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Feasibility Study Report

Lake Hancock Target Range

NAS Whidbey Island
Whidbey Island, Washington

Department of the Navy
Naval Facilities Engineering Command Northwest
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FEASIBILITY STUDY REPORT
FOR
LAKE HANCOCK TARGET RANGE

NAVAL AIR STATION WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criteria (USEPA)
bgs	below ground surface
BIP	Blow-In-Place
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
COPC	contaminant of potential concern
CSF	Cancer Slope Factor (USEPA)
CSL	cleanup screening level
CTO	Contract Task Order
CWA	Clean Water Act
DoD	Department of Defense
DOT	Department of Transportation
Ecology	Washington State Department of Ecology
EOD	Explosive ordnance disposal
EODT	EOD Technology
FS	Feasibility Study
GHG	greenhouse gas
GPS	Global Positioning System
GRA	General Response Action
HVAR	high velocity air rocket
LHTR	Lake Hancock Target Range
LUC	Land Use Control
MC	Munitions Constituents
MCL	Maximum Contaminant Level (USEPA)
MDAS	Material Documented as Safe
MDEH	Material Documented as an Explosive Hazard
MEC	Munitions and Explosives of Concern
mg/kg	milligram per kilogram
MPPEH	Material Potentially Presenting an Explosive Hazard
msl	mean sea level
MTCA	Model Toxics Control Act
NAS	Naval Air Station
NAVFAC	Navy Facilities Engineering Command

NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NERP	Navy Environmental Restoration Program
NFA	No Further Action
NPL	National Priorities List
NPW	Net Present Worth
O&M	operation and maintenance
ORS	ordnance related scrap
OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
PPE	personal protective equipment
QA	quality assurance
QC	quality control
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RD	Remedial Design
RfD	Reference Dose (USEPA)
RI	Remedial Investigation
ROD	Record of Decision
SCAR	sub-caliber rockets
SEDRANK	Sediment Management Standard Ranking Method for Sediments
SHA	Site Hazard Assessment
SI	Site Investigation
SMS	sediment management standards
SVOC	Semivolatile organic compound
TBC	To Be Considered (criterion)
Tetra Tech	Tetra Tech NUS, Inc.
URSG	URS Greiner, Inc.
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UXO	Unexploded Ordnance
WAC	Washington Administrative Code
WARM	Washington Ranking Method
WDNR	Washington Department of Natural Resources
XRF	X-Ray Fluorescence

GLOSSARY OF MUNITIONS TERMS

Department of Defense Explosive Safety Board (DDESB): The DDESB mission is to provide objective advice to the Secretary of Defense and Service Secretaries on matters concerning explosives safety and to prevent hazardous conditions to life and property on and off Department of Defense installations from the explosives and environmental effects of DoD titled munitions.

Discarded Military Munitions (DMM): Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage are for the purpose of disposal. The term does not include unexploded ordnance, military munitions that area being held for future use of planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations. (10 U.S.C. 2710(e)(2))

Explosive Hazard: A condition where danger exists because explosives are present that may react (e.g., detonate, deflagrate) in a mishap with potential unacceptable effects (e.g., death, injury, damage) to people, property, operational capability, or the environment.

Explosive Ordnance Disposal (EOD): The detection, identification, field evaluation, rendering-safe, recovery, and final disposal of unexploded explosive ordnance. It may also include the rendering-safe and/or disposal of explosive ordnance (EO) that has become hazardous by damage or deterioration, when disposal of such EO requires techniques, procedures, or equipment that exceeds the normal requirements for routine disposal. (Naval Operations Instruction 8027.1G, 14 February 1992)

Munitions Constituents (MC): Any material originating from unexploded ordnance, discarded military munitions, or other military munitions, including explosive and nonexplosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions. (10 U.S.C. 2710 (e)(4))

Material Documented as Safe (MDAS): MPPEH that has been assessed and documented as not presenting an explosive hazard and for which the chain of custody has been established and maintained. This material is no longer considered to be MPPEH.

Material Documented as an Explosive Hazard (MDEH): (Formerly referred to as material documented as hazardous, or MDAH.) MPPEH that cannot be documented as MDAS, that has been assessed and documented as to the maximum explosive hazards the material is known or suspected to present, and for which the chain of custody has been established and maintained. This material is no longer considered to be MPPEH.

Military Munitions: Military munitions means all ammunition products and components produced for or used by the armed forces for national defense and security, including ammunition products or components under the control of the Department of Defense, the Coast Guard, the Department of Energy, and the National Guard. The term includes confined gaseous, liquid, and solid propellants, explosives, pyrotechnics, chemical and riot control agents, smokes, and incendiaries, including bulk explosives, and chemical warfare agents, chemical munitions, rockets, guided and ballistic missiles, bombs, warheads, mortar rounds, artillery ammunition, small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges, and devices and components thereof. The term does not include wholly inert items, improvised explosives devices, and nuclear weapons, nuclear devices, and nuclear components, other than non-nuclear components of nuclear devices that are managed under the nuclear weapons program of the Department of Energy after all required sanitization operations under the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) have been completed. (10 U.S.C. 101 (e)(4))

Munitions and Explosives of Concern (MEC): This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks, means unexploded ordnance, DMM, or MC (e.g., trinitrotoluene, hexogen) present in high enough concentrations to pose an explosive hazard. (Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, 18 December 2003)

Material Potentially Presenting an Explosive Hazard (MPPEH): Military munitions, to include their components; munitions packaging material; residues from the research, development, testing and evaluation, production, use (to include range residues), operational and quality testing, or demilitarization of munitions; or any other materials, equipment, or facilities potentially contaminated with explosives. Both end items and residues derived from processing end-items within the United Nations Organization Hazard class. Munitions related items, pieces, models, training aids, etc. that are suspected, but not confirmed, to be wholly inert. (DoD 4715.13, 01 February 2002)

It is material owned or controlled by the Department of Defense that, prior to determination of its explosives safety status, potentially contains explosives or munitions (e.g., munitions containers and packaging material; munitions debris remaining after munitions use, demilitarization, or disposal; and range-related debris) or potentially contains a high enough concentration of explosives that the material presents an explosive hazard (e.g., equipment, drainage systems, holding tanks, piping, or ventilation ducts that were associated with munitions production, demilitarization, or disposal operations). Excluded from MPPEH are munitions within the DoD-established munitions management system and other items that may present explosion hazards (e.g., gasoline cans and compressed gas cylinders) that are not munitions and are not intended for use as munitions.

Range: A designated land or water area set aside, managed, and used for range activities of the DoD. Ranges include firing lines and positions, maneuver areas, firing lanes, test pads, detonation pads, impact areas, electronic scoring sites, buffer zones with restricted access and exclusionary areas, and airspace areas designated for military use in accordance with regulations and procedures prescribed by the Administrator of the Federal Aviation Administration. (10 U.S.C. 101(e)(3))

Unexploded Ordnance (UXO): Military munitions that have been primed, fused, armed, or otherwise prepared for action; have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and remain unexploded either by malfunction, design, or any other cause. (10 U.S.C. 101(e)(5))

1.0 INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF REPORT

1.1.1 Purpose

This Feasibility Study (FS) Report for the Lake Hancock Target Range (LHTR) at the Naval Air Station (NAS) Whidbey Island, Washington, was prepared for Navy Facilities Engineering Command (NAVFAC) Northwest by Tetra Tech NUS, Inc. (Tetra Tech) under Contract Task Order (CTO) KR02 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) IV Contract Number N62470-08-D-1001. The document was prepared to fulfill the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and is consistent with United States Environmental Protection Agency (USEPA) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (1988), the Navy Environmental Restoration Program (NERP) Manual (Navy, 2006), and the Washington State Model Toxics Control Act (MTCA). This FS Report describes the formulation and evaluation of remedial alternatives to determine whether and how to remove potential munitions and explosives of concern (MEC)/material potentially containing and explosive hazard (MPPEH) and munitions debris from the former LHTR. The FS establishes Remedial Action Objectives (RAOs) and cleanup goals; screens remedial technologies; and assembles, evaluates, and compares remedial alternatives. The FS is based on data collected during the Site Hazard Assessment of the Lake Hancock Target Bombing Range [URS Greiner, Inc. (URSG), 1998], the Final Preliminary Assessment of NAS Whidbey Island (Malcolm Pirnie, 2007), the Site Investigation of the Lake Hancock Munitions Response Site (Tetra Tech EC, 2010), and also the Archaeological Trip Report (URS Consultants, 1996), Ecological Survey Report (URS Consultants, 1996) and the Final Report for the Aerial and Ground Based Geophysical Survey conducted at the Former Lake Hancock Target Area (EOD Technology, 1996) along with the guidance documents Munitions Response Remedial Investigation/Feasibility Study Guidance (United States Army, 2009) and Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, 1998).

The purpose of the FS process is to gather and evaluate information sufficient to select an appropriate remedy for a site based on an informed risk management decision-making process. Within an FS report, the results of previous investigations are used to develop and evaluate potential remedial alternatives that will reduce risks to human health and the environment that have been identified at the site. The alternatives should provide cost-effective methods to mitigate the identified risks, and the range of alternatives should be adequate so that decisions can be made regarding the selected response action.

Subsequent to the FS, the Navy presents the preferred remedial alternative(s) in a Proposed Plan. Following a 30-day public comment period, the Navy selects the remedial alternative(s) and seeks the concurrence of Washington State Department of Ecology (Ecology). The final remedial alternative(s) are presented in a Record of Decision (ROD).

1.1.2 Document Organization

This FS Report has been organized with the intent of meeting the general requirements specified in the Remedial Investigation (RI)/FS Guidance Document (USEPA, 1988) and MTCA. This report contains the following five sections:

- Section 1.0, Introduction, summarizes the purpose of the report, provides site background information, summarizes the findings of the previous investigations, and provides the report outline.

- Section 2.0, Remedial Action Objectives and General Response Actions, presents the RAOs, identifies Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) criteria, and develops General Response Actions (GRAs).

- Section 3.0, Screening of Remediation Technologies and Process Options, provides a two-tiered screening of potentially applicable remediation technologies, and identifies the technologies that were assembled into remedial alternatives.

- Section 4.0, Assembly and Detailed Analysis of Remedial Alternatives, assembles the remedial technologies retained from the Section 3.0 screening process into multiple remedial alternatives, describes these alternatives, and performs a detailed analysis of these alternatives in accordance with seven of the nine CERCLA criteria.

- Section 5.0, Comparative Analysis of Remedial Alternatives, compares the remedial alternatives to one another on a criterion-by-criterion basis, for each of the seven CERCLA analysis criteria used in Section 4.

Sustainability evaluations were performed for each remedial alternative and are provided in Appendix A. Appendix B contains the cost estimates for each alternative.

1.2 SITE BACKGROUND

The following paragraphs provide background information about NAS Whidbey Island and LHTR. Figure 1-1 provides the general location map and shows general features of the NAS Whidbey Island, and Figure 1-2 shows the main site features at LHTR.

1.2.1 Description and History of NAS Whidbey Island

NAS Whidbey Island is located on the north central part of Whidbey Island adjacent to the town of Oak Harbor, Washington (see Figure 1-1). It is located about 30 miles north of Seattle, and lies between Olympic Peninsula and the Interstate-5 corridor of western Washington. The island forms the northern boundary of Puget Sound.

The NAS was commissioned on September 21, 1942, originally as a base for seaplane patrol operations, rocket firing training, torpedo overhaul, and both recruit and petty officer training. NAS Whidbey Island is divided into four distinct parcels: 1) the main airfield or Ault Field, 2) Seaplane Base located at Crescent Harbor, 3) Lake Hancock Target Range, and 4) Outlying Field Coupeville. The Mission of Naval Air Station Whidbey Island is to provide the highest quality facilities, services and products to the Naval Aviation Community, and all organizations utilizing the NAS on Whidbey Island.

1.2.2 Description and History of the Lake Hancock Target Range

The Lake Hancock Target Range occupies roughly 423 acres approximately 20 miles south of Ault field and 1 mile north of Greenbank, Washington. The site includes a saltwater lagoon (Lake Hancock) surrounded by a salt marsh. To the east, the site is bordered by a horseshoe-shaped ridge. A 50-foot-wide channel connects Lake Hancock to Admiralty Inlet, which creates a tidal influence to Lake Hancock. The range was formerly used as a commercial cranberry bog and fish trap by the Native American Coast Salish Tribe during the early 1900s. In the early 1900s, the entire area surrounding the lake was largely isolated from Admiralty Inlet and contained freshwater wetlands. However, the area now exists as a saltwater marsh, as a result of a large storm in 1914 that breached the land along the beach. Lake Hancock is an exceptionally large and diverse coastal lagoon system that includes salt marsh, brackish marsh, freshwater marsh, and bog forest. These communities have been recognized by the Nature Conservancy and the Washington Department of Natural Resources (WDNR) as unique and valuable natural resources as identified under the Natural Heritage Program.

The site was obtained by the Department of Defense (DoD) circa 1943. LHTR was used for aerial bombing training between 1943 and 1971, and a portion of the site is currently used to monitor training in Admiralty Bay and other Navy and Marine training exercises that do not include military ordnance. During

World War II, practice bombs used in training altered the marsh surface. The large number of salt pans (small, shallow ponds of saline water without emergent vegetation) may be the result of the impact of the munitions. The range was damaged by fire in 1951 and remained inactive until 1953, after which time it was re-activated. It was reportedly heavily used in 1957.

Munitions utilized at this range included practice bombs and rockets equipped with spotting charges or filled with sand to aid in strike determinations. Aircraft would approach the site from the east, make a steep diving approach over the target area, release the practice bombs, and exit the area westward over Admiralty Inlet. The original range included a triangular shaped yellow target with a white bull's-eye, a radar screen, two range and deflection observation shacks, a scoring house (for determining the aircraft range and dive angle), and an observation post with a radio transmitter and receiver. A scoring building was constructed near the beach in the northwest corner of the property. A microwave tower and building were also constructed on the north end of the property approximately 1,500 feet inland and approximately 200 feet east of the scoring station.

The LHTR was listed as closed in 2002; the site is no longer used for aerial bombing target practice. This area is still underneath restricted air space, and a portion of the site is currently being used by the military to monitor training in Admiralty Bay and for other military training exercises. The Navy uses the area just off shore of LHTR which is known as operating area Navy 7. However, when this operating area is not activated, access to the public from the water is not restricted. The LHTR is currently fenced on the north, east, and south sides with locked gates, but is accessible from the beach. Access to the beach and lake by the general public is restricted by the Navy; however, there are no physical barriers to prevent access to the beach or lake. Future land use is consistent with current land use (military installation). No future residential uses are planned for this site.

Lake Hancock is not listed on the National Priorities List (NPL). The Navy is the lead agency for this site and Ecology has regulatory oversight of LHTR.

1.2.3 <u>Site Investigations</u>

Previous Removal Actions

In 1972 and 1973, three separate surface clearances were conducted by military personnel to support potential land transfer options. The first clearance, between October 2 and November 3, 1972, was conducted on debris located primarily near the target area. Divers also cleared the intertidal area from the beach to 50 yards out into Admiralty Inlet. A large number of rocket motors were found in the waters off the beach. Divers also searched the lagoon and determined its depth to be about 2 feet. No ordnance was found within the lagoon due to the muddy lake bottom. Approximately 14 tons of munitions debris (consisting of bombs, rockets, and smoke/pyrotechnic devices) were removed during this clearance. All recovered munitions debris was declared inert. The second search was conducted during the first 2 weeks of May 1973, and the third was conducted in August 1973. The third search was hindered by the presence of scrap metals, and only three inert rocket motors were found and removed from the site. During these three clearances, more than 15 tons of ordnance-related scrap (ORS) was removed from the site. During the three surface clearances, the following ordnance items were found and identified:

- MK 23, 43, 76 and 89 practice bombs.
- 2.25-inch sub-caliber rockets (SCARs).
- 5-inch high velocity air rockets (HVARs).
- 100-, 250-, and 500-pound water sand filled bombs.
- MK 6, 25, and 58 smoke bombs.

Approximately 97 percent of all munitions recovered at Lake Hancock during the 1970s were 2.25-inch SCARs for aircraft. In addition to the three clearances referenced above, a fourth clearance was conducted at Lake Hancock on an unknown date. The occurrence of the clearance was documented in a February 1982 memorandum from the Executive Officer of NAS Whidbey. The document stated that several undetonated 25-pound bombs containing spotting charges had been recovered from the site.

There are no records indicating the use of full-up live ordnance at the LHTR site, and previous site investigations and searches did not reveal any evidence of live ordnance. However, it is still possible that ordnance capable of causing harm to human and ecological receptors, (e.g., unexpended rocket motors and cartridges) depending upon the type of spotting charge, could be encountered.

Archaeological Trip Report, Lake Hancock Target Range (URS Consultants, 1996)

In May, 1996, an archaeological reconnaissance survey of LHTR was conducted, to relocate known archaeological sites to determine whether sediment sampling activities (planned as part of the Site Hazard Assessment investigation at Lake Hancock) might adversely impact cultural resources on the property. Four known archaeological sites, presumed eligible for listing on the National Register of Historic Places, were located and visual inspections of these sites were made in order to compare descriptions given on Washington Archaeological Site Inventory forms to their condition during this survey. The survey concluded that as long as sampling personnel were restricted from the locations of the known archaeological sites and archaeologically sensitive areas, it was highly unlikely that the limited samples planned would impact cultural resources located at LHTR. The survey further recommended that in the event of a major excavation, that an archaeologically trained person be present to determine whether subsurface cultural materials were encountered during excavation.

Ecological Survey Report, Lake Hancock (URS Consultants, 1996)

This survey was conducted to provide information on site conditions during work plan design for the Site Hazard Assessment investigation at Lake Hancock, and the subsequent report provided a qualitative discussion of the potential effects of remedial alternatives on the habitats present at Lake Hancock. The results of the survey led to the conclusion that the planned sampling for the Site Hazard Investigation would pose minimal impacts to Lake Hancock; therefore, no mitigation measures were recommended.

This report further stated that the results of the Site Hazard Assessment might indicate the need for remedial actions centered around the aerial bombing target in the southwest corner of the site. Almost all active sediment remediation activities in this area of the site were determined to be impractical and would likely cause excessive ecological damage, because they would require heavy equipment operation (e.g., backhoes, trucks, and front-end loaders) in an area where the substrate is a loose sediment down to at least 3 feet. Furthermore, the report stated that any active remedial activities would temporarily destroy the existing salt marsh and could negatively impact adjacent areas through mass movement of sediment. Therefore, active remedial action was not recommended for most of the saltmarsh area.

Final Report for the Aerial and Ground Based Geophysical Surveys (EOD Technology, Inc., 1996)

EOD Technology (EODT) conducted aerial and ground-based geophysical surveys using magnetometry and electromagnetics to detect surface and subsurface ferrous objects within the former target area at LHTR. The aerial survey and ground verification surveys positively identified surface and subsurface metallic debris and anomalies of various origins, such as: steel plates, braided steel wire rope, railroad spikes embedded in large timber, and an expended 2.25 inch rocket motor (visually identified). Several anomalies were identified as strong signals that had the potential for being unexploded ordnance (UXO) and/or inert ORS. EODT also identified lower signal intensity anomalies that were to be treated as possible UXO/ORS.

Site Hazard Assessment, Lake Hancock Target Bombing Range (URSG, 1998)

URS Greiner conducted a multi-phase Site Hazard Assessment (SHA) at LHTR (URSG, 1998). The Preliminary Phase investigation (discussed above) involved ecological, archaeological, and geophysical screening surveys. Because of the ecological resources at the site, the Preliminary Phase geophysical surveys were conducted by air, with ground-based confirmation to identify any target range metallic debris which still remained after the removal sweeps of the 1970s and 1980s. The Initial Phase investigation of the SHA was performed to assess potentially elevated chemical levels near the target zone. Phase I was performed to sample sediment and surface water near identified geophysical anomalies. Phase II activities involved removing rusted steel plates and visibly contaminated sediments from the site. X-ray fluorescence (XRF) screening measurements for metals, and confirmational sampling were also conducted to assess the effectiveness of the removal process.

The results of Phase I of the SHA are as follows:

- No significant release or threatened release of a hazardous substance had occurred. The SHA confirmed the presence of organics and inorganics in sediment and surface water at low concentrations; they were of limited extent and were determined not to be a threat.

- Suspected hazardous substances were identified and information was provided about their extent and concentrations. The SHA identified inorganics and organics in surface water and soil, and defined the limited extent of one hazardous substance (lead) in soil.

- Site characteristics that could result in the hazardous substances entering and moving through the environment were identified. The SHA characterized contaminant levels at selected locations throughout the site, including at the location of a former metal observation shed where exceedances of the Washington Sediment Management Standards (SMS) cleanup screening levels (CSLs) were detected. However, water quality measurements suggested no significant partitioning of heavy metals to surface water.

- The potential for the threat to human health and the environment was evaluated. The SHA evaluation identified no immediate threat to human health or the environment.

- Hazard rankings using the Washington Ranking Method (WARM) and Sediment Management Standard Ranking Method for Sediments (SEDRANK) were calculated for the site under Washington Administrative Code (WAC) 173-340-330.

Phase II was initiated in response to Phase I exceedances of marine sediment standards at the location of the former metal observation shed (see above). Heavy metal concentrations (lead, copper, and zinc) in that area were found to be statistically correlated with iron concentrations in proximity to a set of rusted 0.25-inch steel plates. The Navy removed the plates and sampled discolored soils below the plates. Sediment samples were field screened with a portable XRF unit to direct the extent and depth of sediment removal near the plates. The results of Phase II of the SHA are as follows:

- Fourteen rusted steel plates and four 16-gallon drums of visibly contaminated soils and rust debris were airlifted from the LHTR site by the NAS Whidbey Island Search and Rescue Unit. The rusted plates were recycled and the drums of soil were disposed of off site.

- XRF field screening samples collected during Phase II showed that iron concentrations diminished rapidly with increasing depth below the metal plates.

- Phase II confirmation samples analyzed at an off-site laboratory showed a high correlation between lead, copper, zinc, and iron. Concentrations of lead, copper, zinc, and iron had been effectively reduced from pre-removal (Phase I) levels.

- Only 1 of 14 sample analyses (including the reanalysis of 3 apparently anomalous samples) contained a lead result slightly above the Washington SMS CSLs. All other heavy metal detections were below SMS regulatory levels.

Therefore, No Further Action (NFA) was recommended for this site because all Ecology criteria for evaluating the success of the cleanup action at LHTR had been fulfilled. The Navy installed perimeter signs to prevent unauthorized entry into the site and to further reduce potential damage to this area.

Preliminary Assessment, Naval Air Station Whidbey Island, Washington (Malcolm Pirnie, Inc., 2007)

The Preliminary Assessment (PA) summarized the history of munitions use for the following former ranges at NAS Whidbey Island: Aviation Fleet Gunnery School Machine Gun Ranges, Polnell Point, the Lake Hancock Target Range, and the Crescent Harbor Practice Range. The PA provided an assessment of the current conditions with respect to MEC and munitions constituents (MC).

A visual survey of the Lake Hancock Target Range was conducted in August 2006 during the PA site visit. The purpose of the visual survey was to identify any MEC-related materials (e.g., rocket motors, warheads, rocket body, fragmentation, debris), evidence of MC (e.g., ground scarring, stressed vegetation, chemical residue), or surface features that could provide additional information to aid in site characterization. Because of the large size of the range, the site reconnaissance covered approximately 5 percent of the site. However, because of the predominance of open space, approximately 50 percent of the site was visually observed. The site walk concentrated on the target area and the area surrounding it in the southern half of the range, the beach to the west, and the southern area around Lake Hancock. The visual survey was conducted at low tide; under these conditions, the team observed isolated pools of water within the salt marsh, exposed mud flats, and a lowered lake level. Many salt pans were observed within the southern half of the range area, particularly around the former target area, and these salt pans may have been created from the impact of munitions in the area.

The former target center consisted of approximately 1.5 acres of exposed water with emergent vegetation along the edges. No visual evidence of the former range structures, including the target center and scoring houses, was observed during the visual survey. The presence of timbers laid out in a linear pattern east of the target area provided evidence of the former target structures. Practice 2.75-inch rocket motors and warheads were observed during the site reconnaissance. The highest concentration of motors was located near the target area. Several rocket motors were found at a distance of 900 feet or more from the center of the target, in the direction of the beach. The munitions debris surrounding the target area was encountered within exposed water from the surface to a depth of approximately 6 to 8 inches. Exposed munitions debris was also observed protruding from embankments along surface drainages in some locations. The condition of the items (rusted and deteriorating) and locations within the water prevented the team from determining whether items represented MEC or munitions debris. Munitions debris was also observed on the western beach of the property. One rocket motor was found amidst debris collected on the beach (logs and trash washed onto the beach), and two rocket motors were found in the surf along the beach. All of the munitions debris was corroded, and several pieces had rocks and other debris cemented to the item.

Based on the historical use of the range and the observance of expended rocket components in several locations during the site reconnaissance, the entire Lake Hancock property was classified as suspected to contain MEC in the PA Report. While the majority of remaining ordnance items are likely present within and surrounding the former target center, the presence of munitions debris along the western beach indicates that misfires likely occurred during training operations. Such occurrences may have distributed munitions debris to other areas within the property. In addition, historical documentation obtained at the installation indicated that there had been complaints from a landowner south of the range about bombs entering off-site properties.

Explosive compounds were not detected in samples collected from the impact/target area where the majority of the residual munitions debris was located (based on observations made during the site reconnaissance and known range operations). The analytical data indicated that MC contamination either did not remain on the range or that it was present within the limits of regulatory criteria, given the sporadic distribution of residual munitions debris across the remaining portions of the site.

<u>MEC Pathway Analysis</u>

The PA determined that the potential existed for MEC to be present in surface and subsurface soil and sediment, based on the former use of the site as a target training range and the recovery of rocket motors and warheads from the target area and beach. It was determined that MEC and munitions debris may be present in the subsurface soil and subsurface sediment of Lake Hancock up to a depth of 10 feet. While the items observed during the PA site reconnaissance were all determined to be inert munitions debris, the potential exists for practice bombs and rockets containing unfired spotting charges to be present.

Potentially complete exposure pathways were identified in the PA for all receptors that may access the site. Navy personnel, contractors, and trespassers who gain access to the site may come into contact with MEC via handling/removing or walking overtop of the items. Ecological (biota) receptors may come into contact with MEC on the surface or subsurface soil and/or sediment of Lake Hancock. Potential receptors who may be exposed to MEC potentially present on the beach or in the nearshore sediments of Admiralty Inlet are Navy personnel, contractors, visitors and recreational users who may gain access to the site from Admiralty Inlet, trespassers hiking along the beach or the marsh, and ecological receptors foraging or nesting in the area.

MC Pathway Analysis

Sediment and surface water sampling and analysis conducted during the SHA indicated that MC were either not present at the site [explosives and semivolatile organic compounds (SVOCs)], or were within acceptable background levels for the site (metals). Because the samples were collected from locations with the greatest probability of containing MC (the former target area and in areas identified by the geophysical survey), MC were not expected to be present at levels that could endanger human health or the environment. In addition, the low concentrations that were expected to be found are unlikely to migrate to exposure points (domestic wells north and south of the site) at appreciable levels. Well reports for domestic use wells in the area indicate water levels greater than 50 feet in depth; therefore, any MC left at the range are unlikely to migrate vertically to this depth, but could migrate laterally at shallow depths toward Admiralty Inlet. Consequently, the PA pathway analysis for MC indicated that there are no complete pathways to potential receptors.

Site Investigation Report of Lake Hancock Munitions Response Site (Tetra Tech, 2010)

The Site Investigation (SI) report documents the results of MC sampling efforts conducted at the former LHTR. The focus of the sampling activities was to determine whether any chemical constituents remained at this site at concentrations above screening levels as identified in the approved work plan. Several remedial actions and site sampling activities had previously been conducted at this former range during which one chemical constituent (lead) was identified to be above an allowable level at one sampling point. Additionally, the site had never been evaluated for perchlorate, a common chemical constituent associated with rocket fuels. Therefore, to address the prior lead detection and to address the potential for perchlorate, the SI was conducted. The activities conducted during the SI included sampling of surface and subsurface soil, sediment, and surface water to define the nature and extent of potential contamination at the site.

Sampling results indicated that there were no detected contaminants of potential concern (COPC) with concentrations above their respective screening values. Lead was detected above the method detection limit at several locations, but none of the detections were above the screening value of 400 milligrams per kilogram (mg/kg). The maximum lead detection was 239 mg/kg. Perchlorate was analyzed in six soil and surface water samples and three duplicate/triplicate samples. Perchlorate was not detected in any sample.

Four munitions clearances and two sampling events had been conducted at the former LHTR prior to the SI. The most recent of these sampling activities prior to the SI was summarized in an August 2000 Closure Report (URS, 2000) in which the site was recommended for NFA. Sampling activities completed under the SI confirmed that no COPCs existed at the site above their respective screening values. It was therefore recommended that for munitions constituents, the former LHTR be considered NFA.

1.3 SUMMARY OF FINDINGS OF PREVIOUS INVESTIGATIONS

1.3.1 Topography

The Lake Hancock site ranges in elevation from below sea level to approximately 140 feet above mean sea level (msl). The northern and eastern boundaries of the site slope gently to the southwest and west, respectively. The wooded zone in the southwest corner of the range slopes to the northeast. Bluffs approximately 100 feet high are present on the northern and southern beach areas. The rest of the site is virtually flat, and much of it receives regular tidal flooding.

1.3.2 Geology

There are three primary geologic units present at Lake Hancock. These units include a till unit to the south, a marsh deposit unit near the lake, and a recessional-continental deposit unit to the north. In addition, there are sand and gravel beach deposits west of the site on the berm separating the site from Admiralty Inlet.

1.3.3 Soil and Vegetation Types

The wetland soils at the site are low permeability materials consisting of organic and alluvial peat type deposits. The soils at Lake Hancock are glacial in origin, and include parent materials of glacial till, glacial outwash, glacial drift, and glacio-lacustrine and glacio-marine sediments. The majority of the site, including the former target area, is designated as tidal marsh. The sediments within this soil type are largely medium to fine in texture. Tidal marsh soils may be completely submerged during high tide and remain marsh-like at low tide. The western extent of the site bordering on Admiralty Inlet consists of coastal beach soils. This soil type is predominantly gravelly with some sand, and is covered with driftwood and other debris deposited by storms.

The northern and southern portions of the site are classified as Hoypus gravelly loamy sand, with slopes between 5 and 15 percent. Drainage of these soils is considered excessive; internal drainage is very rapid, and the water-holding capacity is low. These soils support the Douglas fir, hemlock, spruce, and cedar vegetation communities. A portion of this soil type in the northeastern portion of the site contains slopes between 15 and 30 percent. The southeast corner of the site consists of Whidbey gravelly sandy loam, which exhibits good natural drainage. Surface runoff is slow as a result of absorption of water by the surface layer and subsoil.

Vegetation within Lake Hancock consists of a mix of salt marsh, mixed forest, Douglas fir, and alder forest. Vegetated wetland areas at Lake Hancock cover roughly one-third of the site, including the former target area. The wetlands support five major plant community types: high salt marsh, low salt marsh, scrub-shrub wetland, freshwater marsh, and Sitka spruce bog. Upland areas include coniferous and deciduous forests as well as an open grassland area that has been planted with coniferous trees. Upland forest vegetation covers about 38 percent of the area, including areas of mixed forest, Douglas fir, and alder forest.

1.3.4 Hydrology and Hydrogeology

The Lake Hancock lagoon is a shallow, permanent pond that covers approximately 37 acres. Two sand spits separate the Lake Hancock lagoon system from the open salt water of Admiralty Inlet. The lagoon system is connected to the marine waters of Admiralty Inlet by a single tidal channel. Surface water directions in the lowland area vary according to the tidal cycle, toward the lake during the flood cycle and toward the Admiralty Inlet during the ebb cycle. Surface water from the bluff faces and beach drain directly into Admiralty Inlet.

Lake Hancock contains intertidal saltwater wetlands with adjacent freshwater wetlands, possibly with limited hydrologic connection to the salt water. Approximately 1 mile of shoreline separates the marsh habitat from Admiralty Inlet. Salt pans are present within the southern half of the range area, particularly around the former target area. There are no significant freshwater incursions into this marsh, it exists as a marine-influenced habitat. Surface runoff or penetration would be the only freshwater entering the wetland system at Lake Hancock.

Hydrogeologic conditions at LHTR are not known. Groundwater monitoring wells have not been installed within the property boundary. In addition, there are no known groundwater production wells within the LHTR area. As aquifer elevations generally reflect the surface topography and most of the site is located near sea level, it is anticipated that the water table is very shallow. The groundwater direction is likely west toward Admiralty Inlet. The primary source of water for NAS Whidbey Island is the Skagit pipeline, which pumps water to Whidbey Island from the Skagit River, located approximately 18 miles to the northeast.

A 4-mile radius water well search was conducted by Banks Information Solutions during the PA for LHTR. A total of 170 wells were found to be documented within the 4-mile radius, with two wells located on the LHTR. One well, on the northwestern end of the range, is likely an error; the record indicates that the well was drilled in Ferndale, Washington, in Whatcom County, which is a great distance from the site. The other domestic well location at the southwestern end of the range was assigned using the township and range convention and is likely to be actually located outside of the range to the south. There are numerous other domestic use wells surrounding the range.

1.3.5 Cultural and Natural Resources

Archaeological sites have been identified within LHTR. As described in Section 1.2.3, an archaeological survey conducted in 1996 in support of the SHA located and confirmed that archaeologically significant sites exist at LHTR. The survey report concluded that sampling activities would not impact cultural resources, so long as the sampling personnel did not collect samples from the sites. The report recommended the inclusion of an archaeologically trained monitor during any planned excavation activities in order to examine possible subsurface cultural materials.

Lake Hancock is a large and diverse coastal lagoon system that includes salt marsh, brackish marsh, freshwater marsh, and bog forest. A total of 17 habitat types that support a variety of wildlife species have been identified within the property. The largest habitat types include salt marsh (23.8 percent) within the interior of the site, and dense pole forests (27 percent) in the southwest, southeast, and northeast sections of the site. The open marshland, lagoon, and intertidal zones are prime foraging areas for birds of prey in the area, and the grassland and forested areas serve as prime foraging, cover, and nesting habitat for songbirds. The lack of development at the site has enhanced the biological diversity within the Lake Hancock property. The presence of the unique coastal lagoon system led to the area being placed on the Washington Register of Natural Areas in 1992 under an agreement between the Navy and The Nature Conservancy. These communities have also been recognized by The Nature Conservancy and the WDNR as unique and valuable natural resources as identified under the Natural Heritage Program.

1.3.6 <u>Endangered and Special Status Species</u>

Several of the sensitive bird species, as identified in the PA, are known to occur within the LHTR, including the great blue heron, common loon, and red-necked grebe. Among the threatened and endangered species, only the bald eagle is known to frequent the area. Lake Hancock may have been a past nesting site for the bald eagle, and the birds may use Lake Hancock as their home range. The threatened marbled murrelet has been documented off shore at the site; however, suitable nesting habitat is not present at Lake Hancock.

1.3.7 <u>Wetlands</u>

A saltwater lagoon, salt marsh, and freshwater wetland system occupy approximately 200 acres of the LHTR site. The lagoon is connected to Admiralty Inlet by a saltwater slough and the hydrology in the marsh system is tidally driven. Approximately 32 acres of freshwater marsh scrub-scrub wetland, and forested bog border the salt marsh. Overall, wetlands comprise roughly 55 percent of the area at the Lake Hancock site.

Lake Hancock is a coastal lagoon surrounded by salt marsh and driftwood-strewn mudflats. The area was once a freshwater lake and marsh, however, storms over the last century has breached the sand bar that once separated this area from Admiralty Inlet. Tidal flow to this area was established via two channels, one of which has since been closed off by beach dune development; the remaining inlet provides for tidal access during each cycle.

True salt marshes are a relatively rare wetland type in the State of Washington and the marsh at Lake Hancock is considered to have biological values of statewide significance. Consequently, this area was listed on the Washington Register of Natural Areas in 1992 under agreement between the Navy and the Nature Conservancy.

Numerous types of wetlands exist at the Lake Hancock site including: Estuarine, Subtidal, Unconsolidated Bottom; Estuarine, Intertidal, Emergent, Persistent; Estuarine, Intertidal, Unconsolidated Shore; Palustrine, Forested, Broad Leaved Deciduous; Palustrine, Forested, Needle Leaved Evergreen; Palustrine, Scrub-shrub, Broad Leaved Deciduous; and Palustrine, Emergent, Persistent. Approximately 231.5 acres of the Lake Hancock site are wetlands.

WDNR has identified Lake Hancock as a high quality wetland/aquatic ecosystem. Most of the wetland area at the site has been designated as an element occurrence of “High Salinity Lagoon, Northern Puget Trough”. This is a landscape level element occurrence that incorporated four specific types of estuarine marsh occurrences: sandy, high salinity low marsh; sandy, moderate salinity low marsh; silty, moderate salinity low marsh; and, transition zone wetland. These areas are further described below. Two other marsh types occur on the south side of the lagoon: high salinity low marsh and low salinity low marsh. The Lake Hancock system is recognized for its high quality and has been designated as a registry site in the Washington Register of Natural Areas. This type of element occurrence is high priority for protection in Washington State.

The high salinity lagoon (landscape level occurrence) covers 191 acres including the 38 acre high salinity pond, additional smaller ponds, and the remaining marsh wetlands listed next. The dominant plant species in this area are an unvegetated lagoon, tidal sloughs, 12 acres of driftwood-covered mudflat, and marsh vegetation listed in the remaining wetlands. This area is considered in good ecological condition and has a high state priority for protection rating. The sandy, high salinity low marsh and sandy, moderate salinity low marsh (element occurrence) covers 80.4 acres and the dominant plant species are pickleweed, seashore saltgrass, jaumea, seaside arrowgrass, orache, Canada sandspurry, sea plantain, and saltmarsh dodder. This area is considered in very good ecological condition and has a moderate state priority for protection rating. The silty, moderate salinity low marsh covers 30.1 acres and the dominant plant species are seaside arrowgrass, pickleweed, seashore saltgrass, orache, sea plantain, jaumea, and alkaligrass. This area is considered in very good ecological condition and has a moderate state priority for protection rating. The transition zone wetland covers 4.7 acres and the dominant plant species are cattail and Pacific silverweed. This area is considered in good ecological condition and has a very high state priority for protection rating. The low elevation freshwater wetland covers 9 acres and the dominant plant species are red alder, lodgepole pine, Sitka spruce, western hemlock, sweet gale, and slough sedge. This area is considered in good ecological condition and has a high state priority for protection rating.

1.3.8 Nature and Extent of Contamination

There are no elevated levels of chemical contaminants present in the soil, sediment, or surface water of LHTR. The SHA confirmed the presence of organics and inorganics in sediment and surface water at low concentrations; however, they were of limited extent and were determined not to be a threat. Sampling results from the SI at LHTR indicated that there were no COPCs above their respective screening values.

For this FS, there is the potential for MEC/MPPEH to be present at the site as a result of former bombing activities. To date, munitions-related items and debris have been located primarily near the target area. However, munitions debris has been observed scattered throughout the site and rocket motors have been found in the waters off the beach out into Admiralty Inlet.

1.3.9 Contaminant Fate and Transport

There is no chemical contamination above screening concentrations present in the soil, sediment, or surface water of LHTR. Munitions-related items, debris, and/or MEC/MPPEH present at this site are not expected to migrate significantly from the point of impact; however, munitions-related items may migrate as a result of erosion and tidal activity.

1.3.10 Human Health Risk

The potential threat to human health from COPCs was evaluated in the SHA, and no immediate threat to human health was identified.

For this FS, the presence of MEC/MPPEH at the site is of concern. Munitions-related items have been observed on the surface, and based on site history and the results of previous removal actions, are most likely present in the subsurface. The exposure pathway for potential human receptors at this site (which include Navy personnel, contractors, and trespassers) is direct contact with munitions items located on the surface, and possibly in the shallow subsurface if items have migrated through erosion and tidal activity. There is a human health hazard associated with potential munitions-related items present at this site because spotting charges and unburned propellants may remain within munitions items and cause injuries if detonated. It is important to note that exposure to MEC does not mean that an incident or injury will occur, since a receptor would have to disturb the MEC item (e.g., apply heat, friction, or shock to the item) in order to be exposed to actual explosive hazards.

1.3.11 Ecological Risk

A Baseline Ecological Risk Assessment for chemical contamination was not conducted, because there are no COPCs at this site. The potential threat to the environment from chemical contamination was evaluated in the SHA, and no immediate threat to the environment was identified.

For this FS, the presence of MEC/MPPEH at the site is of concern. Similar to the pathway for human health receptors, the exposure pathway for any potential ecological receptors at this site is direct contact of munitions-related items on the surface, and to a lesser extent, in the shallow subsurface.

1.3.12 Conclusions

There are no COPCs at the LHTR. MEC/MPPEH potentially present on the surface, and most likely in the subsurface, are a concern at LHTR.

