FINAL

ACTION MEMORANDUM

SHEPLEY'S HILL LANDFILL BARRIER WALL

FORMER FORT DEVENS ARMY INSTALLATION, DEVENS, MA

JUNE 2012

Prepared for:
US Army Corp of Engineers
New England District
Concord, Massachusetts

Prepared by:
Sovereign Consulting Inc.
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SOVEREIGN CONSULTING INC.

NOTICE

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SHEPLEY'S HILL LANDFILL
BARRIER WALL
Action Memorandum

FINAL VERSION

Devens, Massachusetts

June 2012

CERTIFICATION:

I hereby certify that the enclosed Report, shown and marked in this submittal, is that proposed to be incorporated with Contract Number W912WJ-10-D-0003 Delivery Order 0002. This Document was prepared in accordance with USACE Scope of Work and is hereby submitted for Government Approval.

Reviewed By:

Sovereign Project Manager — Date 6/20/12

Sovereign Quality Control Manager — Date 6/20/12

Received By:

USACE Project Manager — Date 6/20/12

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

AMEC	AMEC Earth and Environmental, Inc.
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirements
ATP	Arsenic Treatment Plant
bgs	Below Ground Surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cys	Cubic Yards
DOD	Department of Defense
DERP	Defense Environmental Restoration Program
EE/CA	Engineering Evaluation/Cost Analysis
ESI	Expanded Site Investigation
Fort Devens	Former Fort Devens
FS	Feasibility Study
FSSR	Feasibility Study Screening Report
g/day	Grams per Day
MassDEP	Massachusetts Department of Environmental Protection
MassGIS	Massachusetts Geographic Information System
NCP	National Contingency Plan
NHESP	Natural Heritage Endangered Species Program
NTCRA	Non-Time-Critical Removal Action
NPL	National Priorities List
O&M	Operations and Maintenance
OU	Operable Unit
PAHs	Polycyclic Aromatic Hydrocarbons
PRB	Permeable Reactive Barrier
PVC	Polyvinyl Chloride
RAA	Removal Action Alternative
RAO	Removal Action Outcome
RI	Remedial Investigation
ROD	Record of Decision
SA	Study Area
SAR	Supplemental Addendum Report
SARA	Superfund Amendments and Reauthorization Act
SB	Soil-Bentonite
SHL	Shepley's Hill Landfill
Sovereign	Sovereign Consulting Inc.
TBC	To Be Considered
µg/L	Microgram per Liter
USEPA	U.S. Environmental Protection Agency
VOC(s)	Volatile Organic Compound(s)
ZVI	Zero-Valent Iron

1.0 PURPOSE

This Action Memorandum was prepared by Sovereign Consulting Inc. (Sovereign) on behalf of the Army in order to document the decision for the U.S. Army Corps of Engineers (USACE) to perform the Non-Time-Critical Removal Action (NTCRA) described herein for Shepley's Hill Landfill (SHL), located at the former Fort Devens Army Installation in Devens, Massachusetts

The NTCRA is being performed pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The site falls under CERCLA because of historical activities of the U.S. Department of Defense (DOD). Under CERCLA, the DOD is given lead agency responsibility for implementing appropriate investigations and removal actions where environmental impacts have or may have occurred from historical activities at DOD sites and where such releases may constitute a residual human health threat. Mitigating this site fits within the mission of the Defense Environmental Restoration Program (DERP).

The primary project goal of this NTCRA is to mitigate the arsenic-in-groundwater flux from SHL to Red Cove/Plow Shop Pond to reduce risk to environmental receptors consistent with local conditions in Plow Shop Pond by the installation of a slurry barrier wall to restrict groundwater flow to Red Cove/Plow Shop Pond. This Action Memorandum follows the Engineering Evaluation/Cost Analysis (EE/CA) prepared to support the NTCRA (Sovereign, 2012b).

This Action Memorandum was prepared using current U.S. Environmental Protection Agency (USEPA) guidance (USEPA 1993 and USEPA 2009). The Action Memorandum was prepared by Sovereign, on behalf of the Army, under contract W912WJ-10-D-0003 DO#0002.

2.0 SITE CONDITIONS AND BACKGROUND

The NCP states that a removal action may be conducted at a site where a threat to human health and welfare or the environment is established. An appropriate removal action is taken to abate, minimize, stabilize, mitigate, or eliminate the release or threat of release at a site. The conditions at SHL which support the need for a NTCRA are further described in detail below.

2.1 Site Description

The SHL is located in the northeast corner of the main post of the former Fort Devens (Fort Devens). Fort Devens is located approximately 35 miles northwest of the city of Boston, within the towns of Ayer, Shirley (Middlesex County), Harvard and Lancaster (Worcester County) (**Figure 1**). Fort Devens was established in 1917 for military training and logistical support during World War I. Fort Devens became a permanent Base in 1931, and continued service until its Base Realignment and Closure (BRAC) Committee closure in 1996. The landfill is bordered to the northeast by Plow Shop Pond, to the west by Shepley's Hill, to the south by recent commercial development, and to the east by land formerly containing a railroad roundhouse.

2.1.1 *Removal Site Evaluation*

Subsequent to closure of the landfill (1987-1993), remedial investigations (RIs) under CERCLA evaluated soil, sediment, surface water, and groundwater conditions at and in the immediate vicinity of the landfill. The results confirmed the presence of various contaminants, particularly certain inorganic analytes and volatile organic compounds (VOC), in groundwater, sediment, and surface water at or adjacent to SHL. A Feasibility Study (FS) and Record of Decision (ROD) resulted in a remedy that required long term monitoring and maintenance of the existing landfill cap and groundwater monitoring. The ROD (USAEC, 1995) required the Army to perform groundwater monitoring and five-year reviews to evaluate the effectiveness of the selected remedial action, which relied heavily on the previously installed landfill cap, to attain groundwater cleanup goals by 2008 and to reduce potential exposure risks. If groundwater contaminant concentrations, primarily arsenic, met risk-based performance standards (cleanup goals) over time, the ROD did not require further action; however, if cleanup goals were not met, the ROD required implementation of a groundwater extraction contingency remedy. Due to continued elevated contaminant concentrations, the Army installed and started full time operation of a groundwater extraction and treatment system in March 2006 to address groundwater contamination emanating from the northern portion of the landfill (Sovereign, 2011).

All available data indicate that the current remedies – landfill capping and groundwater extraction – have reduced but not eliminated groundwater flow from SHL into Plow Shop Pond, identified as AOC 72. The AOC 72 RI results suggest that groundwater discharge contributes arsenic to sediment that may accumulate to levels that result in conditions that pose unacceptable risks, and therefore remedies that further minimize arsenic-in-groundwater flux would be most protective (AMEC, 2011).

