marsh, and Apponagansett Swamp South (Estimated 17,300 cy)	2,160,000
• Wetlands Restoration	1,750,000
• Cap Construction	968,900
• Groundwater Extraction System Construction	501,500
• Water Treatment System (oxidation/filtration - iron removal) (UV/ozonation - organic removal)	378,200
• Contingency (25%)	3,048,200
TOTAL CAPITAL COSTS	$15,241,100
EQUIPMENT REPLACEMENT COSTS	PRESENT WORTH
• Treatment System, Submersible Pumps, Monitoring Wells, and Sampling Equipment Replacement (see Table 11-6)	$ 347,000
• Site Security Fence Replacement	20,200
PRESENT WORTH OF REPLACEMENT COSTS	$ 367,200
OPERATING AND MAINTENANCE (O&M) COSTS (For 30 Year Period)	
• Water Treatment O&M	$ 1,560,000
• Extraction System O&M	158,300
• Groundwater and Sediment Monitoring Program	659,600
• Site Security	72,250
• Cap Maintenance	18,500
• 5-Year Review - Public Meetings	38,950
PRESENT WORTH OF O&M COSTS	$ 2,507,600
PRESENT WORTH OF ALTERNATIVE	$18,115,900

Note: Additional cost details are located in:
- Table 10-3 for Alternative SC-2.
- Table 10-6 for Alternative SC-4.
- Table 10-10 for Alternative SC-7.
- Table 11-6 for Alternative MM-5.

FIGURE 12-14: ALT. SA-7
TOTAL PRESENT WORTH: $18,116,000

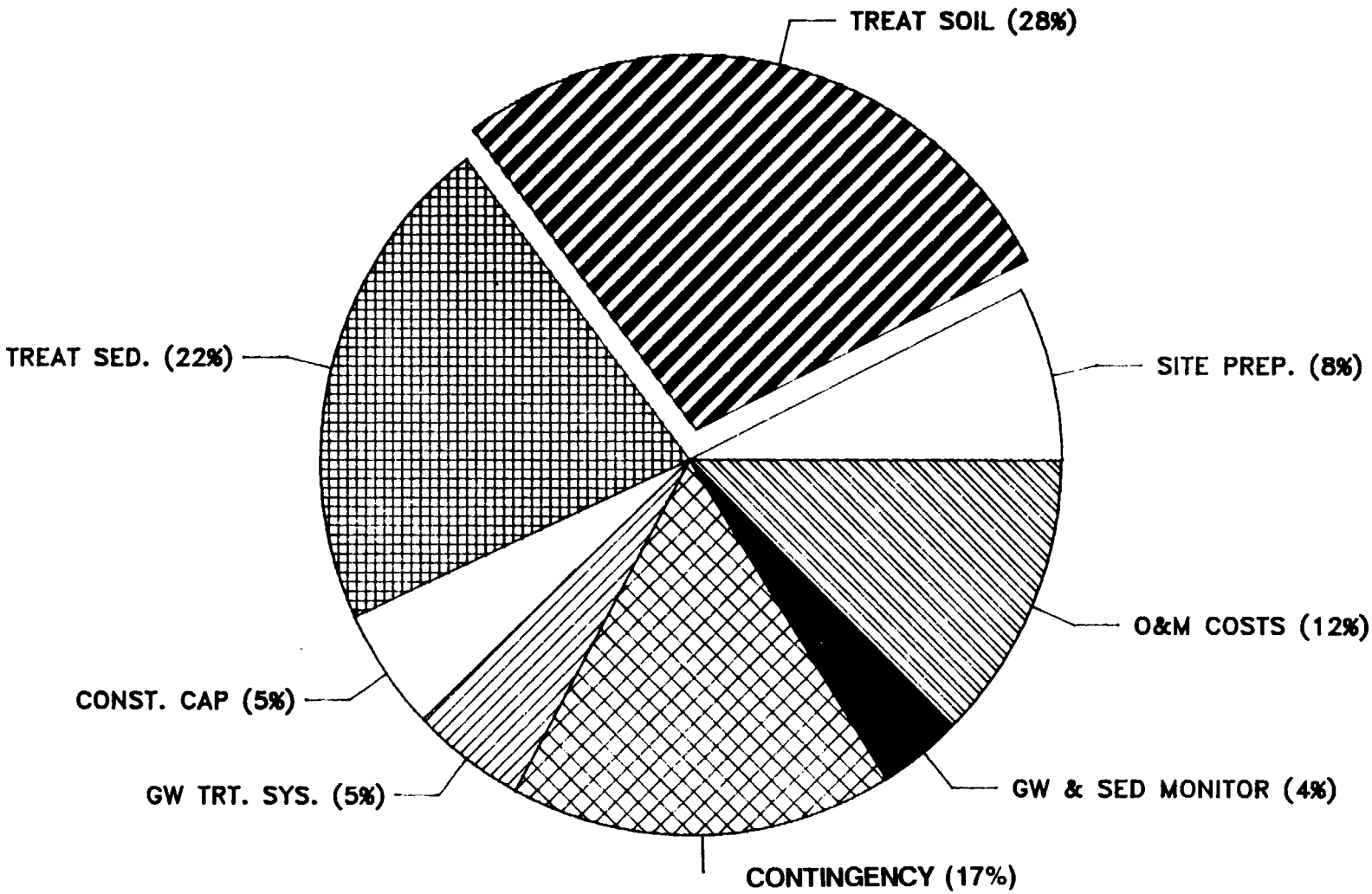
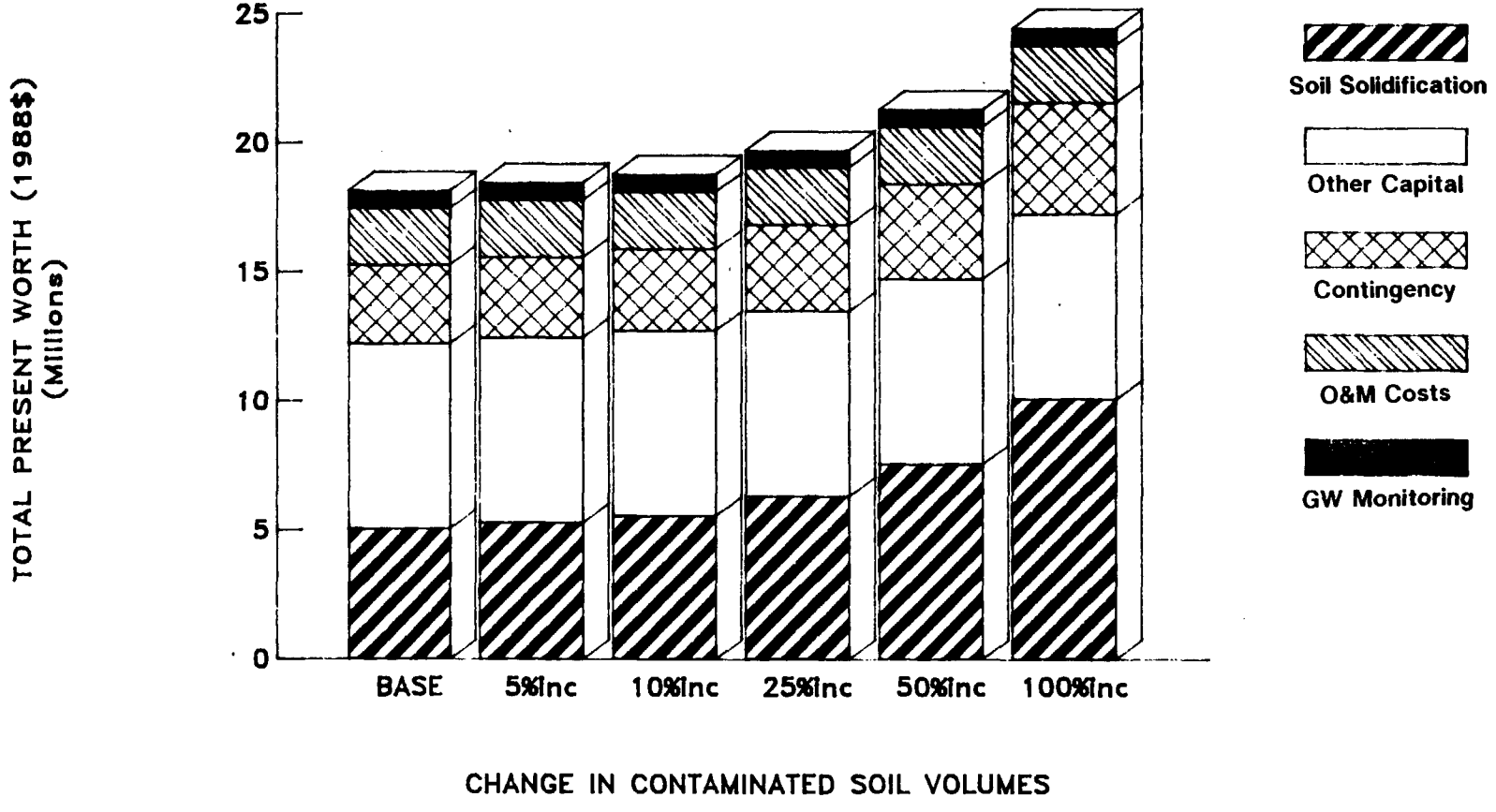