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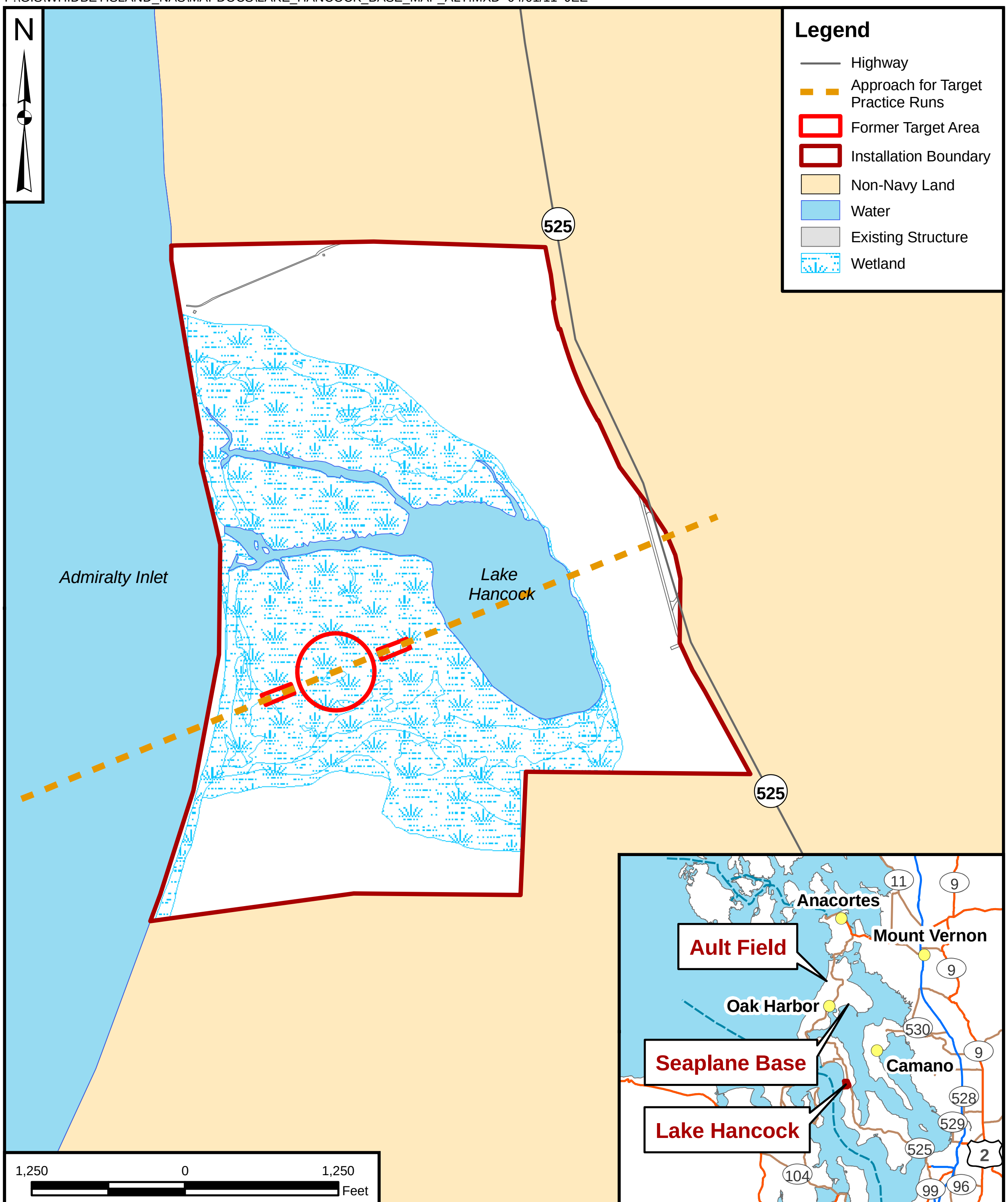

DRAWN BY S. PAXTON	DATE 02/17/11	LAKE HANCOCK TARGET RANGE REGIONAL LOCATION MAP NAS WHIDBEY ISLAND WHIDBEY ISLAND, WASHINGTON	CONTRACT NUMBER	CTO NUMBER 041
CHECKED BY M. COFFMAN	DATE 04/01/11		APPROVED BY	DATE
REVISED BY	DATE		APPROVED BY	DATE
SCALE AS NOTED		NAVFAC	FIGURE NO. FIGURE 1-1	REV 0

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DRAWN BY S. PAXTON	DATE 02/17/11	NAVFAC	LAKE HANCOCK TARGET RANGE SITE LOCATION MAP NAS WHIDBEY ISLAND WHIDBEY ISLAND, WASHINGTON	CONTRACT NUMBER ___	CTO NUMBER 041
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SCALE AS NOTED				FIGURE NO. FIGURE 1-2	REV 0

2.0 REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

This section develops RAOs, GRAs, and presents remediation goals for removal of munitions-related items. The regulatory requirements and guidances (e.g., ARARs) that may potentially govern remedial activities are presented in this section. In addition, this section presents the materials of concern identified in Section 1.0 and the conceptual pathways through which these contaminants may affect human health and the environment.

2.1 MEDIA AND CONTAMINANTS OF CONCERN

There are no COPCs present at LHTR. MEC/MPPEH potentially present at the site are a concern, and the exposure pathway for potential human and ecological receptors is direct contact with munitions-related items in site media. Exposure to MEC does not mean that an incident or injury will occur, since a receptor would have to disturb the MEC item (e.g. apply heat, friction or shock to the item) in order to be exposed to actual explosive hazards.

2.2 REMEDIAL ACTION OBJECTIVES AND ARARS/TBCS

RAOs are medium-specific goals that define the objective of conducting remedial actions to protect human health and the environment. The RAOs specify the materials of concern, potential exposure routes and receptors, and acceptable residual risk that will remain at the site.

The development of remediation goals takes into consideration location-specific and action-specific ARARs and TBCs at this site. There are no chemical-specific ARARs and TBCs as there are no chemical contaminants of concern at this site.

The remedial action selected must reduce risks to and be protective of human health and the environment, maintain that protection over time, and comply with federal and state ARARs/TBCs. Several removal actions have been conducted at LHTR which have significantly reduced the risks to human health and the environment. However, MEC/MPPEH items potentially remain on site. Therefore, to manage the residual risk to site receptors from munitions-related items and MEC/MPPEH that remain at the site, remedial action alternatives were evaluated and are described in the remaining sections of this FS.

2.2.1 Statement of Remedial Action Objectives

To protect the public from potential current and future health risks, as well as to protect the environment, the following RAOs have been developed for LHTR.

RAO No. 1: Prevent and/or reduce the potential for site receptors to come in direct contact MEC/MPPEH items remaining at LHTR.

RAO No. 2: Minimize the impact to wetlands and other natural and archaeological resources located at LHTR.

2.2.2 Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria

ARARs consist of the following:

- Any standard, requirement, criterion, or limitation under federal environmental law.
- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-siting law that is more stringent than the associated federal standard, requirement, criterion, or limitation.

Per 40 Code of Federal Regulations (CFR) 300.400(g)(3), TBCs are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing a remedial action or are necessary for determining what is protective to human health and/or the environment. Examples of TBCs include USEPA Drinking Water Health Advisories, Reference Doses (RfDs) and Cancer Slope Factors (CSFs).

According to 40 CFR 300.430(f)(1)(i)(A), overall protection of human health and the environment and compliance with ARARs are threshold requirements that each remedial alternative must meet to be eligible for selection.

2.2.2.1 Definitions

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) at 40 CFR 300.5 provides the following definitions for ARARs:

- Applicable Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- Relevant and Appropriate Requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, although not "applicable" to a hazardous substance, pollutant, contaminant, or remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

Per 40 CFR 300.400(g)(3), other advisories, criteria, or guidance are to be considered for a particular release. The TBC category consists of advisories, criteria, or guidance developed by USEPA, other federal agencies, or states that may be useful in developing CERCLA remedies.

Under CERCLA Section 121(d)(4), USEPA may waive compliance with an ARAR if one of the following conditions can be demonstrated:

- The remedial action selected is only part of a total remedial action that will attain the ARAR level or standard of control upon completion.
- Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.
- Compliance with the requirement is technically impracticable from an engineering perspective.
- The remedial action selected will attain a standard of performance that is equivalent to that required by the ARAR through the use of another method or approach.
- With respect to a state requirement, the state has not consistently applied the ARAR in similar circumstances at other remedial actions within the state.
- Compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the facility with the availability of Superfund money for response at other facilities (fund-balancing). This condition only applies to Superfund-financed actions.

USEPA in various guidance documents and the NCP has divided ARARs into three categories to facilitate identification. Chemical-specific and location-specific ARARs are identified early in the process, generally during the RI; and action-specific ARARs are normally identified during the FS in the detailed analysis of alternatives. These three types of ARARs are defined as follows:

- <u>Chemical-Specific</u>: Health- or risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples include maximum contaminant levels (MCLs) and Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC).

- Location-Specific: Restrict actions or contaminant concentrations in certain environmentally sensitive areas. Examples of these areas regulated under various federal laws include floodplains, wetlands, and locations where endangered species or historically significant cultural resources are present.

- Action-Specific: Technology- or activity-based requirements, limitations on actions, or conditions involving special substances. Examples of action-specific ARARs include: Resource Conservation and Recovery Act (RCRA) regulations for generation, characterization, and management of hazardous wastes; and CWA effluent limitations and pre-treatment standards for wastewater discharges.

The following section discusses location- and action-specific ARARs and TBCs for this site.

2.2.2.2 Chemical-Specific ARARs and TBCs

Chemical sampling and analysis have resulted in an NFA recommendation; therefore, there are no chemical-specific ARARs or TBCs for this site.

2.2.2.3 Location-Specific ARARs and TBCs

Federal and State of Washington laws and regulations are potential location-specific ARARs/TBCs for any remedial action at LHTR. Potential location-specific ARARs/TBCs include federal and State of Washington regulations, as well as regulations for the protection of fish and wildlife and their habitat, protection of wetlands, and protection of historic and archaeological resources.

Table 2-1 presents federal and State of Washington location-specific ARARs and TBCs for this FS.

2.2.2.4 Action-Specific ARARs and TBCs

Potential action-specific ARARs/TBCs include federal and State of Washington regulations; hazardous waste generation, storage, disposal, and transportation regulations, including specific regulations for MEC-related wastes and solid waste regulations.

Action-specific ARARs/TBCs focus primarily on the management of MEC as a potential explosive hazard. Munitions that would otherwise be classified as hazardous wastes can be managed in accordance with the substantive requirements of the Resource Conservation and Recovery Act and the Washington hazardous waste management regulations when treated wholly on site.

Table 2-2 presents federal and State of Washington action-specific ARARs and TBCs for this FS.

2.3 GENERAL RESPONSE ACTIONS

GRAs are broadly defined remedial approaches that may be used (by themselves or in combination with one or more of the others) to attain the RAOs.

GRAs describe categories of actions that could be implemented to satisfy or address a component of the RAOs for the site. Remedial action alternatives are formed using GRAs singly or in combination to meet the RAOs. The remedial action alternatives, composed of GRAs, will be capable of achieving the RAOs at the site.

The following GRAs will be considered at LHTR:

- No Action
- Land Use Controls
- Detection
- Removal
- Treatment and Disposal

TABLE 2-1

LOCATION-SPECIFIC ARARs AND TBCs
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Requirement/ Criteria	Citation	Synopsis	Status	Evaluation/Action to be Taken
Federal				
Coastal Zone Management Act	16 USC 1451 et seq.	Applies to actions that affect coastal resources. Ensures that remedial action/corrective measures protect coastal resources.	Applicable	A Coastal Zone Consistency Determination will be prepared to identify that the Navy's actions are consistent to the maximum extent practicable with the enforceable policies of the State's Shoreline Management Program.
Floodplain Management and Protection of Wetlands	44 CFR 9	FEMA regulations that set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11988 Floodplain Management and Executive Order 11990, Protection of Wetlands.	Applicable	Remedial actions will take place in a floodplain and near wetlands, alternatives would be considered that would reduce the risk of loss and restore and preserve the floodplain and wetlands.
CWA Section 404(b)(1) Guidelines for Specifications of Disposal Sites for Dredged or Fill Material	33 USC 40 CFR Part 230 and 33 CFR 320-323	Regulates the placement of fill materials in waters of the United Sates including wetlands. No activity which adversely affects an aquatic ecosystem, including wetlands, shall be permitted if a practicable alternative that has less adverse impact is available. If there is no other practical alternative, impacts must be minimized.	Applicable	The Navy will take steps to minimize adverse impacts to wetlands.

TABLE 2-1

LOCATION-SPECIFIC ARARs AND TBCs
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Requirement/ Criteria	Citation	Synopsis	Status	Evaluation/Action to be Taken
Fish and Wildlife Coordination Act	16 USC Part 661 et seq.	Requires any federal agency proposing to modify a body of water to coordinate with the US Fish and Wildlife Service or National Marine Fisheries Service and appropriate state agencies if an alteration of a body of water will occur as a result of remedial activities.	Applicable	Agencies will be consulted, and remedial activities will be conducted to avoid disturbance of affect fish and wildlife and their habitat.
Endangered Species Act	16 USC 1531 et seq.; 50 CFR 17 and 402	Provides for consideration of the impacts on federally-listed endangered/threatened species and their habitats. Requires federal agencies to ensure that any action carried out by the agency is not likely to jeopardize the continued existence of any endangered/threatened species and their habitats.	Applicable	Threatened and/or endangered species have been reported at LHTR as well as nearby LHTR. Site surveys will be conducted prior to beginning remedial activities to determine if any threatened or endangered species are present. If ESA species are present and Navy actions will have an effect on the listed species, then Navy will consult with USFWS and NMFS.
The Bald and Golden Eagle Protection Act	16 USC 668-668(d)	Requires project activities to protect and preserve eagle habitat.	Applicable	Bald eagles have been observed at and near LHTR, and the area has been identified as a current and past nesting site. Appropriate actions will be taken during remedial action to ensure that no eagles and their habitat are affected. Site surveys will be conducted prior to beginning remedial activities to determine if any bald eagles or potential nesting areas are present.

TABLE 2-1

LOCATION-SPECIFIC ARARs AND TBCs
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Requirement/ Criteria	Citation	Synopsis	Status	Evaluation/Action to be Taken
Migratory Bird Treaty Act	16 USC 703-712	Provides protection for migrating birds, nests, and eggs. Makes it illegal for people to "take" migratory birds, their eggs, feathers, or nests.	Applicable	Appropriate actions will be taken during remedial action to ensure that no migratory birds or nests are affected. Site surveys will be conducted prior to beginning remedial activities to determine if any birds and nesting areas are present.
National Historic Preservation Act	16 USC 470 et seq; 36 CFR 800	Preserves sites with archaeological and historic significance. Section 106 of the Act requires consultation with appropriate agencies to identify historic properties potentially affected by the site activities, assess the effects, and seek ways to avoid, minimize, or mitigate adverse effects on historic properties.	Applicable	Archaeologically significant sites have been identified at LHTR that may be disturbed by removal activities, so the State Historic Preservation Office will be consulted per Section 106 of the Act. An archeological specialist will be on site during remedial activities and any identified archeologically significant areas will be protected during remediation.
State				
Shoreline Management Act and State of Washington Coastal Zone Management Program	Chapter 173-27 WAC and Chapter 90.58 RCW	The SMA regulates most shorelines of the state including marine waters, streams and rivers (with a mean annual flow of 20 cfs or more), lakes and reservoirs or water areas of the state (larger than 20 acres), associated wetlands, and portions of the flood plain. The CZMP applies to activities which may impact Washington's coastal resources (within 15 counties specified).	Applicable	Agencies will be consulted, and remedial activities will be conducted to avoid disturbance of shorelines and to minimize impacts to coastal resources in accordance with the Shoreline Management Element of the Island County Comprehensive Plan.

LOCATION-SPECIFIC ARARs AND TBCs
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Requirement/ Criteria	Citation	Synopsis	Status	Evaluation/Action to be Taken
Water Quality Standards For Surface Waters	Chapter 173-201A WAC	Regulates wetland water quality and antidegradation.	Applicable	Remedial actions will take place near wetlands, alternatives would be considered that would reduce the risk of loss and restore and preserve wetlands according to Ecology guidance.

Notes:

ARARs	Applicable or Relevant and Appropriate Requirements.
CFR	Code of Federal Regulations.
CWA	Clean Water Act.
CZMP	Coastal Zone Management Program.
LHTR	Lake Hancock Target Range.
NMFS	National Marine Fisheries Service
RCW	Revised Code of Washington.
SMA	Shoreline Management Act.
TBCs	To Be Considered Criteria.
USC	Unites States Code.
WAC	Washington Administrative Code

TABLE 2-2

ACTION-SPECIFIC ARARs AND TBCs
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Requirement/ Criteria	Citation	Synopsis	Status	Evaluation/Action to be Taken
Federal				
RCRA - Identification and Listing of Hazardous Waste	40 CFR 261, subparts A, B, C, and D	Identifies those solid wastes that are subject to regulation as a hazardous waste.	Applicable	Materials removed during removal action will be analyzed by appropriate test methods and, if applicable, managed in accordance with the substantive requirements of the hazardous waste regulations.
RCRA -Standards Applicable to Generators of Hazardous Waste	40 CFR 262 Subparts A, B, C, and D	Establishes standards for generators of hazardous waste.	Applicable	Any hazardous waste that is generated from during remedial activities would be managed in compliance with these standards prior to disposal.
Military Munitions Rule	40 CFR 266 Subpart M	Regulations identify when military munitions become solid waste, and if hazardous, how they are managed.	Applicable	Military munitions to be disposed of off-site are solid waste. A hazardous waste determination will be made prior to disposal.
LUC Guidance	Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions (DoD/Navy, October, 2003)	Provides a framework for the efficient implementation of land use controls at DoD installations.	To be considered	Land use controls, to restrict residential use, for UXO construction support, and signage, if required, would be developed in the ROD with clear objectives including when and where LUCs will be implemented, and identifying the responsibilities for implementation, monitoring, reporting, and enforcement of LUCs. Implementation actions, operation, maintenance, and enforcement actions would be described in subsequent design documents.

TABLE 2-2

ACTION-SPECIFIC ARARs AND TBCs
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Requirement/ Criteria	Citation	Synopsis	Status	Evaluation/Action to be Taken
State				
Washington Clean Air Act - General Regulations for Air Pollution Sources	RCW 70.94; WAC 173-400-040 (3) and (8)	Establishes standards and rules generally applicable to the control and/or prevention of the emission of air contaminants.	Applicable	Fugitive dust may be generated during munitions and soil excavation, handling, or treatment activities.
Designation of Dangerous Waste	WAC 303-060-070	Identifies those solid wastes that are subject to regulation as a hazardous waste.	Applicable	Wastes may be generated depending on MEC/MPPEH findings and type of treatment.
Requirements for Generators of Dangerous Waste	WAC 303-060-170	Establishes standards for generators of hazardous waste.	Applicable	Any hazardous waste that is generated from during remedial activities would be managed in compliance with these standards prior to disposal.
Dangerous Waste Regulations (Military Munitions)	WAC Chapter 173-303-578	Washington state has adopted portions of the federal MR and amended other portions by developing state-specific military munitions regulations. Military munitions regulations for the State of Washington are located with the state's hazardous waste program regulations, Chapter 173-303 – Dangerous Waste Regulations	Applicable	Munitions will be managed and disposed of according to these regulations.

TABLE 2-2

ACTION-SPECIFIC ARARs AND TBCs
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Requirement/ Criteria	Citation	Synopsis	Status	Evaluation/Action to be Taken
Model Toxics Control Act (MTCA)	WAC Chapter 173-340-100, -110, -200, -360, -370, -400, -410, -420, -800, -810, and -840	Creates a comprehensive regulatory scheme to identify, investigate, and clean up contaminated properties that are, or may be, a threat to human health or the environment. MTCA requires owners and operators to report the discovery of hazardous substances that had been previously released on or under their property.	Applicable	Selection of and implementation of remedial actions will be conducted according to MTCA.

Notes:

ARARs	Applicable or relevant and appropriate requirements.
CFR	Code of Federal Regulations.
DoD	Department of Defense.
LUC	Land Use Control.
MEC	Munitions and Explosives of Concern.
MPPEH	Material Potentially Presenting an Explosive Hazard.
MTCA	Model Toxics Control Act
RCRA	Resource Conservation and Recovery Act.
RCW	Revised Code of Washington.
ROD	Record of Decision.
TBCs	To Be Considered Criteria.
UXO	Unexploded Ordnance
WAC	Washington Administrative Code.

3.0 SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This section identifies, screens, and evaluates the potential technologies and process options that may be applicable to the remedial alternatives for LHTR. The primary objective of this phase of the FS is to develop an appropriate set of remedial technologies and process options to be used for developing the remedial alternatives.

The basis for technology identification and screening began in Section 2.0 with the following:

- Identification of ARARs
- Development of RAOs
- Identification of GRAs

A technology screening evaluation is performed in this section with the completion of the following analytical steps:

- Identification and screening of remedial technologies and process options
- Evaluation and selection of representative process options

A variety of technologies and process options are identified for each GRA (see Section 2.4), and are evaluated to determine if they could achieve the RAOs identified in Section 2.2. The selection of technologies and process options for initial screening is based on the Guidance for Conducting RI/FSs under CERCLA (USEPA, 1988) and MTCA. The screening is first conducted at a preliminary level to focus on relevant technologies and process options; then, the screening is conducted at a more detailed level based on certain evaluation criteria. Finally, technologies and process options retained through the detailed screening process are used to develop remedial alternatives. The screening criteria are:

<u>Effectiveness</u>

The effectiveness evaluation is focused on the following elements:

- Potential effectiveness of process options in handling MEC/MPPEH present at the site and in meeting the RAOs.
- Potential impacts to human health and the environment during the implementation phases.
- Reliability and proven effectiveness of process options with respect to the materials of concern and the site-specific conditions.

Implementability

The implementability evaluation includes both the technical and institutional (administrative) feasibility of implementing each technology or process option. This initial technology screening eliminates technology types or process options that are clearly ineffective or unworkable at the site. The institutional aspects considered include the following:

- Potential for obtaining regulatory approval.
- Availability of necessary equipment and skilled workers to implement the technology.
- Availability of treatment, storage, and disposal services.
- Time required for implementation.
- Ability to achieve the RAOs within a reasonable timeframe.

Cost

For the screening cost evaluation, a qualitative cost analysis is presented to indicate whether costs are prohibitive or if other process options within the same technology type would be comparably effective and implementable but less costly. Preliminary cost estimates for the remedial technologies retained in the screening step are presented in Section 4.

3.1 PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This section identifies and screens remediation technologies and process options based on implementability with respect to site-specific conditions and materials of concern. Table 3-1 summarizes the results of this preliminary screening process. It presents the GRAs, identifies the technologies and process options, and provides a brief description of each process option followed by comments about the results of the screening process.

As indicated in Table 3-1, several process options (towed/cart-mounted detectors, mechanized excavation, mass excavation and mechanized soil processing, disassembly or render safe procedures, and contained detonation chambers) are eliminated as a result of the initial screening process. The technologies and process options retained for more detailed screening include:

General Response Action	Technology	Process Options
No Action	None	Not applicable
Land Use Controls	Engineering Controls - Active Controls	Physical Controls/Fencing and Signage
	Institutional Controls - Passive Controls	Residential Use Restriction/Deed and Zoning Restrictions
		Construction Support
Detection	Visual Observation	Visual Observation and Identification of MEC/MPPEH Items on the Surface
	Instrument-Aided Detection	Use of Hand-Held/Man Portable Magnetometer/Ferrous and All-Metals Detectors
Removal	Surface Removal	Manual Removal from Ground Surface
	Subsurface Removal [up to 1 foot (below ground surface (bgs)]	Manual Excavation/Intrusive Investigation and Removal
Treatment and Disposal	MEC/Material Documented as an Explosive Hazard (MDEH)	Blow-In-Place
		Consolidate and Blow
		MEC Residual Processing
	Material Documented as Safe (MDAS) and Munitions-Related Scrap	Treatment and Transport of MDAS and Munitions-Related Scrap for Off Site Disposal

3.2 DETAILED SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

3.2.1 No Action

No Action consists of maintaining the status quo at a site. As required under CERCLA regulations, the No Action alternative is carried through the FS to provide a baseline for comparison with other alternatives and their effectiveness in mitigating risks posed by site contaminants.

Effectiveness

No Action would not be effective in meeting RAO 1. No Action would not be effective in preventing and/or reducing the potential for site receptors to come in direct contact with MEC/MPPEH and munitions-related scrap remaining at the LHTR because no MEC/MPPEH nor munitions-related scrap removal would take place. Because no action would be taken, there would be no impacts to wetlands and archaeological resources; therefore, RAO 2 would be met.

Implementability

There would be no implementability concerns because no action would be implemented.

Cost

Because there is no action, there are no associated costs.

Conclusion

No Action is retained because of CERCLA requirements, although it would not be effective in reducing the potential for site receptors to come in direct contact with MEC/MPPEH and munitions-related scrap remaining at the LHTR.

3.2.2 Land Use Controls

Land Use Controls (LUCs) would be designed to protect human health and the environment from residual risks present at the LHTR. LUCs would consist of administrative and legal mechanisms (e.g., deed or zoning restrictions, permits, construction support, etc.) designated as institutional controls, and/or physical controls (e.g., fencing, security guards, etc.) designated as engineering controls. Site-specific LUCs would typically be formulated through an LUC remedial design (RD) that is prepared in accordance with the Navy's LUC Principles (DoD, 2003) following approval of the ROD. LUCs would typically also include the performance of regular site inspections to verify continued implementation.

Effectiveness

Site use restrictions would be effective for reducing human and ecological exposure to MEC/MPPEH present at LHTR through the use of access controls and/or implementation of deed restrictions. Permanent or interim deed or zoning restrictions could be effectively used to prevent residential use of the LHTR. UXO support would also be required during any ground disturbing activities (up to 10 feet bgs) at LHTR. The effectiveness of these measures would be dependent on adequate enforcement of the administrative controls. Physical restrictions such as additional signage, fencing, physical barriers, and site security could also be effectively used to restrict access to the LHTR.

Implementability

Currently, site use is controlled by the Navy. If the area is redeveloped in the future, limitations on use (e.g., residential use, well installation, building construction methods) of the LHTR would be readily implementable as part of any property transfer process and documentation. Short-term LUCs would be easily implemented until any remedial action is complete.

Cost

Site use restrictions are generally inexpensive, although long-term administration, enforcement, and maintenance would be required if LUCs are applied long-term.

Conclusion

LUCs are retained for use in combination with other GRAs for the development of remedial alternatives.

3.2.3 Detection

Detection of MEC/MPPEH items on the surface and in the shallow subsurface (up to 1 foot bgs) would need to be conducted before any removal activities could begin. Detection of munitions-related items would be conducted through visual and detector-aided surveys. Hand-held, man portable, magnetometer/ferrous and all-metals detectors would be used to detect anomalies. Areas at LHTR that are covered by standing water and are not solid ground will not be surveyed and will be excluded. It is unknown at this time the exact locations and how much area will be excluded. The locations of the areas not surveyed and excluded will be identified via GPS and these areas will be presented in a Remedial Action Completion Report.

Once a munitions-related item is identified during the remedial action, the UXO Team Leader would make a determination as to whether the item is MEC or MPPEH. If the item is MEC and not safe to move, it would be left in place and prepared for MEC Blow-In-Place (BIP) treatment (see Section 3.2.5.1). If the item is deemed MEC and safe to move, it could be transported to a staging area to await MEC treatment (see Section 3.2.5.1). MPPEH items would be segregated into MDEH and MDAS. MDEH items could be transported to a staging area to await treatment using MEC treatment procedures, or, if determined that the item was not safe to move, it would be left in place and prepared for BIP treatment. MDAS would then be segregated into those requiring demilitarization or venting, and those items that are munitions-related scrap. MDAS would be inspected and certified prior to transport off site to an approved metal recycler (see Section 3.2.5.2).

Effectiveness

Numerous munitions-related items have previously been identified at LHTR; however, the entire removal action area has not been walked/surveyed since the last removal action. Therefore, a visual survey of the entire removal action area would be conducted to identify remaining munitions-related items on the surface. The conduct of visual and detector-aided surveys are the industry standard for locating munitions-related items. It is assumed based on historical munitions use and previous removal actions, that the majority of munitions-related items that would be present at LHTR are ferrous items; therefore, magnetometers would be used to locate shallow subsurface anomalies and to identify surface munitions-related items that may not be visible, e.g., items that may be covered by brush and other vegetation present at the site. There is also the potential that munitions-related items may be made of nonferrous materials; therefore, all-metals detectors will be used during detector-aided surveying. During the visual and detector-aided surveys, UXO Technicians would provide essentially complete coverage of the accessible portions of the removal action area.

Implementability

A visual and detector-aided survey could be easily implemented. The length of time for completion of this phase of a remedial action would be dependent on the number of personnel available to complete the surveys and the area to be surveyed. Prior to surveying, Archeological and Ecological surveys within the removal action area boundary should be conducted to locate known archeological sites and identify wetlands areas where ecological habitat may be impacted by the remedial activities. Detection activities would not adversely affect the ecological habitat as disturbance to the area would be minimal; UXO Technicians would walk the site. Tidal marsh areas that exist at LHTR may be completely submerged during high tide and may remain marshlike at low tide which may hinder work at the site. Therefore, all work will be conducted at low tide to provide optimal access to the site.

Cost

In general, the costs to conduct visual and detector-aided surveys would be low; however, such costs could become high if surveying is to be implemented on an annual basis.

Conclusion

Detection is retained for use in combination with other GRAs for the development of remedial alternatives.

3.2.4 Removal

Process options for surface and subsurface (up to 1 foot bgs) removal of munitions-related items would include manual removal of surface items and manual excavation and removal of subsurface anomalies, up to one foot bgs. Note that metallic non-munitions debris encountered while conducting these remedial activities would also be removed from the site and transported off-site for disposal to an approved commercial metal recycler.

3.2.4.1 Manual Removal of Surface Items

The following types of munitions-related items identified on the ground surface would be manually removed: MEC which is categorized as safe to move; MDEH which is categorized as safe to move; and, MDAS. Once items are “removed,” they would be moved and combined with other MEC, MDEH, or MDAS as appropriate, treated if necessary, and transported off-site for disposal. Each “removal” would be conducted by a UXO team. The removal effort would be carried out by UXO teams, each team consisting of six UXO personnel, these teams would them break into groups appropriately to complete the work. Should items be identified as MEC which are not safe to move, these items would be treated in place before being handled.

Effectiveness

This removal method would be very effective and could provide valuable data about items collected from the surface. This method would focus on recovering each item one at a time. It is also the removal method least likely to expose MEC/MPPEH to inadvertent movement, jarring, or impact that could lead to unplanned detonation.

Implementability

Manual removal could be implemented in almost any terrain and climate and would be limited only by the number of UXO personnel available. This is currently one of the most widely used methods for removal of MEC/MPPEH. Depending on the items identified, equipment required to conduct the surface removals would be minimal.

Manual removal can, however, be very difficult and time-consuming and requires a high degree of direct MEC/MPPEH exposure for workers. Manual-removal is a labor-intensive operation which must be performed by UXO Technicians.

A staging area would need to be established for those items which have been removed while they are awaiting treatment and disposal.

Cost

Costs for hand removal would be moderate depending on how many munitions-related items would be identified, and how many UXO Technicians are available to conduct the removals.

Conclusion

Manual removal is retained because of its effectiveness and ease of implementation. Manual removal will be considered for use in combination with other GRAs and technologies for the development of remedial alternatives.

3.2.4.2 Manual Excavation and Removal of Subsurface Items

Manual excavation is the industry standard for investigation and removal of subsurface anomalies. Without intrusive investigation, the identity of anomalies is unknown. The method involves using manual tools (e.g., shovels, picks, trowels, etc.) to excavate selected items using only human power to do the work. Excavations using manual procedures would be conducted at each anomaly location identified during the detection phase of the remedial activity until the sidewalls and bottom of each small excavation (up to 1 foot bgs and 2 feet diameter) were clear of anomalies. Each excavation would be conducted by an intrusive dig team. Each intrusive “dig team” would consist of qualified UXO personnel.

As described previously, once a munitions-related item is excavated, the UXO Team Leader would make a determination as to whether the item is MEC or MPPEH. If the item is MEC and not safe to move, it would be left in place and prepared for MEC BIP treatment. If the item is deemed MEC and safe to move, it could be transported to a staging area to await MEC treatment. MPPEH items would be segregated by whether they were determined to be MDEH and either not safe to more or safe to move, or MDAS and transported to a staging area to await treatment and disposal.

Effectiveness

This removal method would be very effective, and could provide valuable data about items identified in the subsurface. This method focuses on recovering each item/anomaly one at a time, and the results of each excavation are verified in real-time. It is also the removal method least likely to expose MEC/MPPEH to inadvertent movement, jarring, or impact that could lead to unplanned detonation.

Implementability

Manual excavations could be implemented in almost any terrain and climate, and are the only viable removal method in very tough terrain (e.g., steep, reduced access, etc.). This method is currently the most widely used for removal of munitions-related items, and all firms and personnel in the MEC industry have developed effective methods for this removal technology. Equipment required to conduct the excavations is minimal and consists of manual tools.

Manual excavation can, however, be very difficult and time-consuming and requires a high degree of direct MEC/MPPEH exposure for workers. Manual excavation is a labor-intensive operation which must be performed by UXO Technicians.

Cost

Costs for manual excavation would be moderate and would depend on the number of anomalies identified for excavation, and how many UXO Technicians are available to conduct the excavations.

Conclusion

Manual excavation is retained because of its effectiveness and ease of implementation. Manual excavation will be considered for use in combination with other GRAs and technologies for the development of remedial alternatives.

3.2.5 Treatment and Disposal

The technologies considered under this GRA are MEC/MDEH treatment, and treatment of MDAS and munitions-related scrap. Process options evaluated include: BIP; consolidate and blow; MEC residual processing; and off-site treatment and disposal of MDAS and munitions-related scrap.

As described previously, once a munitions-related item is identified during the detection phase of a remedial action at the site, the UXO Team Leader would make the final determination if the item is MEC or MPPEH, and subsequently if the MPPEH item is MDEH, MDAS, or munitions-related scrap.

3.2.5.1 MEC/MDEH Treatment

If identified at LHTR, MEC/MDEH would need to be treated during the remedial activities. Based on the results of the previous removal actions conducted at this site, and the history of munitions used, it is not anticipated that any MEC/MDEH would be identified at LHTR. Therefore, it is unlikely that any treatment of MEC/MDEH would be required during remedial activities; however, these options will be evaluated and included in the planning and preparation of any remedial activities at LHTR in the event that MEC/MDEH are identified.

Blow-In-Place

BIP is the destruction of MEC/MDEH by detonating the item without moving it from the location where it is found. Normally, this is accomplished by placing an explosive charge alongside the item. Individual MEC/MDEH items are evaluated using this approach, which requires direct exposure of personnel to each individual item. Based on the types of munitions known to have been used at LHTR, and the results of previous removal actions, it is not anticipated that MEC/MDEH would be identified at LHTR. However, if necessary, BIP operations would be conducted by UXO Technicians. After MEC/MDEH treatment, 100 percent of all recovered items would be re-inspected to determine if they are free of explosive hazards and able to be classified as MDAS.

<u>Effectiveness</u>

BIP operations are highly effective, items are disposed of individually, and confirmation is done immediately after disposal operations. This treatment option does not require the movement of MEC/MDEH. This reduces personnel exposure and contributes to workers' safety. However, each MEC/MDEH item must be separately evaluated, which increases the exposure of personnel to danger areas. These operations require a higher ratio of donor/priming explosives for each item (as compared to consolidated disposal operations). These operations also present the possibility of repeated public exposure to demolition operations. Waste streams generated from BIP operations may also fall under further regulatory guidance for treatment and/or final disposition.

<u>Implementability</u>

BIP would be relatively easy to implement when site conditions/environment and location permit. BIP operations are suitable for singular or low-volume MEC/MDEH items located in areas capable of accommodating high-order detonations and providing the associated safety distances. These operations often allow application of certain engineering controls (e.g., shot temping, barriers, and employment of On-Site Ordnance Demolition Containers) which may result in reduced safety distance requirements.

These types of operations require less general area security, signage, and access controls than other treatment operations (consolidate and blow). Scrap and residue collection may also be required after demolition.

Little equipment is necessary for this treatment option other than that associated with demolition materials and equipment. Application of engineering controls would require items such as manual shovels or mechanized handling equipment for earth moving, sand bags, or specific controls such as On-Site Ordnance Demolition Containers. Donor/priming explosives would need to be purchased for demolitions. This would require permits, and a storage area for purchased explosives if these items are to be stored on-site. There would also be many issues to be consider related to the transportation of explosives to the site, and once on site, to the detonation location of the MEC/MDEH item(s) at the site.

This option may adversely impact wetlands and archeological areas known to exist at LHTR, depending on where MEC/MDEH items are located, since MEC/MDEH items are detonated at the location where they are found.

Cost

Costs associated with BIP operations are low compared to other treatment operations. The man-hours associated with this treatment option are approximately the same as other treatment options. Little expense is associated with equipment, with the exception of demolitions materials and equipment. However, costs will increase with the number of demolitions.

Conclusion

BIP is retained for use in combination with other GRAs and technologies for the development of remedial alternatives for any MEC/MDEH item that cannot safely be moved from the location where found. It is not anticipated that any MEC/MDEH items would be located; therefore, this treatment option is not likely to be utilized.

Consolidate and Blow

Consolidate and blow operations are defined as the collection, configuration, and subsequent destruction of MEC/MDEH by explosive detonation. This process can be used “in grid” (i.e., within a current working sector), or at an established demolition ground, but can only be employed for munitions that have been inspected and deemed safe to move. Based on the types of munitions known to have been used at LHTR, and the results of previous removal actions, it is not anticipated that MEC will be identified at LHTR. However, if necessary, consolidate and blow operations would be conducted by UXO Technicians. After MEC/MDEH treatment, 100 percent of all recovered items would be re-inspected to determine if they are free of explosive hazards and able to be classified as MDAS.

Effectiveness

Consolidate and blow operations are very effective and are suitable for limited operations involving large numbers of stable MEC/MDEH items. This option requires fewer planned explosions than BIP to affect disposal of the MEC/MDEH items. Additionally, in many cases, MEC/MDEH items that are being destroyed can serve as donor explosives for other munitions that are harder to destroy. More time is required to assemble the shots than would be necessary to address individual MEC/MDEH items such as with BIP. This increases personnel exposure, and movement and configuration of MEC/MDEH for consolidation operations requires a greater number of personnel to remain in proximity/contact with MEC/MDEH for a greater period of time.

There is also greater risk of kick-outs as the quantity of munitions in each respective shot increases. An increase in kick-outs results in a larger area potentially affected by kick-outs where scrap and residual collection would be required. This increases the difficulty in locating all kick-outs after demolition operations cease. In addition, the larger shot size would increase security/control requirements. Furthermore, waste streams generated from consolidate and blow operations could fall under further regulatory guidance for treatment and/or final disposition.

Implementability

Specific requirements regarding surrounding features (e.g., buildings roads, etc.) and area size must be addressed prior to implementing this MEC treatment option, but special tools and equipment required for implementation are limited. Larger detonations also increase the coordination concern with other agencies (e.g., Federal Aviation Administration and/or military air traffic control, etc.).

Additionally, there may be special requirements for protective packaging and transportation of MEC/MDEH to the consolidation area. If vehicles are needed, they may be required to meet Department of Transportation (DOT) and other agency requirements for transport of ammunitions and explosives. Planning for consolidate and blow operations must also take into account the possibility that MEC/MDEH may have to be temporarily stored if an interruption or suspension of work takes place during the remedial activity. Consolidate and blow operations also require increases in both occurrence and complexity of site communications. In addition, emergency fire support requirements increase as the site increases in size in order to ensure adequate coverage in the event of a fire. An area would need to be identified for the consolidation and detonation area.

Cost

Costs associated with consolidate and blow operations are moderate compared to other treatment operations. The man-hours associated with this treatment option are approximately the same as other treatment options; however, there may be additional equipment/vehicle requirements in order to transport MEC/MDEH/munitions. Security, signage, and access controls costs would also increase as demolition and safety areas increase.

Conclusion

Consolidate and blow is retained for use in combination with other GRAs and technologies for the development of remedial alternatives for MEC/MEDH items identified that are safe to move. It is not anticipated that any MEC/MDEH items will be located; therefore, this treatment option is not likely to be utilized.

MEC Residual Processing

MEC/MDEH treatment activities leave behind residue ranging from packaging materials to metal scrap from munitions. Metallic scrap can (and often must) be recycled in accordance with DoD regulations. This scrap must have all hazardous materials (including explosives and other MC) removed prior to releasing it to commercial facilities. MEC/MDEH items may need to undergo one or more residual treatment processes to meet the requirements for being classified as free of explosives.

The methods evaluated include: chemical decontamination; flashing furnaces; and shredding, cutting, and other manual procedures.

Chemical Decontamination

Chemical decontamination is still in development and three of the more studied methods include: supercritical water oxidation, photocatalysis, and molten salt oxidation.

Effectiveness

Compared to other MEC residual processing methods, the effectiveness of chemical decontamination is low to medium. Most of these methods are still in some stage of development or testing.

Implementability

Compared to other MEC residual processing methods, chemical decontamination is not easily implemented because of added equipment, facilities, skilled labor, and possible hazardous materials requirements.

Cost

Relative costs are medium to high when compared to other MEC residue treatment options.

Conclusion

Chemical decontamination is not retained for use in the development of remedial alternatives because of its low to medium effectiveness and ease of implementability, and relatively high cost.

Flashing Furnaces

The purpose of flashing furnaces is to thermally remove minor explosives residue from metallic scrap. These types of systems are also known by terms such as deactivation chambers, deactivation furnaces, and incinerators.

Effectiveness

Compared to other MEC residual processing methods, the effectiveness is high. Flashing furnaces are highly effective in removing minor residue from metal scrap. This is one of the best methods available for obtaining the highest level decontamination standards.

Implementability

Flashing furnaces require additional facilities and equipment, but not as much as other technologies such as blast chambers. These systems also produce hazardous waste streams requiring further disposition. Therefore, compared to other MEC residual processing methods, the use of flash furnaces is not easily implemented.

Cost

Flashing furnaces present relatively high costs among residue treatment options.

Conclusion

Flashing furnaces are not retained for use in the development of remedial alternatives because of medium ease of implementability and relatively high cost.

Shredding/Cutting and Use of Other Manual Procedures

These technologies are intended to deform and/or demilitarize munitions-related items, thus making them unusable for weapons purposes. This results in unusable remnants and overall reduced volume of scrap. These options can also be used with MDAS (see Section 3.2.5.2).

Effectiveness

Compared to other MEC residual processing methods, the effectiveness is moderate. However, if an explosive hazard and/or MC are present, these methods offer no integral means of eliminating these hazards from scrap and residue; therefore, additional processes and equipment are required.

Implementability

Compared to other MEC residual processing methods, shredding/cutting and the use of other manual procedures is relatively easy to implement, depending on the equipment required/used.