2.1.2 *Physical location*

The SHL (42.554760° latitude and -71.597273° longitude) encompasses approximately 84 acres in the northeast corner of the main post of the former Fort Devens (Fort Devens). Fort Devens is located approximately 35 miles northwest of the city of Boston, within the towns of Ayer, Shirley (Middlesex County), Harvard and Lancaster (Worcester County) (**Figure 1**).

The surrounding land use is a mixture of commercial, industrial, and residential areas. The landfill is bordered to the northeast by Plow Shop Pond, to the west by Shepley's Hill, to the south by recent commercial development, and to the east by land formerly containing a railroad roundhouse. Nonacoicus Brook, which drains Plow Shop Pond, and several residences are located north of the landfill (**Figure 1**). The center of the Town of Ayer, which has a population of 7,427 and a population density of approximately 819 people per square mile according to the 2010 census, is located approximately 0.5 miles northeast of the SHL.

As the project location is a former landfill, there are no potential historical landmarks or structures with historical significance located at the SHL. According to the Massachusetts Natural Heritage Endangered Species Program (NHESP), there is no threatened or endangered species habitat identified at the SHL. However, six species are listed as having threatened or endangered status in the Town of Ayer. The threatened species include vesper sparrow (*Pooecetes gramineus*), grasshopper sparrow (*Ammodramus savannarum*), and Blanding's turtle

(*Emydoidea blandingii*), and the three endangered species include the upland sandpiper (*Bartramia longicauda*) and two vascular plants (Houghton's flatsedge [*Cyperus houghtonii*] and wild senna [*Senna hebecarpa*]) (AMEC, 2011). In addition, Plow Shop Pond is within the Squannassit Area of Critical Environmental Concern and is thus classified as a sensitive ecosystem. The arsenic-in-groundwater flux to Red Cove/Plow Shop Pond presents potential contamination of this sensitive ecosystem.

2.1.3 Site characteristics

SHL was reportedly operating by the early 1940s, and evidence from test pits within the landfill suggests earlier usage, possibly as early as the mid-nineteenth century (Harding ESE, 2002). The landfill contains a variety of waste materials, including incinerator ash, demolition debris, asbestos, sanitary wastes, glass, and other wastes. The maximum depth of the refuse occurs in the central portion of the landfill and is estimated to be about 40 feet below ground surface (bgs). The volume of waste in the landfill has been estimated at over 1.5×10^6 cubic yards (cys), of which approximately 1.6×10^5 cys (11%) is below the water table. The saturated wastes may be emplaced in a wetland reducing environment; at least two areas previously mapped as wetlands appear to have been filled (Harding ESE, 2002) and have been found to be underlain by peat deposits (Sovereign, 2011).

The landfill was closed in five phases between 1987 and 1992-93 in accordance with Massachusetts Regulations at 310 CMR 19.000. The Massachusetts Department of Environmental Protection (MassDEP) approved the closure plan in 1985. Closure consisted of installing a 30-mil polyvinyl chloride (PVC) membrane cap, covered with soil and vegetation and incorporating gas vents. Closure also included installation of wells to monitor groundwater quality around the landfill, and construction of drainage swales to control surface water runoff. MassDEP issued a Landfill Capping Compliance Letter approving the closure in February 1996.

2.1.4 Release or threatened release into the environment of a hazardous substance, or pollutant or contaminant

Elevated arsenic concentrations in groundwater at SHL have impacted Red Cove/Plow Shop Pond which is located downgradient and in close proximity to the northern portion of the landfill. Red Cove is a shallow cove with a water depth of less than one meter. Iron oxides precipitate as an orange-red floc or sediment in Red Cove as reduced groundwater discharges to oxygenated surface water. Arsenic is adsorbed by or co-precipitated with the iron floc. Therefore, left unmitigated, the arsenic flux to Plow Shop Pond could accumulate to unacceptable levels of risk (AMEC, 2011).

Potential sources of arsenic in groundwater include (1) bedrock, (2) till, (3) aquifer sand overlying bedrock and underlying waste or peat, (4) landfill waste, and (5) peat. Due to the placement of the cap on the landfill, any potential leachate from the landfill waste is now limited to the ~10% that is present within the saturated zone. Arsenic is released into groundwater from the aquifer sands by naturally occurring and landfill-induced reducing conditions caused by carbon degradation and oxygen depletion that lead to anaerobic conditions. Portions of the landfill overlay pre-existing, buried peat deposits that induced reducing conditions prior to emplacement of the landfill over the buried peat and associated

wetlands. Therefore, the buried peat deposits within the landfill footprint caused arsenic mobilization to the north end of the site toward Nonacoicus Brook as well as east toward Plow Shop Pond; however, the flow into the pond is by a minor pathway that is cross gradient to the bulk of flow (Sovereign, 2011). This natural process will persist even if the landfill waste were to be removed. Recent estimates indicate that peat degradation and reducing conditions could persist for a period of greater than a hundred years.

Elevated arsenic concentrations in groundwater at SHL have subsequently impacted Red Cove/Plow Shop Pond which is located downgradient and in close proximity to the northern portion of the landfill. Current arsenic flux to Red Cove is estimated at approximately 14 grams per day (g/day) and is estimated to have been 20 g/day pre-arsenic treatment plant (ATP) with the landfill cap in place (AMEC, 2011).

2.1.5 National Priorities List status

Pursuant to CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA), Fort Devens was placed on the National Priorities List (NPL) on November 21, 1989 because of environmental contamination at several locations.

2.1.6 Maps, Figures, and other Graphic Representations

A Site Location Map for SHL and a figure presenting the conceptual layout of the selected Removal Action Alternative (RAA) for SHL are included as **Figures 1 and 2**, respectively. The distribution of arsenic in groundwater is shown on **Figure 3**.

2.2 Other Actions to Date

2.2.1 Previous actions

Previous investigations and removal actions at SHL related to the arsenic-in-groundwater flux to Red Cove/Plow Shop Pond include the following:

Final Expanded Site Investigation: Remedial Oversight of Activities at Fort Devens Plow Shop Pond and Grove Pond (Gannett Fleming, 2006): The Final Expanded Site Investigation (ESI) conducted by Gannett Fleming on behalf of the USEPA included an evaluation of data collected from a decade of field investigation efforts within Plow Shop Pond [Area of Contamination (AOC) 72], including toxicity testing of benthic invertebrates and amphibians, as well as chemical analysis of sediment, soils, surface water, groundwater, pore water, and biota. The ESI concluded that sediment data collected throughout the 1990s from AOC 72 indicated elevated concentrations of several contaminants including arsenic, cadmium, chromium, mercury, and lead that could potentially pose human health and ecological risks throughout both ponds. Relatively higher concentrations of arsenic and manganese in sediment were detected in the vicinity of Red Cove and are related to groundwater discharge from SHL.