FIGURE 12–15: ALT. SA7 Cost Sensitivity

UNCERTAINTY OF CONTAMINATED SOIL VOLUME



12.9 ALTERNATIVE SA-8

This alternative has treatment as its principal element for site soils to 10^{-6}, sediments to lower value SQCs, and the on-site bedrock groundwater (less than 150 feet). This alternative permanently treats the soils and sediments by incineration, and site groundwater by UV/Ozonation.

Site activities would proceed as follows:

- set up construction trailer, offices, utilities
- clear and grub site, Middle Marsh, and Apponagansett Swamp
- relocate the unnamed stream, construct concrete-lined channel
- construct on-site sedimentation pond and off-site haul roads
- excavate and incinerate on-site soils; initiate construction of groundwater treatment plant
- excavate and incinerate sediments
- construct impermeable cap, reconstruct wetlands
- install on- and off-site extraction wells with associated piping
- topsoil and vegetate cap area
- complete groundwater treatment plant and fence area

The time required to complete remediation with this alternative is approximately seven years. This alternative complies with SARA's preference for permanent treatment; soils, sediments, and groundwater are permanently treated by this alternative. Incineration and UV/Ozonation are destruction technologies and will significantly reduce the mobility, toxicity, and volume of contaminated material. This alternative will be effective in hydraulically controlling the site groundwater and treating the groundwater within the site area as long as the extraction system remains operational. As with the other alternatives, institutional controls will be needed to regulate private well installation.

For cost purposes, it is assumed that the active collection system will be operated for a period of 30 years with routine monitoring to determine the well system's effectiveness. The site, when revegetated, will be an open grassed area. This

alternative is consistent with a projected future use of the site (i.e., soccer field).

12.9.1 Evaluation Summary

A summary of the 9-criteria evaluation for SA-8 is located in Table 12-16.

12.9.2 Cost Summary

The last alternative, SA-8, provides incineration of all contaminated soil to 10^{-6} and PCB-contaminated sediments to lower value SQCs and includes the use of a groundwater extraction and treatment system. Table 12-17 summarizes the costs for this alternative. Total capital costs for this alternative are $85.1 million. Capital costs include costs associated with site preparation, incineration of contaminated site soils, incineration of PCB-contaminated sediments, construction of the site cap, restoration of wetlands, construction of the groundwater extraction and treatment system, and a 25-percent contingency. Replacement of the treatment system, pumps, and monitoring wells will be required. These costs total $367,200. The present worth of the operating/maintenance costs, which include pump and treat operating/maintenance, is $2.5 million. The total present worth of the alternative is $88 million. These costs make this alternative the most expensive. It is more than one and a half times the cost of Alternative SA-6, which is the next most costly alternative.