Cost

The cost of some shredding/cutting equipment may be high as compared other equipment used in other manual procedures that may be used for this technology. Therefore, costs will depend on the type of equipment used for this technology. Commercial metal recyclers can also be used in some cases to conduct the shredding/cutting, which may require lower costs than renting or buying shredding/crushing equipment.

Conclusion

This technology is retained for use in the development of remedial alternatives. However, only the use of manual procedures for shredding/cutting and off-site commercial metal recyclers is retained. It is not anticipated that any MEC/MDEH items will be located; therefore, this treatment option is not likely to be utilized for MEC/MDEH. However, this technology is being retained for use with MDAS (see Section 3.2.5.2); therefore, if MEC/MDEH are identified at LHTR, this technology can be used to treat both MEC/MDEH and MDAS items.

3.2.5.2 Treatment and Off-Site Disposal of MDAS and Other Munitions-Related Scrap

Once a munitions-related item is identified as MDAS or munitions-related scrap, has been treated as necessary, and MDAS is certified and verified, then these items can be released to a certified subcontractor/approved commercial metal recycler for off-site disposal.

MDAS items requiring treatment/demilitarization (resembling military munitions) or venting may be treated/demilitarized on site using manual procedures, or containerized and transported to an approved commercial metal recycler. Certified MDAS and any metallic non-munitions debris would be transported off-site for disposal to an approved commercial metal recycler. An “End Use” certification would be generated confirming that the material has been recycled.

Effectiveness

Manual procedures would be very effective for demilitarizing MDAS items expected to be found at LHTR. Should treatment be required, a 100 percent inspection of the demilitarized scrap would be conducted after treatment to ensure no resemblance to military munitions. Once this has been completed, the scrap could be transported to a qualified recycler and recycled. The use of off-site commercial metal recyclers is the industry standard for disposal of MDAS.

Implementability

Manual procedures would be easily implementable, depending on the type of equipment used. Additionally, a recycler that accepts munitions-related scrap would need to be located. No explosives or chemicals are required for this technology and no secondary waste streams are produced. Special consideration would be given to safety issues and associated liabilities when considering and choosing a commercial metal recycler. Particular attention is required during the classification of items, MDAS certification, and documentation of quality assurance (QA)/quality control (QC) procedures associated with the remedial activities. Certification of any scrap leaving the site will require careful inspection by qualified personnel (UXO Technician).

An area would also need to be found for staging and storage of MDAS until the commercial metal recycler could pick up the items.

Cost

The purchase or rental of equipment to be used during manual procedures would be inexpensive. Some commercial metals recycling companies will purchase and/or accept MDAS and munitions-related scrap at little to no cost.

Conclusion

This technology is retained for use in the development of remedial alternatives because of its effectiveness, ease of implementation, and relative cost. The use of manual procedures for shredding/cutting and off-site commercial metal recyclers are retained. This technology is also being retained for use with MEC/MDEH, if MEC/MDEH are identified at LHTR.

3.3 SELECTION OF REPRESENTATIVE TECHNOLOGIES AND PROCESS OPTIONS

The technologies and process options, under the GRAs as noted, were retained for use in combination with other GRAs and technologies for the development of remedial alternatives. The exception is No Action which will be retained as a stand-alone alternative.

The next step was to select representative process options from each technology to assemble an adequate variety of alternatives, and evaluate the alternatives in sufficient detail to aid in the final selection process. The alternatives are presented in Section 4.

TABLE 3-1

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Technology	Process Options	Description	Screening Comment
No Action	Not Applicable	No activities would be conducted at the site.	**Retain: Required by law, retain for baseline comparison to other technologies.**
Land Use Controls	Engineering Controls - Active Controls (Physical Barriers/ Security Guards)	Fencing, markers, and warning signs to restrict site access.	**Retain. Restricted access would reduce risk of exposure and potential disturbance of MEC/MPPEH.**
	Institutional Controls - Passive Controls (Restrictions on land use type)	Administrative action, such as restrict the future land use to military land use.	**Retain. This option will be retained for consideration to prevent residential development.**
	Institutional Controls - Passive Controls (Construction Support)	UXO support during any ground disturbing activities (up to 10 feet bgs).	**Retain. Would reduce risk of exposure and potential disturbance of MEC/MPPEH during any future intrusive actions.**
Detection	Visual Observation	Visually locate and identify surface MEC/MPPEH and MDAS items.	**Retain. Visual observation is retained to identify surface MEC/MPPEH and MDAS items.**
	Hand-held/man portable magnetometer/ferrous and all-metals detectors	UXO Technicians will carry ferrous and all-metals detectors during surveying.	**Retain: UXO Technicians would walk across site carrying metal detectors to identify anomalies.**
	Towed/cart-mounted magnetometer/ferrous and all-metals detectors	Detector is mounted and UXO Technician will push/pull detector across site.	Eliminate. Due to site conditions (soft sediment which is often covered with water) it would be difficult to pull carts, etc., across the site.
Surface Removal	Manual Removal	Remove MEC/MPPEH and MDAS items identified on the ground surface.	**Retain. Manual removal is retained to remove MEC/MPPEH and MDAS items.**

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Technology	Process Options	Description	Screening Comment
Subsurface Removal (to 1 foot bgs)	Manual Excavation	Utilization of manual tools and procedures to investigate and remove individual anomalies.	**Retain. Manual excavation is retained to investigate and remove anomalies.**
	Mechanized Excavation	Use of common construction equipment to dig anomalies (backhoe, bulldozer, loader, etc.).	Eliminate. Would destroy wetlands and archaeological areas at the site. Would be difficult to use due to site conditions (soft sediment which is often covered with water).
	Mass Excavation and Sifting/Mechanized Soil Processing	Use of armored excavation equipment for high-volume earth moving.	Eliminate. Would destroy wetlands and archaeological areas at the site. Would be difficult to use due to site conditions (soft sediment which is often covered with water).
Treatment MEC/MDEH	Blow-in-Place	Detonation of explosive materials without moving the item from the location where it was found.	**Retain: Addresses MEC/MDEH items which cannot safely be moved from the location they are found. There would be potential to damage wetlands and archaeological areas at the site.**
	Consolidate and Blow	The collection, configuration, and subsequent destruction by explosive detonation of MEC/MDEH.	**Retain: Address MEC/MDEH items that can be safely moved from the location they are found. Munitions will be collected, moved, and detonated in a designated disposal area, outside of wetlands and archaeological sites.**
	Contained Detonation Chambers	Involves detonation in chamber, vessel, or facility designated and constructed chamber for the purpose of containing blast and fragments from MEC/MDEH detonation.	Eliminate: It is not expected that many MEC/MDEH items, if any, will need to be detonated. Would be costly and not easily implemented.

TABLE 3-1

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Technology	Process Options	Description	Screening Comment
	Disassembly or Render Safe Procedures	These procedures enable the neutralization and/or disarming of munitions to occur. Additional disposal procedures are generally required along with this process option. Must be conducted by military EOD.	Eliminate: Hazardous to personnel performing procedures. Procedures are manpower intensive and specialized tools and equipment are required. Difficult to implement.
	MEC Residual Processing	Should BIP or consolidate and blow be conducted, these activities may leave behind residue ranging from packaging materials to metal scrap from munitions. This scrap must have all hazardous materials (MC) removed prior to releasing it to commercial facilities for disposal.	**Retain: Should MEC/MDEH be identified on-site, residual processing may need to take place.**
Treatment and Disposal of MDAS, Munitions-Related Scrap, and Metallic Non-Munitions Debris	Treatment and Off-Site Disposal	Treatment of MDAS and other munitions-related scrap and disposal of certified MDAS, munitions-related scrap and other metallic non-munitions debris at a permitted off-site facility.	**Retain. Off-site disposal of certified MDAS, munitions-related scrap, and other metallic non-munitions debris is retained for use with surface removal and subsurface excavation options.**

bgs = below ground surface
EOD = Explosive ordnance disposal
MC = Munitions constituents
MDAS = Material documented as safe
MDEH = Material documented as an explosive hazard
MEC = Munitions and explosives of concern
MPPEH = Material potentially presenting an explosive hazard
UXO = Unexploded ordnance

4.0 ASSEMBLY AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents an evaluation of each remedial alternative with respect to the criteria of the NCP (40 CFR Part 300). These criteria and their relative importance are described in the following subsections.

4.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES

As outlined in Sections 2.2 and 2.3, RAOs and GRAs for the Site were developed to: 1) prevent and/or reduce the potential for site receptors to come in direct contact with MEC/MPPEH items remaining at LHTR, and 2) to minimize the impact to wetlands and other natural and archaeological resources located at LHTR. This section presents the development and detailed analysis of the remedial alternatives to achieve the Site RAOs. Each alternative was developed from the technologies that were retained from the screening process presented in Section 3. The alternatives incorporate a variety of technologies. From the technologies retained from the preliminary screening summarized in Table 3-1, the following potential remedial alternatives were developed to mitigate the potential risk to site receptors at LHTR from MEC/MPPEH:

- Alternative 1: No Action
- Alternative 2: Surface Removal with Land Use Controls
- Alternative 3: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
- Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls

Note: Based on the results of the previous removal actions conducted at this site, and the history of munitions used, it is not anticipated that any MEC/MDEH would be identified at LHTR. Therefore, it is unlikely that any treatment of MEC/MDEH would be required during remedial activities; however, these options are evaluated and included in the planning and preparation of Alternatives 2 through 4 at LHTR in the event that MEC/MDEH are identified at LHTR.

4.1.1 <u>Evaluation Criteria</u>

In accordance with the NCP (40 CFR Part 300.430), the following nine criteria are used for the evaluation of remedial alternatives:

- Overall Protection of Human Health and the Environment.
- Compliance with ARARs.
- Long-Term Effectiveness and Permanence.

- Reduction of Toxicity, Mobility, or Volume through Treatment.
- Short-Term Effectiveness.
- Implementability.
- Cost.
- State Acceptance.
- Community Acceptance.

The last two evaluation criteria, State Acceptance and Community Acceptance, are not formally addressed until the ROD is prepared. Each of the remaining seven criteria are discussed below.

4.1.1.1 Overall Protection of Human Health and the Environment

Alternatives must be assessed for adequate protection of human health and the environment, in both the short and long term, from unacceptable risks posed by hazards or contaminants present at the site by eliminating, reducing, or controlling exposure to these hazards. Overall protection draws on the assessments of the other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

4.1.1.2 Compliance with ARARs

Alternatives must be assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility siting laws. CERCLA Section 121(d), specifies in part, that remedial actions for cleanup of hazardous substances must comply with requirements and standards under federal or more stringent state environmental laws and regulations that are applicable or relevant and appropriate (i.e., ARARs) to the hazardous substances or particular circumstances at a site, or a waiver must be obtained [see also 40 CFR 300.430(f)(1)(ii)(B)]. ARARs include only federal and state environmental or facility siting laws/regulations and do not include occupational safety or worker protection requirements. In addition, per 40 CFR 300.405(g)(3), other advisories, criteria, or guidance may be considered in determining remedies (TBC guidance category).

4.1.1.3 Long-Term Effectiveness and Permanence

Alternatives must be assessed for the long-term effectiveness and permanence they offer, along with the degree of certainty that the alternative would prove successful. Factors to be considered, as appropriate, include the following:

- Magnitude of Residual Risk - Risk posed by residual materials at the conclusion of remedial activities. The characteristics of residuals should be considered to the degree that they remain hazardous, taking into account their volume and mobility.

- Adequacy and Reliability of Controls - Controls such as containment systems and LUCs that are necessary to manage residual materials and untreated waste must be shown to be reliable. In assessing controls, the following must be considered: the uncertainties associated with land disposal for providing long-term protection from residuals; the potential need to replace technical components of the alternative; and potential exposure pathways and risks posed if the remedial action needs replacement.

4.1.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which the alternative employs recycling or treatment that reduces the toxicity, mobility, or volume is to be assessed, including how treatment is used to address the principal threats posed by the site. Chemical contamination is not a concern at this site; therefore, toxicity is not a concern. Factors to be considered, as appropriate, include the following:

- The treatment or recycling processes the alternative employs and the materials that these processes will treat.

- The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled.

- The degree of expected reduction in mobility or volume of waste as a result of treatment or recycling, and the amount of reduction(s) that is occurring.

- The degree to which the treatment is irreversible.

- The type and quantity of residuals that will remain following treatment considering the persistence and mobility of such substances.

- The degree to which treatment reduces the inherent hazards posed by the principal threats at the site.

4.1.1.5 Short-Term Effectiveness

The short-term impacts of the alternatives are to be assessed considering the following:

- Short-term risks that might be posed to the community during implementation.

- Potential impacts on workers during the remedial action and the effectiveness and reliability of protective measures.

- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation.

- Time until protection is achieved.

Although not a CERCLA-criterion, the sustainability of each alternative is also evaluated per Navy policy. Sustainability factors are similar to those evaluated as part of the Short-Term Effectiveness criterion, so they are discussed in this section. Sustainability evaluations provide insight into elements of a remedy that have the greatest impact on the environmental footprint. Other factors that are considered include emissions of criteria air pollutants, water usage, and energy consumption. Sensitivity analysis of such factors can help provide an optimal design that minimizes the overall environmental footprint of the remedial action. Sustainability evaluations were performed for each remedial alternative and are provided in Appendix A.

4.1.1.6 Implementability

The ease or difficulty of implementing the alternatives is to be assessed by considering the following types of factors, as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, reliability of the technology, ease of undertaking additional remedial actions, and ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities to be coordinated with other offices and agencies, and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions).

- Availability of services and materials, including the availability of adequate off-site treatment capacity, storage capacity, and disposal capacity and services; availability of necessary equipment and specialists and provisions to ensure necessary additional resources; availability of services and materials; and availability of prospective technologies.

4.1.1.7 Cost

Capital costs, including both direct and indirect costs, and annual operations and maintenance (O&M) costs are provided. A net present value of the capital and O&M costs is also provided. Typically, the cost estimate accuracy range is plus 50 percent to minus 30 percent.

4.1.2 Relative Importance of Criteria

Among the nine criteria, the threshold criteria are considered to be:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs (excluding those that may be waived)

The threshold criteria must be satisfied for an alternative to be eligible for selection.

Among the remaining criteria, the following five criteria are considered to be the primary balancing criteria:

- Long-Term Effectiveness and Permanence.
- Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment.
- Short-Term Effectiveness.
- Implementability.
- Cost.

The balancing criteria are used to weigh the relative merits of the alternatives.

The remaining two of the nine criteria (State Acceptance and Community Acceptance) are considered to be modifying criteria that must be considered during remedy selection. The state's concerns that must be assessed include the state's position and key concerns related to the preferred alternative and other alternatives, and state comments on ARARs or the proposed use of waivers. The assessment of community acceptance consists of evaluating community responses to the Proposed Plan, and includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. These last two criteria will be evaluated after the FS has been reviewed by the State of Washington and the Proposed Plan has been made available for public review and comment.

4.1.3 Selection of Remedy

The selection of a remedy is a two-step process. The first step consists of identification of a preferred alternative and presentation of the alternative in a Proposed Plan to the community for review and comment. The preferred alternative must meet the following criteria:

- Protection of human health and the environment.
- Compliance with ARARs unless a waiver is justified.
- Cost effectiveness in protecting human health and environment and in complying with ARARs.
- Utilization of permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable.

The second step consists of the review of the public comments and determination of whether or not the preferred alternative continues to be the most appropriate remedial action for the site, in consultation with the State of Washington.

4.2 ASSEMBLY AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The detailed descriptions and evaluation of the remedial alternatives developed for LHTR are presented in Sections 4.2.1 through 4.2.4.

Alternative 1 was developed and analyzed to serve as a baseline for comparison to the other alternatives, as required by CERCLA and the NCP. Alternatives 2, 3, and 4 were developed to allow for different variations of removal of surface and/or subsurface munitions-related items at LHTR. A description and detailed analysis of these alternatives are presented in the following sections.

The areas shown on Figures 4-1, 4-2, and 4-3 were selected as the area(s) for active remediation/removal action, because based on historical use and results of past removal actions, these are the areas which would be expected to contain the highest density of munitions-related items.

4.2.1 Alternative 1: No Action

4.2.1.1 Description

The No Action alternative maintains the site as is. This alternative would not be effective in preventing and/or reducing the potential for site receptors to come in direct contact with MEC/MPPEH items remaining on the surface and in the shallow subsurface, because no MEC/MPPEH removal would take place. This alternative is retained to provide a baseline for comparison to other alternatives. It should be noted that the government will respond to any MEC discovery at this site regardless of whether the site is designated for "No Action."

4.2.1.2 Detailed Analysis

Overall Protection of Human Health and the Environment

No action would not result in any reduction in explosive safety hazard risks at the site. There could be unacceptable risks to human health and the environment from direct exposure to MEC/MPPEH. Because no action would be taken, there would be no impacts to wetlands and potential archaeological resources.

Compliance with ARARs and TBCs

Because no action would take place, Alternative 1 would comply with some location and action-specific ARARs or TBCs listed in Tables 2-1 and 2-2.

Long-Term Effectiveness and Permanence

Alternative 1 would have little long-term effectiveness and permanence because exposure to MEC/MPPEH would continue, and there would be no LUCs to restrict residential development, to construct additional engineering controls, or to provide UXO construction support.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 would not reduce the volume of MEC/MPPEH present at this site because no remedial activities would occur. Toxicity and mobility of contaminants are not a concern at this site as there are no chemical contaminants of concern. However, if MEC/MPPEH are identified on-site there may be potentially hazardous substances associated with these items, and environmental sampling would need to be conducted to confirm their presence.

Short-Term Effectiveness

Because no action would occur, implementation of Alternative 1 would not have any short-term adverse impact from cleanup activities to the local community or the environment. Alternative 1 would achieve the RAO of not adversely impacting wetlands and other natural and archaeological resources located at the site because no action would occur. However, munitions-related items that are present at LHTR would remain on-site, and their presence may adversely impact the wetlands and archeological resources over time.

Implementability

Because no action would occur, Alternative 1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable. Implementability of additional administrative measures is not applicable because no such measures would be taken.

Cost

There is no cost associated with the No Action alternative.

4.2.2 Alternative 2: Surface Removal with Land Use Controls

4.2.2.1 Description

The following activities would be associated with the implementation of Alternative 2:

- Archeological and Ecological/Wetlands surveys within the removal action area boundary to locate known archeological sites and identify wetlands areas prior to the beginning of any remedial action activities (see Figure 4-1). The boundaries/locations of these areas would be recorded via Global Positioning System (GPS) for future reference. Based on previous investigations and observations during the site visit, it is assumed that all of the proposed removal action area is identified as wetlands. It is assumed that remedial activities would impact wetlands; activities would be conducted to mitigate damage to wetlands. Further, based on previous archeological surveys (URS Consultants, 1996), it is assumed that archeologically significant areas are not present within the removal action area boundary. An archeological expert will be on site during excavations to ensure that potential archeological areas are not present and if so, are not disturbed.

- Visual and detector-aided (magnetometer and all-metals detectors) surveys to locate surface munitions-related items within the removal action area (Figure 4-1). The site would be subdivided into grids prior to surveying. All work would be conducted at low tide.

- Identification of areas with a high density of munitions related items would take place during the detection phase of the remedial activity and would include target areas and those areas where more than 10 munitions items were identified in a grid. The boundaries of these areas would be recorded via GPS for future reference.

- Manual removal of surface items within the entire removal action area. Metallic non-munitions debris encountered while conducting these remedial activities would also be removed from the site and transported off-site.

- Determination by the UXO Team Leader as to whether detected munitions-related items are MEC or MPPEH. If an item is MEC and not safe to move, it would be left in place and prepared for MEC BIP treatment. If an item is deemed MEC and safe to move, it could be transported to a staging area to await MEC treatment. MPPEH items would be further differentiated as either MDEH or MDAS. MDEH items could be transported to a staging area to await MEC treatment procedures, or if determined unsafe to move, would be left in place and prepared for BIP treatment. MDAS would be further classified as either requiring demilitarization or venting, or as being munitions-related scrap. MDAS would be inspected and certified prior to transport off site to an approved metal recycler.

- If MEC is identified on the surface within 50 feet of the edge of the investigation area, step-outs will be conducted in 50-foot increments in all directions to form a 50 by 50 foot grid.

- The recording of the location of MEC/MDEH items using GPS. All items would be given a unique identification number, and all information and observations would be recorded on the MEC Tracking Log. No MEC/MDEH item would be moved until a positive identification is made.

- Depending on the density of MDAS and other munitions-related scrap items identified, it may be impractical to record individual item's locations and identity via GPS. Therefore, "areas" of MDAS and munitions-related scrap items would be recorded if the density of such items is so great that it would be impractical to record individual locations. In such cases, the number(s) and type(s) of items would be qualitatively described.

- Treatment of MEC/MDEH, in the event that such items are identified at LHTR. However, based on the results of the previous removal actions conducted at this site and the history of munitions used, it is not anticipated that MEC/MDEH would be identified at LHTR, still, these activities would need to be included in the remedial alternative for planning and preparation in the event that MEC/MDEH are identified at LHTR.

- If MEC/MDEH items are identified at LHTR, explosive substances (MC) could be present and confirmatory sampling would need to be conducted after these items are removed from the site to confirm the absence or presence of potential chemical contamination (MC only).

- Re-inspection of 100 percent of all recovered items after MEC/MDEH treatment to determine if they are free of explosive hazards and able to be classified as MDAS.

- Onsite treatment/demilitarization of MDAS items resembling military munitions or in need of venting. Items could also be containerized and transported off-site to an approved commercial metal recycler.

- Transport of certified MDAS and any metallic non-munitions debris to an approved off-site commercial metal recycler for disposal.

- Obtaining an "End Use" certification confirming that material has been recycled.

- Surface inspection annually of the high density areas with surface removal, as necessary.

  - The need for annual inspections of high density areas would be evaluated after three annual inspections and would be reduced to every five years (in high density areas only) if no MEC/MDEH or less than 10 MDAS items are identified in the most recent survey.

  - Once reduced to five-year inspections of high density areas, five-year inspections would be ended after one five-year inspection with no MEC/MDEH and less than 10 MDAS items identified.

- Surface inspections every five years within entire removal action area (as shown on Figure 4-1) with surface removal, as necessary.

  - The need for five-year inspections within the entire removal action area would be evaluated after two five-year inspections and would be ended if no MEC/MPPEH items or less than 10 MDAS items are identified.

- Application of LUCs to the entire LHTR site. LUCs would include:

  - Residential use restrictions. Land use would be restricted to military uses.

  - Construction support for any intrusive/construction activities in this area. UXO support would be necessary during any ground-disturbing activities (up to 10 feet bgs).

  - Signage designating area as restricted access area and potential UXO area.

  - An annual one-day site visit would be conducted to verify LUCs.

4.2.2.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 2 would be protective of human health and the environment.

Surface removal of munitions-related items would reduce the risk of exposure and direct contact for both human and ecological receptors whose most likely exposure would be contact with MEC via handling/removing or walking overtop of items. Surface removal in high density munitions areas would be repeated on an annual basis while surface removal would be repeated throughout the entire removal action area every 5 years. This would ensure that munitions-related risks at the site are being reevaluated regularly, and mitigated if present. A site receptor would have to disturb a munitions-related item to be exposed to explosive hazards; therefore, by actively removing these items, the risks would be reduced and this alternative would be protective of both human health and the environment.

Although less likely, exposure to MEC items in the shallow subsurface would be possible for both human and ecological receptors. Furthermore, items located in the subsurface could migrate to the surface through erosion and tidal activity. Alternative 2 does not directly address subsurface munitions related items. Although risks in the subsurface would not be immediately addressed, these risks would be addressed in future annual removals as munitions items present in the subsurface would eventually migrate to the surface over time.

Application of LUCs would also be protective of human health and the environment by reducing the risk of exposure and direct contact to MEC/MPPEH located at this site. LUCs would include restrictions to prevent residential use, UXO support during any ground-disturbing activities (up to 10 feet bgs), and the installation of additional signs, fencing, and physical barriers.

Compliance with ARARs and TBCs

Alternative 2 may not comply with ARARs and TBCs that deal with wetlands and other ecologically sensitive areas because this alternative does not exclude the performance of remedial activities within wetlands. Activities will be conducted to mitigate damage to wetlands and other ecological sensitive areas and an archeological expert would be on site to ensure that potential archeological areas are not disturbed. Alternative 2 would comply with all other ARARs and TBCs. The location- and action-specific ARARs and TBCs are listed in Tables 2-1 and 2-2. Table 4-1 provides a list of guidance that will also be evaluated and used, as applicable, during the remedial action.

Long-Term Effectiveness and Permanence

Alternative 2 would provide long-term effectiveness and permanence through the performance of annual surface removals within high density munitions areas, and surface removals within the entire removal action area every 5 years. This alternative does not immediately address items potentially located in the subsurface. No MEC detection method is 100 percent accurate, and based on site history, munitions-related items would most likely remain on the surface and in the subsurface after the initial removal action is complete. Even though the subsurface is not directly addressed in this alternative, munitions items would likely migrate from the subsurface to the surface via surface erosion and tidal activity; therefore, the annual surface inspections and removals would be conducted in response to the presence and migration of MEC/MPPEH items at the site, and would reduce risk of exposure for receptors to residual MEC hazards which would remain on-site. The removal frequency would be evaluated periodically and could be reduced if appropriate. Furthermore, the engineering and administrative controls proposed as LUCs in this alternative are considered reliable and would be effective to reduce the risk of exposure and direct contact for both human health and ecological receptors. Engineering controls, such as fencing and signs, would need to be monitored and periodically repaired and/or replaced.

Reduction of Toxicity, Mobility, or Volume through Treatment

There are no COPCs present at LHTR; therefore, toxicity and mobility of chemical contaminants are not a concern at this site. By conducting the removal action(s), the volume of munitions-related items located at LHTR would be reduced. Furthermore, any metallic items removed from LHTR would be sent to an off-site metals recycler for disposal. If MEC/MPPEH items are identified at LHTR, explosive substances (MC) could be present and confirmatory sampling would need to be conducted after these items are removed from the site to confirm the absence or presence of potential chemical contaminants (MC only).

Short-Term Effectiveness

Alternative 2 would reduce human health and ecological risks in the short term because risks to site receptors would be reduced as soon as the first removal action was completed. While this alternative does not directly address the subsurface, it is expected that these items would migrate to the surface over time via erosion and tidal activity, and would be addressed during future removals. Exposure of workers to explosive hazards may be present during remedial activities, but would be minimized by compliance with the requirements of the Occupational Safety and Health Administration (OSHA) and other explosives safety guidance, including wearing of appropriate personal protective equipment (PPE) and adherence to site-specific health and safety procedures. However, if MEC/MPPEH items are identified at the site and detonations occur, these detonations could impact the surrounding community. Implementation of LUCs would not adversely impact the surrounding community or the environment.

Wetlands and archaeological areas would be identified prior to the beginning of remedial activities to ensure that any impact would be minimized. If wetlands were adversely impacted, such as if by MEC/MDEH detonations on site, the loss would be temporary, although it would be years before the original conditions were restored.

Sustainability evaluations were performed for this remedial alternative and are provided in Appendix A. Since the excavating will be done by hand, there will be no heavy equipment used and any impacts would only come from transportation. Greenhouse gas (GHG) emissions would be approximately 12.6 tons. NO_x, SO_x, and PM_{10} emissions would result from transportation. Site transportation would contribute to energy demand. Water usage is not associated with this alternative.

Implementability

This remedial alternative would occur in phases as described in Section 4.2.2.1. The performance of these activities would require a high degree of coordination between field personnel, the Navy, and other parties involved in the remedial activity. The visual and detector-aided surveys could be easily implemented and the length of time for completion would depend on the number of UXO personnel available to complete the surveys.

Surface inspection and manual removal are easily implemented and can be implemented in almost any terrain and climate. Manual removal is a very labor-intensive operation, can be very difficult and time-consuming, and would also require a high degree of direct MEC/MPPEH exposure for workers should MEC/MPPEH be identified at LHTR. Equipment utilized during this phase would be easy to obtain (manual tools) and would be relatively inexpensive.

Should MEC/MPPEH be identified at LHTR, the treatment of these items would not be easily implemented. Permits would be required to obtain donor/priming explosives, an area for staging and storage of explosives for detonation would be required, and higher general area security, signage, and access controls would be required than if treatment were not necessary. If MEC are moved, there would be special requirements for protective packaging and transportation of MEC to the consolidation area for treatment. Should items be located that cannot be moved, the detonations could adversely impact wetlands and archeological areas known to exist at LHTR.

The use of manual tools for treatment/demilitarization, if necessary, would be easily implementable, depending on the type of equipment used. Additionally, a commercial metal recycler that accepts munitions-related scrap would need to be located. Furthermore, special consideration would need to be given to safety issues and associated liabilities when considering and choosing a commercial metal recycler. Particular attention would be required during classification of items, MDAS certification, and in the documentation QA/QC procedures associated with the remedial activities. Certification of any certified MDAS and munitions-related scrap leaving the site would require careful inspection by qualified personnel (UXO Technician). An area would also need to be found for staging and storage of MDAS and munitions-related scrap items until the commercial metal recycler could pick up the items.

Implementation of LUCs at this site could readily be accomplished. The administrative aspects of the LUCs for this property are currently under the control of the Navy.

Cost

The estimated costs for Alternative 2 are as follows:

Capital Cost: $ 387,750
(initial removal)

30-Year Net Present Worth (NPW) of Annual Costs: $ 877,112
(assume three annual removals years 1, 2, and 3; two 5-year removals years 5 and 10; and LUC site inspection and report for 30 years):

30-Year NPW: $ 1,264,862

A detailed breakdown of estimated costs for this alternative is provided in Appendix B.

4.2.3 Alternative 3: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls

4.2.3.1 Description

The following activities would be associated with the implementation of Alternative 3:

- Archeological and Ecological/Wetlands surveys within the removal action area boundary to locate known archeological sites and identify wetlands areas prior to the beginning of any remedial action activities (see Figure 4-2). The boundaries/locations of these areas would be recorded via GPS for future reference. Based on previous investigations and observations during the site visit, it is assumed all of the proposed removal action area is identified as wetlands. It is assumed that remedial activities would impact wetlands; activities would be conducted to mitigate damage to wetlands. Further, based on previous archeological surveys (URS Consultants, 1996), it is assumed that archeologically significant areas are not present within the removal action area boundary. An archeological expert will be on site during excavations to ensure that potential archeological areas are not present, and if so, are not disturbed.

- Visual and detector-aided (magnetometer and all-metals detectors) surveys to locate surface munitions-related items and shallow subsurface anomalies (up to 1 foot bgs) within the removal action area. The site would be subdivided into grids prior to surveying. All work would be conducted at low tide.

- Identification of areas with a high density of munitions related items would take place during the detection phase of the remedial activity and would include the target areas and those areas where more than 10 munitions items were identified in a grid. The boundaries of these areas will be recorded via GPS for future reference.

- Manual removal of surface items, and intrusive investigations/manual excavation and removal of subsurface anomalies to a maximum depth of 1 foot bgs. Metallic non-munitions debris encountered while conducting these remedial activities would also be removed from the site and transported off-site.

- Determination by the UXO Team Leader as to whether detected munitions-related items are MEC or MPPEH. If an item is MEC and not safe to move, it would be left in place and prepared for MEC BIP treatment. If an item is deemed MEC and safe to move, it could be transported to a staging area to await MEC treatment. MPPEH items would be further differentiated as either MDEH or MDAS. MDEH items could be transported to a staging area to await MEC treatment procedures, or if determined unsafe to move, would be left in place and prepared for BIP treatment. MDAS would be further classified as either requiring demilitarization or venting, or as being munitions-related scrap. MDAS would be inspected and certified prior to transport off site to an approved metal recycler.

- If MEC is identified in either the surface or shallow subsurface within 50 feet of the edge of the investigation area, step-outs will be conducted in 50-foot increments in all directions to form a 50 by 50 foot grid.

- The recording of the location of MEC/MDEH items using GPS. All items would be given a unique identification number, and all information and observations would be recorded on the MEC Tracking Log. No MEC/MDEH item would be moved until a positive identification is made.

- Depending on the density of MDAS and other munitions-related scrap items identified, it may be impractical to record individual item's locations via GPS. Therefore, "areas" of MDAS and munitions-related scrap items would be recorded if the density of such items is so great that it would be impractical to record individual locations. In such cases, the number(s) and type(s) of items would be qualitatively described.

- Treatment of MEC/MDEH, in the event that such items are identified at LHTR. However, based on the results of the previous removal actions conducted at this site and the history of munitions used, it is not anticipated that MEC/MDEH would be identified at LHTR, still, these activities will need to be included in the remedial alternative for planning and preparation in the event that MEC/MDEH are identified at LHTR.

- If MEC/MDEH items are identified at LHTR, explosive substances (MC) could be present and confirmatory sampling would need to be conducted after these items are removed from the site to confirm the absence or presence of potential chemical contamination (MC only).

- Re-inspection of 100 percent of all recovered items after MEC/MDEH treatment to determine if they are free of explosive hazards and able to be classified as MDAS.

- Onsite treatment/demilitarization of MDAS items resembling military munitions or in need of venting. Items could also be containerized and transported off-site to an approved commercial metal recycler.

- Transport of certified MDAS, munitions-related scrap, and any metallic non-munitions debris to an approved off-site commercial metal recycler for disposal.

- Obtaining an “End Use” certification confirming that material has been recycled.

- Surface inspection annually of the high density areas with surface removal, as necessary.

  - The need for annual inspections of high density areas would be evaluated after three annual inspections and would be reduced to every five years (in high density areas only) if no MEC/MDEH or less than 10 MDAS items are identified in the most recent survey.

  - Once reduced to five-year inspections of high density areas, five-year inspections would be ended after one five-year inspection with no MEC/MDEH and less than 10 MDAS items identified.

- Surface inspections every five years within the entire removal action area (as shown on Figure 4-2) with surface removal, as necessary. Wetlands and archeological areas would be excluded from the subsurface inspection and removal area.

- The need for five-year inspections of the entire removal action area would be evaluated after two five-year inspections and ended after if no MEC/MPPEH items and less than 10 MDAS items are identified.

- Application of LUCs to the entire LHTR site. LUCs would include:

  - Residential use restrictions. Land use would be restricted to military uses.

  - Construction support for any intrusive/construction activities in this area. UXO support would be necessary during any ground-disturbing activities (up to 10 feet bgs).

  - Signage designating area as restricted access area and potential UXO area.

  - An annual one-day site visit would be conducted to verify LUCs.

4.2.3.2 Detailed Analysis

<u>Overall Protection of Human Health and the Environment</u>

Alternative 3 would be protective of human health and the environment.

Surface and subsurface removal of munitions-related items would reduce the risk of exposure and direct contact for both human and ecological receptors. The most likely exposure for site receptors would be contact with MEC via handling/removing or walking overtop of items. Although less likely, exposure to MEC items in the shallow subsurface is possible for both human and ecological receptors. Furthermore, items located in the subsurface could migrate to the surface through erosion and tidal activity. Surface removal in high density munitions areas would be repeated on an annual basis, while surface removal would be repeated throughout the entire removal action area every 5 years. This would ensure that risks are being reevaluated regularly and mitigated if present. A site receptor would have to disturb a munitions-related item to be exposed to explosive hazards; therefore, by actively removing these items, the risks would be reduced and this alternative would be protective of both human health and the environment.

Application of LUCs would also be protective of human health and the environment by reducing the risk of exposure and direct contact to MEC/MPPEH located at this site. LUCs would include restrictions to prevent residential use, UXO support during any ground disturbing activities (up to 10 feet bgs), and the installation of additional signs, fencing, and physical barriers.

Compliance with ARARs and TBCs

Alternative 3 may not comply with ARARs and TBCs that deal with wetlands and other ecologically sensitive areas because this alternative does not exclude the performance of remedial activities within wetlands. Activities will be conducted to mitigate damage to wetlands and other ecological sensitive areas and an archeological expert would be on site during excavations to ensure that potential archeological areas are not disturbed. Alternative 3 would comply with all other ARARs and TBCs. The location- and action-specific ARARs and TBCs are listed in Tables 2-1 and 2-2, respectively. Table 4-1 provides a list of guidance that will also be evaluated and used, as applicable, during the remedial action.

Long-Term Effectiveness and Permanence

Alternative 3 would provide long-term effectiveness and permanence through the performance of annual surface removals within high density munitions areas, and surface removals within the entire removal action area every 5 years. No MEC detection method is 100 percent accurate, and based on site history, munitions-related items would most likely remain on site after the initial removal action is complete. Munitions items could also migrate from the subsurface to the surface via surface erosion and tidal activity; migration would be reduced through subsurface removals. Therefore, the inspections and additional annual removals would be conducted in response to the presence and migration of MEC/MPPEH items at the site, and would reduce risk of exposure for receptors to residual MEC hazards which would remain on-site. The removal frequency would be evaluated periodically and could be reduced if appropriate. Furthermore, the engineering and administrative controls proposed as LUCs in this alternative are considered reliable and would be effective to reduce the risk of exposure and direct contact for both human health and ecological receptors. Engineering controls, such as fencing and signs, would need to be monitored and periodically repaired and/or replaced.

Reduction of Toxicity, Mobility, or Volume through Treatment

There are no COPCs present at LHTR; therefore, toxicity and mobility of chemical contaminants are not a concern at this site. By conducting the removal action(s), the volume of munitions-related items located at LHTR would be reduced. Furthermore, any metallic items removed from LHTR would be sent to an off-site metals recycler for disposal. If MEC/MPPEH items are identified at LHTR, explosive substances (MC) could be present and confirmatory sampling would need to be conducted after these items are removed from the site to confirm the absence or presence of potential chemical contaminants (MC only).

Short-Term Effectiveness

Alternative 3 would reduce human health and ecological risks in the short term because risks to site receptors would be reduced as soon as the first removal action was completed. Exposure of workers to explosive hazards may be present during remedial activities, but would be minimized by compliance with the requirements of OSHA and other explosives safety guidance, including wearing of appropriate PPE and adherence to site-specific health and safety procedures. However, if MEC/MPPEH items are identified at the site and detonations occur, these detonations could impact the surrounding community. Implementation of LUCs would not adversely impact the surrounding community or the environment.

Wetlands and archaeological areas would be identified prior to the beginning of remedial activities to ensure that any impact would be minimized. If wetlands were adversely impacted, such as if by MEC/MDEH detonations on site, the loss would be temporary, although it would be years before the original conditions were restored. Further, wetlands are not excluded from intrusive subsurface activities under this alternative, and it is assumed that at least a portion of these areas would be adversely impacted, and the compliance with RAO 2 is reduced.

Sustainability evaluations were performed for this remedial alternative and are provided in Appendix A. Since the excavating will be done by hand, there will be no heavy equipment used and any impacts would only come from transportation. GHG emissions would be approximately 13 tons. NO_x, SO_x, and PM_{10} emissions would result from transportation. Site transportation would contribute to energy demand. Water usage is not associated with this alternative.

Implementability

This remedial alternative would occur in phases as described in Section 4.2.3.1. The performance of these activities would require a high degree of coordination between field personnel, the Navy, and other parties involved in the remedial activity. The visual and detector-aided surveys could be easily implemented and the length of time for completion would depend on the number of UXO personnel available to complete the surveys.

Manual removal and excavation are easily implemented and can be implemented in almost any terrain and climate. Manual removal and excavation are very labor-intensive operations, and subsurface excavation and removal is significantly more labor-intensive than just surface removal. Manual removal and excavation can be very difficult and time-consuming, and also require a high degree of direct MEC/MPPEH exposure for workers should MEC/MPPEH be identified at LHTR. Equipment utilized during this phase would be easy to obtain (manual tools) and would be relatively inexpensive.

Should MEC/MPPEH be identified at LHTR, the treatment of these items would not be easily implemented. Permits would be required to obtain donor/priming explosives, an area for staging and storage of explosives for detonation would be required, and higher general area security, signage, and access controls would be required than if treatment were not necessary. If MEC are moved, there would be special requirements for protective packaging and transportation of MEC to the consolidation area for treatment. Should items be located that cannot be moved, the detonations could adversely impact wetlands and archeological areas known to exist at LHTR.

The use of manual tools for treatment/demilitarization, if necessary, would be easily implementable, depending on the type of equipment used. Additionally, a commercial metal recycler that accepts munitions-related scrap would need to be located. Furthermore, special consideration would need to be given to safety issues and associated liabilities when considering and choosing a commercial metal recycler. Particular attention would be required during classification of items, MDAS certification, and in the documentation of QA/QC procedures associated with the remedial activities. Certification of any certified MDAS and munitions-related scrap leaving the site would require careful inspection by qualified personnel (UXO Technician). An area would also need to be found for staging and storage of MDAS and munitions-related scrap items until the commercial metal recycler could pick up the items.

Implementation of LUCs at this site could readily be accomplished. The administrative aspects of the LUCs for this property are currently under the control of the Navy.

<u>Cost</u>

The estimated costs for Alternative 3 are as follows:

Capital Cost: $ 561,043
(initial removal)

30-Year Net Present Worth (NPW) of Annual Costs: $ 877,112
(assume three annual removals years 1, 2, and 3; two 5-year removals years 5 and 10; and LUC site inspection and report for 30 years)

30-Year NPW: $1,438,155

A detailed breakdown of estimated costs for this alternative is provided in Appendix B.

4.2.4 Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls

4.2.4.1 Description

The following activities would be associated with the implementation of Alternative 4:

- Archeological and Ecological/Wetlands surveys within the removal action area boundary to locate known archeological sites and identify wetlands areas prior to the beginning of any remedial action activities (see Figure 4-3). The boundaries/locations of these areas would be recorded via GPS for future reference. Based on previous investigations and observations during the site visit, it is assumed that all of the proposed removal action area is identified as wetlands. It is assumed that remedial activities would impact wetlands; activities would be conducted to mitigate damage to wetlands. Further, based on previous archeological surveys (URS Consultants, 1996), it is assumed that archeologically significant areas are not present within the removal action area boundary. An archeological expert will be on site during excavations to ensure that potential archeological areas are not present, and if so, are not disturbed.