Draft Final RI for AOC 72 (AMEC, 2011): An RI was completed by the Army in 2011 during which surface water and sediment within Plow Shop Pond and Grove Pond were sampled for a variety of contaminants including arsenic, chromium, and mercury. The sources of the contaminants were attributed to current and historic releases of arsenic to groundwater from the SHL site in the Red Cove area as well as historic releases of chromium, mercury, and arsenic

liquid wastes from the Hartnett Tannery formerly located at Grove Pond. Results from the Draft Final RI indicated that sediment within the Former Railroad Roundhouse Site [Study Area (SA) 71] had elevated levels of polycyclic aromatic hydrocarbons (PAHs) and metals including lead, zinc, antimony and copper. In order to reduce the current and potential risks to human health and the environment posed by contaminants that originate from the SHL site and SA 71, an EE/CA for sediment removal at AOC 72 in support of a NTCRA was proposed.

Final Shepley's Hill Landfill Supplemental Groundwater and Landfill Cap Assessment for Long-term Monitoring and Maintenance - Addendum Report (Sovereign, 2011): The Supplemental Addendum Report (SAR) documented several investigations conducted at the SHL including the evaluation of arsenic in groundwater migration toward Plow Shop Pond and the strength and duration of dissolved arsenic conditions. Groundwater profiling along the eastern side of the landfill identified dissolved arsenic concentrations between 58 and 1,350-micrograms per liter (µg/l), while groundwater sampling confirmed dissolved arsenic concentrations of 818 and 918-µg/l. In addition, drilling operations in this area indicated a shallower than previously extrapolated bedrock surface. The shallower rock elevations were plotted and included in the refined particle track model that document a bedrock trough trending northward through the landfill and that the shallower rock ridge along the east side of the landfill appears to restrict arsenic migration to a northerly direction. The primary source of arsenic in groundwater is naturally occurring solid phase arsenic in the aquifer sand that is mobilized by groundwater under reducing conditions (bedrock and till are documented secondary sources of arsenic). Reducing conditions have been created by both landfill waste and naturally occurring peat deposits.

Final AOC 72 EE/CA (Sovereign, 2012a): The EE/CA was prepared to evaluate response measures for a NTCRA at AOC 72 and its purpose was to evaluate removal action alternatives for the contaminated sediment in AOC 72. Specifically, the EE/CA addressed sediment in and around Red Cove that has been impacted by groundwater flow originating from SHL. According to the RI for AOC 72, arsenic is accumulating in sediment due to groundwater discharge from SHL through the pond bottom in the vicinity of Red Cove.

2.2.2 *Current Actions*

As detailed in **Section 2.1.1**, current actions at the SHL include long term monitoring and maintenance of the existing landfill cap, the operation of a groundwater extraction and treatment system via the ATP in accordance with the ROD, and pending supplemental investigations to update and refine the conceptual site model. In addition, current investigations and removal actions at SHL related to the arsenic-in-groundwater flux to Red Cove/Plow Shop Pond include the following:

Draft Final SHL Barrier Wall EE/CA (Sovereign, 2012b): The EE/CA was prepared for the SHL to evaluate several RAAs to mitigate the arsenic-in-groundwater flux from SHL to Red Cove/Plow Shop Pond. The evaluated RAAs included no action, the installation of a barrier wall with a permeable reactive barrier (PRB), and the installation of a barrier wall without a PRB. The recommended RAA was the installation of a barrier wall without a PRB. Discussion of the selected RAA is presented in **Section 5** below.

SHL Pre-Construction Investigation Workplan Addendum (Sovereign, 2012c): The Pre-Construction Investigation Workplan Addendum (Addendum) was prepared to detail supplemental data collection activities to address several of the previously identified field data needs, to assist in the constructability of a barrier wall between SHL and Red Cove, and to support the barrier wall construction documents. The Addendum was based on the results of the field investigations conducted at the Shepley's Hill Landfill in November and December 2011. The data collected under the Addendum will be incorporated into the preparation of the SHL barrier wall construction documents; no separate data summary report will be prepared for the data collected.

Draft SHL Removal Action Work Plan (Sovereign, 2012d): The Removal Action Work Plan (RAWP) was prepared to detail the installation of a vertical hydraulic barrier wall at the SHL to mitigate the arsenic-in-groundwater flux from SHL to Red Cove/Plow Shop Pond. As detailed in the RAWP, groundwater modeling was performed and a pre-construction investigation was conducted to aid in designing the location, length, and depth of the barrier wall. The RAWP included the results of the preconstruction investigation and design plans and specifications.

2.3 State and Local Authorities' Role

2.3.1 *State and Local Actions to Date*

No prior State or Local actions have been taken at the SHL.

2.3.2 *Potential for Continued State/Local Response*

The selected removal action for the SHL and corresponding documents will be reviewed by USEPA Region I and MassDEP.

3.0 THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT

Section 300.415(b)(2) of the National Contingency Plan (NCP) lists a number of factors to consider in determining whether a Removal Action is appropriate, including:

(i) *Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants;*
(ii) *Actual or potential contamination of drinking water supplies or sensitive ecosystems;*
(iii) *Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers, that may pose a threat of release;*
(iv) *High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate;*
(v) *Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released;*
(vi) *Threat of fire or explosion;*
(vii) *The availability of other appropriate federal or state response mechanisms to respond to the release; and*
(viii) *Other situations or factors that may pose threats to public health or welfare or the environment.*

An evaluation of the conditions in SHL indicates that factors (i) and (ii) are applicable as described below.

(i) *Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.*

Elevated groundwater arsenic concentrations at the SHL site are migrating to and impacting Red Cove, which is located downgradient/cross gradient of and in close proximity to the eastern portion of the landfill. If the arsenic-in-groundwater flux to Red Cove is not sufficiently mitigated, the arsenic flux to Plow Shop Pond could accumulate to unacceptable levels of risk (AMEC, 2011).

(ii) *Actual or potential contamination of drinking water supplies or sensitive ecosystems.*

Plow Shop Pond is within the Squannassit Area of Critical Environmental Concern and is thus classified as a sensitive ecosystem. The arsenic-in-groundwater flux to Red Cove presents potential contamination impacts of this sensitive ecosystem.

A NTCRA is therefore appropriate to abate, prevent, minimize, stabilize, mitigate, or eliminate such threats. In particular, a NTCRA is necessary to remove, control or contain the risk from the potential exposure to the release of hazardous substances from the arsenic-in-groundwater flux to Red Cove/Plow Shop Pond.

4.0 ENDANGERMENT DETERMINATION

Given the weight of evidence presented in the aforementioned reports as summarized in Sections 2 and 3, an actual or threatened release of hazardous substances from this site may present an imminent and substantial endangerment to public health, or welfare, or the environment. Because more than six months planning time is available before on-site activities must be initiated, this Removal Action will be conducted as a NTCRA.

5.0 PROPOSED ACTIONS AND ESTIMATED COSTS

This section describes the proposed RAAs and associated costs for SHL.