Figure 12-16 provides a graphic representation of the costs for Alternative SA-8. Incineration of soil and sediment and related contingency contribute to nearly 92 percent of the overall alternative cost. A cost-sensitivity analysis using changes in contaminated soil volumes as the key variable was performed. The results, contained in Figure 12-17, indicate that if a 100-percent increase in soil volume is realized, the total present worth of the alternative will increase from $88 to nearly $120 million.

12.10 COMPARATIVE ANALYSIS OF ALTERNATIVES

A comparative analysis was performed to evaluate the relative performance of each alternative in relation to each of the evaluation criterion. The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that the key trade-offs can be identified. The comparative analysis is presented for each criterion in the following subsections. This comparative analysis serves as a summary for the detailed evaluation of alternatives.

TABLE 12-16

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-8
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
1. Short-term Effectiveness	
• Time until implementation is achieved	Remedial completion time is estimated at 7 years. Component time requirements are as follows: - 1 year for site preparation, installation of the groundwater extraction system, construction of the groundwater treatment system, and lining of the unnamed stream - 6 years for incineration of soils and sediments
• Protection of community during remedial action	Dust control measures, emissions control equipment, and atmospheres dispersion would prevent airborne contaminant concentrations from impacting public health.
• Protection of workers during remedial action	A 40-hour health and safety training course would be required of all workers. Personal protective equipment would be needed to prevent dermal or inhalation exposure during excavation, incineration, well installation, and capping operations.
• Environmental impacts	Minimal air quality impacts can be expected during excavation, handling, and incineration of soils. Incinerator emissions would be treated prior to atmospheric release. Sediment removal would impact Middle Marsh and Apponagansett Swamp but restoration is proposed. Excavation and construction activities in the unnamed stream would cause resuspension and transport of PCB sediments which may impact downstream biota. Therefore, mitigative measures are proposed.
2. Long-term Effectiveness and Permanence	
• Magnitude of residual risks	Contaminated groundwater would continue to migrate in bedrock fracture zones. Soil risks would be reduced to 10^{-6} and sediment risks to SQCs.

TABLE 12-16 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-8
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
• Adequacy of controls	Incineration would permanently destroy soil and sediment organics. Groundwater extraction and treatment would effectively draw back the contaminant plume, but would not stop migration of contaminants within bedrock fractures. Institutional controls would still be necessary.
• Reliability of controls	The cap should effectively reduce precipitation infiltration and prevent exposure to ash and untreated soils for 30 years or more provided that maintenance is performed as scheduled. Pumps are likely to require replacement every few years and major groundwater treatment equipment components (e.g., UV/ozone reactor); once during the 30-year treatment period. Daily operation checks and routine maintenance would be necessary to maintain treatment efficiency. In order to be effective, institutional controls would require strict adherence and enforcement.
3. Reduction of Toxicity, Mobility, and Volume	Incineration would permanently reduce the toxicity and mobility of 68,250 cubic yards of contaminated soils and 17,300 cubic yards of PCB sediments. Groundwater extraction and treatment would reduce the toxicity and volume of the contaminant plume by 30-60 gpm gpd, and mobility of the plume would be constrained by pumping.
4. Implementability	
• Technical feasibility	Incineration would require the mobilization of specialized equipment and would require trial burn testing to determine operating parameters. Groundwater treatment would require bench-scale testing to determine design parameters. Further characterization of the site may be required to properly position extraction wells.

TABLE 12-16 (continued)

EVALUATION CRITERIA SUMMARY
SITE ALTERNATIVE SA-8
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CRITERIA	ASSESSMENT
• Administrative feasibility	Construction activities would have to be coordinated with the City of New Bedford to obtain rights-of-way to the golf course. Institutional controls to regulate well installation would need to be implemented with state and city officials.
• Availability of services and materials	Construction requirements can be contracted locally. Incineration equipment and specialists can be contracted through a number of vendors (e.g., Roy F. Weston, ENSCO, IT Corp, C-E Raymond). Groundwater extraction and treatment equipment are readily available within the wastewater treatment industry.
5. Cost	Present worth of alternative = $87,989,700 (See Table 12-17).
6. Compliance with ARARs	Restoration of Middle Marsh and Apponagansett Swamp would have to be performed to meet wetlands protection ARARs. SDWA and Massachusetts Drinking Water Standards would not be attained in bedrock fracture zones. A waiver may be justifiable due to technical impracticability. The incinerator would be equipped with emissions controls to comply with the Clean Air Act and DEQE Air Quality Standards.
7. Overall Protection of Human Health and the Environment	Incineration of soils and sediment would permanently mitigate risks to human health and aquatic biota. Groundwater treatment would lower the water table, thereby shutting off seeps and eliminating surface water contamination. The cap could be used for limited recreational use (e.g., soccer field) as residual soil risks would be less than 10^{-6}.
8. State Acceptance	The state supports this alternative because it provides a form of permanent treatment for the site soils and bedrock groundwater.
9. Community Acceptance	To be addressed following the public comment period.

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TABLE 12-17

COST SUMMARY TABLE
ALTERNATIVE SA-8
TREATMENT AS A PRINCIPAL ELEMENT
SOURCE CONTAINMENT
ACTIVE GROUNDWATER CONTROLS
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

CAPITAL COSTS	
• Site Preparation	$ 1,403,300
• Excavation, Screening Incineration, and On-site Disposal of All Soils to 10^{-6} Target Level (68,250 Cubic Yards)	24,630,000
• Excavation, Dewatering, Incineration, and On-Site Disposal of Contaminated Sediments (67,300 Cubic Yards)	33,210,000
• Wetlands Restoration	7,000,000
• Cap Construction	968,900
• Groundwater Extraction System Construction	501,500
• Water Treatment System (oxidation/filtration - iron removal) (UV/ozonation - organic removal)	378,200
• Contingency (25%)	17,023,000
TOTAL CAPITAL COSTS	$85,114,900
EQUIPMENT REPLACEMENT COSTS	PRESENT WORTH
• Treatment System, Submersible Pumps, Monitoring Wells, and Sampling Equipment Replacement (see Table 11-6)	$ 347,000
• Site Security Fence Replacement	20,200
PRESENT WORTH OF REPLACEMENT COSTS	$ 367,200
OPERATING AND MAINTENANCE (O&M) COSTS (For 30 Year Period)	
• Water Treatment O&M	$ 1,560,000
• Extractions System O&M	158,300
• Groundwater and Sediment Monitoring Program	659,600
• Site Security	72,250
• Cap Maintenance	18,500
• 5-Year Review - Public Meetings	38,950
PRESENT WORTH OF O&M COSTS	$ 2,507,600
PRESENT WORTH OF ALTERNATIVE	$87,989,700

Note: Additional cost details are located in:
- Table 10-3 for Alternative SC-2.
- Table 10-7 for Alternative SC-5.
- Table 10-9 for Alternative SC-6.
- Table 11-6 for Alternative MM-5.