- Visual and detector-aided (magnetometer and all-metals detectors) surveys to locate surface munitions-related items and shallow subsurface anomalies (up to 1 foot bgs) within the removal action area. The site would be subdivided into grids prior to surveying. All work would be conducted at low tide.

- Identification of areas with a high density of munitions related items would take place during the detection phase of the remedial activity and would include target areas and those areas where more than 10 munitions items were identified in a grid. The boundaries of these areas will be recorded via GPS for future reference.

- Manual removal of surface items, and intrusive investigations/manual excavation and removal of subsurface anomalies to a maximum depth of 1 foot bgs. Metallic non-munitions debris encountered while conducting these remedial activities would also be removed from the site and transported off-site.

- Determination by the UXO Team Leader as to whether detected munitions-related items are MEC or MPPEH. If an item is MEC and not safe to move, it would be left in place and prepared for MEC BIP treatment. If an item is deemed MEC and safe to move, it could be transported to a staging area to await MEC treatment. MPPEH items would be further differentiated as either MDEH or MDAS. MDEH items could be transported to a staging area to await MEC treatment procedures, or if determined to be unsafe to move, would be left in place and prepared for MEC BIP treatment. MDAS would be further classified as either requiring demilitarization or venting, or as being munitions-related scrap. MDAS would be inspected and certified prior to transport off site to an approved metal recycler.

- If MEC is identified on the surface within 50 feet of the edge of the investigation area, step-outs will be conducted in 50-foot increments in all directions to form a 50 by 50 foot grid.

- The recording of the location of MEC/MDEH items using GPS. All items would be given a unique identification number, and all information and observations would be recorded on the MEC Tracking Log. No MEC/MDEH item would be moved until a positive identification is made.

- Depending on the density of MDAS and other munitions-related scrap items identified, it may be impractical to record individual item's locations via GPS. Therefore, "areas" of MDAS and munitions-related scrap items would be recorded if the density of such items is so great that it would be impractical to record individual locations. In such cases, the number(s) and type(s) of items would be qualitatively described.

- Treatment of MEC/MDEH, in the event that such items are identified at LHTR. However, based on the results of the previous removal actions conducted at this site and the history of munitions used, it is not anticipated that MEC/MDEH would be identified at LHTR, still, these activities would need to be included in the remedial alternative for planning and preparation in the event that MEC/MDEH are identified at LHTR.

- If MEC/MDEH items are identified at LHTR, explosive substances (MC) could be present and confirmatory sampling would need to be conducted after these items are removed from the site to confirm the absence or presence of potential chemical contamination (MC only).

- Re-inspection of 100 percent of all recovered items after MEC treatment to determine if they are free of explosive hazards and able to be classified as MDAS.

- Onsite treatment/demilitarization of MDAS items resembling military munitions or in need of venting. Items could also be containerized and transported off-site to an approved commercial metal recycler.

- Transport of certified MDAS, munitions-related scrap, and any metallic non-munitions debris to an approved off-site commercial metal recycler for disposal.

- Obtaining an "End Use" certification confirming that material has been recycled.

- Surface inspection annually of high density areas with surface removal, as necessary.

  - The need for annual inspections of high density areas would be evaluated after three annual inspections and would be reduced to every five years (in high density areas only) if no MEC/MDEH or less than 10 MDAS items are identified in the most recent survey.

  - Once reduced to five-year inspections of high density areas, five-year inspections would be ended after one five-year inspection with no MEC/MDEH and less than 10 MDAS items identified.

- Surface inspections every five years of entire removal action area (as shown on Figure 4-3) with surface removal, as necessary.

  - The need for five-year inspections of the entire removal action area would be evaluated after two five-year inspections and ended if no MEC/MPPEH items and less than 10 MDAS items are identified.

- Application of LUCs to the entire LHTR site. LUCs would include:

  - Residential use restrictions. Land use would be restricted to military uses.

  - Construction support for any intrusive/construction activities in this area, UXO support is necessary during any ground disturbing activities (up to 10 feet bgs).

  - Signage designating area as restricted access area and potential UXO area.

  - An annual one-day site visit would be conducted to verify LUCs.

4.2.4.2 Detailed Analysis

<u>Overall Protection of Human Health and the Environment</u>

Alternative 4 would be protective of human health and the environment.

Surface and subsurface removal of munitions-related items would reduce the risk of exposure and direct contact for both human and ecological receptors. The most likely exposure for site receptors would be contact with MEC via handling/removing or walking overtop of items. Although less likely, exposure to MEC items in the shallow subsurface is possible for both human and ecological receptors. Furthermore, items located in the subsurface could migrate to the surface through erosion and tidal activity. Surface removal in high density munitions areas would be repeated on an annual basis while surface removal would be repeated throughout the entire removal action area every 5 years. This would ensure that risks are being reevaluated regularly and mitigated if present. A site receptor would have to disturb a munitions-related item to be exposed to explosive hazards; therefore, by actively removing these items, the risks would be reduced and this alternative would be protective of both human health and the environment.

Application of LUCs would also be protective of human health and the environment by reducing the risk of exposure and direct contact to MEC/MPPEH located at this site. LUCs would include restrictions to prevent residential use, UXO support during any ground disturbing activities (up to 10 feet bgs), and the installation of additional signs, fencing, and physical barriers.

<u>Compliance with ARARs and TBCs</u>

Alternative 4 may not comply with ARARs and TBCs that deal with wetlands and other ecologically sensitive areas because this alternative does not exclude the performance of remedial activities within wetlands. Activities will be conducted to mitigate damage to wetlands and other ecological sensitive areas and an archeological expert would be on site during excavations to ensure that potential archeological areas are not disturbed. Alternative 4 would comply with all other ARARs and TBCs. The location- and action-specific ARARs and TBCs are listed in Tables 2-1 and 2-2, respectively. Table 4-1 provides a list of guidance that will also be evaluated and used, as applicable, during the remedial action.

<u>Long-Term Effectiveness and Permanence</u>

Alternative 4 would provide long-term effectiveness and permanence through the performance of annual surface removals within high density munitions areas, and surface removals within the entire removal action area every 5 years. No MEC detection method is 100 percent accurate, and based on site history, munitions-related items would most likely remain on site after the initial removal action is complete. Munitions items could also migrate from the subsurface to the surface via surface erosion and tidal activity; therefore, these inspections and additional removals would be conducted in response to the presence and migration of MEC/MPPEH items at the site, and would reduce risk of exposure for receptors to residual MEC hazards which would remain on-site. The removal frequency would be evaluated periodically and could be reduced if appropriate. Furthermore, the engineering and administrative controls proposed as LUCs in this alternative are considered reliable and would be effective to reduce the risk of exposure and direct contact for both human health and ecological receptors.

Engineering controls, such as fencing and signs, would need to be monitored and periodically repaired and/or replaced.

Reduction of Toxicity, Mobility, or Volume through Treatment

There are no COPCs present at LHTR; therefore, toxicity and mobility of chemical contaminants are not a concern at this site. By conducting the removal action(s), the volume of munitions-related items located at LHTR would be reduced. Furthermore, any metallic items removed from LHTR would be sent to an off-site metals recycler for disposal. If MEC/MPPEH items are identified at LHTR, explosive substances (MC) could be present and confirmatory sampling would need to be conducted after these items are removed from the site to confirm the absence or presence of potential chemical contaminants (MC only).

Short-Term Effectiveness

Alternative 4 would reduce human health and ecological risks in the short term because risks to site receptors would be reduced as soon as the first removal action was completed. Exposure of workers to explosive hazards may be present during remedial activities, but would be minimized by compliance with the requirements of OSHA and other explosives safety guidance, including wearing of appropriate PPE and adherence to site-specific health and safety procedures. However, if MEC/MPPEH items are identified at the site and detonations occur, these detonations could impact the surrounding community. Implementation of LUCs would not adversely impact the surrounding community or the environment.

Wetlands and archaeological areas would be identified prior to the beginning of remedial activities to ensure that any impact would be minimized. If wetlands were adversely impacted, such as if by MEC/MDEH detonations on site, the loss would be temporary, although it would be years before the original conditions were restored. Wetlands are not excluded from intrusive subsurface activities under this alternative, and it is assumed that at least a portion of these areas would be adversely impacted, and the compliance with RAO 2 is reduced.

Sustainability evaluations were performed for this remedial alternative and are provided in Appendix A. Since the excavating will be done by hand, there will be no heavy equipment used and any impacts would only come from transportation. GHG emissions would be approximately 13.2 tons. NO_x, SO_x, and PM_{10} emissions would result from transportation. Site transportation would contribute to energy demand. Water usage is not associated with this alternative.

<u>Implementability</u>

This remedial alternative would occur in phases as described in Section 4.2.4.1. The performance of these activities would require a high degree of coordination between field personnel, the Navy, and other parties involved in the remedial activity. The visual and detector-aided surveys could be easily implemented and the length of time for completion would depend on the number of UXO personnel available to complete the surveys.

Manual removal and excavation are easily implemented and can be implemented in almost any terrain and climate. Manual removal and excavation are very labor-intensive operations, can be very difficult and time-consuming, and also require a high degree of direct MEC/MPPEH exposure for workers should MEC/MPPEH be identified at LHTR. Equipment utilized during this phase would be easy to obtain (manual tools) and would be relatively inexpensive.

Should MEC/MPPEH be identified at LHTR, the treatment of these items would not be easily implemented. Permits would be required to obtain donor/priming explosives, an area for staging and storage of explosives for detonation would be required, and higher general area security, signage, and access controls would be required than if treatment were not necessary. If MEC are moved, there would be special requirements for protective packaging and transportation of MEC to the consolidation area for treatment. Should items be located that cannot be moved, the detonations could adversely impact wetlands and archeological areas known to exist at LHTR.

The use of manual tools for treatment/demilitarization, if necessary, would be easily implementable, depending on the type of equipment used. Additionally, a commercial metal recycler that accepts munitions-related scrap would need to be located. Furthermore, special consideration would need to be given to safety issues and associated liabilities when considering and choosing a commercial metal recycler. Particular attention would be required during classification of items, MDAS certification, and in the documentation of QA/QC procedures associated with the remedial activities. Certification of any certified MDAS and munitions-related scrap leaving the site would require careful inspection by qualified personnel (UXO Technician). An area would also need to be found for staging and storage of MDAS and munitions-related scrap items until the commercial metal recycler could pick up the items.

Implementation of LUCs at this site could readily be accomplished. The administrative aspects of the LUCs for this property are currently under the control of the Navy.

<u>Cost</u>

The estimated costs for Alternative 4 are as follows:

Capital Cost: (initial removal)	$ 907,151
30-Year Net Present Worth (NPW) of Annual Costs:	$ 898,487

(assume three annual removals years 1, 2, and 3; two 5-year removals years 5 and 10; and LUC site inspection and report for 30 years)

30-Year NPW:	$1,805,638

A detailed breakdown of estimated costs for this alternative is provided in Appendix B.

TABLE 4-1

GUIDANCE TO BE USED IN REMEDIAL ACTION
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Requirement/ Criteria	Citation [(1)]	Brief Description	Consideration in the Remedial Action Process
Federal			
Transportation	ATF P 5400.1	Bureau of Alcohol, Tobacco, Firearms and Explosives, vehicle bomb explosion hazard and evacuation distance table.	These standards would be applicable if explosives/MEC/MPPEH are transported.
MEC/UXO Management	DoD 4160-21-M-1, Revision 1	Defense Demilitarization Manual, its purpose is to set for DoD demilitarization policy, prescribe uniform procedures for assigning demilitarization codes to DoD property, and direct methods for completing demilitarization.	Applicable to work conducted at munitions sites where MEC/MPPEH may be present.
MEC/UXO Management	DoD 4160.21-M	Defense Material Disposition Manual	Applicable to work conducted at munitions sites where MEC/MPPEH may be present.
MEC/UXO Management	DoD 6055.9-STD	Ammunitions and Explosives Safety Standards DoD standard issued under the DDESB that established policies and procedures necessary to provide protection to personnel as a result of DoD ammunitions, explosives, or chemical agents and contamination of real property currently or formerly owned, leased, or used by DoD.	Applicable to work conducted at munitions sites where MEC/MPPEH may be present.
MEC/UXO Management	DoD Instruction 4140.62	Material Potentially Presenting an Explosive Hazard	Applicable to work conducted at munitions sites where MEC/MPPEH may be present.
MEC/UXO Management	DoD 4715.11	Environmental and Explosives Safety Management on Department of Defense, Active and Inactive Ranges Within the United States	Applicable to work conducted at munitions sites where MEC/MPPEH may be present.

TABLE 4-1

GUIDANCE TO BE USED IN REMEDIAL ACTION
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Requirement/ Criteria	Citation [1]	Brief Description	Consideration in the Remedial Action Process
MEC/UXO Management	DDESB TP 16	Methodologies for Calculating Primary Fragment Characteristics	May be applicable depending on types of munitions suspected at site.
MEC/UXO Management	DDESB TP 18	Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel	Applicable to work conducted at munitions sites where MEC/MPPEH may be present.
MEC/UXO Management	NAVSEA OP 5 Volume 1	Ammunition and Explosives Safety Ashore: Safety Regulations for Handling, Storing, Production, Renovation, and Shipping	Applicable to work conducted at munitions sites where MEC/MPPEH may be present.
MEC/UXO Management	NAVSEA OP 2165	Navy Transportation Safety Handbook for Ammunition, Explosives, and Related Hazardous Materials	Applicable if explosives/MEC/MPPEH are transported.
MEC/UXO Management	NAVSEA OP 2239	Motor Vehicle Driver's Handbook, Ammunition, Explosives, and Related Hazardous Materials	Applicable if explosives/MEC/MPPEH are transported.
MEC/UXO Management	NAVSEA OP 4570.1	Demilitarization and Disposal of Excess, Surplus, and Foreign Excess Ammunition, Explosives and Other Dangerous Articles and Inert Ordnance Material	Applicable to work conducted at munitions sites where MEC/MPPEH may be present.
MEC/UXO Management	NAVSEA OP 8020.9	Non-Nuclear Ordnance and Explosives Handling Qualification and Certification Program	Applicable to work conducted at munitions sites where MEC/MPPEH may be present.
MEC/UXO Management	NAVSEAINST 8020.1H	DoD Ammunition and Explosive Hazard Classification Procedures Joint Technical Bulletin	Applicable if MEC/MPPEH are identified at LHTR.
MEC/UXO Management	NOSSA Instruction 8020.15B	Explosive Safety Review, Oversight and Verification of Munitions Responses	May apply to work conducted during the remedial activity.

Requirement/ Criteria	Citation [1]	Brief Description	Consideration in the Remedial Action Process
MEC/UXO Management	EM 1110-1-4009	Engineering and Design – Ordnance and Explosives Response, manual provides personnel with procedures to be used to perform engineering and design activities for all phases of the Military Munitions Response Program	Applicable to work conducted during the remedial activity.
MEC/UXO Management	OE Guidance Memoranda, December, 2000	Interim Final Management Principles for Implementing Response Action at Closed, Transferring, and Transferred Ranges	Applicable to work conducted at munitions sites.
MEC/UXO Management	OE Guidance Memoranda, January, 1994	Application of the Hazardous Waste Operations and Emergency Response Regulation to Ordnance and Explosives Sites	Applicable to work conducted at munitions sites.
MEC/UXO Management	OE Guidance Memoranda, May, 1997	Coordination with the Ordnance and Explosives Center of Expertise (OE CX)	Applicable to work conducted at munitions sites.
MEC/UXO Management	OPNAVINST 5090.1	Environmental and Natural Resources Protection Manual (Navy)	Potential guidance for operations that may impact environmental and natural resources.
MEC/UXO Management	OPNAVINST 5102.1C	Mishap Investigation and Reporting	May apply to work conducted during the remedial activity.
MEC/UXO Management	OPNAVINST 5530.13	Department of the Navy Physical Security Instruction for Sensitive Conventional Arms, Ammunition, and Explosives	Applicable to work conducted at munitions sites.
MEC/UXO Management	OPNAVINST 8026.2	Assignment for the Responsibility and Management of the Navy Munitions Disposition Program	Potentially applicable if MEC/MPPEH identified on site.
MEC/UXO Management	OPNAVINST 8026.2A	Navy Munitions Disposition Policy	Potentially applicable if MEC/MPPEH identified on site.

TABLE 4-1

GUIDANCE TO BE USED IN REMEDIAL ACTION
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Requirement/ Criteria	Citation [1]	Brief Description	Consideration in the Remedial Action Process
MEC/UXO Management	OPNAVINST 8027.1	Inter-service Responsibilities for Explosive Ordnance Disposal	Potentially applicable if MEC/MPPEH identified on site.
MEC/UXO Management	OPNAVINST 8027.6E	Naval Responsibilities for Explosive Ordnance Disposal	Potentially applicable if MEC/MPPEH identified on site.
MEC/UXO Management	OPNAVINST 8070.1B	Responsibilities for Technical Escort of Dangerous Materials	Potentially applicable if dangerous materials are acquired or are transported from the site.
MEC/UXO Management	SWO60-AA-MMA-010	Demolition Materials	Potentially applicable if demolition materials are acquired or are transported from the site.
MEC/UXO Management	EP 385-1-95b	Explosives Safety Submission	Applicable for intrusive work done at munitions response site.
MEC/UXO Management	EP 75-1-2	Munitions and Explosives of Concern Support During Hazardous, Toxic, and Radioactive Waste and Construction Activities	Applicable to work conducted at munitions sites.
MEC/UXO Management	EP 1110-1-18	Ordnance and Explosive Response	Potentially applicable to work conducted at munitions sites.
MEC/UXO Management	EP 1110-1-24	Establishing and Maintaining Institutional Controls for Ordnance and Explosives Projects	Applicable to work conducted at munitions sites.
MEC/UXO Management	ER 1110-1-8153	Engineering and Design Ordnance Explosives Response	Applicable to work conducted at munitions sites.
MEC/UXO Management	IGD 98-04	USACE Huntsville Interim Guidance: Reportable Material at Ordnance Explosives Response Sites	Applicable to work conducted at munitions sites.
MEC/UXO Management	USACE DID OE-025.01	Personnel/Work Standards; U.S. Army Engineering and Support Center	Applicable to work conducted at munitions sites.

TABLE 4-1

GUIDANCE TO BE USED IN REMEDIAL ACTION
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Requirement/ Criteria	Citation [1]	Brief Description	Consideration in the Remedial Action Process
MEC/UXO Management	USACE, 2003	Ordnance and Explosives Digital Geophysical Mapping Guidance – Operational Procedures and Quality Manual	Applicable to work conducted at munitions sites where geophysical applications are used.
MEC/UXO Management	USEPA, 2003	USEPA Guidelines for Munitions Response	Applicable to work conducted at munitions sites.
MEC/UXO Management	27 CFR 55	Commerce in Explosives, contains regulations related to manufactures and dealers of explosives and the acquisition and disposition of explosives	Applicable if donor explosives are purchased.

1. The most updated and recent guidance will be reviewed and followed at the time of the removal action.

Notes:

ATF	Alcohol, Tobacco, and Firearms.
CFR	Code of Federal Regulations.
DDESB	Department of Defense Explosives Safety Board.
DoD	Department of Defense.
EM	Engineer Manual.
EP	Engineer Pamphlet.
ER	Engineer Regulation.
IGD	Interim Guidance Document.
MEC	Munitions and Explosives of Concern.
MPPEH	Munitions Potentially Presenting an Explosive Hazard.
NAVSEA	Naval Sea Systems Command.
NAVSEAINST	Naval Sea Systems Command Instruction.
NOSSA	Naval Ordnance Safety and Security Activity.
OE	Ordnance and Explosives.
OP	Operations Pamphlet.
OPNAVINST	Office of the Chief of Naval Operations Instruction.
TP	Technical Paper.
USACE	United States Army Corps of Engineers.
USEPA	United States Environmental Protection Agency.
UXO	Unexploded Ordnance.

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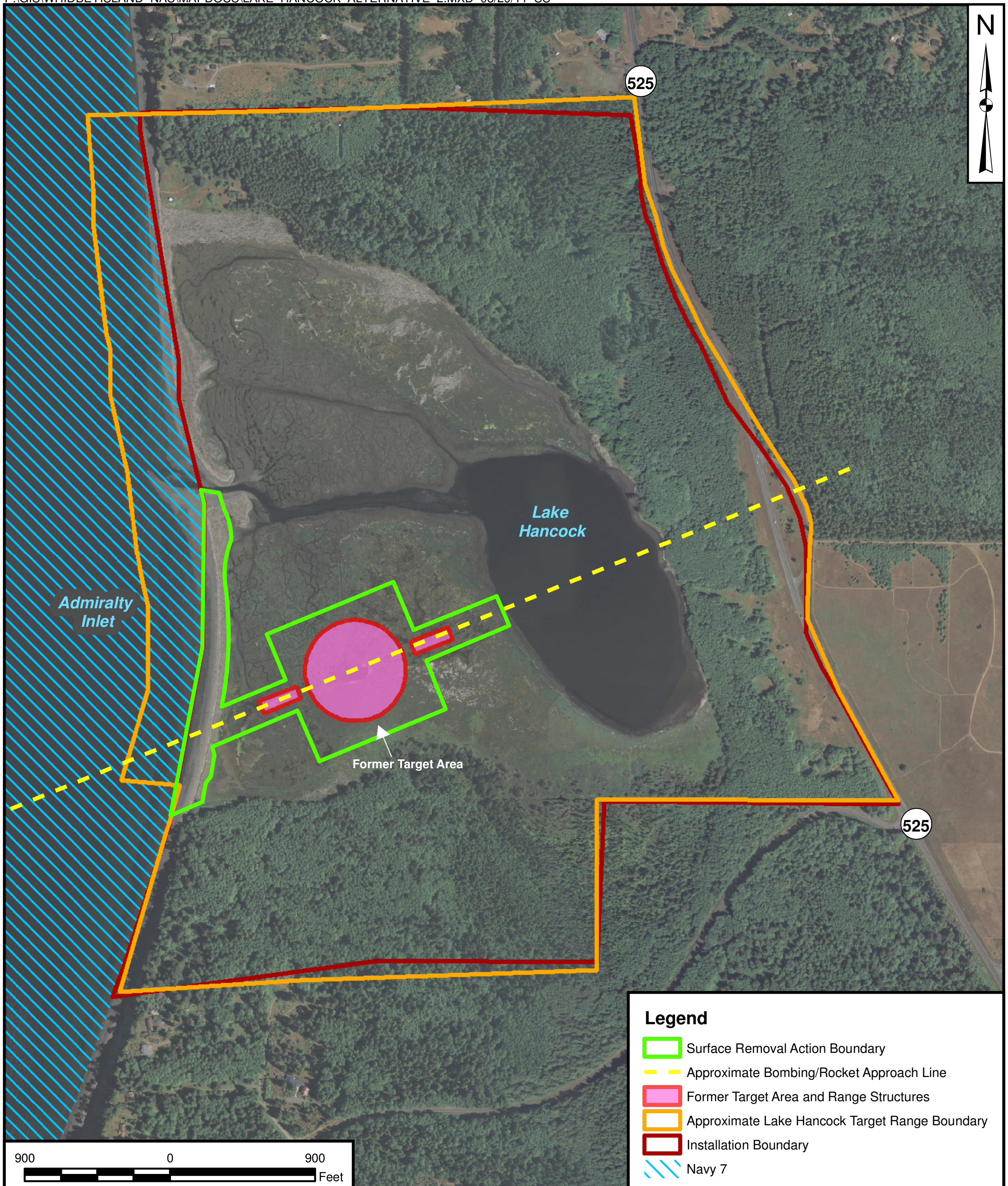

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M. COFFMAN	08/29/11
REVISED BY	DATE
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NAVFAC

LAKE HANCOCK TARGET RANGE
ALTERNATIVE 2
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

CONTRACT NUMBER	CTO NUMBER
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APPROVED BY ___	DATE ___
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FIGURE NO. FIGURE 4-1	REV 0

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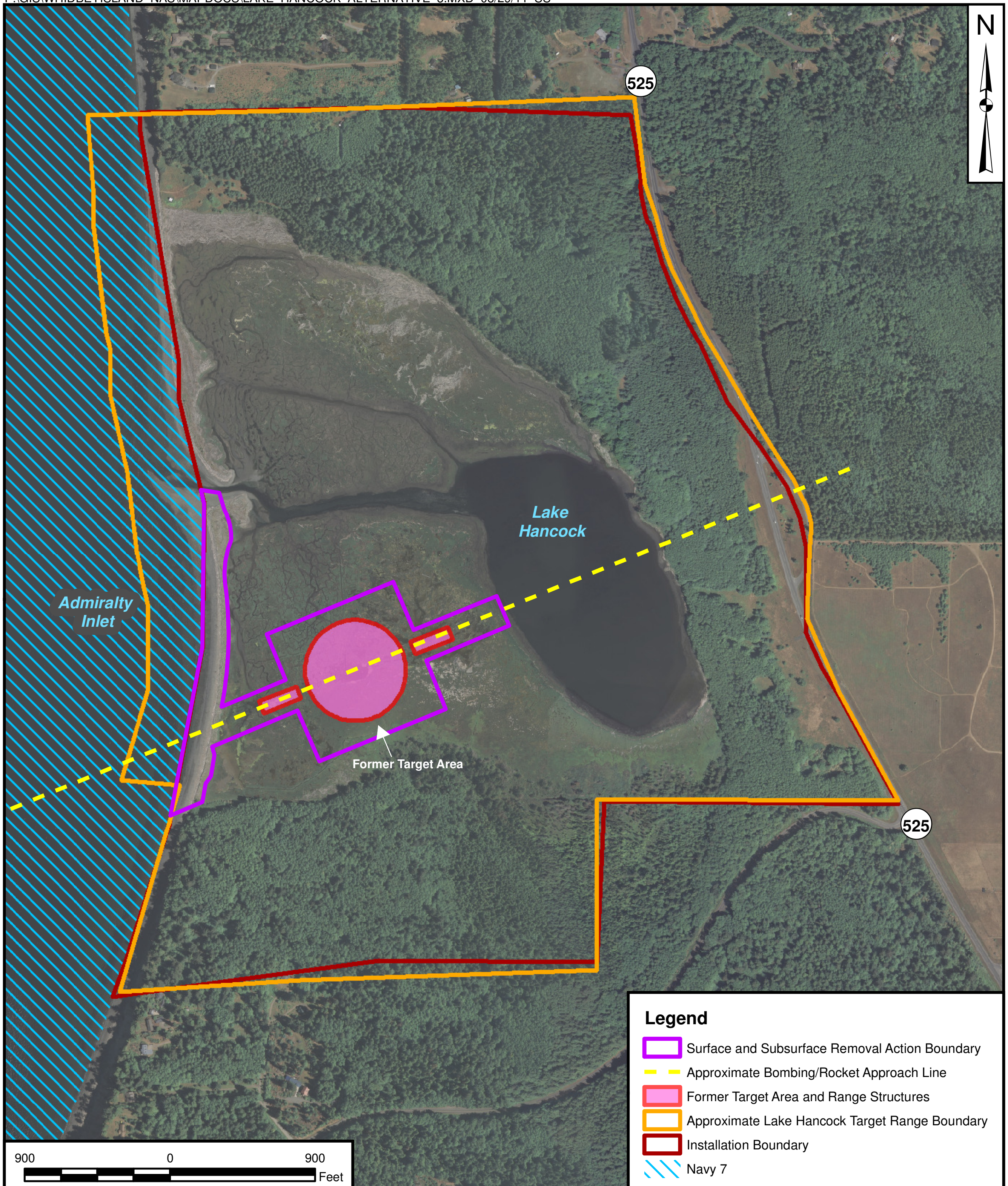

DRAWN BY	DATE			CONTRACT NUMBER	CTO NUMBER
S. PAXTON	02/17/11	NAVFAC	LAKE HANCOCK TARGET RANGE ALTERNATIVE 3 NAS WHIDBEY ISLAND WHIDBEY ISLAND, WASHINGTON	___	KR02
CHECKED BY	DATE			APPROVED BY ___	DATE ___
M. COFFMAN	08/29/11				
REVISED BY ___	DATE ___			APPROVED BY ___	DATE ___
SCALE AS NOTED				FIGURE NO. FIGURE 4-2	REV 0

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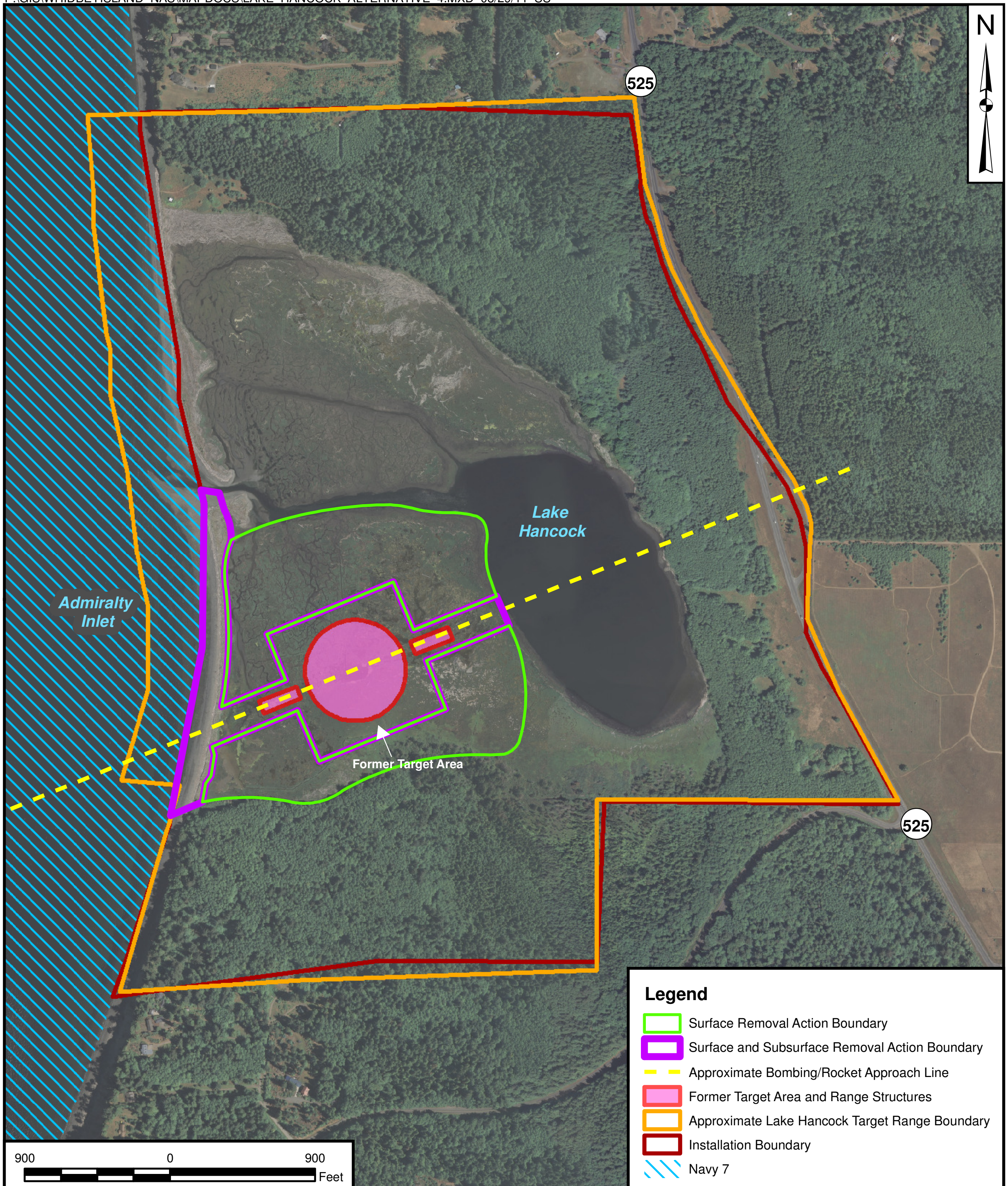

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SCALE AS NOTED		NAVFAC	FIGURE NO. FIGURE 4-3	REV 0

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section compares remedial alternatives presented in Section 4.0 of this FS. The criteria for comparison are identical to those used for the detailed analysis of individual alternatives.

5.1 COMPARISON OF REMEDIAL ALTERNATIVES BY CRITERIA

The following remedial alternatives for the LHTR are compared in this section:

- Alternative 1: No Action
- Alternative 2: Surface Removal with Land Use Controls
- Alternative 3: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
- Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls

5.1.1 Overall Protection of Human Health and the Environment

Alternative 1 would not be protective of human health and the environment because the explosive hazards would not be removed or mitigated. Furthermore, the absence of LUCs would allow for increased chances of exposure.

Alternatives 2, 3, and 4 would provide protection to human health and the environment. Surface and shallow subsurface removals of munitions-related items would remove explosive hazards present in the surface and shallow subsurface at the site, thereby reducing the risk of exposure by human and ecological receptors. Alternatives 2 and 3 cover the same area (see Figures 4-1 and 4-2); Alternative 2 consists of surface removal only while Alternative 3 consists of both surface and subsurface removal within the same area. Alternatives 3 and 4 consist of both surface and subsurface removal, these alternatives covers the same area for subsurface removal while Alternative 4 covers an expanded area for surface removal as compared to Alternative 3 (see Figures 4-2 and 4-3). While Alternative 2 does not directly address the subsurface, it is expected that these items would migrate to the surface over time via erosion and tidal activity, so, by conducting annual surface removals, items which have migrated to the surface from the subsurface would be addressed. Surface removals would be conducted annually, for Alternatives 2, 3, and 4, within high density areas and every 5 years within the entire removal action area boundary, thereby addressing residual risks which would remain at the site. Wetlands would be included within the removal action areas for each alternative, which may adversely impact these sensitive environments; therefore, compliance with RAO 2 would be reduced.

LUCs proposed as part of Alternatives 2, 3, and 4 would provide protection of human health by restricting the area from residential use, providing UXO support during construction activities should any development occur in the area, and posting additional warning signs for trespassers and hikers that may enter the site.

5.1.2 Compliance with ARARs and TBCs

Alternative 1 may not comply with location- and action-specific ARARs or TBCs, although most would not apply. Alternative 1 would comply with wetlands and other natural resources ARARs because not action would be taken, these sensitive environments would not be impacted.

Alternative 2, 3, and 4 may not comply with ARARs and TBCs that deal with wetlands and other ecologically sensitive areas because these alternatives do not exclude the performance of remedial activities in these areas. These alternatives would comply with all other location- and action-specific ARARs and TBCs.

5.1.3 Long-Term Effectiveness and Permanence

Alternative 1 would have no long-term effectiveness and permanence because there would be no activities to remove MEC/MPPEH, and no LUCs to restrict site access and use.

Alternative 2 would provide long-term effectiveness and permanence through the performance of surface removals of munitions-related items, while Alternatives 3 and 4 would provide long-term effectiveness and permanence through a combination of surface removals of munitions-related items and limited shallow subsurface removals of munitions-related items. Alternative 2 does not directly address the subsurface; however, items which would migrate to the surface would be addressed during future annual surface removals. Conducting annual surface removals within high density areas and surface removals within the entire removal action area boundary every 5 years during Alternatives 2, 3, and 4, would reduce risks from residual explosive hazards remaining on site after the initial removal action has been completed. Additionally, LUCs proposed for Alternatives 2, 3, and 4, are considered adequate and reliable and would be protective of human health and the environment.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

There are no COPCs at LHTR; therefore, reduction of toxicity and mobility of chemical contaminants are not applicable. Alternatives 2, 3, and 4 would achieve a reduction in the volume of munitions-related items present at LHTR by removing these items from the site. Additional future removal actions would continue to reduce the volume of munitions-related items present at the site. Certified MDAS and any metallic non-munitions debris which may also be located at the site, would be transported off-site for disposal to an approved commercial metal recycler, thereby reducing the volume of these materials present at the site.

Alternative 1 would not achieve reduction of volume of munitions-related items at LHTR.

5.1.5 Short-Term Effectiveness

Implementation of Alternative 1 would not result in risks to site workers or adversely impact the surrounding community or environment because no remedial activities would be performed. Because no actions would be implemented in Alternative 1, there would be no impacts on sustainability factors.

Alternatives 2, 3, and 4 would reduce human and ecological receptor risks in the short term because risks to site receptors would be reduced as soon as the first removal action was completed.

Implementation of Alternatives 2, 3, and 4 may result in exposing site workers to explosive hazards during remedial activities, particularly during detonations of MEC/MDEH should any occur. However, these risks of exposure would be effectively controlled by compliance with OSHA and other explosive safety procedures.

Wetlands areas would not be excluded from the removal action area under Alternatives 2, 3, and 4. It is assumed that remedial activities would impact wetlands. Activities conducted during Alternatives 2, 3, and 4 would be conducted to mitigate damage to wetlands and an archeological expert would be on site during excavations to ensure that potential archeological areas are not present, and if so, are not disturbed. If wetlands were adversely impacted during any alternative, such as if MEC/MDEH detonations would take place on site, the loss would be temporary, although it would be years before the original conditions were restored.

Implementation of Alternatives 2, 3, and 4 would have a slight adverse impact on the surrounding community or environment should MEC/MDEH detonations take place. These alternatives would also have short-term impact as a result of the transport of metallic items for off-site disposal and metal recycling.

Alternative 4 would have the highest GHG emissions and energy demand, followed by Alternative 3, with Alternative 2 having the lowest GHG emissions and energy demand. Alternatives 2, 3, and 4 have approximately the same NO_x, SO_x, and PM_{10} emissions.

5.1.6 Implementability

Alternative 1 would be easiest to implement because there would be no action taken.

Alternatives 2, 3, and 4 would all be implemented in phases. The difference between the alternatives is in the area(s) and depth(s) where detection and removal would take place. These differences would also affect the length of time for completion. It is assumed that Alternative 2 would be most easily implemented and completed within the shortest amount of time, with Alternative 3 next, and Alternative 4 being the most difficult to implement and taking the longest to complete.

Should MEC/MDEH be identified on site during Alternatives 2, 3, or 4, treatment of these items would be more difficult to implement than if only MDAS and metallic debris are found on site during the completion of any of these alternatives.

Implementation of LUCs under Alternatives 2, 3, and 4 could readily be accomplished. The administrative aspects of the LUCs for this property are currently under the control of the Navy.

5.1.7 Cost

The capital and O&M costs and NPW of the alternatives are as follows.

Alternative	Capital	NPW of Annual Costs	NPW
1	0	0	0
2	$387,750	$877,112	$1,264,862
3	$561,043	$877,112	$1,438,155
4	$907,151	$898,487	$1,805,638

Detailed cost estimates are provided in Appendix B.

5.2 SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Table 5-1 summarizes the comparative analysis of the remedial alternatives.

TABLE 5-1

SUMMARY OF COMPARATIVE EVALUATION OF ALTERNATIVES
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Evaluation Criteria	Alternative 1: No Action	Alternative 2: Surface Removal with Land Use Controls	Alternative 3: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls	Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Overall Protection of Human Health and Environment	No action would not result in any reduction in explosive safety hazard risk at the site.	Would be protective of human health and the environment by reducing the risk of exposure to munitions items present on the surface. Inclusion of wetlands areas in the removal action area may adversely impact these sensitive environments.	Would be protective of human health and the environment by reducing the risk of exposure to munitions items present on the surface and within the shallow subsurface. Inclusion of wetlands areas in the removal action area may adversely impact these sensitive environments.	Would be protective of human health and the environment by reducing the risk of exposure to munitions items present on the surface and within the shallow subsurface. Inclusion of wetlands areas in the removal action area may adversely impact these sensitive environments.
Compliance with ARARs and TBCs:				
Chemical-Specific	Not applicable	Not applicable	Not applicable	Not applicable
Location-Specific	Would comply with some ARARs/TBCs	May not comply with some ARARs/TBCs related to wetlands, would comply with all other ARARs/TBCs	May not comply with some ARARs/TBCs related to wetlands, would comply with all other ARARs/TBCs	May not comply with some ARARs/TBCs related to wetlands, would comply with all other ARARs/TBCs
Action-Specific	Would comply with some ARARs/TBCs	May not comply with some ARARs/TBCs related to wetlands, would comply with all other ARARs/TBCs	May not comply with some ARARs/TBCs related to wetlands, would comply with all other ARARs/TBCs	May not comply with some ARARs/TBCs related to wetlands, would comply with all other ARARs/TBCs

SUMMARY OF COMPARATIVE EVALUATION OF ALTERNATIVES
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Evaluation Criteria	Alternative 1: No Action	Alternative 2: Surface Removal with Land Use Controls	Alternative 3: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls	Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Long-Term Effectiveness and Permanence	Would have no long-term effectiveness and permanence since no action would occur. Munitions items would remain on site.	Would provide long-term effectiveness and permanence through the performance of an initial surface removal and annual surface removals in high density areas, and surface removals within the entire removal action area every five years. While this alternative does not directly address the subsurface, it is expected that subsurface items will migrate to the surface, over time, via erosion and tidal activity and would then be addressed during future annual surface removals. Wetlands areas are included in the removal action area. LUCs are considered reliable and would be effective to reduce risks to site receptors.	Would provide long-term effectiveness and permanence through the performance of surface and limited subsurface removals and annual surface removals in high density areas, and removals within the entire removal action area every five years. Wetlands areas are included in the removal action area. LUCs are considered reliable and would be effective to reduce risks to site receptors. Alternative 3 would provide slightly more long-term effectiveness and permanence than Alternative 2.	Would provide long-term effectiveness and permanence through the performance of surface and subsurface removals and annual surface removals in high density areas, and removals within the entire removal action area every five years. Wetlands and are included in the removal action area. LUCs are considered reliable and would be effective to reduce risks to site receptors. Alternative 4 would provide slightly more long-term effectiveness and permanence than Alternatives 2 and 3.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	There are no COPCs at LHTR; therefore, reduction of toxicity and mobility of chemical contaminants are not applicable. Would not reduce volume of munitions-related items since no removal would occur.	There are no COPCs at LHTR; therefore, reduction of toxicity and mobility of chemical contaminants are not applicable. Would reduce volume of munitions-related items through removal. Additional removal(s) may be necessary to address items that may remain.	There are no COPCs at LHTR; therefore, reduction of toxicity and mobility of chemical contaminants are not applicable. Would reduce volume of munitions-related items through removal. Additional removal(s) may be necessary to address items that may remain. Alternative 3 would be slightly more effective than Alternative 2.	There are no COPCs at LHTR; therefore, reduction of toxicity and mobility of chemical contaminants are not applicable. Would reduce volume of munitions-related items through removal. Additional removal(s) may be necessary to address items that may remain. Alternative 4 would be slightly more effective than Alternatives 2 and 3.