5.1 Proposed Actions

5.1.1 Proposed Action Description

The Removal Action Objective (RAO) for SHL is the following:

- Mitigate the arsenic-in-groundwater flux from SHL to Red Cove/Plow Shop Pond to reduce risk to environmental receptors consistent with local conditions in Plow Shop Pond.

To mitigate the arsenic-in-groundwater flux from SHL to Red Cove/Plow Shop Pond and reduce risk to environmental receptors consistent with local conditions in Plow Shop Pond, a barrier wall will be installed along the eastern edge of the SHL to intercept and divert groundwater flowing east into Red Cove/Plow Shop Pond. Particle track analysis indicates that a wall with a total length of approximately 850 feet would be sufficient to intercept groundwater flowing east into Red Cove/Plow Shop Pond from the landfill footprint. A conceptual layout is provided on **Figure 2**.

Particle track analysis was conducted using the SHL104 model under ambient conditions. A low-permeability barrier wall was added to the model using the MODFLOW horizontal flow boundary package, which assigns a separate hydraulic conductivity value to a vertical cell wall. A value of 1.0×10^{-7} cm/sec was used to reflect the very low conductivity of a slurry wall. The analysis shows that flow paths along the eastern landfill boundary are effectively diverted north. A few particles originating from the landfill footprint still travel northeast and discharge to Plow Shop Pond; however, these particles originate in the southeastern portion of the landfill where arsenic concentrations are low. Additionally, the travel-time for this pathway is very slow, and consequently represents a negligible flux compared to the current flow regime.

Installation of the low-permeability slurry wall will be conducted by placing a soil-bentonite slurry into an excavated trench. Slurry placement would occur as the excavation is occurring to prevent collapsing of the trench. Excavation could be performed using a standard or long-stick backhoe excavator while slurry placement would be performed by a front-end loader. The slurry would consist of excavated material mixed with water and bentonite. The trench will be excavated through the overburden and will be completed to the top of competent bedrock to assure that a good, low-permeability contact occurs between the overburden barrier and the underlying bedrock. Weathered bedrock that can be reasonably excavated by conventional ripping with a large excavator will be removed to reach competent bedrock. Refusal has been defined as the depth at which three passes of the excavator rock ripping bucket or the rippers of the ripping bucket result in less than 0.1 feet of advancement of the excavation.

During the installation of the barrier wall, excavated materials will be reused to the maximum extent possible based on results slurry mix testing to create the soil-bentonite slurry wall at the desired permeability of $<10^{-7}$ cm/sec. In addition, the backfill for the barrier wall will likely consist of excavated soils that are supplemented with 25 to 50 percent (30 to 35 percent is typical and provides a more stable backfill) imported plastic fines/clay (the actual amount will be dependent upon the quality of clay available and the gradation of the trench cuttings), slurry, and dry bentonite. Any landfill waste material encountered during the installation of the barrier wall will be segregated during trenching operations for offsite disposal at a licensed facility in accordance with state and federal regulations.

The capital costs for the wall installation and 1 year of O&M, which would consist of inspections and annual groundwater monitoring, are estimated at $1.8 million. Though the remedy duration is determinate, 1 year of O&M and monitoring were included for costing purposes, as it is planned that this remedy will be part of the final remedy for SHL. Therefore, the long term monitoring costs would be included as part of the SHL final remedy to determine the remedy's long term effectiveness of mitigating arsenic-in-groundwater flux to Red Cove/Plow Shop Pond, after the initial 1 year monitoring program, included herein.

5.1.2 *Contribution to Remedial Performance*

In accordance with the ROD (USAEC, 1995), the Army is required to reduce potential exposure risks associated with the arsenic-in-groundwater flux from the SHL to Red Cove/Plow Shop Pond. All available data indicate that the current remedies – landfill capping and groundwater extraction – have reduced but not eliminated groundwater flow from SHL into Plow Shop Pond and the risk to environmental receptors from the arsenic-in-groundwater flux (AMEC, 2011).

The installation of a barrier wall along the eastern edge of the landfill is expected to contribute to the remedial performance at the SHL by mitigating the arsenic-in-groundwater flux to Red Cove/Plow Shop Pond. As demonstrated by particle track analysis, a barrier located along the eastern edge of the landfill would effectively mitigate the arsenic-in-groundwater flux and achieve the RAO by intercepting and diverting groundwater flowing east into Red Cove/Plow Shop Pond from the landfill footprint under non-pumping conditions from the ATP (Sovereign, 2012d).

5.1.3 *Engineering Evaluation/Cost Analysis*

In May 2012, an EE/CA was prepared to address arsenic-in-groundwater flux from the SHL and to evaluate response measures for the NTCRA at SHL (Sovereign, 2012b). The EE/CA included a summary of site conditions, a summary of the risk drivers for the site, the RAO for the NTCRA, descriptions of RAAs, and the results of a detailed and comparative analysis of RAAs. The alternatives developed for SHL and evaluated in the EE/CA included No Action, Barrier Wall/PRB and Barrier Wall and are summarized below.

Alternative 1 – No Action

This alternative considered no action to the impacted areas.

Alternative 2 – Barrier Wall/PRB

This alternative consisted of a barrier to mitigate groundwater flow from the landfill footprint to the east into Red Cove/Plow Shop Pond by way of a relatively impermeable slurry wall along the eastern portion of the landfill. A section of the wall would be filled with zero valent iron (ZVI) to create a PRB to reduce arsenic concentrations in groundwater flowing into the pond. The PRB would be installed in a funnel and gate arrangement where an impermeable cutoff wall (funnel) is installed with a gap that is filled with the ZVI substrate (gate). The slurry wall would consist of a soil-bentonite slurry mixture.

The capital costs for the Barrier Wall/PRB installation and 1 year of O&M are estimated at $4.3 million. The annual O&M would consist of inspections, annual groundwater monitoring, and the redevelopment of the wall to maintain permeability at the end of the 1 year period. This wall redevelopment could include injection of conditioned water to clear sections of the wall that have become fouled and their permeability decreased. Though the remedy duration is determinate, 1 year of O&M and monitoring were included for costing purposes, as it is planned that this remedy will be part of the final remedy for SHL. Therefore, the long term monitoring costs would be included as part of the SHL final remedy to determine the remedy's

long term effectiveness of mitigating arsenic-in-groundwater flux to Red Cove/Plow Shop Pond, after the initial 1 year monitoring program, included herein.

Alternative 3 – Barrier Wall

This is the selected alternative described in **Section 5.1**.

All of the aforementioned alternatives were evaluated according to their effectiveness in meeting the RAO, implementability, and cost. The comparative analysis of the alternatives for the Red Cove area against the evaluation criteria is summarized in the table below.