FIGURE 12-16: ALT. SA-8
TOTAL PRESENT WORTH: $87,990,000

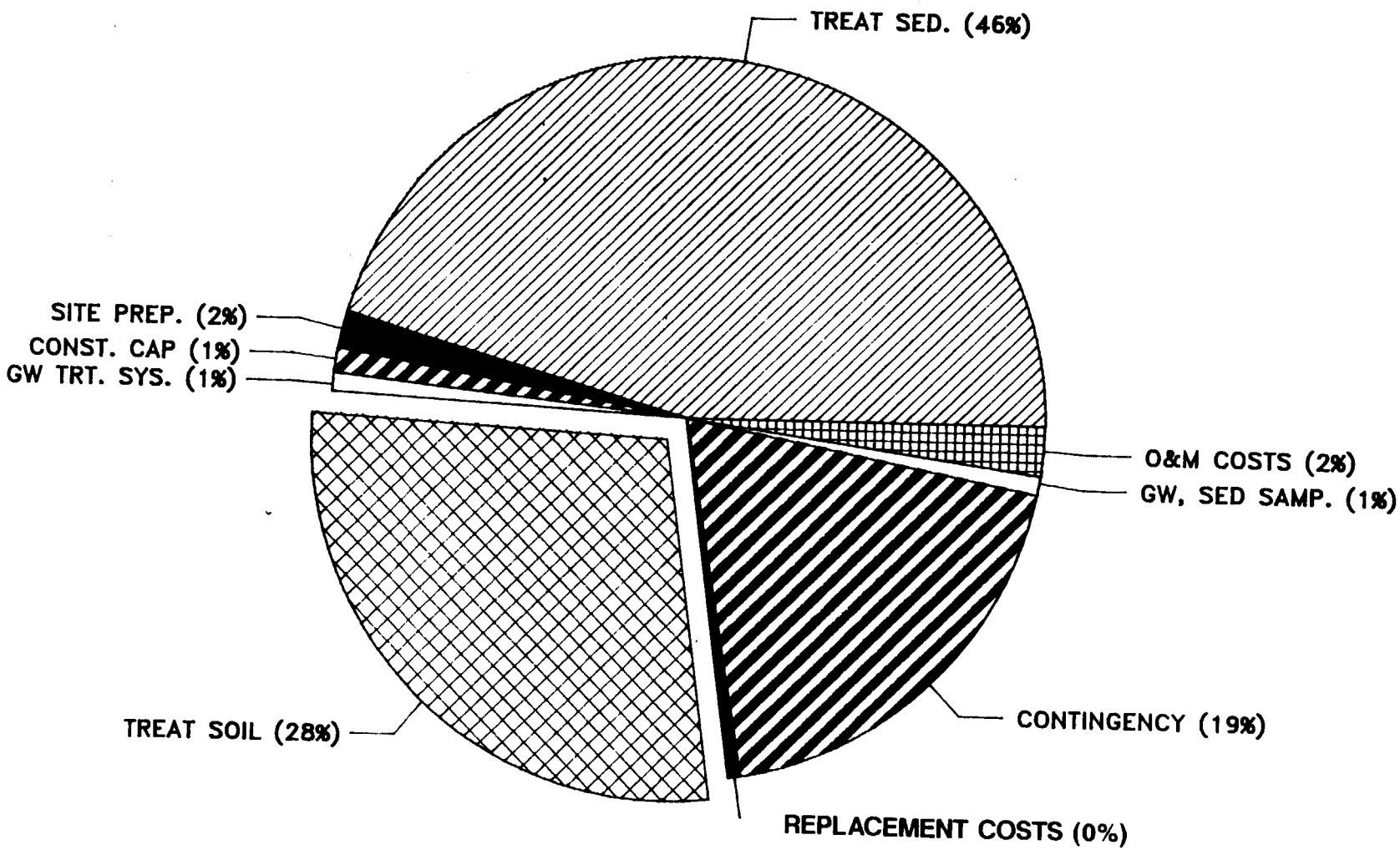
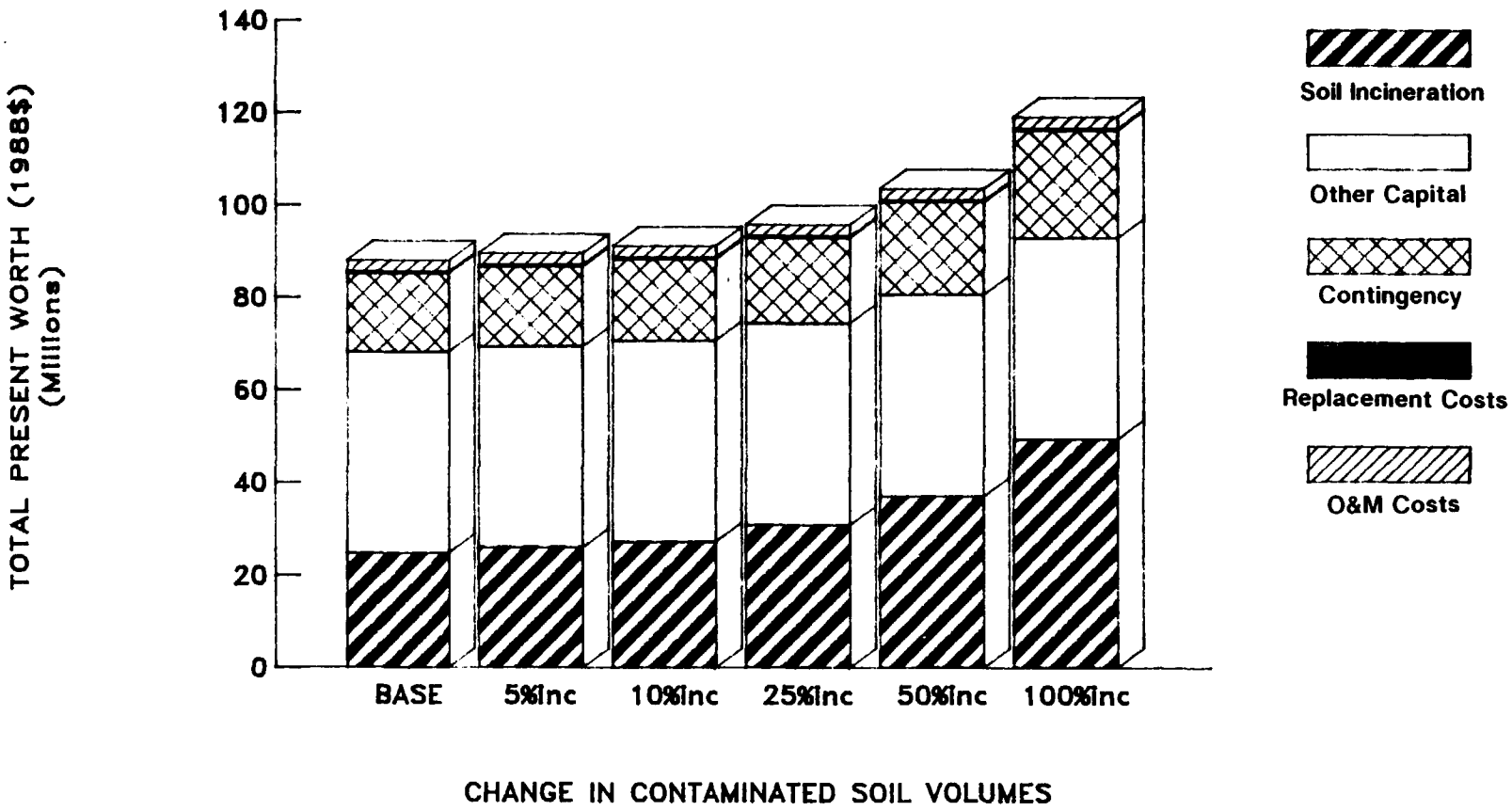