TABLE 5-1

SUMMARY OF COMPARATIVE EVALUATION OF ALTERNATIVES
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Evaluation Criteria	Alternative 1: No Action	Alternative 2: Surface Removal with Land Use Controls	Alternative 3: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls	Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Short-Term Effectiveness	Would not reduce human or ecological receptor risks in the short term nor would there be any short-term risk to site workers or adverse impact to the surrounding community or environment since no action would occur. Munitions-related items would remain on site.	Would reduce human and ecological receptor risks in the short term because risks to site receptors would be reduced as soon as the first removal action was completed. Exposure of workers to explosive hazards may be high during remedial activities. This risk would be reduced through compliance with site-specific health and safety procedures and explosives safety guidance. The RAOs would be partially achieved immediately upon completion of the first removal of munitions-related items from the site. While this alternative does not directly address the subsurface, it is expected that these items will migrate to the surface, over time, via erosion and tidal activity and would be addressed during future annual removals. Implementation of this alternative would have a slight short-term adverse impact on the surrounding community or environment should MEC/MDEH detonations take place. This alternative would also have short-term impact due to transport of metallic items for off-site disposal and metal recycling.	Would reduce human and ecological receptor risks due to surface and subsurface exposure in the short term because risks to site receptors would be reduced as soon as the first removal action was completed. Exposure of workers to explosive hazards may be high during remedial activities. This risk would be reduced through compliance with site-specific health and safety procedures and explosives safety guidance. The RAOs would be partially achieved immediately upon completion of the first removal of munitions-related items from the surface and subsurface. By the inclusion of wetlands areas within the subsurface removal action area, these sensitive areas may be adversely impacted and compliance with RAO 2 would be reduced. Implementation of this alternative would have a slight short-term adverse impact on the surrounding community or environment should MEC/MDEH detonations take place. This alternative would also have short-term impact due to transport of metallic items for off-site disposal and metal recycling.	Would reduce human and ecological receptor risks due to surface and subsurface exposure in the short term because risks to site receptors would be reduced as soon as the first removal action was completed. Exposure of workers to explosive hazards may be high during remedial activities. This risk would be reduced through compliance with site-specific health and safety procedures and explosives safety guidance. The RAOs would be partially achieved immediately upon completion of the first removal of munitions-related items from the site. By the inclusion of wetlands areas within the subsurface removal action area, these sensitive areas may be adversely impacted and compliance with RAO 2 would be reduced. Implementation of this alternative would have a slight short-term adverse impact on the surrounding community or environment should MEC/MDEH detonations take place. This alternative would also have short-term impact due to transport of metallic items for off-site disposal and metal recycling.

TABLE 5-1

SUMMARY OF COMPARATIVE EVALUATION OF ALTERNATIVES
LAKE HANCOCK TARGET RANGE
NAS WHIDBEY ISLAND
WHIDBEY ISLAND, WASHINGTON

Evaluation Criteria	Alternative 1: No Action	Alternative 2: Surface Removal with Land Use Controls	Alternative 3: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls	Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Implementability	Technical and administrative implementation would be simple since there would be no action to implement.	The detection and removal components of this alternative could be performed with manual tools, which would be readily available for this purpose. Should MEC/MDEH items be identified on site, the technical implementability of this phase would be more difficult than if only MDAS and other metallic related scrap items are identified on site. A commercial metal recycler that would accept munitions related scrap will need to be located. Comparatively, this alternative would be completed within the shortest amount of time.	The detection and removal components of this alternative could be performed with manual tools, which would be readily available for this purpose. Should MEC/MDEH items be identified on site, the technical implementability of this phase would be more difficult than if only MDAS and other metallic related scrap items are identified on site. A commercial metal recycler that would accept munitions related scrap will need to be located. Comparatively, this alternative would be completed within a timeframe between Alternative 2 and Alternative 4.	The detection and removal components of this alternative could be performed with manual tools, which would be readily available for this purpose. Should MEC/MDEH items be identified on site, the technical implementability of this phase would be more difficult than if only MDAS and other metallic scrap items are identified on site. A commercial metal recycler that would accept munitions related scrap will need to be located. Comparatively, this alternative would be completed within the longest amount of time.
Costs: Capital 30-Yr NPW of O&M 30-Yr NPW	There would be no current costs associated with the No Action alternative. However, No Action could result in the exposure of future receptors to munitions-related items that would remain on site. Costs associated with future corrective actions could be substantial.	Capital Cost: $387,750 30-Year NPW of Annual Costs: $877,112 30-Year NPW: $1,264,862	Capital Cost: $561,043 30-Year NPW of Annual Costs: $877,112 30-Year NPW: $1,438,155	Capital Cost: $907,151 30-Year NPW of Annual Costs: $898,487 30-Year NPW: $1,805,638

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APPENDIX A

SUSTAINABLE REMEDIATION EVALUATION

APPENDIX A

Sustainability Evaluation of Remedial Alternatives
for
Lake Hancock Target Range

Naval Air Station Whidbey Island

Whidbey Island, Washington

March 2011

Objective

This Sustainable Remediation Evaluation (SRE) of Remedial Alternatives including references is provided as an appendix to the Feasibility Study (FS) for Lake Hancock Target Range, Naval Air Station (NAS) Whidbey Island, Whidbey Island, Washington. The purpose of the SRE is to assess the sustainability of the proposed remedial alternatives using the metrics of greenhouse gas (GHG) emissions, energy use, air emissions of criteria pollutants, water consumption, and worker safety. The results of the SRE are intended to provide additional information for consideration with the remedy selection criteria described in the FS and to enhance the understanding of the net environmental benefit of the selected remedy.

Sustainability Evaluation Policy Background

Department of Defense (DOD) and Navy policies require continual optimization of remedies in every phase from remedy selection through site closeout. In January 2007, Executive Order 13423 set targets for sustainable practices for (i) energy efficiency, greenhouse gas emissions avoidance or reduction, and petroleum products use reduction, (ii) renewable energy, including bioenergy, (iii) water conservation, (iv) acquisition, (v) pollution and waste prevention and recycling, etc. In October 2009, Executive Order 13514 was issued, which reinforced these sustainability requirements and established specific goals for federal agencies to meet by 2020.

In August 2009 DOD issued policy for “Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program.” The DOD policy and related Navy guidance state that opportunities to increase sustainability should be considered throughout all phases of remediation (i.e., site investigation, remedy selection, remedy design and construction, operation, monitoring, and site closeout). In response to this policy, the

Navy issued an updated Navy Guidance for “Optimizing Remedy Evaluation, Selection, and Design” (Battelle, 2010), which includes sustainability evaluations as part of the traditional Navy optimization review process for remedy selection, design, and remedial action operation. In August 2010 the Naval Facilities Engineering Command (NAVFAC) issued policy requiring use of the SiteWise tool to perform sustainability reviews as part of all Feasibility Studies. As such, this sustainability evaluation of remedial alternatives is being performed to estimate the environmental footprint associated with each alternative in the interest of increasing the sustainability of remedial action at Lake Hancock Target Range.

Evaluation Tools

This evaluation was done by using the Navy’s SiteWise tool. SiteWise is a stand-alone tool developed jointly by the U.S. Navy, U.S. Army Corps of Engineers (USACE), and Battelle that assesses the environmental footprint of a remedial alternative/technology in terms of a consistent set of metrics. The assessment is carried out using a building block approach where every remedial alternative is first broken down into modules that mimic the remedial phases in most remedial actions, including remedial investigation (RI), remedial action constructions (RAC), remedial action operation (RA-O), and long-term monitoring (LTM). Once broken down into various modules, the footprint of each module is individually calculated. The different footprints are then combined to estimate the overall footprint of the remedial alternative. This building block approach reduces redundancy in the sustainability evaluation and facilitates the identification of specific activities that have the greatest environmental footprint. The inputs that need to be considered include (1) production of material required by the activity; (2) transportation of the required materials to the site; (3) all site activities to be performed; and (4) management of the waste produced by the activity.

Sustainability Evaluation Framework

The sustainability evaluation performed for Alternatives 2, 3, and 4 considered life-cycle metrics for GHG emissions, criteria pollutant emissions, energy consumption, and water usage. The no action alternative (Alternative 1) was not evaluated, as hypothetically no direct emissions or consumption occur as part of implementation of the no action alternatives.

The following three remedial alternatives were analyzed, which are summarized in detail in the Feasibility Study:

- Alternative 2: Surface Removal with Land Use Controls
- Alternative 3: Surface and Limited Subsurface Removal (to 1 foot bgs) with Land Use Controls
- Alternative 4: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls

Life cycle impacts were calculated for energy consumption, emissions of greenhouse gases (GHG) [carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)] and criteria pollutants [nitrogen oxides (NO_x), sulfur oxides (SO_x) and particulate matter (PM_{10})], water usage, and energy consumption. In addition, worker safety and life cycle cost were considered.

Calculation of these metrics was divided into four modules – materials production; transportation of personnel; transportation of materials, and equipment; equipment use and miscellaneous; and residual handling. Cost estimates from the Feasibility Study and design calculations from each alternative were used as a basis for quantities and related assumptions.

Limitations and Assumptions

Since the excavating will be done by hand, there will be no heavy equipment used and the impacts will be only coming from transportation. The following assumptions were made:

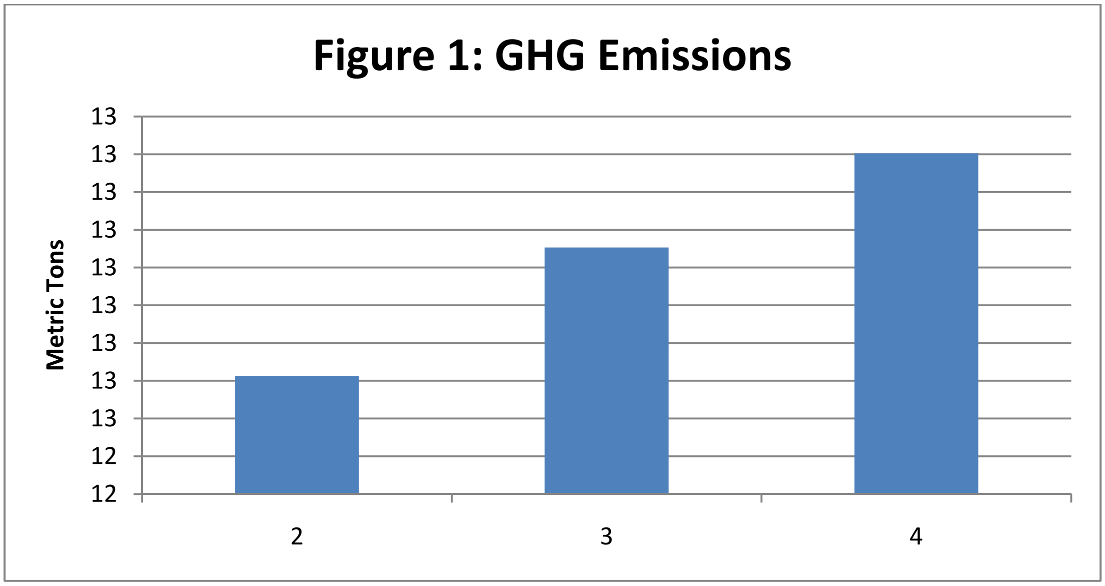
- 1 person will be flying to the site, approximately 2100 each way, 4200 round trip.
- Each person driving to the site will travel approximately 1000 miles.
- 30 miles per person is assumed for daily travel to and from the site.
- 10 drums will be removed for Alternative 2, weighing approximately 400 pounds each
- 12 drums will be removed for Alternative 3 and 14 drums will be removed Alternative 4, weighing approximately 400 pounds each
- 1 drum will be removed for each annual removal, years 1, 2, 3, 5, and 10, weighing approximately 400 pounds each

Sustainability Evaluation Results

The SiteWise input sheets and summary of results are in the attachment to this report. The following section summarizes the results of the evaluation and provides figures.

Greenhouse Gas Emissions

Emissions of CO_2, CH_4, and N_2O were normalized to CO_2 equivalents (CO_2e), which is a cumulative method of weighing GHG emissions relative to global warming potential. Analysis of GHG emissions for each alternative are summarized in Figure 1. Alternative 2 has the least amount of GHG emissions and Alternative 4 has the most. This is due to the additional days spent onsite for Alternative 4 and the travel associated with this.



Criteria Pollutant Emissions

Criteria pollutant emissions for NO_x, SO_x, and PM_{10} were estimated for each remedy. Results from the evaluation of NO_x, SO_x, and PM_{10} are summarized in Figures 2, 3, and 4 respectively. Alternative 4 has the most criteria pollutant emissions, again due to the most amount of travel daily to the site.

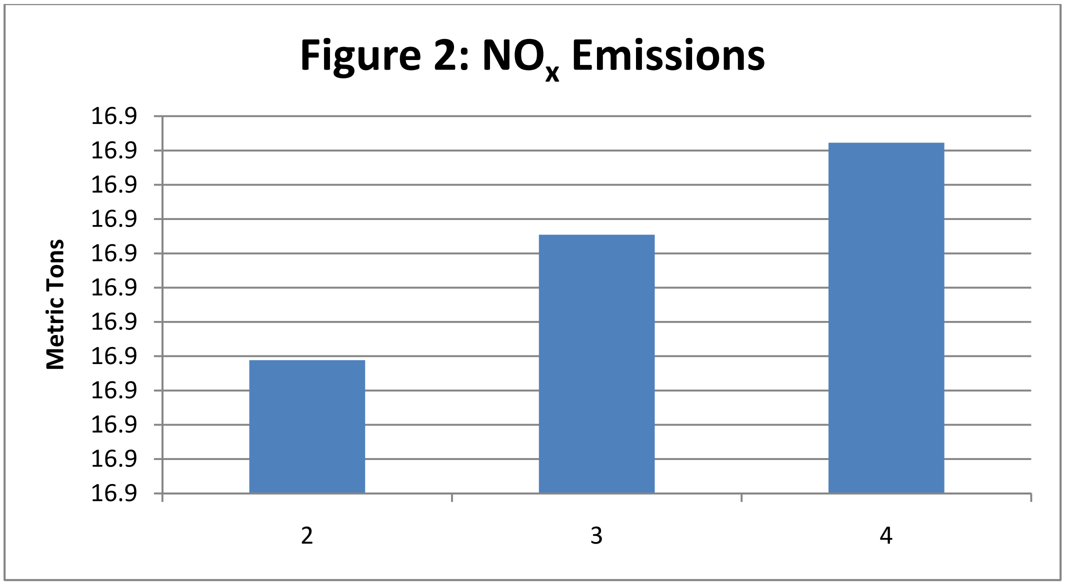


Figure 2: NOx Emissions
Metric Tons
16.9
2
3
4

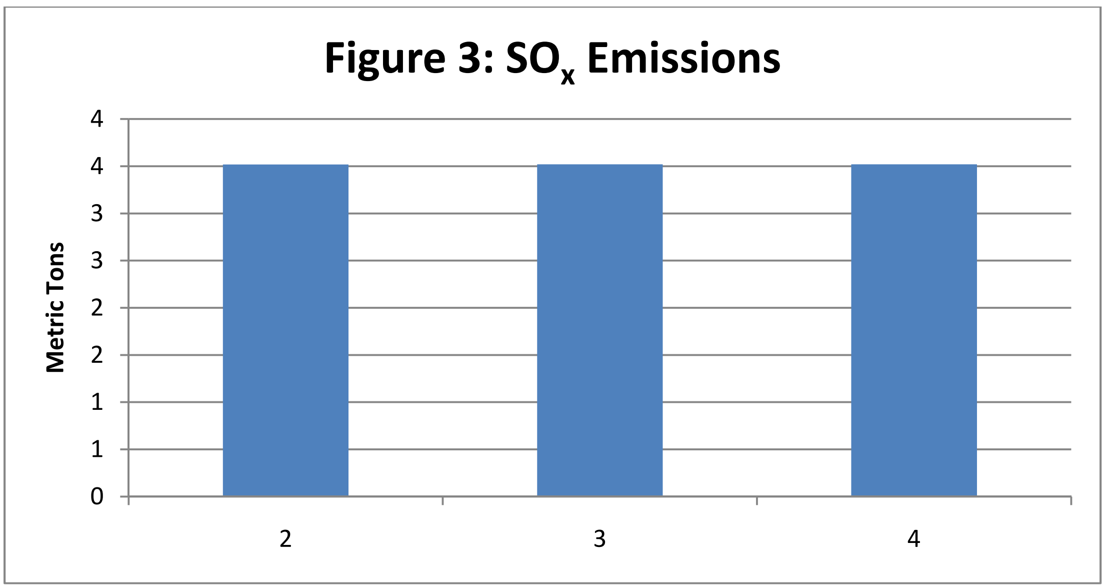
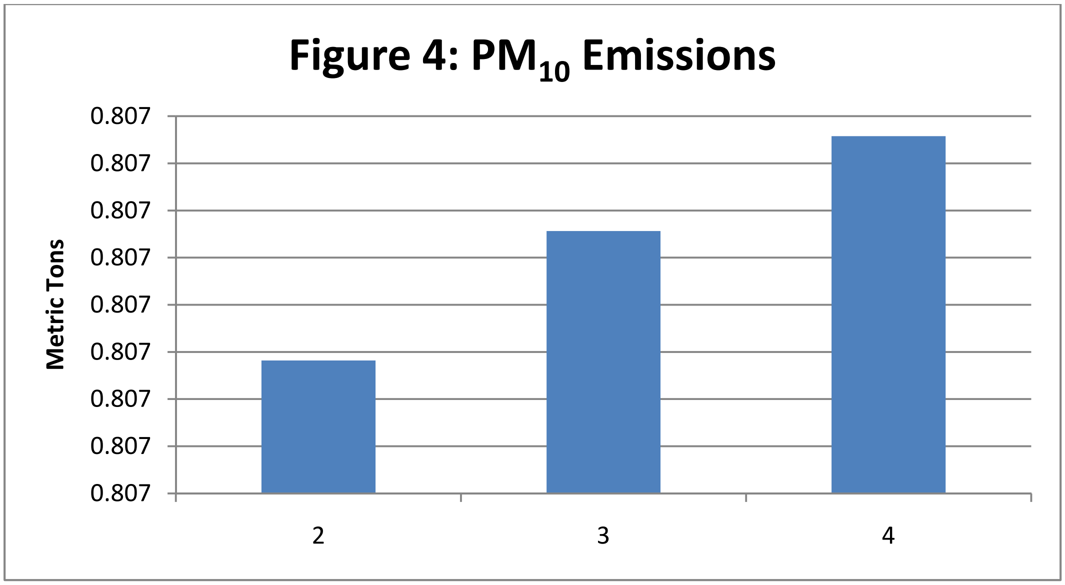
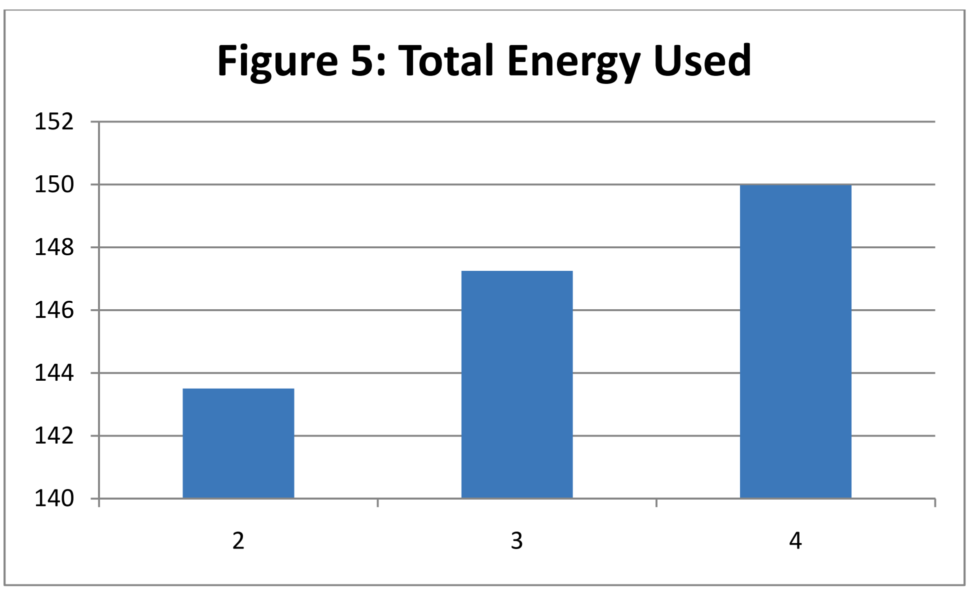


Figure 3: SOx Emissions
Metric Tons
4
3
2
1
0
2
3
4



Energy Consumption

Similar to GHG, and Criteria Pollutants, Energy consumption is also proportional to days traveled to and from the site by site workers.

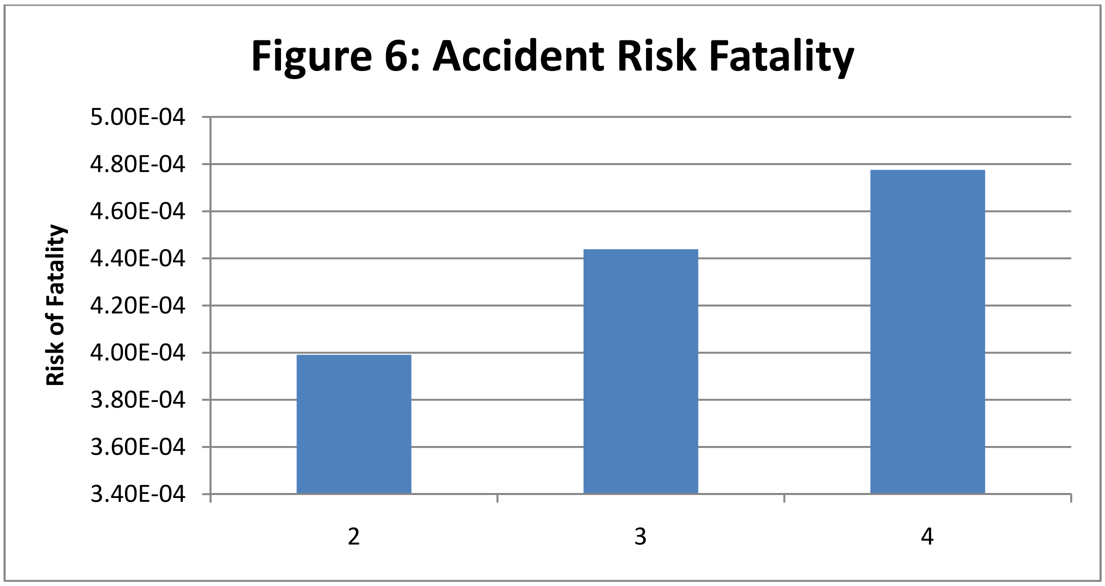


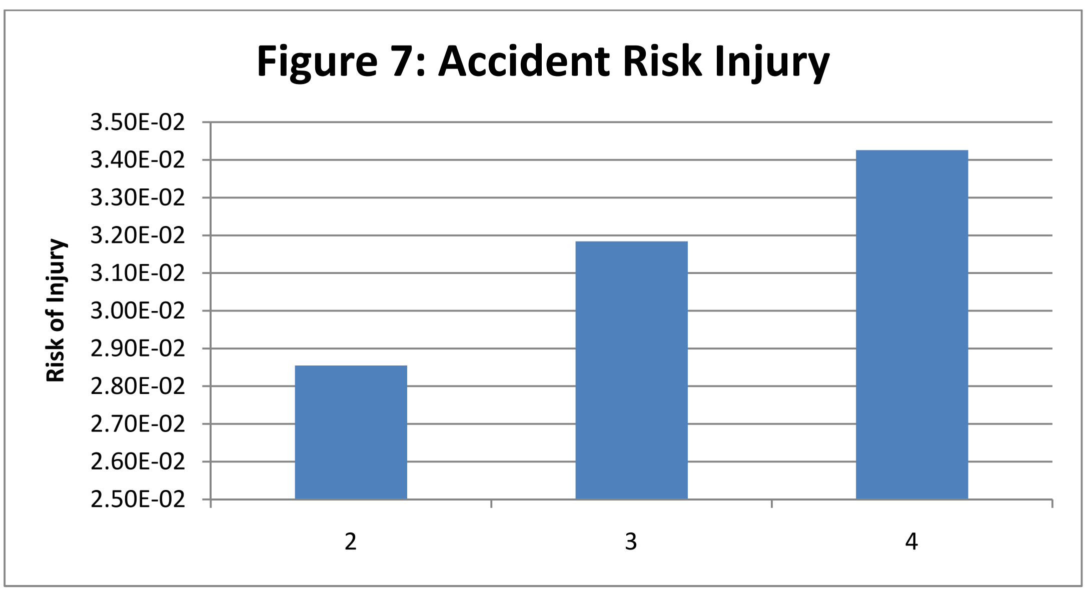
Water Usage

Since transportation is the only input into this model, there is no water usage.

Accident Risk

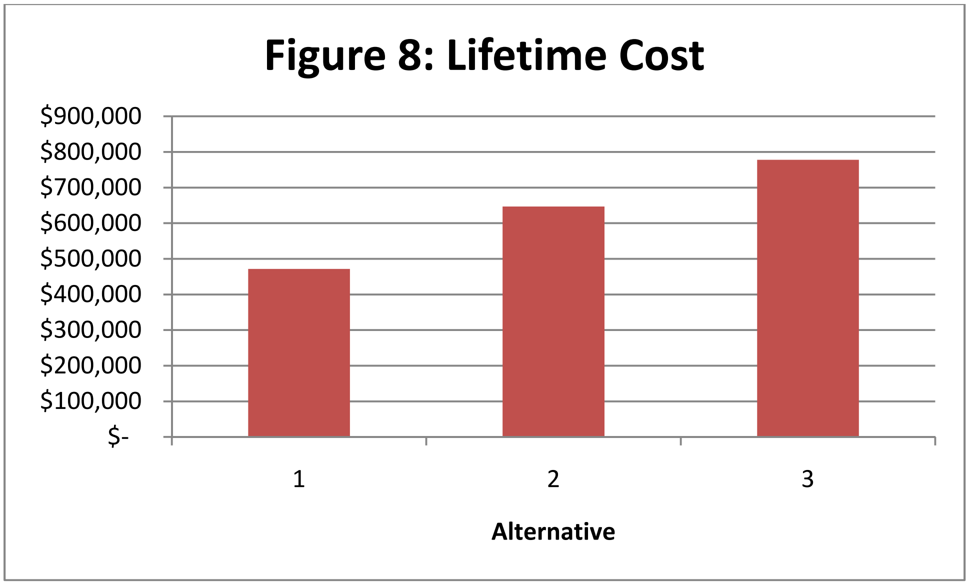
Accident risk comes from traveling by car and plane to and from the site. Thus, Alternative 2 has the least risk, and Alternative 4 has the highest amount of risk.





Cost of Remedy Alternatives

The estimated life-cycle costs are summarized in Figure 8. The costs increase as the excavating becomes more intensive for each alternative and travel to and from the site increases.



<u>Conclusions</u>

In general, optimization of the selected remedy to decrease the primary components of GHG emissions could potentially increase the net environmental benefit of remedy implementation. During selection and design of the remedy, a sensitivity analysis considering elements of the remedy that have the greatest impact on remedy effectiveness, life-cycle cost, and sustainability metrics may provide additional insight into appropriate optimization.

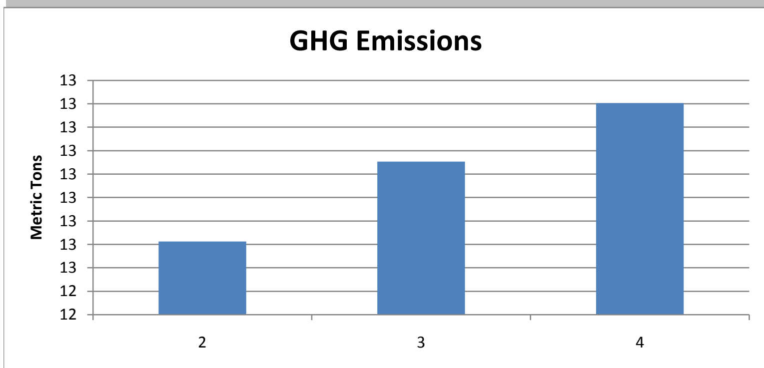
Measures identified in the evaluation that may reduce the environmental footprint of the alternatives are listed below for consideration.

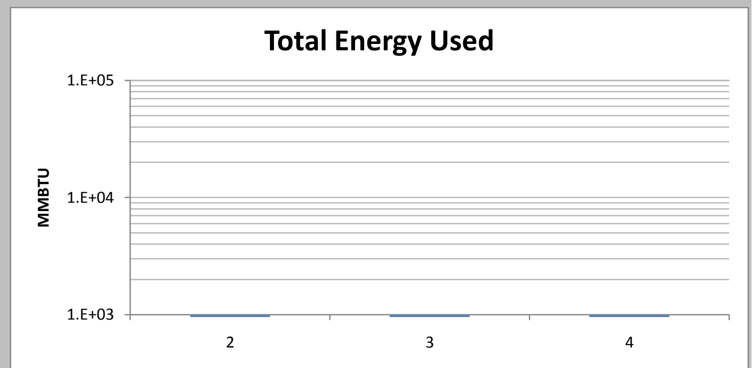
- Assuming site workers will be coming from the same place, carpooling daily to and from the site is a simple and effective way to reduce impact for this remedy implementation.
- Some reduction of the environmental footprint, particularly GHG emissions, could be realized for all alternatives through the possible use of emission control measures such as alternate fuel sources (e.g. biodiesel), equipment exhaust controls (e.g. diesel), and equipment idle reduction for the trucks transporting the removed material.

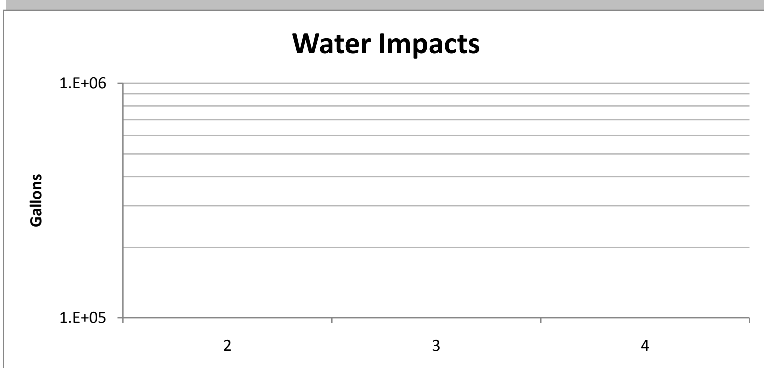
- Purchasing carbon offsets for all transportation would offset GHG impacts.
- Worker risk can be minimized if travel distances are minimized.

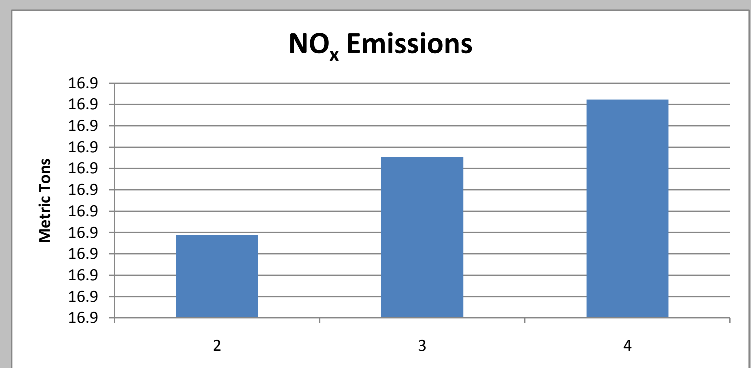
Continual optimization of the selected remedy and related monitoring plan throughout the project life-cycle (FS, RD, RA, RAO/LTM phases) in accordance with Navy policy and guidance will continually reduce the life-cycle environmental footprint, as well as costs, of the project.

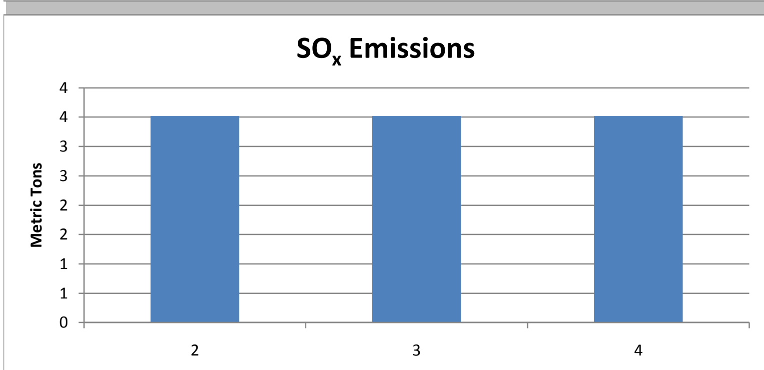
Remedial Alternatives	GHG Emissions	Total energy Used	Water Consumption	NO_x emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
2	12.61	143.51	0.00E+00	1.69E+01	3.53E+00	8.07E-01	4.01E-04	2.86E-02
3	12.95	147.25	0.00E+00	1.69E+01	3.53E+00	8.07E-01	4.47E-04	3.19E-02
4	13.20	149.98	0.00E+00	1.69E+01	3.53E+00	8.07E-01	4.80E-04	3.43E-02

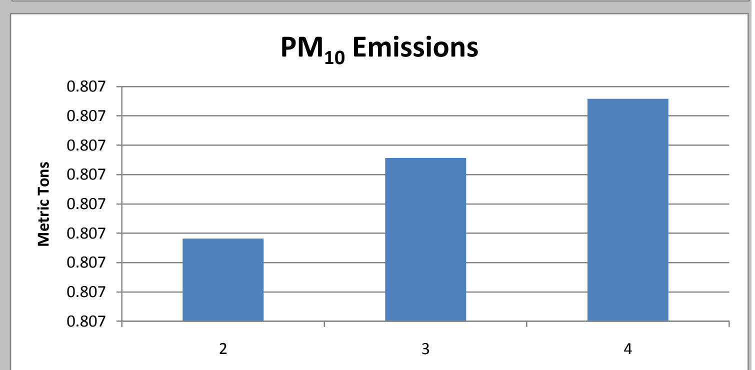


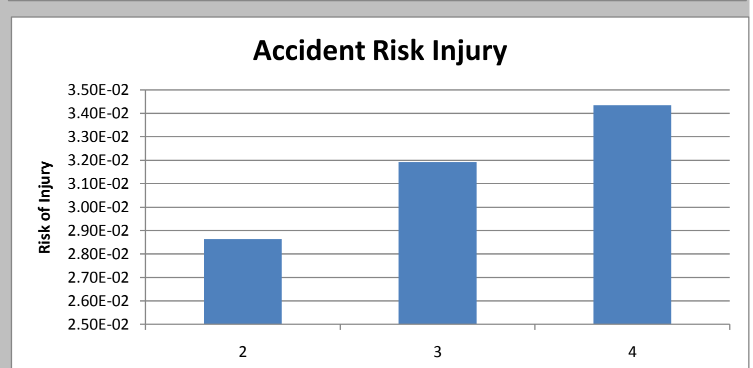






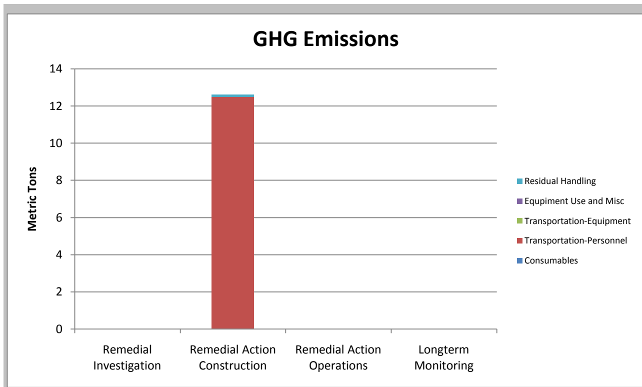


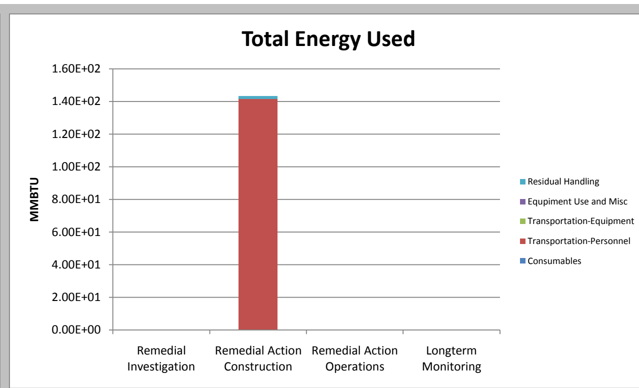


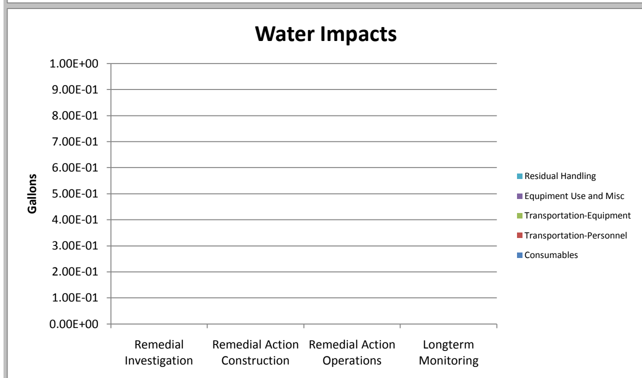


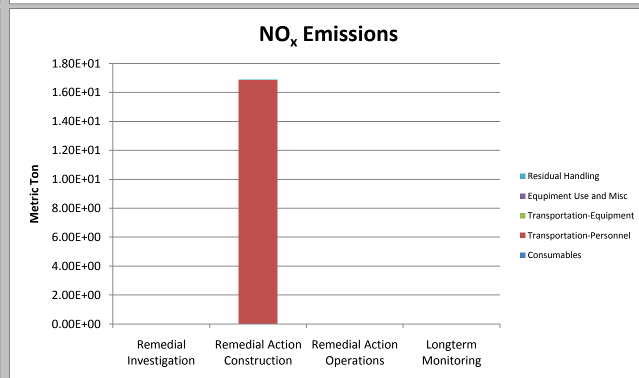
Sustainable Remediation - Environmental Footprint Summary
2

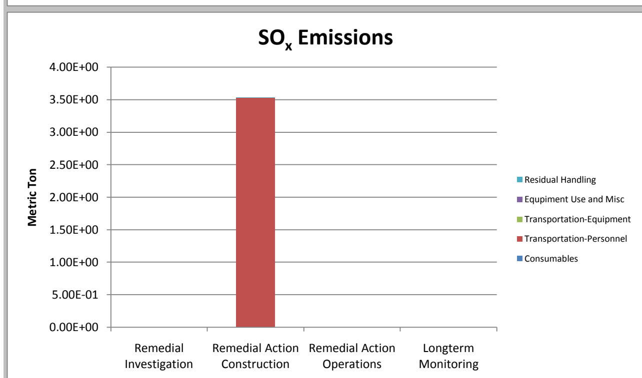
Phase	Activities	GHG Emissions metric ton	Total Energy Used MMBTU	Water Impacts gallons	NO_x Emissions metric ton	SO_x Emissions metric ton	PM_{10} Emissions metric ton	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	12.49	1.4E+02	NA	1.7E+01	3.5E+00	8.1E-01	4.0E-04	2.9E-02
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.12	1.8E+00	NA	1.4E-04	2.6E-05	1.8E-05	3.8E-07	7.9E-05
	Sub-Total	12.61	1.44E+02	0.00E+00	1.69E+01	3.53E+00	8.07E-01	4.01E-04	2.86E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total		**12.61**	**1.44E+02**	**0.00E+00**	**16.89**	**3.53**	**8.07E-01**	**4.01E-04**	**0.03**

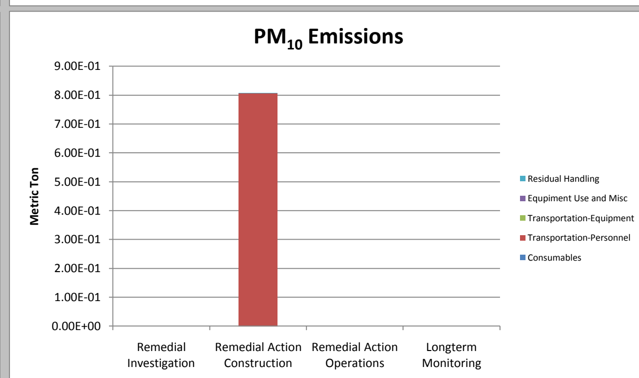

GHG Emissions
Metric Tons
14
12
10
8
6
4
2
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

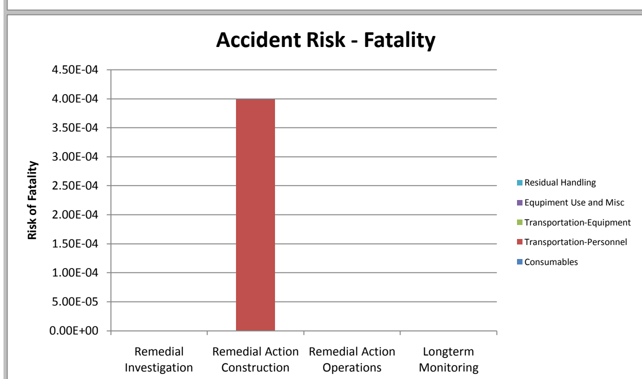

Total Energy Used
MMBTU
1.60E+02
1.40E+02
1.20E+02
1.00E+02
8.00E+01
6.00E+01
4.00E+01
2.00E+01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