ALTERNATIVE NAME	EFFECTIVENESS	IMPLEMENTABILITY	COST ($ Millions)
Alternative 1 – No Action	Does not meet RAOs or protectiveness.	Already implemented	$0
Alternative 2 – *Barrier Wall/PRB*	Will meet RAOs and provide protectiveness.	Implementation is feasible; pre-construction investigations to develop the approach and methodology are ongoing.	$4.3
Alternative 3 – *Barrier Wall*	Will meet RAOs and provide protectiveness.	Implementation is feasible; pre-construction investigations to develop the approach and methodology are ongoing.	$1.8

Based on the results of the comparison of alternatives, the recommended RAA was Alternative 3 – Barrier Wall. Alternative 3 provided protectiveness, was readily implementable, complied with the RAO and applicable or relevant and appropriate requirements (ARARs), and had relatively lower costs.

5.1.4 Applicable or Relevant and Appropriate Requirements

ARARs are federal and state public health and environmental requirements used to (1) evaluate the appropriate extent of site cleanup, (2) scope and formulate removal action alternatives, and (3) govern the implementation and operation of a selected removal action. CERCLA and the NCP require that removal actions attain ARARs to the greatest extent practicable. To determine practicability, factors such as the urgency and scope of the remedial action should be considered. ARARs for the proposed removal action are provided on Table 1. Implementation of the proposed alternative (Alternative 3 – Barrier Wall) will satisfy ARARs, to be considered (TBC) criteria and guidance to the extent practicable.

5.1.5 Project schedule

It is estimated that the removal action, from initial site preparation activities to site restoration, will take approximately 12 weeks and will begin in July 2012.

5.2 Estimated Costs

The removal action at SHL will be funded entirely by the Army. The removal action for SHL is estimated to cost approximately $1.8 million, including pre-design activities, implementation, and 1 year of operations & maintenance (O&M).

6.0 EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

If the selected removal action, as described herein, is delayed or not implemented, arsenic-in-groundwater flux from SHL to Red Cove / Plow Shop Pond may continue to pose a risk to human health and/or the environment.

7.0 OUTSTANDING POLICY ISSUES

No outstanding policy issues were identified.

8.0 ENFORCEMENT

As indicated in **Section 3**, the basis for action under the NCP is determined by the threats to public health, welfare, and the environment posed by conditions at SHL. Funding for this action will be provided entirely by Department of the Army BRAC DERP and the removal action will be conducted in accordance with CERCLA requirements, the Interagency Agreement, and applicable Massachusetts State regulations. Results from the removal action will be documented in a Removal Action Completion Report.

9.0 RECOMMENDATION

This document presents the selected NTCRA for arsenic-in-groundwater flux from SHL to Red Cove/Plow Shop Pond at Fort Devens, Massachusetts, developed in accordance with CERCLA, as amended, and consistent with the NCP. Conditions at SHL meet the NCP Section 300.415(b)(2) criteria for a removal action. Therefore, the Army is proceeding forward with the selected removal action.

Signed:

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Robert J. Simeone **Date**
BRAC Environmental Coordinator
Department of the Army
Base Realignment and Closure Division

10.0 REFERENCES

1 AMEC 2011. *Draft Final Remedial Investigation for AOC 72.* Prepared for USACE-NAE. March.

2 Gannett Fleming 2006. *Final Expanded Site Investigation: Remedial Oversight of Activities at Fort Devens Plow Shop Pond and Grove Pond.* Prepared for USEPA Region I. May.

3 Harding ESE, 2002. *Revised Draft Shepley's Hill Landfill Supplemental Groundwater Investigation, Devens Reserve Forces Training Area.* Devens, MA. February.

4 Sovereign, 2011. *Shepley's Hill Landfill Supplemental Groundwater and Landfill Cap Assessment for Long-term Monitoring and Maintenance – Addendum Report.* Prepared for USACE-NAE. August.

5 Sovereign, 2012a. Final *AOC 72 Engineering Evaluation/Cost Analysis.* Prepared for USACE-NAE. March.

6 Sovereign 2012b. Draft Final *Shepley's Hill Landfill Barrier Wall Engineering Evaluation/Cost Analysis.* Prepared for USACE-NAE. May.

7 Sovereign 2012c. *Shepley's Hill Landfill Pre-Construction Investigation Workplan Addendum.* Prepared for USACE-NAE. April.

8 Sovereign 2012d. Draft *Shepley's Hill Landfill Barrier Wall Removal Action Work Plan.* Prepared for USACE-NAE. April.

9 USEPA Office of Solid Waste and Emergency Response 1993. *Conducting Non-Time-Critical Removals under CERCLA.* December.

10 USEPA Office of Solid Waste and Emergency Response 2009. *Superfund Removal Guidance for Preparing Action Memoranda.* September.

FIGURES

FIGURE 1
SITE LOCUS

FORT DEVENS
AYER, MASSACHUSETTS

0 1,000 Feet

1 in = 1,000 ft

N
W E
S

Legend

APPROXIMATE SITE BOUNDARY

NOTES AND SOURCE INFORMATION:
TOPO: 2009 NATIONAL GEOGRAPHIC SOCIETY, i-cubed
IMAGERY:ESRI, i-cubed, USDA FSA, USGS, AEX,
GEO EYE, GETMAPPING, AEROGRID, IGP