FIGURE 12-17: ALT. SA8 Cost Sensitivity

UNCERTAINTY OF CONTAMINATED SOIL VOLUME



12.10.1 Short-term Effectiveness

Each alternative would be equally effective at protecting the community during remedial actions. Alternative SA-6 would pose the greatest risks to workers because ISV inherently poses more opportunities for accident occurrence due to the high voltage used, the temperature of the melt, and the production of off-gases. Alternative SA-8 poses similar risks to workers because incineration utilizes high operating temperatures.

SA-2 and SA-3 have the best overall short-term effectiveness. Neither would create adverse environmental impacts during construction and both would mitigate the greatest and most likely human health risks (i.e., via dermal contact with surface soils) in the most timely manner, although environmental risks would not be mitigated.

SA-2, SA-3, SA-4, and SA-5 have implementation times of 2 to 3 years, while SA-7 and SA-8 have implementation times of 4 and 7 years, respectively.

SA-1, the no-action alternative, has no short-term effectiveness, in that it involves no initial construction activities.

12.10.2 Long-term Effectiveness and Permanence

Each site alternative provides about the same degree of long-term effectiveness for groundwater (except no-action), in that groundwater seeps to the unnamed stream would be mitigated and contaminant migration within bedrock fractures would continue. Neither passive nor active collection would restore the overburden or bedrock aquifer to a drinkable quality, although the active system would attempt to remove and treat groundwater in and adjacent to quarry pits.

Alternative SA-8 provides the best long-term effectiveness, in that incineration would permanently mitigate contaminated surface soils and sediments without producing potentially hazardous residuals. Alternative SA-6 is similar in long-term effectiveness to Alternative SA-8, in that surface soils would be permanently mitigated, but sediments would not. Solidification of sediments would immobilize PCBs; however, treatment is not proven to be permanent.

Alternatives SA-4, SA-5, and SA-7 each involve solidification as the principal element and, therefore, have similar long-term effectiveness. SA-7 is the best of the three, in that soils would be mitigated to a residual risk of 10^{-6} (versus 10^{-5} for SA-5) and off-site sediments to SQCs, whereas SA-4 and SA-5 would leave Middle Marsh and Apponagansett Swamp South untreated.

Alternatives SA-2 and SA-3 have the least long-term effectiveness in that they contain no SC treatment component. They both rely on a cap to contain site soils, which would control risks for 30 years or more, but is more susceptible to failure than treatment alternatives.

Alternative SA-1, the no-action alternative, has minimal long-term effectiveness.

12.10.3 Reduction of Toxicity, Mobility, and Volume

Each of the site alternatives developed accomplishes some level of reduction in the toxicity, mobility, or volume of site contaminants. The extent of reduction will be summarized in this subsection.

Alternative SA-8 provides the greatest reduction in toxicity, mobility, and volume of site contaminants. Soil and sediment contamination is permanently destroyed by incineration and contaminants in on-site groundwater (less than 150 feet) are permanently destroyed by UV/ozonation. UV/ozonation is an innovative technology and, coupled with the metal removal step, is believed to be feasible for treating site groundwater.

Alternatives SA-5 and SA-7 have the same permanent destruction for on-site groundwater; however, permanent reduction is only achieved for mobility of soils and sediments. The treatment process (i.e., solidification) for soils and sediments does not reduce the volume or toxicity of contaminated material, but rather increases the volume due to the addition of the solidifying agent.