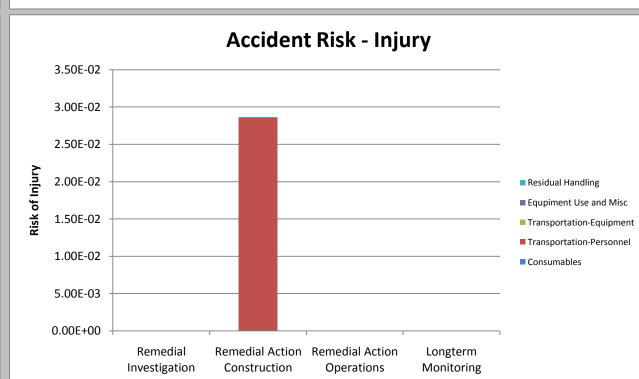

Water Impacts
Gallons
1.00E+00
9.00E-01
8.00E-01
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NO_x Emissions
Metric Ton
1.80E+01
1.60E+01
1.40E+01
1.20E+01
1.00E+01
8.00E+00
6.00E+00
4.00E+00
2.00E+00
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SO_x Emissions
Metric Ton
4.00E+00
3.50E+00
3.00E+00
2.50E+00
2.00E+00
1.50E+00
1.00E+00
5.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

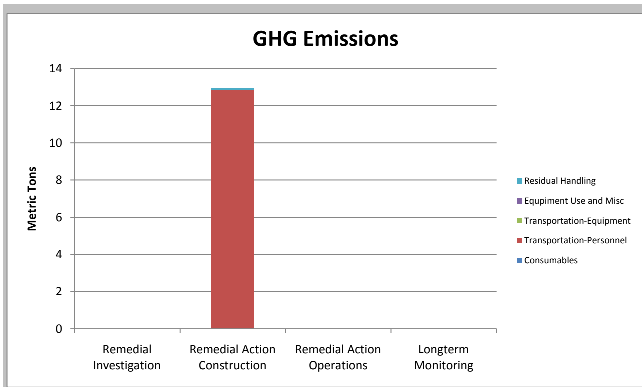

PM_{10} Emissions
Metric Ton
9.00E-01
8.00E-01
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

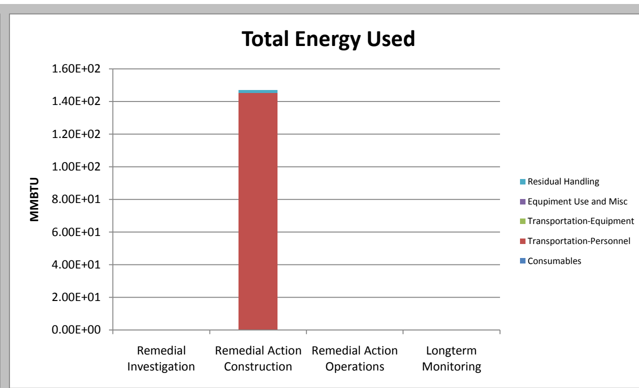

Accident Risk - Fatality
Risk of Fatality
4.50E-04
4.00E-04
3.50E-04
3.00E-04
2.50E-04
2.00E-04
1.50E-04
1.00E-04
5.00E-05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

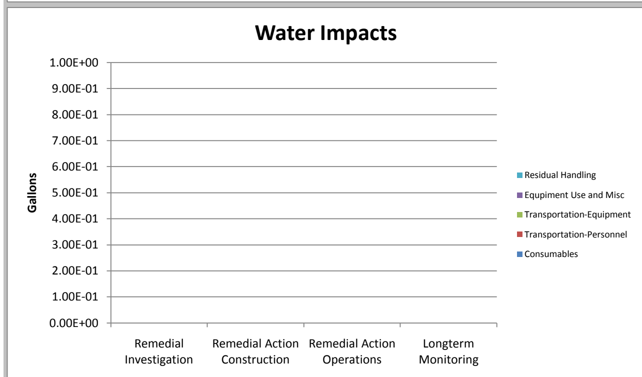

Accident Risk - Injury
Risk of Injury
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

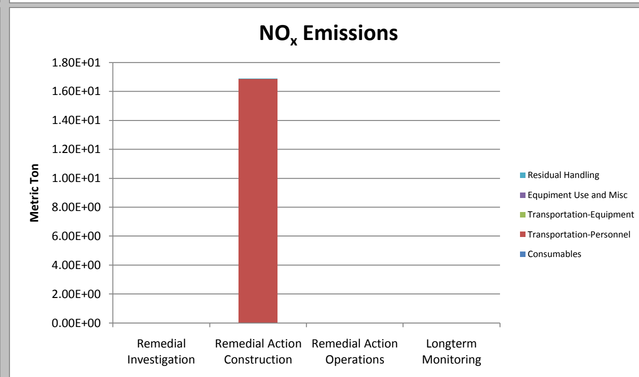
Sustainable Remediation - Environmental Footprint Summary
3

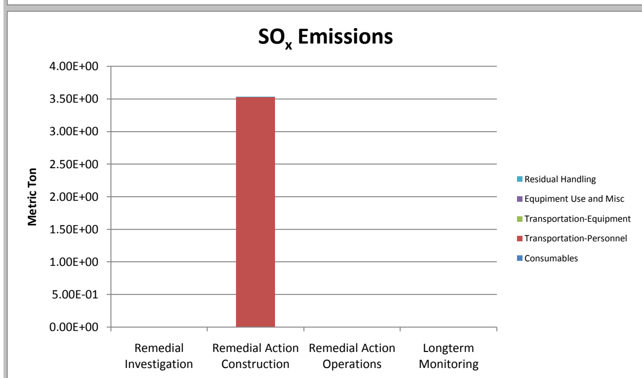
Phase	Activities	GHG Emissions metric ton	Total Energy Used MMBTU	Water Impacts gallons	NO_x Emissions metric ton	SO_x Emissions metric ton	PM_{10} Emissions metric ton	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	12.83	1.5E+02	NA	1.7E+01	3.5E+00	8.1E-01	4.5E-04	3.2E-02
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.12	1.8E+00	NA	1.4E-04	2.6E-05	1.8E-05	3.8E-07	7.9E-05
	Sub-Total	12.95	1.47E+02	0.00E+00	1.69E+01	3.53E+00	8.07E-01	4.47E-04	3.19E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total		**12.95**	**1.47E+02**	**0.00E+00**	**16.89**	**3.53**	**8.07E-01**	**4.47E-04**	**0.03**

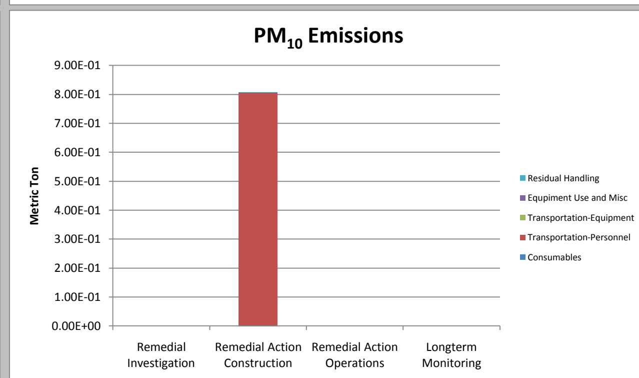

GHG Emissions
Metric Tons
14
12
10
8
6
4
2
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

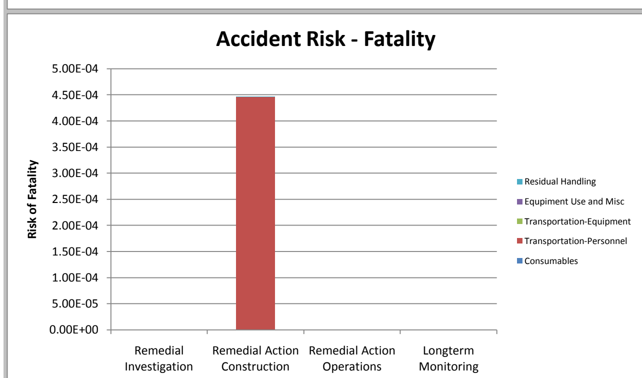

Total Energy Used
MMBTU
1.60E+02
1.40E+02
1.20E+02
1.00E+02
8.00E+01
6.00E+01
4.00E+01
2.00E+01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

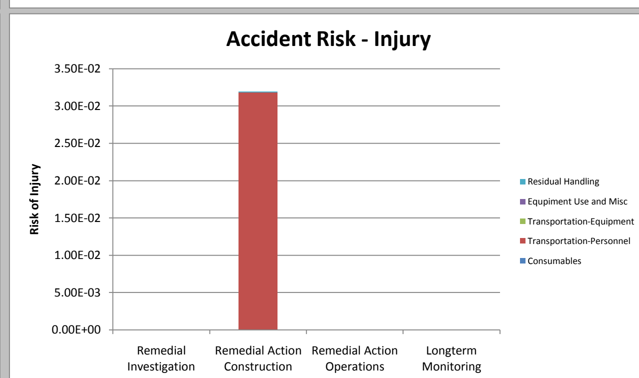

Water Impacts
Gallons
1.00E+00
9.00E-01
8.00E-01
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NO_x Emissions
Metric Ton
1.80E+01
1.60E+01
1.40E+01
1.20E+01
1.00E+01
8.00E+00
6.00E+00
4.00E+00
2.00E+00
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SO_x Emissions
Metric Ton
4.00E+00
3.50E+00
3.00E+00
2.50E+00
2.00E+00
1.50E+00
1.00E+00
5.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

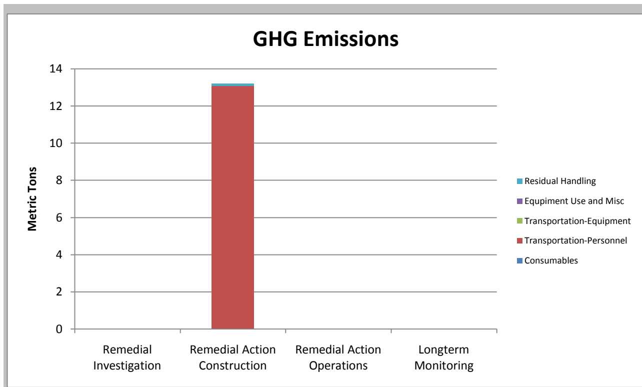

PM_{10} Emissions
Metric Ton
9.00E-01
8.00E-01
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

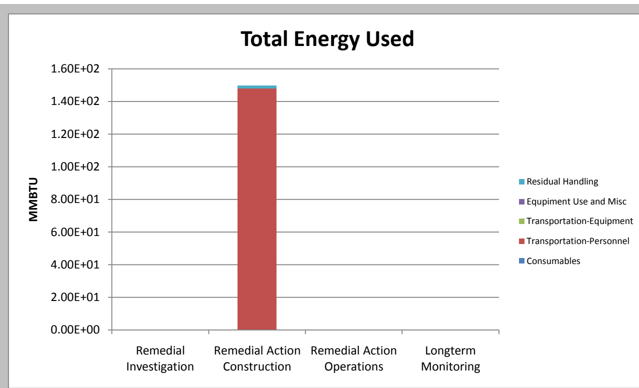

Accident Risk - Fatality
Risk of Fatality
5.00E-04
4.50E-04
4.00E-04
3.50E-04
3.00E-04
2.50E-04
2.00E-04
1.50E-04
1.00E-04
5.00E-05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

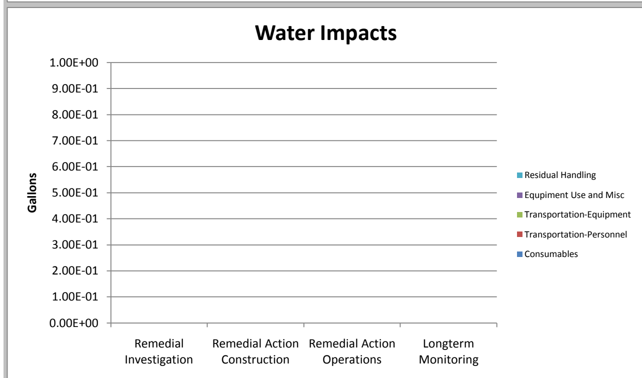

Accident Risk - Injury
Risk of Injury
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

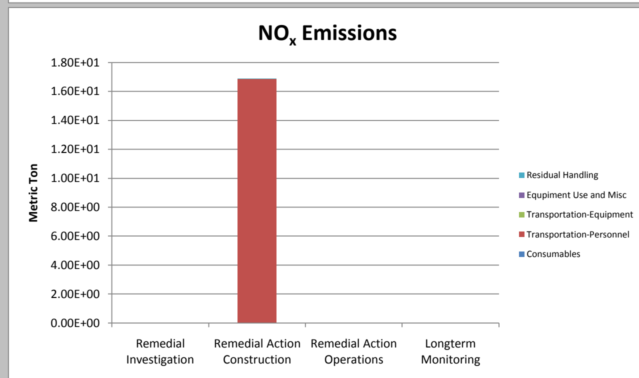
Sustainable Remediation - Environmental Footprint Summary
4

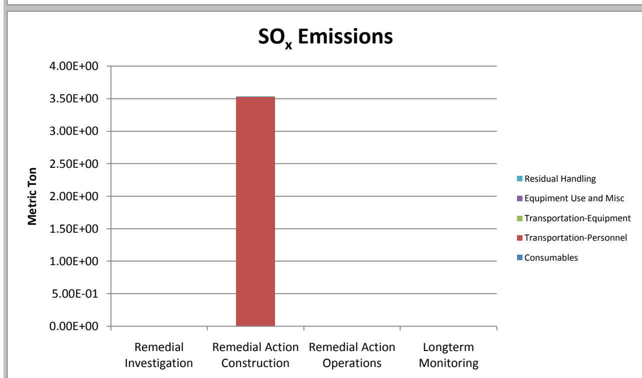
Phase	Activities	GHG Emissions metric ton	Total Energy Used MMBTU	Water Impacts gallons	NO_x Emissions metric ton	SO_x Emissions metric ton	PM_{10} Emissions metric ton	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	13.08	1.5E+02	NA	1.7E+01	3.5E+00	8.1E-01	4.8E-04	3.4E-02
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.12	1.8E+00	NA	1.4E-04	2.6E-05	1.8E-05	3.8E-07	7.9E-05
	Sub-Total	13.20	1.50E+02	0.00E+00	1.69E+01	3.53E+00	8.07E-01	4.80E-04	3.43E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total		**13.20**	**1.50E+02**	**0.00E+00**	**16.89**	**3.53**	**8.07E-01**	**4.80E-04**	**0.03**

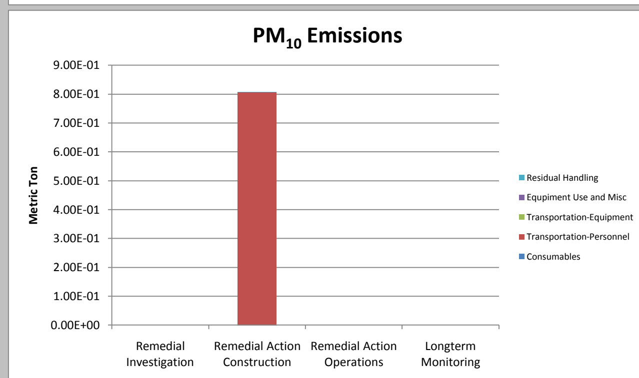

GHG Emissions
Metric Tons
14
12
10
8
6
4
2
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

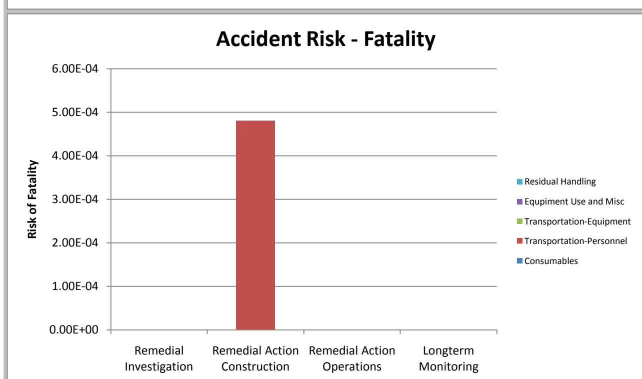

Total Energy Used
MMBTU
1.60E+02
1.40E+02
1.20E+02
1.00E+02
8.00E+01
6.00E+01
4.00E+01
2.00E+01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

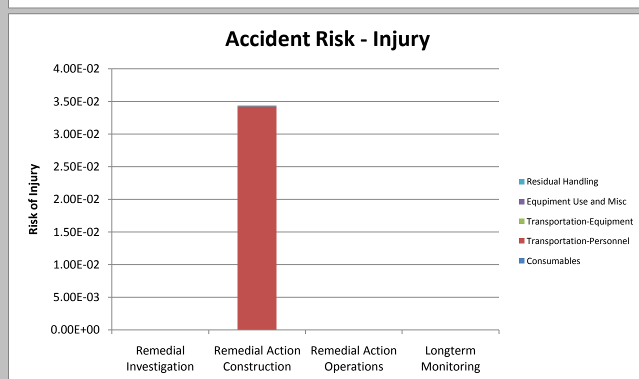

Water Impacts
Gallons
1.00E+00
9.00E-01
8.00E-01
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NO_x Emissions
Metric Ton
1.80E+01
1.60E+01
1.40E+01
1.20E+01
1.00E+01
8.00E+00
6.00E+00
4.00E+00
2.00E+00
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SO_x Emissions
Metric Ton
4.00E+00
3.50E+00
3.00E+00
2.50E+00
2.00E+00
1.50E+00
1.00E+00
5.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM_{10} Emissions
Metric Ton
9.00E-01
8.00E-01
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

Remedial Action Construction

This worksheet allows the user to define material production, transportation, equipment use, and residual handling variables for the remedial alternative

Yellow cells	require the user to choose an input from a drop down menu
White cells	require the user to type in a value

MATERIAL PRODUCTION

WELL MATERIALS	Well Type 1	Well Type 2	Well Type 3	Well Type 4	Well Type 5	Well Type 6
Input number of wells						
Input depth of wells (ft)						
Choose well diameter (in) from drop down menu	1/2	1/2	1/2	1/2	1/2	1/2
Choose material type from drop down menu	PVC	PVC	PVC	PVC	PVC	PVC
Choose specific material schedule from drop down menu	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC

TREATMENT CHEMICALS & MATERIALS	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Treatment 6
Input number of injection points						
Choose material type from drop down menu	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide
Input amount of material injected at each point (pounds dry mass)						
Input number of injections per injection point						

GAC	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Treatment 6
Input weight of GAC used (lbs)						
Choose material type from drop down menu	Virgin GAC	Virgin GAC	Virgin GAC	Virgin GAC	Virgin GAC	Virgin GAC

CONSTRUCTION MATERIALS	Material 1	Material 2	Material 3	Material 4	Material 5	Material 6
Choose material type from drop down menu	HDPE Liner	HDPE Liner	HDPE Liner	HDPE Liner	HDPE Liner	HDPE Liner
Input area of material (ft^2)						
Input depth of material (ft)						

WELL DECOMMISSIONING	Well Type 1	Well Type 2	Well Type 3	Well Type 4	Well Type 5	Well Type 6
Input number of wells						
Input depth of wells (ft)						
Input well diameter (in)	1	1	1	1	1	1
Choose material from drop down menu	Soil	Soil	Soil	Soil	Soil	Soil

TRANSPORTATION

	Initial Mob/Demob	Initial Dailies	Annual Mob/Demob	Annual Dailies		
PERSONNEL TRANSPORTATION - ROAD	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No	No	No
Choose vehicle type from drop down menu*	Light truck	Light truck	Light truck	Light truck	Cars	Cars
Choose fuel used from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Input distance traveled per trip (miles)	1000	30	1000	30		
Input number of trips taken	1	20	5	20		
Input number of travelers	11	12	5	6		
Input estimated vehicular fuel economy (mi/gal) (Input only if known for the vehicle selected, otherwise a default will be used by the tool)						

*For vehicle type 'Other' please enter values in Table 2b in the Look Up Table tab.

PERSONNEL TRANSPORTATION - AIR	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (miles)	4,200	4,200				
Input number of travelers	1	1				
Input number of flights taken	1	5				

PERSONNEL TRANSPORTATION - RAIL	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Choose vehicle type from drop down menu	Intercity rail	Intercity rail	Intercity rail	Intercity rail	Intercity rail	Intercity rail
Input distance traveled (miles)						
Input number of trips taken						
Input number of travelers						

EQUIPMENT TRANSPORTATION - ROAD	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No	No	No
Choose fuel used from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Input distance traveled (miles)						
Input weight of equipment transported (tons)						

EQUIPMENT TRANSPORTATION - AIR	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (miles)						
Input weight of equipment transported (tons)						

EQUIPMENT TRANSPORTATION - RAIL	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (miles)						
Input weight of load (tons)						

EQUIPMENT TRANSPORTATION - WATER	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (mile)						
Input weight of load (tons)						

EQUIPMENT USE

EARTHWORK	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5	Equipment 6
Choose earthwork equipment type from drop down menu	Dozer	Dozer	Dozer	Dozer	Dozer	Dozer
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Input volume of material to be removed (yd^3)						
Will DIESEL-run equipment be retrofitted with a particulate reduction technology?	No	No	No	No	No	No
DRILLING	**Event 1**	**Event 2**	**Event 3**	**Event 4**	**Event 5**	**Event 6**
Input number of drilling locations						
Choose drilling method from drop down menu	Direct Push	Direct Push	Direct Push	Direct Push	Direct Push	Direct Push
Input time spent drilling at each location (hr)						
Input depth of wells (ft)						
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel

For each pump, select only one of the three methods to calculate energy and GHG emissions
Enter "0" for all user input values for unused pump columns or unused methods

PUMP OPERATION	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6
Choose method from drop down	Method 2	Method 1	Method 1	Method 1	Method 1	Method 1
Method 1 - ELECTRICAL USAGE IS KNOWN						
Input pump electrical usage (KWh)	0	0	0	0	0	0
Method 2 - PUMP HEAD IS KNOWN						
Input flow rate (gpm)	0	0	0	0	0	0
Input total head (ft)	0	0	0	0	0	0
Input number of pumps operating	0	0	0	0	0	0
Input operating time for each pump (hrs)	0	0	0	0	0	0
Pump efficiency times motor efficiency (default already present, user override possible)	0.51	0.51	0.51	0.51	0.51	0.51
Input specific gravity (default already present, user override possible)	1	1	1	1	1	1
Method 3 - NAME PLATE SPECIFICATIONS ARE KNOWN						
Input pump horsepower (hp)	0	0	0	0	0	0
Input number of pumps operating	0	0	0	0	0	0
Input operating time for each pump (hrs)	0	0	0	0	0	0
Input pump load (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Input pump motor efficiency (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Region						
Choose region from drop down menu (scroll right to see figure)	AKGD	AKGD	AKGD	AKGD	AKGD	AKGD

DIESEL AND GASOLINE PUMPS	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6
Choose fuel type from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Choose horsepower range from drop down menu	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1
Equipment operating hours (hrs)						
Input estimated fuel consumption rate (gal/hr) (Input only if known for the pump selected, otherwise a default will be used by the tool)						

For each type of equipment, select only one of the methods to calculate energy and GHG emissions
Enter "0" for all user input values for unused equipment columns or unused methods

BLOWER, COMPRESSOR, MIXER, AND OTHER EQUIPMENT	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5	Equipment 6
Choose type of equipment from drop down	Blower	Blower	Blower	Blower	Blower	Blower
Choose method from drop down	Method 1	Method 1	Method 1	Method 1	Method 1	Method 1
Method 1 - NAME PLATE SPECIFICATIONS ARE KNOWN						
Input equipment horsepower (hp)	0	0	0	0	0	0
Input number of equipments operating	0	0	0	0	0	0
Input operating time for each equipment (hrs)	0	0	0	0	0	0
Input equipment load (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Input motor efficiency (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Method 2 - ELECTRICAL USAGE IS KNOWN						
Input equipment electrical usage, if known (KWh)	0	0	0	0	0	0
Region						
Choose region from drop down menu (scroll right to see figure)	AKGD	AKGD	AKGD	AKGD	AKGD	AKGD

GENERATORS	Generator 1	Generator 2	Generator 3	Generator 4	Generator 5	Generator 6
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Choose horsepower range from drop down menu	3 to 6	3 to 6	3 to 6	3 to 6	3 to 6	3 to 6
Input operating hours (hr)						

AGRICULTURAL EQUIPMENT	Tillage Tractor 1	Tillage Tractor 2	Tillage Tractor 3	Tillage Tractor 4	Tillage Tractor 5	Tillage Tractor 6
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Input area to till (acre)						
Choose soil condition from drop down menu	Firm untilled soil	Firm untilled soil	Firm untilled soil	Firm untilled soil	Firm untilled soil	Firm untilled soil
Choose soil type from drop down menu	Clay Soil	Clay Soil	Clay Soil	Clay Soil	Clay Soil	Clay Soil
Input time available (work days)						
Input depth of tillage (in)						

CAPPING EQUIPMENT	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5	Equipment 6
Choose stabilization equipment type from drop down menu	Roller	Roller	Roller	Roller	Roller	Roller
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Input area (ft^2)						
Input time available (work days)						

MIXING EQUIPMENT	Mixer 1	Mixer 2	Mixer 3	Mixer 4	Mixer 5	Mixer 6
Choose fuel type from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Choose horsepower range from drop down menu	1 to 3	1 to 3	1 to 3	1 to 3	1 to 3	1 to 3
Input volume (yd^3)						
Input production rate (yd^3/hr)						
Input estimated fuel consumption rate (gal/hr) (Input only if known for the mixer selected, otherwise a default will be used by the tool)						

RESIDUAL HANDLING

RESIDUE DISPOSAL/RECYCLING	Soil Residue	Residual Water	Material Residue	Other Residuals	Other Residuals	Other Residuals
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No	No	No
Input weight of the waste transported to landfill or recycling per trip (tons)	3					
Choose vehicle type from drop down menu	Heavy Duty	On-road truck	On-road truck	On-road truck	On-road truck	On-road truck
Choose fuel used from drop down menu	Diesel	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Input total number of trips	1					
Input number of miles per trip	100					

LANDFILL OPERATIONS	Operation 1	Operation 2	Operation 3	Operation 4	Operation 5	Operation 6
Input tons of soil or waste to be incinerated (user must input emission factors in the Look Up Table, Table 7a)						

THERMAL/CATALYTIC OXIDIZERS*	Oxidizer 1	Oxidizer 2	Oxidizer 3	Oxidizer 4	Oxidizer 5	Oxidizer 6
Choose oxidizer type from drop down menu	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer
Choose fuel type from drop down menu	natural gas	Propane	natural gas	natural gas	natural gas	natural gas
Input waste gas flow rate (scfm)						
Input time running (hours)						
Input waste gas inlet temperature (F)						
Input contaminant concentration (ppmV)						

*(Electric blowers are included in the analysis)

WATER CONSUMPTION	Treatment System 1	Treatment System 2	Treatment System 3	Treatment System 4	Treatment System 5	Treatment System 6
Input water disposed/collected during treatment (gal)						
Input water disposed/collected during site preparation (gal)						
Input water disposed/collected during sampling (gal)						
Input water disposed/collected during site demobilization (gal)						

LANDFILL METHANE EMISSIONS	Landfill 1	Landfill 2	Landfill 3	Landfill 4	Landfill 5	Landfill 6
Input landfill methane emissions (metric tons)						

OTHER KNOWN ONSITE ACTIVITIES	Entire Site
Input energy usage (MMBTU)	
Water consumption (gallon)	
Input CO_2 emission (metric ton)	
Input N_2O emission (metric ton CO_2 e)	
Input CH_4 emissions (metric ton CO_2 e)	
Input NOx emission (metric ton)	
Input SOx emission (metric ton)	
Input PM_{10} emission (metric ton)	
Input fatality risk	
Input injury risk	

Remedial Action Construction

This worksheet allows the user to define material production, transportation, equipment use, and residual handling variables for the remedial alternative

Yellow cells	require the user to choose an input from a drop down menu
White cells	require the user to type in a value

MATERIAL PRODUCTION

WELL MATERIALS	Well Type 1	Well Type 2	Well Type 3	Well Type 4	Well Type 5	Well Type 6
Input number of wells						
Input depth of wells (ft)						
Choose well diameter (in) from drop down menu	1/2	1/2	1/2	1/2	1/2	1/2
Choose material type from drop down menu	PVC	PVC	PVC	PVC	PVC	PVC
Choose specific material schedule from drop down menu	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC

TREATMENT CHEMICALS & MATERIALS	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Treatment 6
Input number of injection points						
Choose material type from drop down menu	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide
Input amount of material injected at each point (pounds dry mass)						
Input number of injections per injection point						

GAC	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Treatment 6
Input weight of GAC used (lbs)						
Choose material type from drop down menu	Virgin GAC	Virgin GAC	Virgin GAC	Virgin GAC	Virgin GAC	Virgin GAC

CONSTRUCTION MATERIALS	Material 1	Material 2	Material 3	Material 4	Material 5	Material 6
Choose material type from drop down menu	HDPE Liner	HDPE Liner	HDPE Liner	HDPE Liner	HDPE Liner	HDPE Liner
Input area of material (ft^2)						
Input depth of material (ft)						

WELL DECOMMISSIONING	Well Type 1	Well Type 2	Well Type 3	Well Type 4	Well Type 5	Well Type 6
Input number of wells						
Input depth of wells (ft)						
Input well diameter (in)	1	1	1	1	1	1
Choose material from drop down menu	Soil	Soil	Soil	Soil	Soil	Soil

TRANSPORTATION

	Initial Mob/Demob	Initial Daily	Annual Mob/Demob	Annual Dailies		
PERSONNEL TRANSPORTATION - ROAD	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No	No	No
Choose vehicle type from drop down menu*	Light truck	Light truck	Light truck	Light truck	Cars	Cars
Choose fuel used from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Input distance traveled per trip (miles)	1000	30	1000	30		
Input number of trips taken	1	35	5	20		
Input number of travelers	11	12	5	6		
Input estimated vehicular fuel economy (mi/gal) (Input only if known for the vehicle selected, otherwise a default will be used by the tool)						

*For vehicle type 'Other' please enter values in Table 2b in the Look Up Table tab.

PERSONNEL TRANSPORTATION - AIR	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (miles)	4,200	4,200				
Input number of travelers	1	1				
Input number of flights taken	1	5				

PERSONNEL TRANSPORTATION - RAIL	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Choose vehicle type from drop down menu	Intercity rail	Intercity rail	Intercity rail	Intercity rail	Intercity rail	Intercity rail
Input distance traveled (miles)						
Input number of trips taken						
Input number of travelers						

EQUIPMENT TRANSPORTATION - ROAD	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No	No	No
Choose fuel used from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Input distance traveled (miles)						
Input weight of equipment transported (tons)						

EQUIPMENT TRANSPORTATION - AIR	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (miles)						
Input weight of equipment transported (tons)						

EQUIPMENT TRANSPORTATION - RAIL	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (miles)						
Input weight of load (tons)						

EQUIPMENT TRANSPORTATION - WATER	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (mile)						
Input weight of load (tons)						

EQUIPMENT USE

EARTHWORK	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5	Equipment 6
Choose earthwork equipment type from drop down menu	Dozer	Dozer	Dozer	Dozer	Dozer	Dozer
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Input volume of material to be removed (yd^3)						
Will DIESEL-run equipment be retrofitted with a particulate reduction technology?	No	No	No	No	No	No
DRILLING	**Event 1**	**Event 2**	**Event 3**	**Event 4**	**Event 5**	**Event 6**
Input number of drilling locations						
Choose drilling method from drop down menu	Direct Push	Direct Push	Direct Push	Direct Push	Direct Push	Direct Push
Input time spent drilling at each location (hr)						
Input depth of wells (ft)						
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel

For each pump, select only one of the three methods to calculate energy and GHG emissions
Enter "0" for all user input values for unused pump columns or unused methods

PUMP OPERATION	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6
Choose method from drop down	Method 2	Method 1	Method 1	Method 1	Method 1	Method 1
Method 1 - ELECTRICAL USAGE IS KNOWN						
Input pump electrical usage (KWh)	0	0	0	0	0	0
Method 2 - PUMP HEAD IS KNOWN						
Input flow rate (gpm)	0	0	0	0	0	0
Input total head (ft)	0	0	0	0	0	0
Input number of pumps operating	0	0	0	0	0	0
Input operating time for each pump (hrs)	0	0	0	0	0	0
Pump efficiency times motor efficiency (default already present, user override possible)	0.51	0.51	0.51	0.51	0.51	0.51
Input specific gravity (default already present, user override possible)	1	1	1	1	1	1
Method 3 - NAME PLATE SPECIFICATIONS ARE KNOWN						
Input pump horsepower (hp)	0	0	0	0	0	0
Input number of pumps operating	0	0	0	0	0	0
Input operating time for each pump (hrs)	0	0	0	0	0	0
Input pump load (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Input pump motor efficiency (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Region						
Choose region from drop down menu (scroll right to see figure)	AKGD	AKGD	AKGD	AKGD	AKGD	AKGD

DIESEL AND GASOLINE PUMPS	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6
Choose fuel type from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Choose horsepower range from drop down menu	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1
Equipment operating hours (hrs)						
Input estimated fuel consumption rate (gal/hr) (Input only if known for the pump selected, otherwise a default will be used by the tool)						

For each type of equipment, select only one of the methods to calculate energy and GHG emissions
Enter "0" for all user input values for unused equipment columns or unused methods

BLOWER, COMPRESSOR, MIXER, AND OTHER EQUIPMENT	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5	Equipment 6
Choose type of equipment from drop down	Blower	Blower	Blower	Blower	Blower	Blower
Choose method from drop down	Method 1	Method 1	Method 1	Method 1	Method 1	Method 1
Method 1 - NAME PLATE SPECIFICATIONS ARE KNOWN						
Input equipment horsepower (hp)	0	0	0	0	0	0
Input number of equipments operating	0	0	0	0	0	0
Input operating time for each equipment (hrs)	0	0	0	0	0	0
Input equipment load (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Input motor efficiency (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Method 2 - ELECTRICAL USAGE IS KNOWN						
Input equipment electrical usage, if known (KWh)	0	0	0	0	0	0
Region						
Choose region from drop down menu (scroll right to see figure)	AKGD	AKGD	AKGD	AKGD	AKGD	AKGD

GENERATORS	Generator 1	Generator 2	Generator 3	Generator 4	Generator 5	Generator 6
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Choose horsepower range from drop down menu	3 to 6	3 to 6	3 to 6	3 to 6	3 to 6	3 to 6
Input operating hours (hr)						

AGRICULTURAL EQUIPMENT	Tillage Tractor 1	Tillage Tractor 2	Tillage Tractor 3	Tillage Tractor 4	Tillage Tractor 5	Tillage Tractor 6
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Input area to till (acre)						
Choose soil condition from drop down menu	Firm untilled soil	Firm untilled soil	Firm untilled soil	Firm untilled soil	Firm untilled soil	Firm untilled soil
Choose soil type from drop down menu	Clay Soil	Clay Soil	Clay Soil	Clay Soil	Clay Soil	Clay Soil
Input time available (work days)						
Input depth of tillage (in)						

CAPPING EQUIPMENT	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5	Equipment 6
Choose stabilization equipment type from drop down menu	Roller	Roller	Roller	Roller	Roller	Roller
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Input area (ft^2)						
Input time available (work days)						

MIXING EQUIPMENT	Mixer 1	Mixer 2	Mixer 3	Mixer 4	Mixer 5	Mixer 6
Choose fuel type from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Choose horsepower range from drop down menu	1 to 3	1 to 3	1 to 3	1 to 3	1 to 3	1 to 3
Input volume (yd^3)						
Input production rate (yd^3/hr)						
Input estimated fuel consumption rate (gal/hr) (Input only if known for the mixer selected, otherwise a default will be used by the tool)						

RESIDUAL HANDLING

RESIDUE DISPOSAL/RECYCLING	Soil Residue	Residual Water	Material Residue	Other Residuals	Other Residuals	Other Residuals
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No	No	No
Input weight of the waste transported to landfill or recycling per trip (tons)	4					
Choose vehicle type from drop down menu	Heavy Duty	On-road truck	On-road truck	On-road truck	On-road truck	On-road truck
Choose fuel used from drop down menu	Diesel	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Input total number of trips	1					
Input number of miles per trip	100					

LANDFILL OPERATIONS	Operation 1	Operation 2	Operation 3	Operation 4	Operation 5	Operation 6
Input tons of soil or waste to be incinerated (user must input emission factors in the Look Up Table, Table 7a)						

THERMAL/CATALYTIC OXIDIZERS*	Oxidizer 1	Oxidizer 2	Oxidizer 3	Oxidizer 4	Oxidizer 5	Oxidizer 6
Choose oxidizer type from drop down menu	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer
Choose fuel type from drop down menu	natural gas	Propane	natural gas	natural gas	natural gas	natural gas
Input waste gas flow rate (scfm)						
Input time running (hours)						
Input waste gas inlet temperature (F)						
Input contaminant concentration (ppmV)						

*(Electric blowers are included in the analysis)

WATER CONSUMPTION	Treatment System 1	Treatment System 2	Treatment System 3	Treatment System 4	Treatment System 5	Treatment System 6
Input water disposed/collected during treatment (gal)						
Input water disposed/collected during site preparation (gal)						
Input water disposed/collected during sampling (gal)						
Input water disposed/collected during site demobilization (gal)						

LANDFILL METHANE EMISSIONS	Landfill 1	Landfill 2	Landfill 3	Landfill 4	Landfill 5	Landfill 6
Input landfill methane emissions (metric tons)						

OTHER KNOWN ONSITE ACTIVITIES	Entire Site
Input energy usage (MMBTU)	
Water consumption (gallon)	
Input CO_2 emission (metric ton)	
Input N_2O emission (metric ton CO_2 e)	
Input CH_4 emissions (metric ton CO_2 e)	
Input NOx emission (metric ton)	
Input SOx emission (metric ton)	
Input PM_{10} emission (metric ton)	
Input fatality risk	
Input injury risk	

Remedial Action Construction

This worksheet allows the user to define material production, transportation, equipment use, and residual handling variables for the remedial alternative

Yellow cells require the user to choose an input from a drop down menu

White cells require the user to type in a value

MATERIAL PRODUCTION

WELL MATERIALS	Well Type 1	Well Type 2	Well Type 3	Well Type 4	Well Type 5	Well Type 6
Input number of wells						
Input depth of wells (ft)						
Choose well diameter (in) from drop down menu	1/2	1/2	1/2	1/2	1/2	1/2
Choose material type from drop down menu	PVC	PVC	PVC	PVC	PVC	PVC
Choose specific material schedule from drop down menu	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC	Schedule 40 PVC

TREATMENT CHEMICALS & MATERIALS	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Treatment 6
Input number of injection points						
Choose material type from drop down menu	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide
Input amount of material injected at each point (pounds dry mass)						
Input number of injections per injection point						

GAC	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Treatment 6
Input weight of GAC used (lbs)						
Choose material type from drop down menu	Virgin GAC	Virgin GAC	Virgin GAC	Virgin GAC	Virgin GAC	Virgin GAC

CONSTRUCTION MATERIALS	Material 1	Material 2	Material 3	Material 4	Material 5	Material 6
Choose material type from drop down menu	HDPE Liner	HDPE Liner	HDPE Liner	HDPE Liner	HDPE Liner	HDPE Liner
Input area of material (ft^2)						
Input depth of material (ft)						

WELL DECOMMISSIONING	Well Type 1	Well Type 2	Well Type 3	Well Type 4	Well Type 5	Well Type 6
Input number of wells						
Input depth of wells (ft)						
Input well diameter (in)	1	1	1	1	1	1
Choose material from drop down menu	Soil	Soil	Soil	Soil	Soil	Soil

TRANSPORTATION

	Mob/Demob Initial	Initial Dailies	Annual Mob/Demob	Annual Dailies		
PERSONNEL TRANSPORTATION - ROAD	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No	No	No
Choose vehicle type from drop down menu*	Light truck	Light truck	Light truck	Light truck	Cars	Cars
Choose fuel used from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Input distance traveled per trip (miles)	1000	30	1000	30		
Input number of trips taken	1	46	5	20		
Input number of travelers	11	12	5	6		
Input estimated vehicular fuel economy (mi/gal) (Input only if known for the vehicle selected, otherwise a default will be used by the tool)						

*For vehicle type 'Other' please enter values in Table 2b in the Look Up Table tab.