DECEMBER 2010 ROV

SOVEREIGN CONSULTING INC.
905B SOUTH MAIN STREET, UNIT 202
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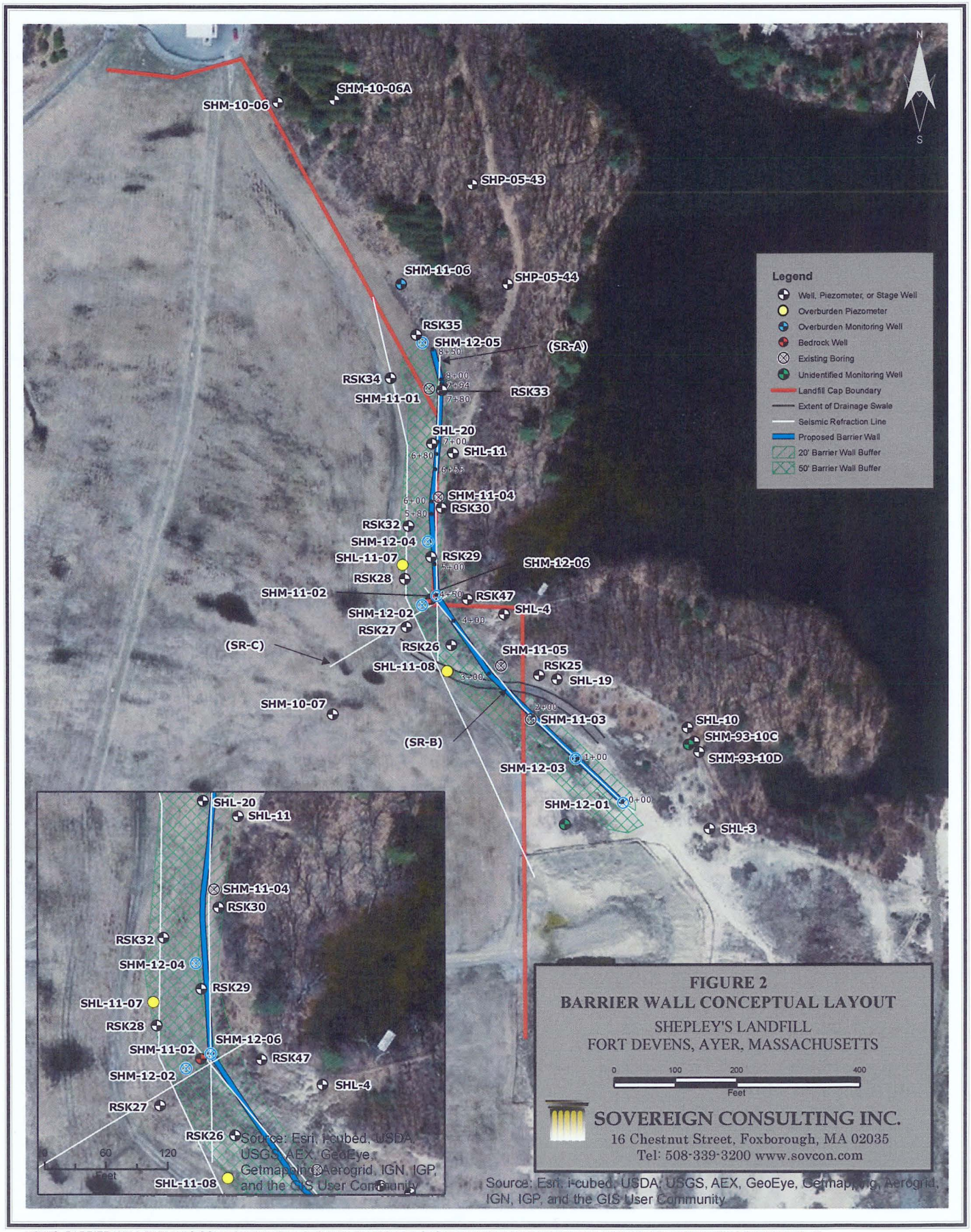
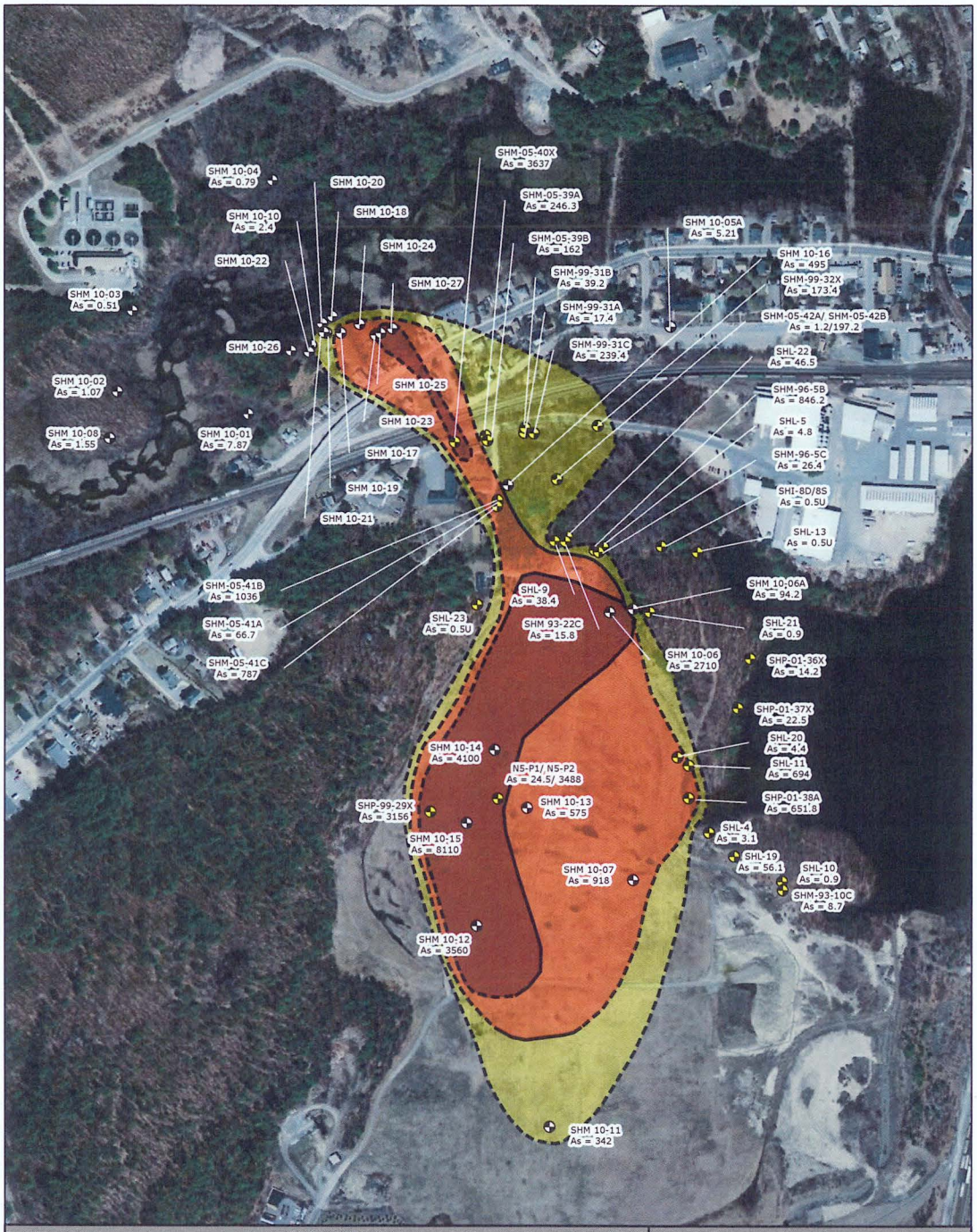


NOTES: BARRIER WALL DATA WAS COLLECTED WITH A GEO EXPLORER® 2008 GEO-XH TRIMBLE UNIT IN MAY 2012. HORIZONTAL ACCURACY IS GENERALLY <1'.
05/16/2012 ROV Updated 06/20/2012 ROV



0 200 400 800 Feet

1 in = 400 ft

Legend

- Boring/Well Location (ARSENIC CONCENTRATIONS REPORTED AS DISSOLVED)
- LTMMP (ARSENIC CONCENTRATIONS REPORTED AS TOTAL)
- ARSENIC CONCENTRATION 100-500 ppb
- ARSENIC CONCENTRATION 500-1000 ppb
- ARSENIC CONCENTRATION >1000 ppb
- ARSENIC CONCENTRATION INTERVAL (DASHED WHERE INFERRED WITH TOTAL CONCENTRATIONS)
- ARSENIC CONCENTRATION INTERVAL

N W E S

FIGURE 3
ARSENIC GROUNDWATER MONITORING WELL RESULTS - AUGUST/SEPTEMBER 2010 SAMPLING EVENT

FORT DEVENS
AYER, MASSACHUSETTS

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DECEMBER 2010 ROV
UPDATED MARCH 2011 ROV; REVISED MAY 2011 ROV

NOTES AND SOURCE INFORMATION:
AERIAL IMAGERY: 2010 ESRI, i-cubed, USDA FSA, USGS, AEX, GEOEYE, GETMAPPING, AEROGRID, IGP
1:4,800
2010 AMEC EARTH AND ENVIRONMENTAL. PROPOSED INVESTIGATIONS NEAR THE IMPACTED AREA. JDP
PLAN BASED ON GROUND WATER RESULTS OBTAINED FROM WELLS DURING THE AUGUST - SEPTEMBER 2010 SAMPLING EVENTS.