Permanent reduction of toxicity, mobility, and volume is accomplished for site soils in Alternative SA-6 by the innovative technology, ISV. Solidification of sediments reduces mobility and increases volume. In this alternative, the overburden groundwater is treated by UV/ozonation; however, the majority of the groundwater is untreated and there is no reduction in mobility, toxicity, or volume of contaminated bedrock groundwater.

Alternatives SA-2 and SA-4 are almost identical for this criteria. As in SA-6, overburden and shallow bedrock groundwater is treated by UV/ozonation and, therefore, permanent reduction in toxicity, mobility, and volume occurs for overburden contaminants. Bedrock groundwater is untreated. Both alternatives reduce the mobility of soil and sediment contaminants by placing these materials beneath a multi-layer cap. Alternative SA-4 accomplishes additional mobility reduction for portions of the soils and sediments by solidifying these materials prior to placement beneath the cap.

Alternative SA-3 accomplishes permanent destruction of on-site groundwater (less than 150 feet) by utilizing the innovative technology UV/ozonation. Mobility of soil contaminants is reduced by the installation of a multi-layer cap. There is no reduction in the toxicity, mobility, or volume of PCB-contaminated sediments.

The no-action alternative (SA-1) does not accomplish reduction in mobility, toxicity, or volume for contaminants present in any of the environmental media.

12.10.4 Implementability

The SA-1 no-action alternative would be the simplest to implement because it would not involve further construction or treatment activities. Each remaining alternative contains capping and some sort of MM control; therefore, SA-2 and SA-3 would be the next simplest to implement since they have no SC component. Of the two, SA-2 would be more easily implemented since SA-3 requires a hydrogeological investigation, with other components (e.g., treatment system) being equal.

Among the alternatives having both a SC and a MM component, SA-4, SA-5, SA-7, and SA-8 are equally implementable. These alternatives would involve either solidification or incineration, both of which entail mobilization of specialized equipment. Both mobile solidifying units and transportable incineration systems are readily available through remediation vendors and could be contracted through standard bidding procedures.

SA-6 would be the most difficult to implement since only one vendor (i.e., BPNL) is available to supply required equipment and services. BPNL would have to fabricate an ISV unit, which would take approximately one year.

12.10.5 Costs

The costs for each of the eight site alternatives and the sensitivity of these costs to various assumptions has already been discussed previously in this section. The present worth of the site alternatives is summarized herein, from the least to the most expensive alternative.

Alternative SA-1	$ 1,186,400
Alternative SA-2	$ 5,063,400
Alternative SA-3	$ 5,827,300
Alternative SA-4	$ 8,285,500
Alternative SA-5	$ 10,047,500
Alternative SA-7	$ 18,115,900
Alternative SA-6	$ 51,308,000
Alternative SA-8	$ 87,989,700

12.10.6 Compliance with ARARs

Alternatives SA-5, SA-7, and SA-8 will comply with location- and most action-specific ARARs. Compliance with the equivalent treatment or disposal requirements of TSCA will need to be determined for Alternatives SA-5 and SA-7 because these alternatives utilize solidification instead of incineration. The time required to comply with chemical-specific ARARs is unknown for on-site groundwater and will need to be assessed with time. Chemical-specific ARARs will not be attained for off-site groundwater in some of the deep bedrock fractures. A technical infeasibility waiver for contaminated bedrock fracture groundwater may be justified for these alternatives. Compliance with location-specific ARARs for these alternatives depends on successful wetlands restoration. The wetlands ARARs, therefore, will not be attained immediately.

Alternatives SA-2, SA-4, and SA-6 will not meet chemical-specific ARARs because the majority of contaminated groundwater will remain untreated. A technical infeasibility waiver may be justified for these alternatives (see Section 11.3.7). SA-4 will comply with location- and action-specific ARARs. SA-6 will comply with action- specific ARARs. Compliance with location-specific ARARs will occur upon successful restoration of the wetland areas.

Alternative SA-3 will comply with location- and most action-specific ARARs. Compliance with chemical-specific ARARs for on-site groundwater will not be immediate and will need to be assessed with time. Chemical-specific ARARs will not be attained for contaminated groundwater located in the deep bedrock fractures. A technical infeasibility waiver may be justified for this water. Chemical-specific ARARs will not be attained for groundwater. Location-specific ARARs will not be attained for the wetland areas.

12.10.7 Overall Protection of Human Health and Environment

Alternative SA-8 is the most protective alternative, provided that the wetland areas in Middle Marsh and Apponagansett Swamp can be restored. In this alternative, all contaminated soils and sediments are treated, the wetlands are restored, the site is capped, and the groundwater within and adjacent to the pits is pumped and treated. This alternative reduces the risks associated with soils, sediments, and site groundwater. A potential future risk related to the contaminated bedrock fracture groundwater will still exist for this alternative and the other seven.

Alternative SA-7 provides soil and sediment treatment, wetlands restoration, site capping, and groundwater pumping within and adjacent to the pits and treatment. This alternative reduces the risks associated with soils, sediments, and site groundwater. The potential for a future risk, however, does exist because residuals (i.e., solidified soils and sediments) remain on-site.

Alternative SA-6 is the next alternative in decreasing order of protection. Risks associated with soils and sediments will be reduced. However, the on-site and deeper on-site and off-site groundwater will not be remediated. The potential future risks associated with the groundwater and residual soils (vitrified block) and sediments (solidified) remaining on-site will be assessed by annual sediment monitoring.

Alternative SA-3 provides containment of site soils and treats site groundwater. This alternative reduces existing risks associated with site soils and groundwater. Environmental risks associated with sediments are not mitigated. In addition, the potential for future risk for site soils still exists because the soils remain on-site, covered but untreated.

Alternatives SA-2, SA-4, and SA-5 differ with respect to soil and sediment treatment. In SA-4 and SA-5, some soils and sediments are solidified and placed below the cap, while in SA-2 only the soil is capped. For these alternatives, the potential for future risks exists for soils, sediments, and the deeper groundwater. The potential risks, however, for SA-4 and SA-5 are less for soils and sediments because solidification should prevent future erosion and/or leaching.