PERSONNEL TRANSPORTATION - AIR	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (miles)	4,200	4,200				
Input number of travelers	1	1				
Input number of flights taken	1	5				

PERSONNEL TRANSPORTATION - RAIL	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Choose vehicle type from drop down menu	Intercity rail	Intercity rail	Intercity rail	Intercity rail	Intercity rail	Intercity rail
Input distance traveled (miles)						
Input number of trips taken						
Input number of travelers						

EQUIPMENT TRANSPORTATION - ROAD	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No	No	No
Choose fuel used from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Input distance traveled (miles)						
Input weight of equipment transported (tons)						

EQUIPMENT TRANSPORTATION - AIR	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (miles)						
Input weight of equipment transported (tons)						

EQUIPMENT TRANSPORTATION - RAIL	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (miles)						
Input weight of load (tons)						

EQUIPMENT TRANSPORTATION - WATER	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5	Trip 6
Input distance traveled (mile)						
Input weight of load (tons)						

EQUIPMENT USE

EARTHWORK	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5	Equipment 6
Choose earthwork equipment type from drop down menu	Dozer	Dozer	Dozer	Dozer	Dozer	Dozer
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Input volume of material to be removed (yd^3)						
Will DIESEL-run equipment be retrofitted with a particulate reduction technology?	No	No	No	No	No	No

DRILLING	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
Input number of drilling locations						
Choose drilling method from drop down menu	Direct Push	Direct Push	Direct Push	Direct Push	Direct Push	Direct Push
Input time spent drilling at each location (hr)						
Input depth of wells (ft)						
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel

For each pump, select only one of the three methods to calculate energy and GHG emissions
Enter "0" for all user input values for unused pump columns or unused methods

PUMP OPERATION	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6
Choose method from drop down	Method 2	Method 1	Method 1	Method 1	Method 1	Method 1
Method 1 - ELECTRICAL USAGE IS KNOWN						
Input pump electrical usage (KWh)	0	0	0	0	0	0
Method 2 - PUMP HEAD IS KNOWN						
Input flow rate (gpm)	0	0	0	0	0	0
Input total head (ft)	0	0	0	0	0	0
Input number of pumps operating	0	0	0	0	0	0
Input operating time for each pump (hrs)	0	0	0	0	0	0
Pump efficiency times motor efficiency (default already present, user override possible)	0.51	0.51	0.51	0.51	0.51	0.51
Input specific gravity (default already present, user override possible)	1	1	1	1	1	1
Method 3 - NAME PLATE SPECIFICATIONS ARE KNOWN						
Input pump horsepower (hp)	0	0	0	0	0	0
Input number of pumps operating	0	0	0	0	0	0
Input operating time for each pump (hrs)	0	0	0	0	0	0
Input pump load (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Input pump motor efficiency (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Region						
Choose region from drop down menu (scroll right to see figure)	AKGD	AKGD	AKGD	AKGD	AKGD	AKGD

DIESEL AND GASOLINE PUMPS	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5	Pump 6
Choose fuel type from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Choose horsepower range from drop down menu	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1	2-Stroke: 0 to 1
Equipment operating hours (hrs)						
Input estimated fuel consumption rate (gal/hr) (Input only if known for the pump selected, otherwise a default will be used by the tool)						

For each type of equipment, select only one of the methods to calculate energy and GHG emissions
Enter "0" for all user input values for unused equipment columns or unused methods

BLOWER, COMPRESSOR, MIXER, AND OTHER EQUIPMENT	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5	Equipment 6
Choose type of equipment from drop down	Blower	Blower	Blower	Blower	Blower	Blower
Choose method from drop down	Method 1	Method 1	Method 1	Method 1	Method 1	Method 1
Method 1 - NAME PLATE SPECIFICATIONS ARE KNOWN						
Input equipment horsepower (hp)	0	0	0	0	0	0
Input number of equipments operating	0	0	0	0	0	0
Input operating time for each equipment (hrs)	0	0	0	0	0	0
Input equipment load (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Input motor efficiency (default already present, user override possible)	0.85	0.85	0.85	0.85	0.85	0.85
Method 2 - ELECTRICAL USAGE IS KNOWN						
Input equipment electrical usage, if known (KWh)	0	0	0	0	0	0
Region						
Choose region from drop down menu (scroll right to see figure)	AKGD	AKGD	AKGD	AKGD	AKGD	AKGD

GENERATORS	Generator 1	Generator 2	Generator 3	Generator 4	Generator 5	Generator 6
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Choose horsepower range from drop down menu	3 to 6	3 to 6	3 to 6	3 to 6	3 to 6	3 to 6
Input operating hours (hr)						

AGRICULTURAL EQUIPMENT	Tillage Tractor 1	Tillage Tractor 2	Tillage Tractor 3	Tillage Tractor 4	Tillage Tractor 5	Tillage Tractor 6
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Input area to till (acre)						
Choose soil condition from drop down menu	Firm untilled soil	Firm untilled soil	Firm untilled soil	Firm untilled soil	Firm untilled soil	Firm untilled soil
Choose soil type from drop down menu	Clay Soil	Clay Soil	Clay Soil	Clay Soil	Clay Soil	Clay Soil
Input time available (work days)						
Input depth of tillage (in)						

CAPPING EQUIPMENT	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5	Equipment 6
Choose stabilization equipment type from drop down menu	Roller	Roller	Roller	Roller	Roller	Roller
Choose fuel type from drop down menu	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Input area (ft^2)						
Input time available (work days)						

MIXING EQUIPMENT	Mixer 1	Mixer 2	Mixer 3	Mixer 4	Mixer 5	Mixer 6
Choose fuel type from drop down menu	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Choose horsepower range from drop down menu	1 to 3	1 to 3	1 to 3	1 to 3	1 to 3	1 to 3
Input volume (yd^3)						
Input production rate (yd^3/hr)						
Input estimated fuel consumption rate (gal/hr) (Input only if known for the mixer selected, otherwise a default will be used by the tool)						

RESIDUAL HANDLING

RESIDUE DISPOSAL/RECYCLING	Soil Residue	Residual Water	Material Residue	Other Residuals	Other Residuals	Other Residuals
Will DIESEL-run vehicles be retrofitted with a particulate reduction technology?	No	No	No	No	No	No
Input weight of the waste transported to landfill or recycling per trip (tons)	4					
Choose vehicle type from drop down menu	Heavy Duty	On-road truck	On-road truck	On-road truck	On-road truck	On-road truck
Choose fuel used from drop down menu	Diesel	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Input total number of trips	1					
Input number of miles per trip	100					

LANDFILL OPERATIONS	Operation 1	Operation 2	Operation 3	Operation 4	Operation 5	Operation 6
Input tons of soil or waste to be incinerated (user must input emission factors in the Look Up Table, Table 7a)						

THERMAL/CATALYTIC OXIDIZERS*	Oxidizer 1	Oxidizer 2	Oxidizer 3	Oxidizer 4	Oxidizer 5	Oxidizer 6
Choose oxidizer type from drop down menu	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer	Simple Thermal Oxidizer
Choose fuel type from drop down menu	natural gas	Propane	natural gas	natural gas	natural gas	natural gas
Input waste gas flow rate (scfm)						
Input time running (hours)						
Input waste gas inlet temperature (F)						
Input contaminant concentration (ppmV)						

*(Electric blowers are included in the analysis)

WATER CONSUMPTION	Treatment System 1	Treatment System 2	Treatment System 3	Treatment System 4	Treatment System 5	Treatment System 6
Input water disposed/collected during treatment (gal)						
Input water disposed/collected during site preparation (gal)						
Input water disposed/collected during sampling (gal)						
Input water disposed/collected during site demobilization (gal)						

LANDFILL METHANE EMISSIONS	Landfill 1	Landfill 2	Landfill 3	Landfill 4	Landfill 5	Landfill 6
Input landfill methane emissions (metric tons)						

OTHER KNOWN ONSITE ACTIVITIES	Entire Site
Input energy usage (MMBTU)	
Water consumption (gallon)	
Input CO_2 emission (metric ton)	
Input N_2O emission (metric ton CO_2 e)	
Input CH_4 emissions (metric ton CO_2 e)	
Input NOx emission (metric ton)	
Input SOx emission (metric ton)	
Input PM_{10} emission (metric ton)	
Input fatality risk	
Input injury risk	

APPENDIX B

COST ESTIMATES

CLIENT: NAS WHIDBEY ISLAND		JOB NUMBER: 112G02853.FS.RA.DF
SUBJECT: Lake Hancock Target Range		
BASED ON:		DRAWING NUMBER:
BY: TJR Date: 8-29-11	CHECKED BY: Date:	APPROVED BY: DATE:

Assumptions

All site labor is from out of area. Travel (mobilization & demobilization) of site personnel and per diem is included in estimate. Per diem @ $151 per day, mob/demob @ $1,400 per trip ($800 travel: $600 labor).

All site labor is set as a 10 hour day.

No MEC/MDEH will be located on the site.

All removed materials can be moved be site personnel.

No restoration of wetlands is included in the estimate.

Standard crew of 12 is used for the cleanup including superintendent for initial removal.

Standard crew of 6 is used for the cleanup including superintendent for removals during years 1, 2, 3, 5, & 10.

Metal drums are used to transport and dispose of removed materials. Maximum weight per drum is 400 pounds.

Install/replace 6 perimeter signs upon completion of first removal.

Time to complete and volume of removed material:

Initial Removal
Alternative 2: 22 days and 10 drums
Alternative 3: 37 days and 12 drums
Alternative 4: 66 days and 14 drums
Follow-up Removal (years 1, 2, & 3)
All alternatives: 20 days and 1 drum
Follow-up Removal (years 5 & 10)
Alternatives 2 & 3: 20 days and 1 drum
Follow-up Removal (years 5 & 10)
Alternative 4: 22 days and 1 drum

NAS WHIDBEY ISLAND
Whidbey Island, Washington
Lake Hancock Target Range
Alternative 2: Surface Removal with Land Use Controls
Capital Cost (First Removal)

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans	220	hr			$38.00		$0	$0	$8,360	$0	$8,360
1.2 Prepare Work Plans	300	hr			$38.00		$0	$0	$11,400	$0	$11,400
1.3 Prepare LUCs	150	hr			$38.00		$0	$0	$5,700	$0	$5,700
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	1	ls			$183.00	$518.00	$0	$0	$183	$518	$701
2.3 Personnel Mobilization/Demobilization	12	ea		$800.00	$600.00		$0	$9,600	$7,200	$0	$16,800
3 FIELD SUPPORT											
3.1 Storage Trailer	1.5	mo				$94.00	$0	$0	$0	$141	$141
3.2 Pickups, 2 each	44	day				$100.00	$0	$0	$0	$4,400	$4,400
4 SURVEY AND REMOVAL											
4.1 Site Superintendent including per diem	22	day		$151.00	$360.00		$0	$3,322	$7,920	$0	$11,242
4.2 UXO Technician including per diem, 11 each	242	day		$151.00	$310.00		$0	$36,542	$75,020	$0	$111,562
4.3 Hand Equipment & Tools	22	day				$450.00	$0	$0	$0	$9,900	$9,900
4.4 Field Transportation, 2 each	44	day				$30.00	$0	$0	$0	$1,320	$1,320
5 DISPOSAL											
5.1 Drums & Pallets	10	ea		$175.00			$0	$1,750	$0	$0	$1,750
5.2 Transportation and Disposal	4,000	lb	$2.95				$11,800	$0	$0	$0	$11,800
6 LAND USE CONTROLS											
6.1 Perimeter Signs	6	ea		$69.50			$0	$417	$0	$0	$417
7 POST CONSTRUCTION COST											
7.1 Contractor Completion Report	150	hr			$38.00		$0	$0	$5,700	$0	$5,700
Subtotal							$11,800	$52,631	$121,483	$19,779	$205,693
Overhead on Labor Cost @ 30%									$36,445		$36,445
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$1,180	$5,263	$12,148	$1,978	$20,569
Tax on Materials and Equipment Cost @ 6.5%								$3,421		$1,286	$4,707
Total Direct Cost							$12,980	$61,315	$170,076	$23,043	$267,414
Indirects on Total Direct Cost @ 15%											$40,112
Profit on Total Direct Cost @ 10%											$26,741
Total Field Cost											$334,267
Engineering on Total Field Cost @ 6%											$20,056
Contingency on Total Field Cost @ 10%											$33,427
TOTAL CAPITAL COST											**$387,750**

NAS WHIDBEY ISLAND
Whidbey Island, Washington
Lake Hancock Target Range
Alternative 2: Surface Removal with Land Use Controls
Capital Cost (Removal Years 1, 2, 3, 5, and 10)

	Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1	**PROJECT PLANNING & DOCUMENTS**											
1.1	Prepare Documents & Plans	100	hr			$38.00		$0	$0	$3,800	$0	$3,800
1.2	Prepare Work Plans	150	hr			$38.00		$0	$0	$5,700	$0	$5,700
2	**MOBILIZATION AND DEMOBILIZATION**											
2.1	Site Support Facilities (trailers, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2	Equipment Mobilization/Demobilization	1	ls			$183.00	$518.00	$0	$0	$183	$518	$701
2.3	Personnel Mobilization/Demobilization	6	ea		$800.00	$600.00		$0	$4,800	$3,600	$0	$8,400
3	**FIELD SUPPORT**											
3.1	Storage Trailer	1	mo				$94.00	$0	$0	$0	$94	$94
3.2	Pickup	20	day				$100.00	$0	$0	$0	$2,000	$2,000
4	**SURVEY AND REMOVAL**											
4.1	Site Superintendent including per diem	20	day		$151.00	$360.00		$0	$3,020	$7,200	$0	$10,220
4.2	UXO Technician including per diem, 5 each	100	day		$151.00	$310.00		$0	$15,100	$31,000	$0	$46,100
4.3	Hand Equipment & Tools	20	day				$450.00	$0	$0	$0	$9,000	$9,000
4.4	Field Transportation, 2 each	40	day				$30.00	$0	$0	$0	$1,200	$1,200
5	**DISPOSAL**											
5.1	Drum	1	ea		$175.00			$0	$175	$0	$0	$175
5.2	Transportation and Disposal	1	ls	$3,300.00				$3,300	$0	$0	$0	$3,300
6	**POST CONSTRUCTION COST**											
6.1	Contractor Completion Report	50	hr			$38.00		$0	$0	$1,900	$0	$1,900
	Subtotal							$3,300	$24,095	$53,383	$16,312	$97,090
	Overhead on Labor Cost @ 30%									$16,015		$16,015
	G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$330	$2,410	$5,338	$1,631	$9,709
	Tax on Materials and Equipment Cost @ 6.5%								$1,566		$1,060	$2,626
	Total Direct Cost							$3,630	$28,071	$74,736	$19,003	$125,440
	Indirects on Total Direct Cost @ 15%											$18,816
	Profit on Total Direct Cost @ 10%											$12,544
	Total Field Cost											$156,800
	Engineering on Total Field Cost @ 4%											$6,272
	Contingency on Total Field Cost @ 10%											$15,680
	TOTAL CAPITAL COST											**$178,753**

NAS WHIDBEY ISLAND
Whidbey Island, Washington
Lake Hancock Target Range
Alternative 2: Surface Removal with Land Use Controls
Annual Cost

Item	Item Cost yearly	Notes
Site Inspection & Report	$2,650	One-day visit to verify LUCs
Subtotal	$2,650	
Contingency @ 10%	$265	
TOTAL	**$2,915**	

NAS WHIDBEY ISLAND
Lake Hancock Target Range
Whidbey Island, Washington
Alternative 2: Surface Removal with Land Use Controls
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.3%	Present Worth
0	$387,750		$387,750	1.000	$387,750
1	$178,753	$2,915	$181,668	0.978	$177,583
2	$178,753	$2,915	$181,668	0.956	$173,591
3	$178,753	$2,915	$181,668	0.934	$169,688
4		$2,915	$2,915	0.913	$2,662
5	$178,753	$2,915	$181,668	0.893	$162,143
6		$2,915	$2,915	0.872	$2,543
7		$2,915	$2,915	0.853	$2,486
8		$2,915	$2,915	0.834	$2,430
9		$2,915	$2,915	0.815	$2,376
10	$178,753	$2,915	$181,668	0.797	$144,717
11		$2,915	$2,915	0.779	$2,270
12		$2,915	$2,915	0.761	$2,219
13		$2,915	$2,915	0.744	$2,169
14		$2,915	$2,915	0.727	$2,120
15		$2,915	$2,915	0.711	$2,073
16		$2,915	$2,915	0.695	$2,026
17		$2,915	$2,915	0.679	$1,980
18		$2,915	$2,915	0.664	$1,936
19		$2,915	$2,915	0.649	$1,892
20		$2,915	$2,915	0.635	$1,850
21		$2,915	$2,915	0.620	$1,808
22		$2,915	$2,915	0.606	$1,768
23		$2,915	$2,915	0.593	$1,728
24		$2,915	$2,915	0.579	$1,689
25		$2,915	$2,915	0.566	$1,651
26		$2,915	$2,915	0.554	$1,614
27		$2,915	$2,915	0.541	$1,578
28		$2,915	$2,915	0.529	$1,542
29		$2,915	$2,915	0.517	$1,507
30		$2,915	$2,915	0.506	$1,474
				TOTAL PRESENT WORTH	**$1,264,862**

NAS WHIDBEY ISLAND
Whidbey Island, Washington
Lake Hancock Target Range
Alternative 3: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Capital Cost (First Removal)

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans	220	hr			$38.00		$0	$0	$8,360	$0	$8,360
1.2 Prepare Work Plans	300	hr			$38.00		$0	$0	$11,400	$0	$11,400
1.3 Prepare LUCs	150	hr			$38.00		$0	$0	$5,700	$0	$5,700
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	1	ls			$183.00	$518.00	$0	$0	$183	$518	$701
2.3 Personnel Mobilization/Demobilization	12	ea		$800.00	$600.00		$0	$9,600	$7,200	$0	$16,800
3 FIELD SUPPORT											
3.1 Storage Trailer	2	mo				$94.00	$0	$0	$0	$188	$188
3.2 Pickups, 2 each	74	day				$100.00	$0	$0	$0	$7,400	$7,400
4 SURVEY AND REMOVAL											
4.1 Site Superintendent including per diem	37	day		$151.00	$360.00		$0	$5,587	$13,320	$0	$18,907
4.2 UXO Technician including per diem, 11 each	407	day		$151.00	$310.00		$0	$61,457	$126,170	$0	$187,627
4.3 Hand Equipment & Tools	37	day				$450.00	$0	$0	$0	$16,650	$16,650
4.4 Field Transportation, 2 each	74	day				$30.00	$0	$0	$0	$2,220	$2,220
5 DISPOSAL											
5.1 Drums & Pallets	12	ea		$175.00			$0	$2,100	$0	$0	$2,100
5.2 Transportation and Disposal	4,800	lb	$2.95				$14,160	$0	$0	$0	$14,160
6 LAND USE CONTROLS											
6.1 Perimeter Signs	6	ea		$69.50			$0	$417	$0	$0	$417
7 POST CONSTRUCTION COST											
7.1 Contractor Completion Report	150	hr			$38.00		$0	$0	$5,700	$0	$5,700
Subtotal							$14,160	$80,161	$178,033	$30,476	$302,830
Overhead on Labor Cost @ 30%									$53,410		$53,410
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$1,416	$8,016	$17,803	$3,048	$30,283
Tax on Materials and Equipment Cost @ 6.5%								$5,210		$1,981	$7,191
Total Direct Cost							$15,576	$93,388	$249,246	$35,505	$393,714
Indirects on Total Direct Cost @ 15%											$59,057
Profit on Total Direct Cost @ 10%											$39,371
Total Field Cost											$492,143
Engineering on Total Field Cost @ 4%											$19,686
Contingency on Total Field Cost @ 10%											$49,214
TOTAL CAPITAL COST											**$561,043**

NAS WHIDBEY ISLAND
Whidbey Island, Washington
Lake Hancock Target Range
Alternative 3: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Capital Cost (Removal Years 1, 2, 3, 5, and 10)

	Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1	**PROJECT PLANNING & DOCUMENTS**											
1.1	Prepare Documents & Plans	100	hr			$38.00		$0	$0	$3,800	$0	$3,800
1.2	Prepare Work Plans	150	hr			$38.00		$0	$0	$5,700	$0	$5,700
2	**MOBILIZATION AND DEMOBILIZATION**											
2.1	Site Support Facilities (trailers, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2	Equipment Mobilization/Demobilization	1	ls			$183.00	$518.00	$0	$0	$183	$518	$701
2.3	Personnel Mobilization/Demobilization	6	ea		$800.00	$600.00		$0	$4,800	$3,600	$0	$8,400
3	**FIELD SUPPORT**											
3.1	Storage Trailer	1	mo				$94.00	$0	$0	$0	$94	$94
3.2	Pickup	20	day				$100.00	$0	$0	$0	$2,000	$2,000
4	**SURVEY AND REMOVAL**											
4.1	Site Superintendent including per diem	20	day		$151.00	$360.00		$0	$3,020	$7,200	$0	$10,220
4.2	UXO Technician including per diem, 5 each	100	day		$151.00	$310.00		$0	$15,100	$31,000	$0	$46,100
4.3	Hand Equipment & Tools	20	day				$450.00	$0	$0	$0	$9,000	$9,000
4.4	Field Transportation, 2 each	40	day				$30.00	$0	$0	$0	$1,200	$1,200
5	**DISPOSAL**											
5.1	Drum	1	ea		$175.00			$0	$175	$0	$0	$175
5.2	Transportation and Disposal	1	ls	$3,300.00				$3,300	$0	$0	$0	$3,300
6	**POST CONSTRUCTION COST**											
6.1	Contractor Completion Report	50	hr			$38.00		$0	$0	$1,900	$0	$1,900
	Subtotal							$3,300	$24,095	$53,383	$16,312	$97,090
	Overhead on Labor Cost @ 30%									$16,015		$16,015
	G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$330	$2,410	$5,338	$1,631	$9,709
	Tax on Materials and Equipment Cost @ 6.5%								$1,566		$1,060	$2,626
	Total Direct Cost							$3,630	$28,071	$74,736	$19,003	$125,440
	Indirects on Total Direct Cost @ 15%											$18,816
	Profit on Total Direct Cost @ 10%											$12,544
	Total Field Cost											$156,800
	Engineering on Total Field Cost @ 4%											$6,272
	Contingency on Total Field Cost @ 10%											$15,680
	TOTAL CAPITAL COST											**$178,753**

NAS WHIDBEY ISLAND
Whidbey Island, Washington
Lake Hancock Target Range
Alternative 3: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Annual Cost

Item	Item Cost yearly	Notes
Site Inspection & Report	$2,650	One-day visit to verify LUCs
Subtotal	$2,650	
Contingency @ 10%	$265	
TOTAL	**$2,915**	

NAS WHIDBEY ISLAND
Lake Hancock Target Range
Whidbey Island, Washington
Alternative 3: Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.3%	Present Worth
0	$561,043		$561,043	1.000	$561,043
1	$178,753	$2,915	$181,668	0.978	$177,583
2	$178,753	$2,915	$181,668	0.956	$173,591
3	$178,753	$2,915	$181,668	0.934	$169,688
4		$2,915	$2,915	0.913	$2,662
5	$178,753	$2,915	$181,668	0.893	$162,143
6		$2,915	$2,915	0.872	$2,543
7		$2,915	$2,915	0.853	$2,486
8		$2,915	$2,915	0.834	$2,430
9		$2,915	$2,915	0.815	$2,376
10	$178,753	$2,915	$181,668	0.797	$144,717
11		$2,915	$2,915	0.779	$2,270
12		$2,915	$2,915	0.761	$2,219
13		$2,915	$2,915	0.744	$2,169
14		$2,915	$2,915	0.727	$2,120
15		$2,915	$2,915	0.711	$2,073
16		$2,915	$2,915	0.695	$2,026
17		$2,915	$2,915	0.679	$1,980
18		$2,915	$2,915	0.664	$1,936
19		$2,915	$2,915	0.649	$1,892
20		$2,915	$2,915	0.635	$1,850
21		$2,915	$2,915	0.620	$1,808
22		$2,915	$2,915	0.606	$1,768
23		$2,915	$2,915	0.593	$1,728
24		$2,915	$2,915	0.579	$1,689
25		$2,915	$2,915	0.566	$1,651
26		$2,915	$2,915	0.554	$1,614
27		$2,915	$2,915	0.541	$1,578
28		$2,915	$2,915	0.529	$1,542
29		$2,915	$2,915	0.517	$1,507
30		$2,915	$2,915	0.506	$1,474
				TOTAL PRESENT WORTH	**$1,438,155**

NAS WHIDBEY ISLAND
Whidbey Island, Washington
Lake Hancock Target Range
Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Capital Cost (First Removal)

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans	220	hr			$38.00		$0	$0	$8,360	$0	$8,360
1.2 Prepare Work Plans	300	hr			$38.00		$0	$0	$11,400	$0	$11,400
1.3 Prepare LUCs	150	hr			$38.00		$0	$0	$5,700	$0	$5,700
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	1	ls			$183.00	$518.00	$0	$0	$183	$518	$701
2.3 Personnel Mobilization/Demobilization	12	ea		$800.00	$600.00		$0	$9,600	$7,200	$0	$16,800
3 FIELD SUPPORT											
3.1 Storage Trailer	3	mo				$94.00	$0	$0	$0	$282	$282
3.2 Pickups, 2 each	132	day				$100.00	$0	$0	$0	$13,200	$13,200
4 SURVEY AND REMOVAL											
4.1 Site Superintendent including per diem	66	day		$151.00	$360.00		$0	$9,966	$23,760	$0	$33,726
4.2 UXO Technician including per diem, 11 each	726	day		$151.00	$310.00		$0	$109,626	$225,060	$0	$334,686
4.3 Hand Equipment & Tools	66	day				$450.00	$0	$0	$0	$29,700	$29,700
4.4 Field Transportation, 2 each	132	day				$30.00	$0	$0	$0	$3,960	$3,960
5 DISPOSAL											
5.1 Drums & Pallets	15	ea		$175.00			$0	$2,625	$0	$0	$2,625
5.2 Transportation and Disposal	6,000	lb	$2.95				$17,700	$0	$0	$0	$17,700
6 LAND USE CONTROLS											
6.1 Perimeter Signs	6	ea		$69.50			$0	$417	$0	$0	$417
7 POST CONSTRUCTION COST											
7.1 Contractor Completion Report	150	hr			$38.00		$0	$0	$5,700	$0	$5,700
Subtotal							$17,700	$133,234	$287,363	$51,160	$489,457
Overhead on Labor Cost @ 30%									$86,209		$86,209
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$1,770	$13,323	$28,736	$5,116	$48,946
Tax on Materials and Equipment Cost @ 6.5%								$8,660		$3,325	$11,986
Total Direct Cost							$19,470	$155,218	$402,308	$59,601	$636,597
Indirects on Total Direct Cost @ 15%											$95,490
Profit on Total Direct Cost @ 10%											$63,660
Total Field Cost											$795,747
Engineering on Total Field Cost @ 4%											$31,830
Contingency on Total Field Cost @ 10%											$79,575
TOTAL CAPITAL COST											**$907,151**

NAS WHIDBEY ISLAND
Whidbey Island, Washington
Lake Hancock Target Range
Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Capital Cost (Removal Years 1, 2, and 3)

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans	100	hr			$38.00		$0	$0	$3,800	$0	$3,800
1.2 Prepare Work Plans	150	hr			$38.00		$0	$0	$5,700	$0	$5,700
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	1	ls			$183.00	$518.00	$0	$0	$183	$518	$701
2.3 Personnel Mobilization/Demobilization	6	ea		$800.00	$600.00		$0	$4,800	$3,600	$0	$8,400
3 FIELD SUPPORT											
3.1 Storage Trailer	1	mo				$94.00	$0	$0	$0	$94	$94
3.2 Pickup	20	day				$100.00	$0	$0	$0	$2,000	$2,000
4 SURVEY AND REMOVAL											
4.1 Site Superintendent including per diem	20	day		$151.00	$360.00		$0	$3,020	$7,200	$0	$10,220
4.2 UXO Technician including per diem, 5 each	100	day		$151.00	$310.00		$0	$15,100	$31,000	$0	$46,100
4.3 Hand Equipment & Tools	20	day				$450.00	$0	$0	$0	$9,000	$9,000
4.4 Field Transportation, 2 each	40	day				$30.00	$0	$0	$0	$1,200	$1,200
5 DISPOSAL											
5.1 Drum	1	ea		$175.00			$0	$175	$0	$0	$175
5.2 Transportation and Disposal	1	ls	$3,300.00				$3,300	$0	$0	$0	$3,300
6 POST CONSTRUCTION COST											
6.1 Contractor Completion Report	50	hr			$38.00		$0	$0	$1,900	$0	$1,900
Subtotal							$3,300	$24,095	$53,383	$16,312	$97,090
Overhead on Labor Cost @ 30%									$16,015		$16,015
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$330	$2,410	$5,338	$1,631	$9,709
Tax on Materials and Equipment Cost @ 6.5%								$1,566		$1,060	$2,626
Total Direct Cost							$3,630	$28,071	$74,736	$19,003	$125,440
Indirects on Total Direct Cost @ 15%											$18,816
Profit on Total Direct Cost @ 10%											$12,544
Total Field Cost											$156,800
Engineering on Total Field Cost @ 4%											$6,272
Contingency on Total Field Cost @ 10%											$15,680
TOTAL CAPITAL COST											**$178,753**

NAS WHIDBEY ISLAND
Whidbey Island, Washington
Lake Hancock Target Range
Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Capital Cost (Removal Years 5 and 10)

Item			Unit Cost				Extended Cost				
Item	Quantity	Unit	Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans	100	hr			$38.00		$0	$0	$3,800	$0	$3,800
1.2 Prepare Work Plans	150	hr			$38.00		$0	$0	$5,700	$0	$5,700
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	1	ls			$183.00	$518.00	$0	$0	$183	$518	$701
2.3 Personnel Mobilization/Demobilization	6	ea		$800.00	$600.00		$0	$4,800	$3,600	$0	$8,400
3 FIELD SUPPORT											
3.1 Storage Trailer	1	mo				$94.00	$0	$0	$0	$94	$94
3.2 Pickup	22	day				$100.00	$0	$0	$0	$2,200	$2,200
4 SURVEY AND REMOVAL											
4.1 Site Superintendent including per diem	22	day		$151.00	$360.00		$0	$3,322	$7,920	$0	$11,242
4.2 UXO Technician including per diem, 5 each	110	day		$151.00	$310.00		$0	$16,610	$34,100	$0	$50,710
4.3 Hand Equipment & Tools	22	day				$450.00	$0	$0	$0	$9,900	$9,900
4.4 Field Transportation, 2 each	44	day				$30.00	$0	$0	$0	$1,320	$1,320
5 DISPOSAL											
5.1 Drum	1	ea		$175.00			$0	$175	$0	$0	$175
5.2 Transportation and Disposal	1	ls	$3,300.00				$3,300	$0	$0	$0	$3,300
6 POST CONSTRUCTION COST											
6.1 Contractor Completion Report	50	hr			$38.00		$0	$0	$1,900	$0	$1,900
Subtotal							$3,300	$25,907	$57,203	$17,532	$103,942
Overhead on Labor Cost @ 30%									$17,161		$17,161
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$330	$2,591	$5,720	$1,753	$10,394
Tax on Materials and Equipment Cost @ 6.5%								$1,684		$1,140	$2,824
Total Direct Cost							$3,630	$30,182	$80,084	$20,425	$134,321
Indirects on Total Direct Cost @ 15%											$20,148
Profit on Total Direct Cost @ 10%											$13,432
Total Field Cost											$167,901
Engineering on Total Field Cost @ 4%											$6,716
Contingency on Total Field Cost @ 10%											$16,790
TOTAL CAPITAL COST											**$191,407**

NAS WHIDBEY ISLAND
Whidbey Island, Washington
Lake Hancock Target Range
Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Annual Cost

Item	Item Cost yearly	Notes
Site Inspection & Report	$2,650	One-day visit to verify LUCs
Subtotal	$2,650	
Contingency @ 10%	$265	
TOTAL	**$2,915**	

NAS WHIDBEY ISLAND
Lake Hancock Target Range
Whidbey Island, Washington
Alternative 4: Expanded Surface and Subsurface Removal (to 1 foot bgs) with Land Use Controls
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.3%	Present Worth
0	$907,151		$907,151	1.000	$907,151
1	$178,753	$2,915	$181,668	0.978	$177,583
2	$178,753	$2,915	$181,668	0.956	$173,591
3	$178,753	$2,915	$181,668	0.934	$169,688
4		$2,915	$2,915	0.913	$2,662
5	$191,407	$2,915	$194,322	0.893	$173,438
6		$2,915	$2,915	0.872	$2,543
7		$2,915	$2,915	0.853	$2,486
8		$2,915	$2,915	0.834	$2,430
9		$2,915	$2,915	0.815	$2,376
10	$191,407	$2,915	$194,322	0.797	$154,798
11		$2,915	$2,915	0.779	$2,270
12		$2,915	$2,915	0.761	$2,219
13		$2,915	$2,915	0.744	$2,169
14		$2,915	$2,915	0.727	$2,120
15		$2,915	$2,915	0.711	$2,073
16		$2,915	$2,915	0.695	$2,026
17		$2,915	$2,915	0.679	$1,980
18		$2,915	$2,915	0.664	$1,936
19		$2,915	$2,915	0.649	$1,892
20		$2,915	$2,915	0.635	$1,850
21		$2,915	$2,915	0.620	$1,808
22		$2,915	$2,915	0.606	$1,768
23		$2,915	$2,915	0.593	$1,728
24		$2,915	$2,915	0.579	$1,689
25		$2,915	$2,915	0.566	$1,651
26		$2,915	$2,915	0.554	$1,614
27		$2,915	$2,915	0.541	$1,578
28		$2,915	$2,915	0.529	$1,542
29		$2,915	$2,915	0.517	$1,507
30		$2,915	$2,915	0.506	$1,474
				TOTAL PRESENT WORTH	**$1,805,638**

APPENDIX C

BACKGROUND INFORMATION

Lake Hancock
Whidbey Island, Washington

Ecological Survey Report

Prepared for the
U.S. Navy

Prepared by:
URS Consultants, Inc.

June 12, 1996

LAKE HANCOCK ECOLOGICAL SURVEY REPORT

PURPOSE AND OBJECTIVES

This survey was conducted to provide information on site conditions that will be used to design a work plan for the upcoming site hazard assessment for Lake Hancock.

Specific objectives of the survey were as follows:

- Confirm the existence of ecologically sensitive habitats.
- Provide a detailed description of existent water quality and sediment characteristics.
- Describe mitigation measures to reduce ecological impacts that might be practiced during intrusive sampling to be conducted during the site hazard assessment.
- Provide a qualitative discussion of potential remedial alternative effects on the habitats present at Lake Hancock.

METHODS

A 1-day field survey was conducted on May 17, 1996. The survey began at 10:00 hours under heavy overcast skies with intermittent showers, a slight wind from the south, and a temperature of 50 degrees Fahrenheit (°F). The weather modified to scattered clouds, with a few light showers, strong southerly winds, and 60°F by the end of the field survey at 16:00 hours. The low tide was minus 1.2 meters (m) at Marrowstone Point at 10:46 hours.

The survey consisted of a site reconnaissance during which each habitat described by Fonda (1981) (i.e., salt marsh, brackish marsh, freshwater marsh, and bog forest) was visited and evaluated. Observations and measurements of surface water quality and sediment characteristics were made at appropriate locations. Observations on flora and fauna were recorded. A photographic record of relevant activities and observation was made. Sediment samples were collected at appropriate locations and brought back to

ORIGINAL

the office for measurement of sediment grain size. Sample station locations are shown on Figure 1.

Surface water quality measurements were made with the Horiba U-10 Water Quality Checker. The multiprobe was carefully submerged in the water and allowed to rest on the sediment surface (the design of the probe kept sensors at least 3 to 5 centimeters [cm] above the sediment surface). The instrument was allowed to equilibrate, and measurements were recorded. The instrument was calibrated for salt water for all samples except the freshwater marsh station (Station 5). Water quality measurements at the brackish marsh location (Station 4) were made using both the salt water and freshwater calibrations. The average of the two measurements is reported.

Sediment samples were collected at several stations and returned to the office for grain size determination. Grain size was estimated by using a volumetric sieving technique in which the percentage by volume of fine grained material less than 63 microns is measured.

RESULTS

Results of the water quality measurements taken at six stations are presented in Table 1.

Table 1
Surface Water Quality Measurements

Station	pH	Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (°C)	Salinity (%)
1	8.5	35.9	3	9.5	12.1	2.26
2	8.3	36.4	7	7.2	15.6	2.29
3	8.7	36.0	22	8.8	15.2	2.26
4	6.9	13.3	11	1.9	16.9	0.76
5	7.4	1.8	10	11.7	15.1	0.08
8	9.5	35.2	15	1.5	20.4	2.23

NTU = Nephelometric turbidity unit

General descriptions of observation and measurements taken at each station are presented below.

Station 1

The station was occupied at 10:00 hours. Station 1 is located at the mouth of the stream discharging from Lake Hancock into Admiralty Inlet. Water flowed swiftly on the outgoing tide and was approximately 50 to 75 cm deep at the deepest point. Substrate was a mixture of cobble and coarse sand (Figures 2 and 3). Some local patches of finer material exist. Several species of low growing algae were attached to the rocky substrate as well as little eel grass (*Zostera marina*). Barnacles and sea anemone were common on rock surfaces. Eight great blue herons were foraging in the shallows at the mouth of the stream, and a bald eagle was resting on the sandy beach. Sea gulls flew overhead, and several varieties of ducks were observed in the off-shore waters. A water quality measurement was taken from the north side of the stream at a depth of 30 cm (see Table 1). A sediment sample was taken from the upper 5 cm in a depositional intertidal area of finer grained material on the north side of the stream. The grain size could not be accurately determined because the high proportion of algae in the sample precluded an accurate measurement. However, a large amount of coarse grained material was retained in the sieve.

Station 2

The station was occupied at 11:00 hours. Station 2 is located about 100 m east of the Admiralty Inlet beach and 150 m north of the stream draining Lake Hancock. At low tide, it was typified by a undulating terrain with standing or slowly draining pools of marine water and mounds of vegetation (Figure 4). Maximum relief was approximately 1 m from the bottom of the deeper pools to the top of the mounds. The pools appeared to be flushed with sea water during each high tide and were free from vegetation. The pool substrate was typically a fine grained loose material in which a person would sink up to 15 to 25 cm. Many dead small crabs were observed in the pools, and interface between the pools and mounds were typically laced with a network of 3- to 5-cm-diameter tunnels presumably made by crabs or some other invertebrate. A water quality measurement was made in one of the shallow pools at a water depth of 10 cm, and results are shown in Table 1. Figure 5 shows the sediment profile of a test pit in a typical pool habitat, a description of which follows:

- Zero to 10 cm of loose silty sand, grey/brown, with few roots. Grain size could not be determined because of partially decomposed fibrous plant material; however, only a small amount of material was retained in the sieve. This suggests that the percent of fine grained material was very high.

- Greater than 10 cm of loose organic silt, lots of dead roots, partially decomposed organic material, and a sulfide odor. Grain size could not be determined because of the high proportion of partially decomposed plant material; however, a large amount of material was retained in the sieve. This suggests that the percent of fine grained material was low.

The crests of the mounds were flat and supported a dense plant community dominated by pickleweed (*Salicornia virginica*) and sea arrow-grass (*Triglochin maritimum*) (Figures 6 and 7). A few clumps of Townsend's cordgrass (*Spartina anglica*) were noted (Figure 7). Figure 8 shows the sediment profile of a test pit in a typical mound habitat and is described as follows:

- Zero to 12 cm of dense root mat, grey/brown, with little sediment present. Grain size could not be determined because of the high proportion of partially decomposed plant material; however, a large amount of material was retained in the sieve. This suggests that the percent of fine grained material was low.

- Twelve to 19 cm of dense root mat, dark brown.

- Nineteen to 25 cm of dense root mat, medium grey/brown. Grain size could not be determined because of the high proportion of partially decomposed plant material; however, a large amount of material was retained in the sieve. This suggests that the percent of fine grained material was low.

- Twenty-five to 27 cm of narrow, light grey horizon, with no live roots.

- Greater than 27 cm of dark chocolate brown, silty clay with no sand, high organic matter content, no live roots, and a sulfide odor. Grain size could not be determined because of the high proportion of partially decomposed plant material; however, a large amount of material was retained in the sieve. This suggests that the percent of fine grained material was low.

A few ducks were observed in the salt marsh pools, and wrens and sparrows were observed foraging on the mounds.

Station 3

The station was occupied at 12:30 hours. Station 3 is located at the southeast corner of Lake Hancock. The tide was low and exposed a broad intertidal zone. The upper portion of the intertidal zone was composed of cobbles and sand, and the lower portion was a soft, fine-grained sand (Figure 9). Cobbles on the upper shore supported barnacles, and numerous small crabs were observed in the small pools of water between the cobbles. Water quality measurements were taken at about 25 to 30 cm water depth, and results are reported in Table 1. A sediment sample was taken from the upper 5 cm of fine-grained substrate, just above the water line. The grain size was 26 percent fines. Sediment characteristics appeared uniform to a depth of 25 to 30 cm, below which large cobbles occurred. Numerous polycheate worms of several species were observed in the sand. Large *Neris* sp. sand worms were present. Numerous bent-nose clams (*Macoma nasuta*), averaging 5 cm in length, were present at 20 cm below the sediment surface. Some ducks were observed in Lake Hancock, as were Canada geese. An eagle was observed resting on the western shoreline of the lake, and a hawk circled overhead. Some small fish were startled while walking along the shoreline in the shallows.

Station 4

The station was occupied at 13:00 hours. Station 4 is located in the brackish wetlands about 50 m south of Lake Hancock. The vegetation in this zone consisted of communities of Baltic rush (*Juncus balticus*) and Pacific silverweed (*Potentilla pacifica*) (Figure 10), sea arrow-grass and Pacific silverweed, and Lyngby's sedge (*Carex Lyngbyei*). The substrate was fine-grained, high organic matter. Sediment was not fully characterized at this station because the brackish wetlands represent a very small portion of the total area at Lake Hancock and are unlikely to be sampled during the site hazard assessment. A water quality measurement was taken in a shallow pool (i.e., 15 cm deep) and results are reported in Table 1. Small wrens and sparrows were observed foraging in the area.

Station 5

This station was occupied at 13:30 hours. Station 5 is located in the freshwater marsh about 100 m south of Lake Hancock. The dominant vegetation is cattail (*Typha latifolia*) and Pacific silverweed (Figures 11 and 12). The substrate was fine-grained and high in organic matter. Sediment was not fully characterized at this station because the freshwater marsh represents a very small portion of the total area at Lake Hancock and is unlikely to be sampled during the site hazard assessment. A water quality measurement was taken in a shallow pool (i.e., 10 cm deep), and results are reported in Table 1. A small brown frog was observed in one of the pools, but was not captured for identification. Small wrens and sparrows foraged in the area, and a pair of king fishers were observed flying over the area.

Station 6

The station was occupied at 13:45. It is located immediately south of the freshwater marsh and represents the bog forest community. Large spruce (*Picea sitchensis*) dominate, with a dense understory of salal (*Gaultheria shallon*) and other shrubs. The vegetation was too dense to allow passage.

Station 7

The station was occupied at 14:00 hours. Station 7 is located southwest of Lake Hancock on flat terrain drained by small channels. Sea arrow-grass, pickleweed, and jaumea (*Jaumea carnosa*) comprised the dominant vegetation (Figure 13). A parasitic orange-colored dodder presumably a salt marsh dodder (*Cuscuta salina*), heavily infested the jaumea. Figure 14 shows the sediment profile of a test pit that is described as follows:

- Zero to 10 cm of dense roots, high organic matter, and little inorganic soil.
- Ten to 25 cm of dark brown to black dense roots with high organic matter. Grain size could not be determined because of the high proportion of partially decomposed plant material; however, a large amount of material

was retained in the sieve. This suggests that the percent of fine grained material was low.