TABLES

Table 1
Chemical Specific ARARs, Criteria, Advisories and Guidance
Shepley's Hill Landfill Barrier Wall

Requirement/Guideline	Citation	Requirement Synopsis	Status	Action to be Taken to Attain Requirement
Federal Requirement/Guideline				
Clean Water Act - National Recommended Water Quality Criteria (NRWQC)	40 CFR 122.44	Remedial actions involving contaminated surface water or groundwater must consider the uses of the water and the circumstances of the release or threatened release. Federal NRWQC are health-based and ecologically based criteria developed for carcinogenic and non-carcinogenic compounds.	Relevant and Appropriate.	Will be attained. Project is designed to mitigate arsenic-in-groundwater flux to Red Cove by diverting groundwater flow away from Red Cove. This action is expected to reduce As concentrations in surface water.
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.	To Be Considered	This alternative will mitigate potential carcinogenic risks caused by exposure to contaminants. Risk will be addressed by diverting arsenic-in-groundwater flux away from Red Cove.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	To Be Considered	This alternative will mitigate potential non-carcinogenic hazards caused by exposure to contaminants. Risk will be addressed by diverting arsenic-in-groundwater flux away from Red Cove.
Early-Life Exposure to Carcinogens	US EPA/630/R-03/003F (March 2005)	Guidance for the assessment of cancer risks to children	To Be Considered	This alternative will mitigate potential non-carcinogenic hazards caused by exposure to contaminants. Risk will be addressed by diverting arsenic-in-groundwater flux away from Red Cove.
Secondary Chronic Values (SCVs)	US DOE (Jones et al., 1997)	Established toxicological benchmarks for screening contaminants of potential concern for effects on sediment associated biota.	To Be Considered	This alternative will mitigate potential toxicological effects on sediment-associated biota by diverting arsenic-in-groundwater flux away from Red Cove.
Sediment Quality Criterion (SQC) Sediment Quality Benchmarks (SQBs)	US EPA, 1996	Established screening toxicity thresholds.	To Be Considered	This alternative will mitigate potential toxicological effects on sediment-associated biota by diverting arsenic-in-groundwater flux away from Red Cove.
Screening Quick Reference Tables (SQRTs) Threshold Effects Level (TEL)	NOAA: Buchman, 1999	TELs represent the concentration below which adverse effects are expected to occur only rarely.	To Be Considered	This alternative will mitigate potential toxicological effects on sediment-associated biota by diverting arsenic-in-groundwater flux away from Red Cove.
Lowest Effect Levels (LELs)	Ontario Ministry of Environment and Energy (OMEE): Persaud et al., 1993	Concentrations at which majority of the sediment-dwelling organisms are not effected.	To Be Considered	This alternative will mitigate potential toxicological effects on sediment-associated biota by diverting arsenic-in-groundwater flux away from Red Cove.
Probable Effects Concentrations (PECs)	MacDonals et al, 2000	Concentration above which the adverse effects on sediment-dwelling organisms are likely to occur.	To Be Considered	This alternative will mitigate potential toxicological effects on sediment-associated biota by diverting arsenic-in-groundwater flux away from Red Cove.
Assessment and Remediation of Contaminated Sediments (ARCS) Program; Sediment effect concentrations	US EPA, 1996	Provides sediment effect concentrations at three levels for the amphipod (Hyallela azteca) and the midge (Chironomus riparius).	To Be Considered	This alternative will mitigate potential toxicological effects on sediment-associated biota by diverting arsenic-in-groundwater flux away from Red Cove.
Guidelines for Carcinogen Risk Assessment	EPA/630/P-03/001F March 2005	Guidance for assessing cancer risk	To Be Considered	This alternative will mitigate potential carcinogenic risks caused by exposure to contaminants. Risk will be addressed by diverting arsenic-in-groundwater flux away from Red Cove.
Massachusetts Requirement/Guideline				
Massachusetts Surface Water Quality Standards	27 M.G.L. 27, 314 CMR 4.03, 4.04 & 4.05	State surface water quality standards incorporate the federal NRWQC as standards for surface waters of the state. Standards establish acute and chronic effects on aquatic life for contaminants including PCBs, cadmium, chromium, copper, and lead.	Applicable	Will be attained. Project is designed to mitigate arsenic-in-groundwater flux to Red Cove by diverting groundwater flow away from Red Cove. This action is expected to reduce As concentrations in surface water.

Table 2
Action Specific ARARs, Criteria, Advisories and Guidance
Shepley's Hill Landfill Barrier Wall