The no-action alternative (SA-1) is the least protective, and the risks identified in the baseline risk assessments (see Sections 6.2 and 6.3) are appropriate.

Floodplains/Wetlands Assessment. Alternative SA-1, the no-action alternative, has minimal impact to the floodplains of the unnamed stream, the Middle Marsh and Apponagansett Swamp wetlands areas. The reason for this is that no activity will occur in these areas under this alternative.

A component of alternatives SA-2 through SA-8 is the construction of a concrete-lined channel in the unnamed stream along the eastern site boundary. This channel will be constructed in the location of the existing stream channel. Water transport in this channel will be increased when compared to the natural channel due to the lowering of the Mannings Roughness Coefficient. Because of this, water ponding during flood conditions at the Hathaway Road culverts will increase the

floodplain in this area. The actual increase has not been calculated but is expected to be small. Any increase in the floodplain in this area can be mitigated by replacing the two existing undersized culverts under Hathaway Road with properly sized, larger diameter culverts.

Alternatives SA-4 through SA-8 involve excavation of sediments in one or all of the following areas; the unnamed stream, the Middle Marsh, water hazards 1 and 2, and the Apponagansett Swamp. Excavation of these sediments is not expected to change the flood storage capacity of the floodplain areas because the groundwater table in these areas is high and groundwater will replace the sediments after they are removed. Thus, the sediment removal component of these alternatives will not create additional water storage.

Alternatives SA-1 through SA-5 have minimal impact on the wetland areas because these areas would not be remediated under these alternatives. Alternatives SA-6 through SA-7 do remediate areas of the Middle Marsh and Apponagansett Swamp. There will be significant short-term impact to these wetlands areas as they will be removed during the remediation process. The long-term impact, however, is expected to be less significant because the wetlands will be restored following excavation.

The largest uncertainty in this wetlands assessment is the successful restoration of the wetlands. The alternatives involving excavation of Middle Marsh and Apponagansett Swamp must weigh the long-term benefits of excavating and treating contaminated sediments against protection of the existing contaminated wetlands.

12.10.8 State Acceptance

Comments received from the Commonwealth of Massachusetts on the draft FS report indicate that the State believes that the remedial action presented in Alternatives SA-5, SA-7, and SA-8 appear to be the only feasible alternatives with the maximum potential reduction of contamination in the surface soils, sediments, shallow groundwater, and deep bedrock groundwater. The State, however, has stated that even these alternatives are considered "temporary" solutions, as defined by the MCP, because of the potential presence of DNAPLs in the former quarry pits and bedrock fractures.

12.10.9 Community Acceptance

As stated in Sections 10.0 and 11.0, formal comments have not been received from the New Bedford community relating to

remedial alternatives for the Sullivan's Ledge site. Formal comments will be received following public meetings, and these comments will be incorporated into the responsiveness summary of the ROD.

12.10.10 Comparative Analysis Summary

Table 12-18 presents a summary of the comparative analysis of the site alternatives.

TABLE 12-18

COMPARISON OF REMEDIAL ALTERNATIVE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

SITE REMEDIAL ALTERNATIVE	SCREENING CRITERIA*		
	SHORT-TERM EFFECTIVENESS	LONG-TERM EFFECTIVENESS	REDUCTION OF TOXICITY, MOBILITY, OR VOLUME
Alternative SA-1: No Action	Minimal construction time. No change to environmental impacts.	Existing risks remain.	No reduction.
Alternative SA-2: Source Containment/Passive Groundwater Controls	Implementation period of 2 years. Minimal impacts to community, workers or environment.	Soil risks decreased by capping. Bedrock groundwater risks remain. Sediment environmental risks remain.	Reduced soil mobility. Reduced TMV of overburden groundwater.
Alternative SA-3: Source Containment/Active Groundwater Controls	Implementation period of 2 years. Minimal impacts to community, workers or environment.	Soil risks decreased by capping. On-site bedrock groundwater risks reduced. Sediment environmental risks remain.	Reduced soil mobility. Reduced TMV of overburden and shallow bedrock groundwater.
Alternative SA-4: Solidification of Soils, Sediments/Source Containment/Passive Groundwater Control	Implementation period of 2 to 3 years. Minimal impacts to community, workers. Potential environmental impact.	Soil and sediment risks reduced. Bedrock groundwater risks remain.	Reduced soil and sediment mobility. Reduced TMV of overburden groundwater.
Alternative SA-5: Solidification of Soils, Sediments/Source Containment/Active and Passive Groundwater Control	Implementation period of 2 to 3 years. Minimal impacts to community, workers. Significant short-term environmental impact.	Soil and sediment risks reduced. On-site bedrock groundwater risks reduced.	Reduced soil and sediment mobility. Reduced TMV of overburden and shallow bedrock groundwater.
Alternative SA-6: ISV Treatment of Soils, Solidification of Sediments/Passive Groundwater Control	Implementation period of 3 years. Minimal impacts to community. Potential impact to workers. Significant short-term environmental impact.	Soil and sediment risks reduced. Bedrock groundwater risks remain.	Reduced TMV of soils. Reduced mobility of sediments. Reduced TMV of overburden groundwater.
Alternative SA-7: Solidification of Soils, Sediments/Source Containment/Active Groundwater Controls	Implementation period of 3 years. Minimal impacts to community, workers. Significant short-term environmental impact.	Soil and sediment risks reduced. On-site bedrock groundwater risks reduced.	Reduced mobility of soils and sediments. Reduced TMV of overburden and shallow bedrock groundwater.
Alternative SA-8: Incineration of Soils, Sediments/Source Containment/Active Groundwater Controls	Implementation period of 7 years. Minimal impacts to community, workers. Significant short-term environmental impacts.	Soil and sediment risks reduced. On-site bedrock groundwater risks reduced.	Reduced TMV of soils and sediments. Reduced TMV of overburden and shallow bedrock groundwater.

* Community and state acceptance are not shown on this table because there were no differences between alternatives.

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TABLE 12-18 (continued)

COMPARISON OF REMEDIAL ALTERNATIVE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

SITE REMEDIAL ALTERNATIVE	SCREENING CRITERIA* IMPLEMENTABILITY	COST (PRESENT WORTH)	COMPLIANCE WITH ARARs	OVERALL PROTECTION
Alternative SA-1: No Action	No implementability constraints.	$1,186,440	Will not comply with chemical-specific ARARs for all groundwater.	Provides no additional protection to human health or environment.
Alternative SA-2: Source Containment/Passive Groundwater Controls	Minimal difficulties with implementability. Pilot scale tests required for groundwater treatment.	$5,063,400	Will not comply with chemical-specific ARARs for all bedrock groundwater. Compliance with location-specific ARARs.	Provides protection from soils and seeps.
Alternative SA-3: Source Containment/Active Groundwater Controls	Pump tests required. Pilot scale tests required for groundwater treatment.	$5,827,300	Will not comply with chemical-specific ARARs for deep fractured bedrock. Compliance with location-specific ARARS.	Provides protection from soils and seeps.
Alternative SA-4: Solidification of Soils, Sediments/Source Containment/Passive Groundwater Control	Bench scale tests for solidification. Pilot scale required for groundwater treatment.	$8,285,500	Will not comply with chemical-specific ARARs for all bedrock groundwater. Compliance with location- and action-specific ARARs.	Provides protection from soils, sediments, and seeps.
Alternative SA-5: Solidification of Soils, Sediments/Source Containment/Active and Passive Groundwater Control	Bench scale tests for solidification. Pump test required. Pilot scale required for groundwater treatment.	$1,047,500	Will not comply with chemical-specific ARARs for deep, fractured bedrock. Compliance with location- and action-specific ARARs.	Provides protection from soils, sediments, and seeps.
Alternative SA-6: ISV Treatment of Soils, Solidification of Sediments/Passive Groundwater Control	Innovative technology - full scale pilot tests required. Limited vendor equipment availability. Groundwater treatment pilot tests.	$51,308,000	Will not comply with chemical-specific ARARs in all bedrock groundwater. Compliance with location- and action-specific ARARs.	Provides long-term protection from soils, sediments, and seeps.
Alternative SA-7: Solidification of Soils, Sediments/Source Containment/Active Groundwater Controls	Solidification bench scale tests. Pump tests required. Groundwater treatment pilot tests.	$18,115,900	Will not comply with chemical-specific ARARs in all bedrock groundwater. Compliance with location- and action-specific ARARs.	Provides protection from soils, sediments, and seeps.

TABLE 12-18 (continued)

COMPARISON OF REMEDIAL ALTERNATIVE
SULLIVAN'S LEDGE SITE
NEW BEDFORD, MASSACHUSETTS

SITE REMEDIAL ALTERNATIVE	SCREENING CRITERIA* IMPLEMENTABILITY	COST (PRESENT WORTH)	COMPLIANCE WITH ARARs	OVERALL PROTECTION
Alternative SA-8: Incineration of Soils, Sediments/Source Containment/Active Groundwater Controls	Test burns required. Pump tests required. Groundwater treatment pilot tests.	$87,989,700	Will not comply with chemical-specific ARARs in all bedrock groundwater. Compliance with location- and action-specific ARARs.	Provides long-term protection from soils, sediments, and seeps.

* Alternatives SA-5, SA-7, and SA-8 are favored by the state because of the degree of treatment for the soils, sediments, and groundwater.

* Community acceptance is not shown on this table because there were no differences between alternatives at this time.

GLOSSARY OF ACRONYMS

GLOSSARY OF ACRONYMS

AALs	Ambient Air Levels
APEG	alkali polyethylene glycol
ARARs	Applicable or Relevant and Appropriate Requirements
ATV	Acoustic Televiewer
AWQC	Ambient Water Quality Criteria
BACT	Best Available Control Technology
BAP	benzo(a)pyrene
BCF	Bioconcentration Factors
BEHP	bis(2-ethylhexyl)phthalate
BOD	Biochemical Oxygen Demand
BPNL	Battelle Pacific Northwest Laboratories
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CN	Curve Numbers
COD	Chemical Oxygen Demand
CWA	Clean Water Act
cy	cubic yards
DEQE	Department of Environmental Quality Engineering (Massachusetts)
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DPW	Department of Public Works
DRE	Destruction and Removal Efficiency
DTC	Diversified Technologies Corporation
EPA	U.S. Environmental Protection Agency
EPM	Equivalent Porous Medium

GLOSSARY OF ACRONYMS
(continued)

FDA	Food and Drug Administration
FOP	Field Operations Plan
FS	Feasibility Study
GAC	Granular Activated Carbon
gpd	gallons per day
HASP	Health and Safety Plan
HELP	Hydrologic Evaluation of Landfill Performance
HI	Hazard Index
HSL	Hazardous Substance List
ISV	In-situ Vitrification
MATC	Maximum Acceptable Toxicant Concentration
MCLs	Maximum Contaminant Levels
MCLGs	Maximum Contaminant Level Goals
MDWPC	Massachusetts Department of Water Pollution Control
MGWQS	Massachusetts Groundwater Quality Standards
MM	Management of Migration
MSL	Mean Sea Level
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NUS	NUS Corporation
PAHs	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls
POTW	Publicly Owned Treatment Works
ppb	parts per billion
ppm	parts per million

GLOSSARY OF ACRONYMS
(continued)

QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RfD	Risk Reference Dose
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SC	Source Control
SCS	Soil Conservation Society
SDWA	Safe Drinking Water Act
SPR	Single Point Resistance
SQCs	Sediment Quality Criteria Values
SVOCs	Semivolatile Organic Compounds
SWDA	Solid Waste Disposal Act
TCE	trichloroethylene
TDS	Total Dissolved Solids
TIS	Transportable Incineration System
TLV	Threshold Limit Value
TOC	Total Organic Carbon
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
USLS	Universal Soil Loss Equation
UV	ultraviolet
VOCs	Volatile Organic Compounds
VSP	Vertical Seismic Profiling

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