Requirement/Guideline	Citation	Requirement Synopsis	Status	Action to be Taken to Attain Requirement
Federal Requirement/Guideline				
Clean Water Act - National Pollutant Discharge Elimination System (NPDES)	40 CFR 122 & 125	Establishes the specifications for discharging pollutants from any point source into the waters of the U.S. Includes storm water standards for activities disturbing more than one acre.	Applicable	Will be attained. Construction activities are anticipated to disturb more than 1 acre, and substantive requirements of this regulation will be addressed during design to minimize adverse impacts. No other point source discharges will occur related to this removal action alternative.
RCRA Subtitle C - Storage and Disposal of Hazardous Waste.	40 CFR 260 - 264	Regulates the generation, transport, storage, treatment and disposal of hazardous wastes. Regulations govern the preparedness, prevention, closure, and post-closure activities at solid waste landfills. The analytical test set forth in Appendix II of 40 CFR part 261 is referred to as the Toxicity Characteristic Leaching Procedures.	Applicable	Will be attained. If waste is generated, it will be tested and disposed consistent with these regulations.
RCRA Subtitle D - Storage and Disposal of Hazardous Waste.	40 CFR 260 - 264	Regulates the generation, transport, storage, treatment and disposal of hazardous wastes. Regulations govern the preparedness, prevention, closure, and post-closure activities at solid waste landfills. The analytical test set forth in Appendix II of 40 CFR part 261 is referred to as the Toxicity Characteristic Leaching Procedures.	Applicable	Will be attained. If waste is generated, it will be tested and disposed consistent with these regulations.
Massachusetts Requirement/Guideline				
Massachusetts Waterways Regulations	310 CMR 9.40	Standards for dredging.	Relevant and Appropriate.	Not applicable to this alternative.
Hazardous Waste Management Identification and Listing of Hazardous Wastes	21C M.G.L. 4 & 6, 310 CMR. 30.100	Massachusetts is delegated to administer RCRA through its State regulations. These standards establish requirements for determining whether wastes are hazardous based on either characteristics or listing.	Applicable	Will be attained. If waste is generated, it will be tested, and if waste is hazardous waste, the waste would be managed consistent with these regulations.
Hazardous Waste Management Requirements for Generators of Hazardous Waste	310 CMR 30.300	Generator requirements outline waste characterization, management of containers, packaging, labeling, and manifesting. Generator requirements apply to contaminated substances meeting the definition of hazardous under 310 CMR 100.	Applicable	Will be attained. Project is designed to mitigate arsenic-in-groundwater flux to Red Cove by diverting groundwater flow away from Red Cove. This action is expected to reduce As concentrations in surface water. In addition, if waste is generated, it will be tested, and if waste is hazardous waste, the waste would be managed consistent with these regulations.
Massachusetts Hazardous Waste Regulations (Storage of Hazardous Waste)	310 CMR 30.340	Allows on-site accumulation of hazardous waste for up to 90 days.	Applicable	Will be attained. If waste is generated, it will be tested, and if waste is hazardous waste, the waste would be managed consistent with these regulations.
Air Pollution Control Regulations	310 CMR 7.09	Defines and regulates air pollution sources including fugitive dust. Establishes emissions limitations for various processes and regions within the state. Sources require source approval and may require a study of health risks. All minor stationary sources are required to apply Best Available Control Technology (BACT) for each pollutant it would have the potential to emit. Major sources of volatile organic compounds (VOCs) are required to apply Lowest Achievable Emission Rate (LAER) and obtain offsets.	Applicable	Will be attained. None of the work proposed for this alternative constitutes a source of stationary minor or major sources of air pollution. Any fugitive dust will be managed through engineering or other controls during removal activities.
Ambient Air Quality Standards	310 CMR 6.00	Sets primary and secondary ambient air quality standards for emissions of sulfur oxides, particulate matter, CO, ozone, nitrogen dioxide, and lead.	Applicable	Will be attained. Construction equipment used in the performance of this alternative will meet standard emissions regulations.
Massachusetts Solid Waste Management Regulations	310 CMR 19.014(3)	The disposal of solid waste must be carried out at a facility in Massachusetts that is approved to manage the particular type of solid waste being disposed.	Applicable	Will be attained. If waste is generated, it will be tested, and if not a hazardous waste, it will be disposed as a solid waste consistent with these regulations.
Federal Criteria, Advisories and Guidance				
Contaminated Sediment Remediation Guidance for Hazardous Waste Sites	EPA540-R-05-012 OSWER 9355.0-85 (December 2005)	Guidance for making remedy decisions for contaminated sediment sites.	To Be Considered	Project is designed to mitigate arsenic-in-groundwater flux to Red Cove by diverting groundwater flow to Red Cove. This action is expected to improve sediment and surface water quality.
Generation of investigation derived waste	USEPA OSWER Publication 9345.3-03 FS (January 1992)	Management of Investigation-Derived Waste (IDW) must ensure protection of human health and the environment.	To Be Considered	If IDW is generated, it will be tested and managed consistent with these regulations.
Massachusetts Criteria, Advisories and Guidance				
Erosion and Sediment Control Guidance		Standards for preventing erosion and sedimentation.	To Be Considered	Erosion controls will be incorporated into the performance of this alternative through Massachusetts Wetlands Protection Action (Location-specific ARAR).
Massachusetts Water Quality Standards Implementation Policy of Toxic Pollutants in Surface Waters		Recommends surface water quality standards for specified contaminants and implementation measures to achieve standards.	To Be Considered	Will be attained. Project is designed to mitigate arsenic-in-groundwater flux to Red Cove by diverting groundwater flow away from Red Cove. This action is expected to reduce As concentrations in surface water.
Massachusetts Threshold Effects Exposure Levels (TELs) and Allowable Ambient Limits (AALs) for Air	Dec-95	These are guidelines used by Massachusetts DEP for air emission permit writing. Under the Clean Air Act Amendments, AALs may be utilized. TELs and AALs provide guidance when assessing significance of monitored and modeled residential contamination from air emissions. They also are used in evaluating worker safety.	To Be Considered	The primary contaminant of concern is As which is not volatile. However, dust monitoring will be conducted during the implementation of this alternative to attain this ARAR.

Table 3
Location Specific ARARs, Criteria, Advisories and Guidance
Shepley's Hill Landfill Barrier Wall

Requirement/Guideline	Citation	Requirement Synopsis	Status	Action to be Taken to Attain Requirement
Federal Requirement/Guideline				
Federal Floodplain Management & Federal Protection of Wetlands	44 CFR 9	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	Relevant and Appropriate	Will be attained. All work will be conducted outside of the 100 year floodplain. In addition, all practicable measures will be taken to minimize and mitigate any adverse impacts. Erosion and sedimentation control measures will be adopted during construction activities. This action will not increase the risk of flooding at Red Cove because pond depth is controlled by Nonacoicus Dam.
Massachusetts Requirement/Guideline				
Massachusetts Wetland Protection Act and regulations	310 CMR 10.00	Regulations restrict dredging, filling, altering, or polluting inland wetland resource areas and imposing performance standards for work in such areas.	Applicable.	Will be attained because (a) all practical measures will be taken to minimize adverse impacts on wetlands; (b) actions will be taken to minimize the impact of hydrologic changes during the work to the extent practicable; and (c) disturbed vegetation will be restored through natural recruitment.
Massachusetts Endangered Species Act and regulations	321 CMR 10.00	Actions must be conducted in a manner that minimizes the impact on Massachusetts listed rare, threatened, or endangered species and species listed by the Massachusetts Natural Heritage Program.	Applicable.	Will be attained because all practical measures will be taken to ensure that Removal Action activities (a) are structurally sound; (b) provide a proper public purpose; (c) do not interfere with public rights or rights of adjacent property owners; and (d) will not adversely affect natural resources.
Massachusetts Areas of Critical Environmental Concern	301 CMR 12.00	Regulations to preserve and restore ACECs and ensure that activities in or impacting on the ACEC are carried out so as to minimize adverse effects on: (a) surface and groundwater quality, (b) habitat values, (c) storm damage prevention or flood control, (d) historical and archeological resources, (e) scenic and recreational resources, and (f) other natural resource values of the area.	Applicable.	Will be attained. All practicable measures will be taken to minimize and mitigate any adverse impacts. Erosion and sedimentation control measures will be adopted during removal activities.