- Greater than 25 cm of brown, few living roots, with a strong sulfide odor. Grain size could not be determined because of the high proportion of partially decomposed plant material; however, only a small amount of material was retained in the sieve. This suggests that the percent of fine grained material was high.

Station 8

The station was occupied at 1430 hours. Station 8 is located in the large pond that is the target center. The immediate area is typified by low mounds (e.g., 10 cm above the high tide mark) of pickleweed and broad drainage channels (Figure 15). The sediment in the channels was a very loose organic material. A shovel would easily penetrate to a depth of 50 cm. The pickleweed mounds sat atop the loose organic material and were "bouncy" as one walked from mound to mound. The substrate in the channels and ponds was covered with a 2 to 3 millimeter (mm) thick bacterial mat. Water quality was measured in the pool at about 15 cm water depth, and results are presented in Table 1. No life was seen in the pool except the bacterial mats and a little green algae (Figure 16).

Random Observations

- A small stand of softstem bulrush (*Scirpus validus*) was observed along the southern border of the site.

- Several extensive stands of California wax-myrtle (*Myrica californica*) approximately 75 cm tall were observed extending from the base of the bog forest south of the site into the flats. The myrtle was growing on a bench elevated 25 cm above the marshlands.

- An abandoned duck blind was located on the target pond.

- The large water body located in the southwest corner of the site, as well as many smaller pools in that area, had characteristics similar to the target pond (i.e., bacterial mat, some green algae, and not much animal life).

- A well used animal trail led from the southwest corner of Lake Hancock into the forest directly to the south. The dominant track on the trail was a small, 4 to 5 cm round-clawed mammal track.

- Small deer tracks were observed at several locations.

- A large garter snake was observed among the beach rye grass (*Elymus mollis*) growing along the sandy berm separating the beach from the marsh in the southwest corner of the site.

- Wave-deposited logs were observed up against the southern and northern borders of the site, proving the whole site can sometimes be inundated with sea water.

DISCUSSION AND CONCLUSIONS

Lake Hancock contains a variety of unique and sensitive habitats. Fonda (1981) and Chappell et al. (1995) defined these habitats and their associated plant communities in detail. They consist of the following:

- A salt marsh that covers most of the area north and west of Lake Hancock. Dominant vegetation is pickleweed and sea arrow-grass. Sample Stations 2 and 8 fall within this community.

- A brackish marsh south and west of Lake Hancock. Dominant vegetation is Baltic rush, Pacific silverweed, Lynby's sedge, and sea arrow-grass. Sample Stations 4 and 7 fall within this community.

- A freshwater marsh south of Lake Hancock at the foot of the slope. Dominant vegetation is cattail and Pacific silverweed. Sample Station 5 falls within this community.

- A bog forest south of Lake Hancock on the gentle north facing hillside. Dominant vegetation is Sitka spruce and salal.

The only rare plant species that potentially occurs at the Lake Hancock site is northern rice root (*Fritillaria camschatcensis*). Chappell et al. (1995) state that Lake Hancock may provide suitable habitat for northern rice foot, although the plant has not been observed at the site. Northern rice foot probably is limited to freshwater and possibly to low salinity habitats. Northern rice root would not be expected to occur in the salt marsh surrounding the bombing target. This is the most likely area for intrusive sampling during the site hazard assessment (SHA).

Varieties of birds and mammals use the marshes as foraging areas. Although no small mammal runs were noted (e.g., voles, mice, and rabbits), tracks of deer and a clawed mammal were observed. Several species of passerine birds (e.g., sparrows, wrens, and finches) forage on insects and seeds in the marshes. Great blue herons, ducks, geese, king fishers, and shorebirds forage in the aquatic areas. Eagles and hawks were observed resting and foraging over the marshes. Although no bird nests were seen, many species probably nest in the surrounding forested area.

Aquatic animal life was abundant in certain areas. The mouth of the stream discharging from Lake Hancock into Admiralty Inlet supported a dense community of barnacles and anemone. The portion of the salt marsh that was regularly tidally influenced contained many small crabs. However, the portion of the salt marsh located in the southwest corner of the marsh apparently is not regularly flushed with sea water, creating stagnant conditions in the pools. Aquatic animals were virtually absent from these pools. The manmade ditch draining the hill to the south of the marsh diverts freshwater from the salt marsh east into Lake Hancock. The ditch may aggravate the stagnant conditions caused by little tidal flushing. The freshwater marshes that border the toe of the hill to the south of Lake Hancock support numerous small invertebrates and amphibians.

Water quality varied across the area (Table 1). Stations forming the salt marsh habitat (Stations 1, 2, 3, and 8) have similar salinity (i.e., uniformly high in the salt marsh, averaging about 2.25 percent) and pH (i.e., varying from 8.3 to 9.5), but variable temperature (i.e., temperature varied from 12.1 to 20.4°centigrade [C]) and dissolved oxygen (i.e., dissolved oxygen varied from 9.5 to 1.5 mg/L). The temperature and dissolved oxygen varied between sample stations because measurements were made at different times of the day and some stations contained flowing water (Stations 1, 2, and 3), while one was a shallow stagnate pool (Station 8). Both temperature and dissolved oxygen at Station 8 reached biologically limiting levels for many aquatic organisms. Salinity was intermediate in the brackish marsh (Station 4) and lowest in the freshwater marsh (Station 5). The pool measured at Station 4 was shallow and stagnant. It was typified by low dissolved oxygen concentrations (i.e., 1.9 mg/L) that would limit aquatic life.

Sediment in Lake Hancock and the stream draining it had a sandy texture. All sediment samples collected from the marsh proper were high in organic matter and had little or no sand. The marsh sediment organic matter was typified as partially decomposed fibrous material.

Under the current concept of the sampling effort required for the site hazard assessment (SHA) for Lake Hancock, it is anticipated that sediment sampling will occur at approximately 10 locations were metallic anomalies are located by the magnetic survey. The location of the sampling is unknown, but will likely occur in the southwest corner of the site were the aerial bombing target was located. The sampling will consist of a two-person field crew using a hand auger to collect sediment samples at various depths below the ground surface for chemical analysis. Sampling will be conducted at the end of the summer and should take approximately 2 days. This sampling effort will pose minimal impacts to Lake Hancock, and no mitigation measures are recommended.

It is possible that results of the SHA could indicate the need for remedial action based on laboratory results. It is also most likely that potential remedial actions will be centered around the aerial bombing target in the southwest corner of the site. Active sediment remediation activities in the southwest corner of the site are impractical and will likely cause excessive ecological damage. Almost all active remedial action measures require heavy equipment operation (e.g., backhoes, trucks, and front-end loaders). Use of heavy equipment in southwest corner of the site is impractical because the substrate is a loose sediment down to at least 3 feet. This situation would prohibit use of heavy equipment. Any active remedial activities would temporarily destroy the existing salt marsh and could negatively impact adjacent areas through mass movement of sediment. Therefore, active remedial action is not recommended for most of the salt marsh area.

REFERENCES

Fonda, R.W. 1981. *Final Report - Evaluation of Lake Hancock: A Potential National Natural Landmark.* U.S. National Park Service, Pacific Northwest Region, Seattle, Washington.

Chappell, C., J. Gamon, B. Stephens, and M. Sheenhan. 1995. *Draft Report - Significant Biological and Natural Features of Naval Air Station Whidbey Island, Island County, Washington.* Washington Natural Heritage Program, Washington State Department of Natural Resources.

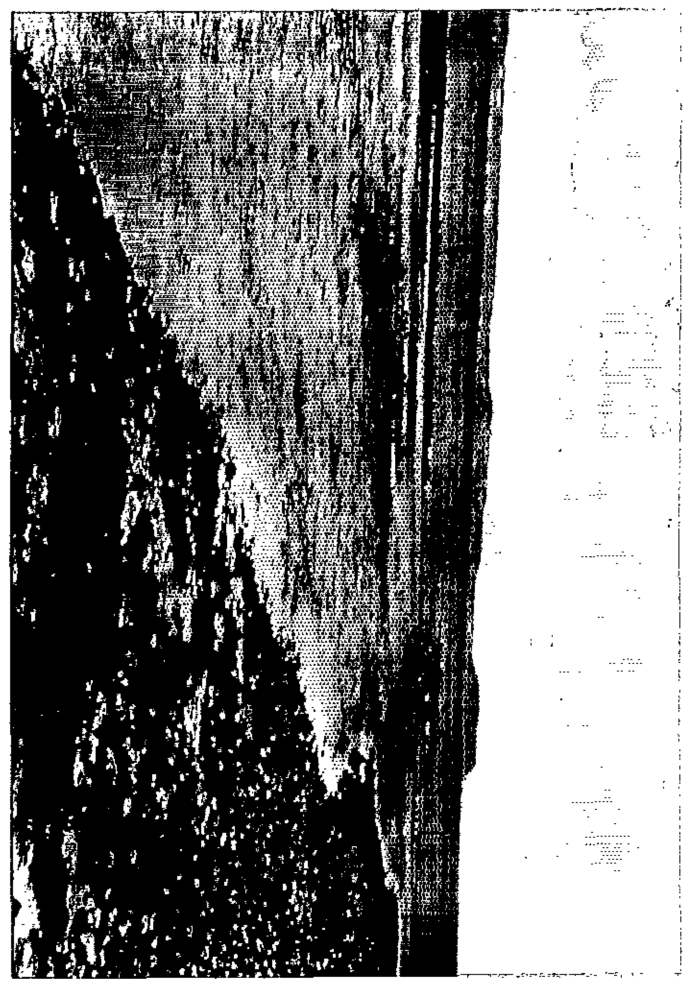


Figure 2
Station 1 – Looking west at discharge stream from Lake Hancock. Tide was low and outgoing. Cabble and sand in right center was the typical substrate. Sediment sample was collected from finer-grained substrate in foreground.

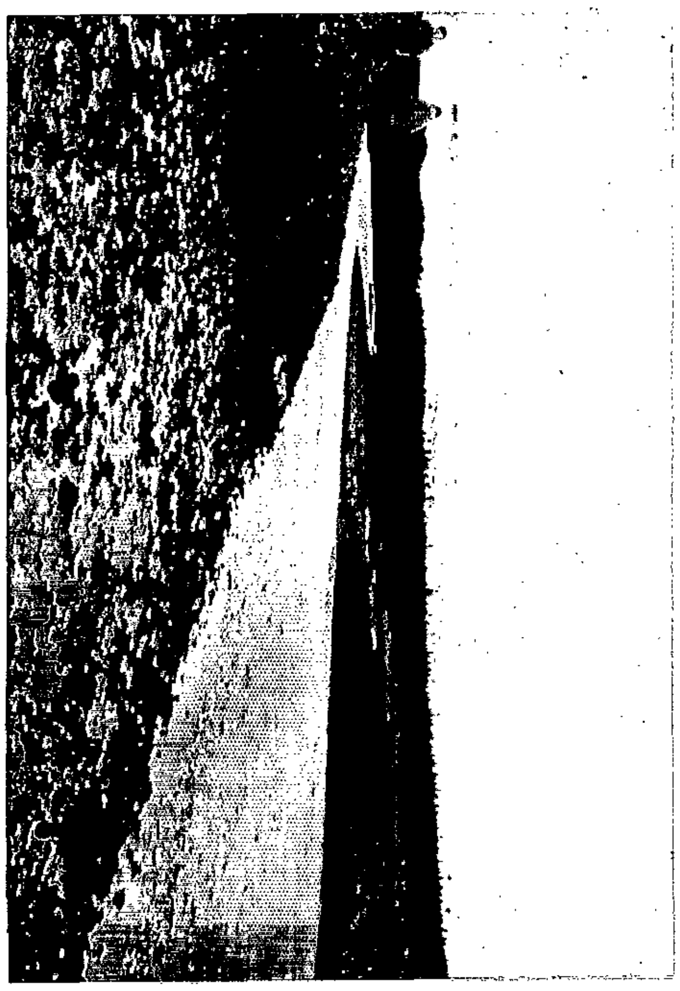
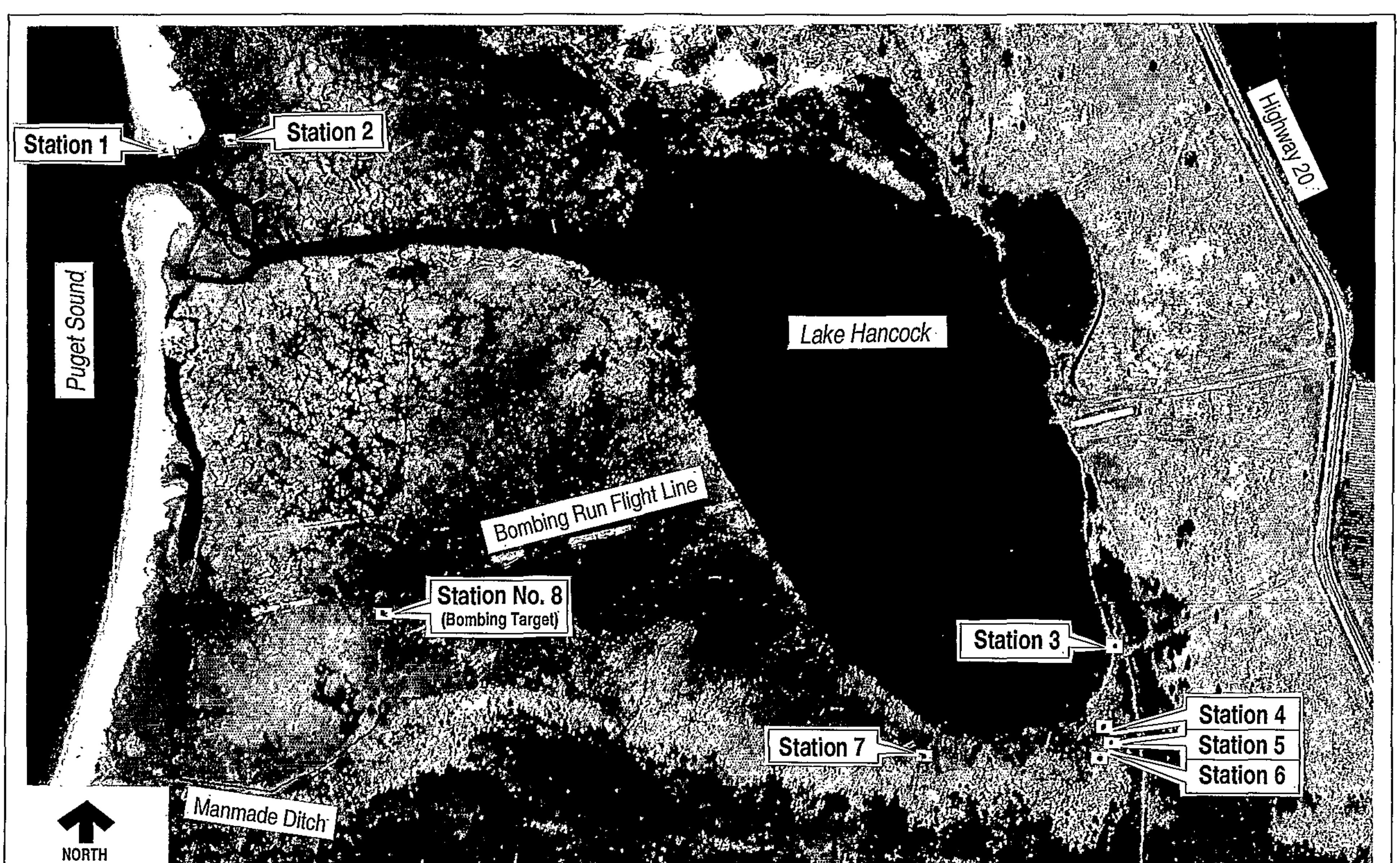


Figure 3
Station 1 – Looking east toward Lake Hancock.

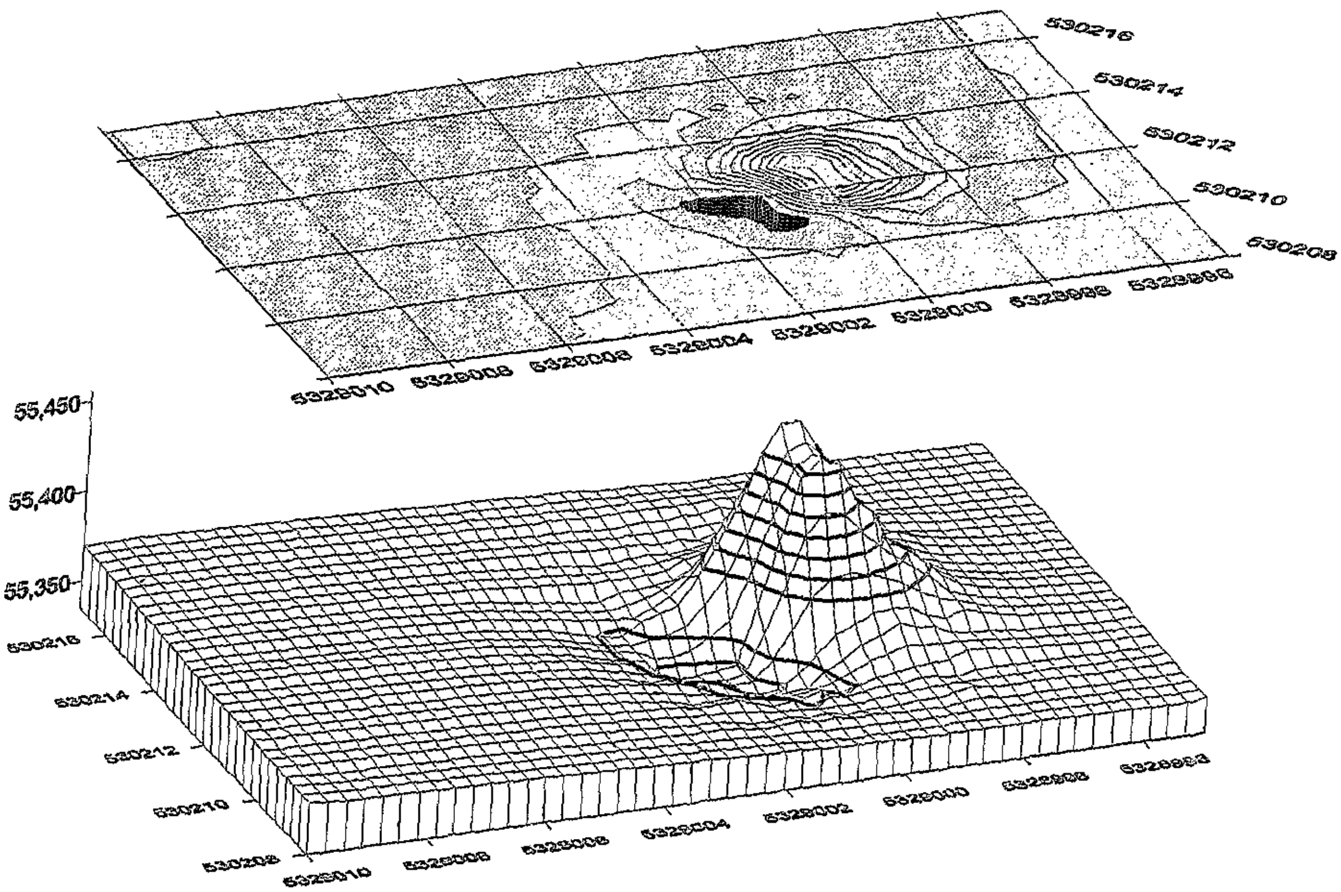


CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 1** **Lake Hancock Station Locations**	CTO 0207 NAS Whidbey Island, WA LAKE HANCOCK

533207002-1-061096

FINAL REPORT
FOR THE
AERIAL AND GROUND BASED GEOPHYSICAL SURVEYS

OF THE
FORMER LAKE HANCOCK TARGET AREA
NAS WHIDBEY
OAK HARBOR, WASHINGTON



Prepared By:
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10511 Hardin Valley Road, Bldg. C
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September 17, 1996

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(423) 690-6061
FAX (423) 690-6065

September 17, 1996

William L. Rohrer
URS Consultants
1100 Olive Way, Suite 200
Seattle, WA 98101

Subject: Report of Aerial and Ground Based Geophysical Survey of NAS Whidbey Lake Hancock Target Range

Dear Mr. Rohrer:

The report of the subject survey is enclosed. If you have any questions or desire clarification of any part of this report, please do not hesitate to contact me anytime at 423-690-6061.

It was a pleasure working with you, your staff and the URS company. EOD Technology, Inc. looks forward to future projects together.

Sincerely,

EOD TECHNOLOGY, INC.

William A. Brindle

William A. Brindle, Jr.
Field Operations Manager

Enclosures as noted: EODT Final Report including Attachment 1
Electronic Disk with Final Report (excluding Attachment 1)

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FINAL REPORT

for the

AERIAL AND GROUND BASED GEOPHYSICAL SURVEY

conducted
at the

FORMER LAKE HANCOCK TARGET AREA
NAS WHIDBEY
OAK HARBOR, WASHINGTON

SUBCONTRACT #SE-96-P-185

Prepared for:

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1.0 INTRODUCTION

EOD Technology, Inc. (EODT) of Knoxville, Tennessee was issued Subcontract Number SE-96-P-185 from URS Consultants, Inc. (URS), dated July 30, 1996, to provide an airborne and ground based survey of the NAS Whidbey Island, Former Lake Hancock Target Range (LHTR). The objective of the aerial and ground based surveys was to identify the possible presence of surface or subsurface anomalies which could be unexploded ordnance (UXO) or inert ordnance related scrap (ORS) within the 418-acre LHTR site.

1.1 DESCRIPTION OF WORK

As part of the US Navy's Comprehensive Long-Term Environmental Action Navy (CLEAN) program, URS was tasked with the performance of a Site Hazard Assessment (SHA) of the LHTR. As a component of this SHA, EODT was tasked with the conduct of an aerial and ground-based geophysical survey using magnetometry and electromagnetics for the detection of surface and sub-surface ferrous objects. The surveys were conducted at the LHTR adjacent to Washington State Highway 525 and Admiralty Inlet, approximately 20 miles south of NAS Whidbey on Whidbey Island.

During this project, the aerial and ground based surveys were conducted over a five day period. While related by objective, the two surveys had distinct missions. The aerial survey was to identify, record and map high concentrations of ferrous objects within the former target area. Once plotted on the two-dimensional, multi-colored maps, each anomaly was assigned an unique identification number, and the northing and easting coordinates were determined and recorded. Once anomalies were plotted by the aerial survey, the ground based survey was conducted to verify the presence of the anomalies and to gain further information related to anomaly depth, size, description, etc.

1.2 GEOPHYSICAL SURVEYS

The aerial surveys were performed by Aerodat utilizing a Eurocopter SA350D Squirrel helicopter towing a multi-component magnetic gradiometer array coupled with real time navigation and data positioning equipment integrated through a Digital Global Positioning System (DGPS) radio link. A complete detailed description of the aerial survey equipment and methodologies has been presented in the attached Aerodat Final Report.

Verification of the anomalies was conducted by EODT personnel. The numbered anomalies identified by the aerial survey were assessed by EODT, URS and Aerodat personnel as to their location, and signal intensity. Those anomalies that were accessible were investigated by EODT personnel utilizing the Geometrics G-858 Ferromagnetic Cesium Magnetometer with Data Logger, in conjunction with a G-868 Base Station and Trimble Pro XL DGPS. Combined, these systems are capable of correlating time/position data with magnetometer sensor data for accurate mapping of anomaly size and signal strength. Where detailed anomaly mapping was not possible due to terrain or other limitations, EODT personnel used the G-858 and G-868/DGPS to verify the anomaly location and to gather additional information related to anomaly size, shape, depth and orientation. As permitted by terrain, 16 anomalies were located and their positioning validated by EODT personnel through the use of a magnetometer and DGPS. EODT personnel also conducted a detailed geophysical survey of two anomalies, from which multi-colored three dimensional maps were generated using the electronically recorded data from the magnetometer and DGPS.

1.3 PERSONNEL AND EQUIPMENT

EODT provided the necessary management, labor, materials, equipment, tools, insurance and services necessary to perform the Scope of Work for this project. Detailed descriptions are provided in applicable sections of this report for the equipment systems and personnel utilized on this project. All aerial and ground based site operations were performed in OSHA Level D personal protective equipment (PPE).

1.4 SITE SPECIFIC WORK PLAN / SAFETY PLAN

In conjunction with it's Corporate Health and Safety Program, EODT personnel generated a site specific Work Plan/Safety Plan (WP/SP) which outlined: the scope of the project; identified the tasks to be completed by EODT; the potential hazards associated with the assigned tasks; the procedures to be used for the completion of the tasks; and the methods to be employed to control task/site hazards. This WP/SP was developed as an attachment to the URS Project Plans and was designed to supplement the URS plans with task specific information. The WP/SP was reviewed by URS, EODT and Aerodat personnel and all personnel complied with the provisions of the EODT WP/SP, and URS Project Plans. To ensure employee awareness and to enhance site safety, tailgate safety briefs were conducted by EODT daily prior to commencing work.

2.0 DESCRIPTION OF THE SURVEY SITE

2.1 TARGET RANGE DESCRIPTION

The Whidbey Island LHTR is located adjacent to U.S. Highway 525, 20 miles south of NAS Whidbey, Washington. The Lake Hancock area consists of approximately 410 acres of marsh with a 60 acre lake located in the middle of the area. The primary target impact area is surrounded with tidal wetland and low lying vegetation.

2.2 OPERATIONAL HISTORY

The LHTR was used for aerial bombing training between 1943 and 1971, and a portion of the site is currently being used to monitor aerial gunnery training in the Admiralty Bay adjacent to the site. During WWII, live training ordnance, which contained spotting charges, were deployed on the site during bombing training. The large number of salt pans (small, shallow ponds of saline water without emergent vegetation) may be due to impact and explosion of munitions. In 1972 and 1973, three separate surface clearances were conducted by military personnel. The first clearance was conducted between October 2 and November 3, 1972, to remove any ordnance items identified; the second search was conducted during the first 2 weeks of May, 1973; and the third was conducted in August 1973, using an MK 10 ordnance locator. The third search was hindered by the presence of scrap metals and only three inert rocket motors were found and removed from the site. Due to the three clearances, an excess of 15 tons of inert ordnance related scrap (ORS) was removed from the site. However, as recent as 1995, ordnance items were still being found at the site. During the three surface clearances, the following ordnance items were found and identified:

- MK 23, 43, 76 and 89 practice bombs
- 2.25-inch SCAR rockets
- 5-inch HVAR rockets
- 100, 250, and 500 pound water sand filled bombs
- MK 6, 25, and 58 smoke bombs

Archival data provided to EODT by URS indicated the presence of one primary practice target, however previous site visits also indicated that secondary target areas may have also been used during past bombing training. One of the purposes of the geophysical surveys was to identify any such secondary targets. There are no records indicating the use of full-up live ordnance at the Lake Hancock Target site, and previous site searches did not reveal any evidence of live ordnance. However, depending upon the type of spotting charge used, it was still possible to encounter ordnance capable of causing harm to site personnel. In all instances where site personnel were involved in the surface investigation of anomalies, EODT personnel adhered to proper site and UXO precautions and procedures.

3.0 INITIAL SITE WORK

3.1 PROJECT SCHEDULE

On Monday, August 12, 1996, EODT personnel met with URS Consultant personnel at the site for initial entry with Base E.F.A. personnel in order to discuss and develop plans of action for both Aerial and Ground Geophysical Surveys. The group was joined by the Aerial team later in the day for ground equipment positioning. Mr. William Rohrer, URS Consultant Project Manager, pointed out to all personnel concerned where the survey efforts should focus. Equipment configuration on the support helicopter was also being accomplished with the initial flight to be conducted August 13, 1996.

3.2 KEY PERSONNEL

During the geophysical surveys of the NAS Whidbey Island Lake Hancock Target Range, the following key personnel worked at, or visited, the site:

Mr. Jeffery Gamey	Aerodat	Manager Environmental Services
Mr. William Brindle Jr.	EODT	Sr. UXO/Field Operations Mgr.
Mr. Terry Willis	EODT	UXO Program Specialist
Mr. D. Nicholas	Eagle Aviation	Helicopter Pilot

4.0 GEOPHYSICAL SURVEY ACTIVITIES

4.1 GENERAL

Prior to geophysical site activities, the first day was spent establishing a DGPS location near a local survey monument, and a magnetic base station was positioned in the vicinity. EODT validation equipment was calibrated and response checked in accordance with (IAW) manufacturer's recommendations and was determined to be functioning properly. The aerial platform instrumentation was installed and functional by mid-day and the initial fly over calibration checks with preliminary data runs were conducted in the late afternoon of August 13, 1996.

4.2 TARGET RANGE SURVEY

4.2.1 Aerial Survey

The aerial survey identifying high concentrations of metallic anomalies using a rigid magnetometer (bird) towed 30 meters beneath the helicopter commenced on August 14, 1996, and concluded on August 15, 1996. The aerial survey entailed four sorties (flights). Information related to the equipment used, and the direction and speed of the traverses are discussed in the Aerodat report located in Attachment 1 of this report.

4.2.2 Ground Survey

The ground based survey was commenced on August 15, 1996 to validate anomalies indicated on a preliminary aerial map. This survey was conducted using a Trimble DGPS Pro XL, G-858 magnetometer, and G-868 Base Station, and was concluded on August 16, 1996. Verifications were conducted at the locations identified in Table 1, with three dimensional geophysical grid survey maps produced for anomalies 30 and 101. All locations investigated were positive anomaly contacts within the parameters of the survey protocol. The survey maps of items 30 and 101 are contained in Figures 1 and 2. Anomalies 17, 18, 41 and 51 were by far the strongest anomalies recorded, however, only item 51 could be verified. The other three items were located in water and mud during both tidal phases and were unaccessible to site personnel by foot.

4.2.3 Ground Survey Equipment

The Model G-858 is a ferromagnetic mapping tool offering exceptional speed and efficiency. This system offers the capabilities needed to determine buried ferromagnetic object depth and orientation. The G-858 has excellent depth of exploration and can detect a single drum at three

Table 1. Results of Ground Based Anomaly Investigations

Anomaly Identification	Anomaly Coordinates		Anomaly Description	Estimated Anomaly Depth
	Northing	Easting		
01	5328489.48	529917.34	Unknown (small item)	3 - 5 inches
10	5328579.86	530192.15	Unknown	6 - 8 inches
16	5326617.38	530256.79	Target debris	Surface
20	5328638.40	530230.49	Target debris	Surface
30	5328723.42	530276.79	Unknown (medium item)	10 - 12 inches
32	5328724.48	529931.80	Unknown	Shallow (1 - 2 inches)
33	5328736.05	529942.41	Wire rope	3 - 5 inches
36	5328740.64	529937.94	Unknown (small item)	Shallow (1 - 2 inches)
39	5328738.94	529930.70	Unknown (small item)	Shallow (1 - 2 inches)
40	5328766.01	529940.94	Timber with rail road spikes	Surface
45	5328785.85	529930.81	Partial metal culvert	Surface
51	5328945.21	530157.33	Four square 1/4 inch steel plates, with nearby expended 2.25 inch rocket motor	Surface
95	5328992.51	530309.41	Unknown (medium item)	6 - 8 inches
100	5329000.89	529910.17	Unknown (small item)	3 - 5 inches
101	5328995.27	530208.96	Unknown (large item)	12 - 18 inches
117	5329078.61	529893.81	"I" Beam	Surface

to four meters in non-ferrous soil. Two modes of operation are available: the magnetometer mode, using a single cesium sensor; or, the gradiometer mode using a paired set of cesium sensors spaced about one meter in width. The magnetometer is used in total field mode, giving the greatest depth of exploration, moderate target discrimination, and requires the use of a base station for contour quality data. The gradiometer mode gives reduced depth, better spatial resolution, and data that can be directly contoured. The system presents a "Quick Look" to the operator of up to five stacked survey profiles. Data is stored in non-volatile RAM for playback review in the field and downloading at the base site. The system includes a comprehensive software package to down-load, edit and interpolate the date into two and three dimensional contour ready format. Hard copy, fully annotated color maps can be produced within minutes after data transfer to the base computer.

The G-858 can be used in conjunction with the Trimble Pro XL DGPS for sub-meter positioning accuracy, and can be upgraded to centimeter accuracy with the addition of the G-868 Base Station. During the survey, the DGPS supplies a time/position stamp to it's output, which is correlated with the G-858 sensor data for accurate mapping.

4.3 SURVEY MAPS AND TRANSPARENCIES

Aerial and ground based survey maps have been enclosed in this report and in the Aerodat report in Attachment 1 to this report. To aid in orientation, a flight path map and an approximate target range map have been superimposed over a reduced version of the Aerodat survey map (target range map not to scale and of approximate size).

5.0 RECOMMENDATIONS

The aerial survey, coupled with the ground verification surveys, positively identified surface and subsurface metallic debris and anomalies of various origins, i.e., steel plates, braided steel wire rope, railroad spikes embedded in large timber, and an expended 2.25 inch rocket motor were visually identified. As previously discussed, several anomalies were identified as strong signals and have the potential for being UXO/ORS sites. While other anomalies were identified with lower signal intensities, each anomaly will have to be treated as a possible UXO/ORS, until proven otherwise. Except for those anomalies listed in Table 1 as being non-UXO related items, EODT recommends that care be taken when sampling near suspect anomlies, and that no sampling be conducted on top of suspect anomalies.

6.0 CONCLUSION

EODT provided both aerial and ground based survey personnel to conduct geophysical surveys as previously described. Time on site was dictated by project duration and access to some anomalies was limited by tidal functions and terrain, with the marsh mud and non-weight bearing vegetation excluding the production of more ground based geophysical grid maps. Evidence of the above mentioned limitations are shown in site pictures 1, 2, and 3, found in Appendix 1 of this report. While more verification geophysical survey grid maps were not possible, EODT personnel conducted ground based validation of all accessible anomalies and were able to verify the presence of surface and subsurface ferrous anomalies at each location.

EODT Group, Inc.
Lake Hancock Anomaly Investigation
Whidbey Island, Washington
Detailed Grid of Anomaly #30

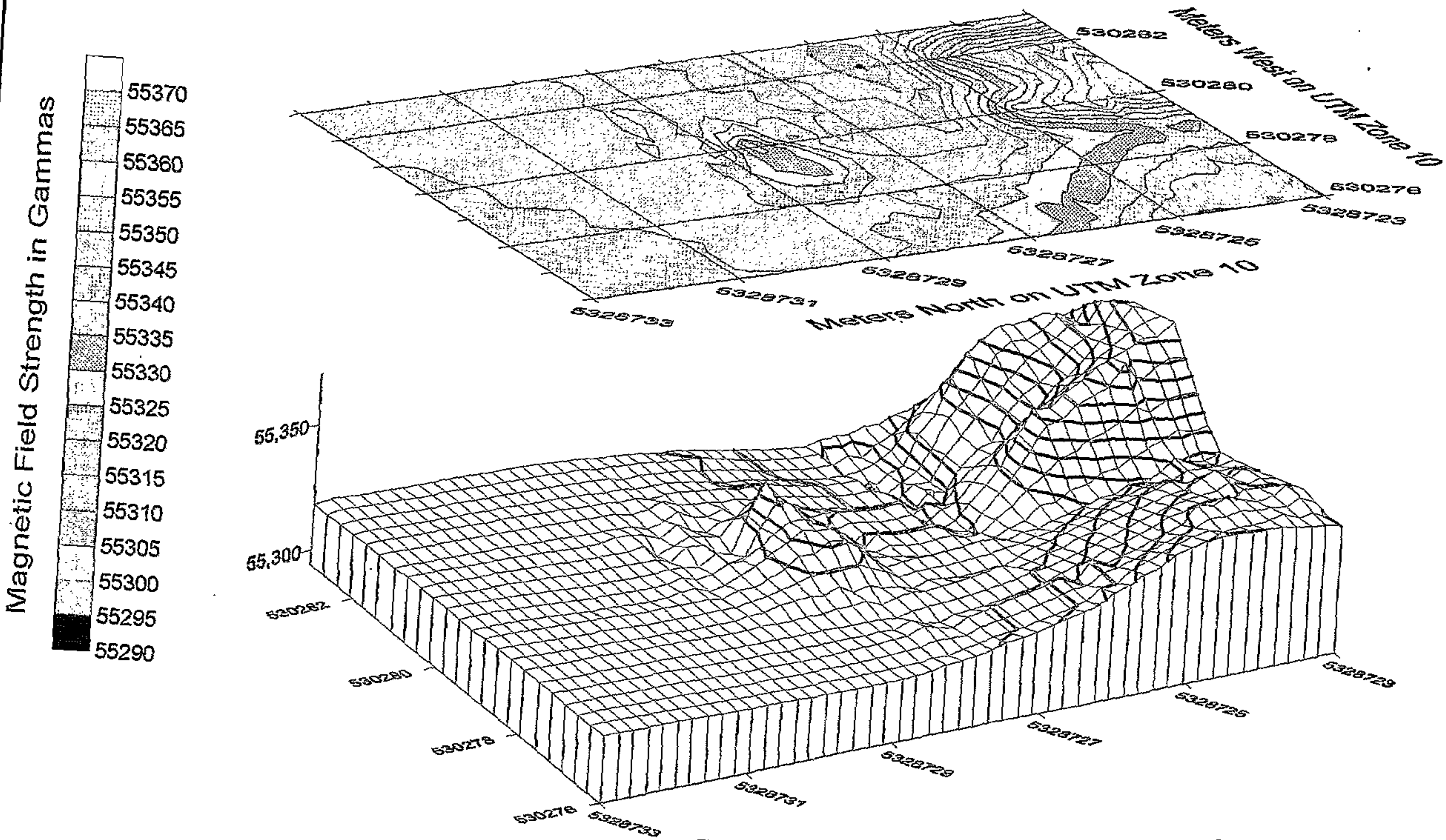


Figure 1

Data Gathered on
August 15th, 1996

EODT Group, Inc.
Lake Hancock Anomaly Investigation
Whidbey Island, Washington
Detailed Grid of Anomaly #101

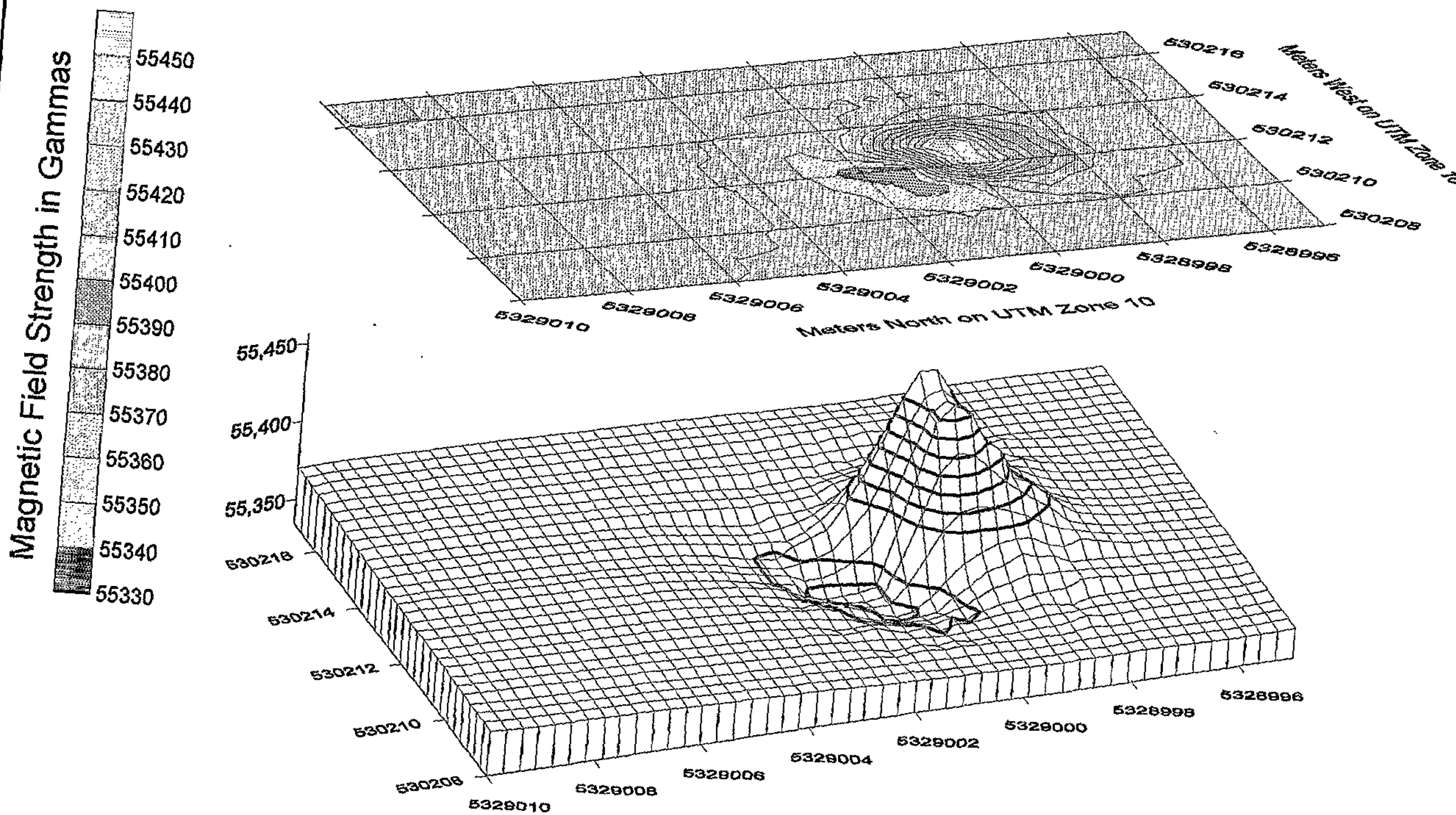
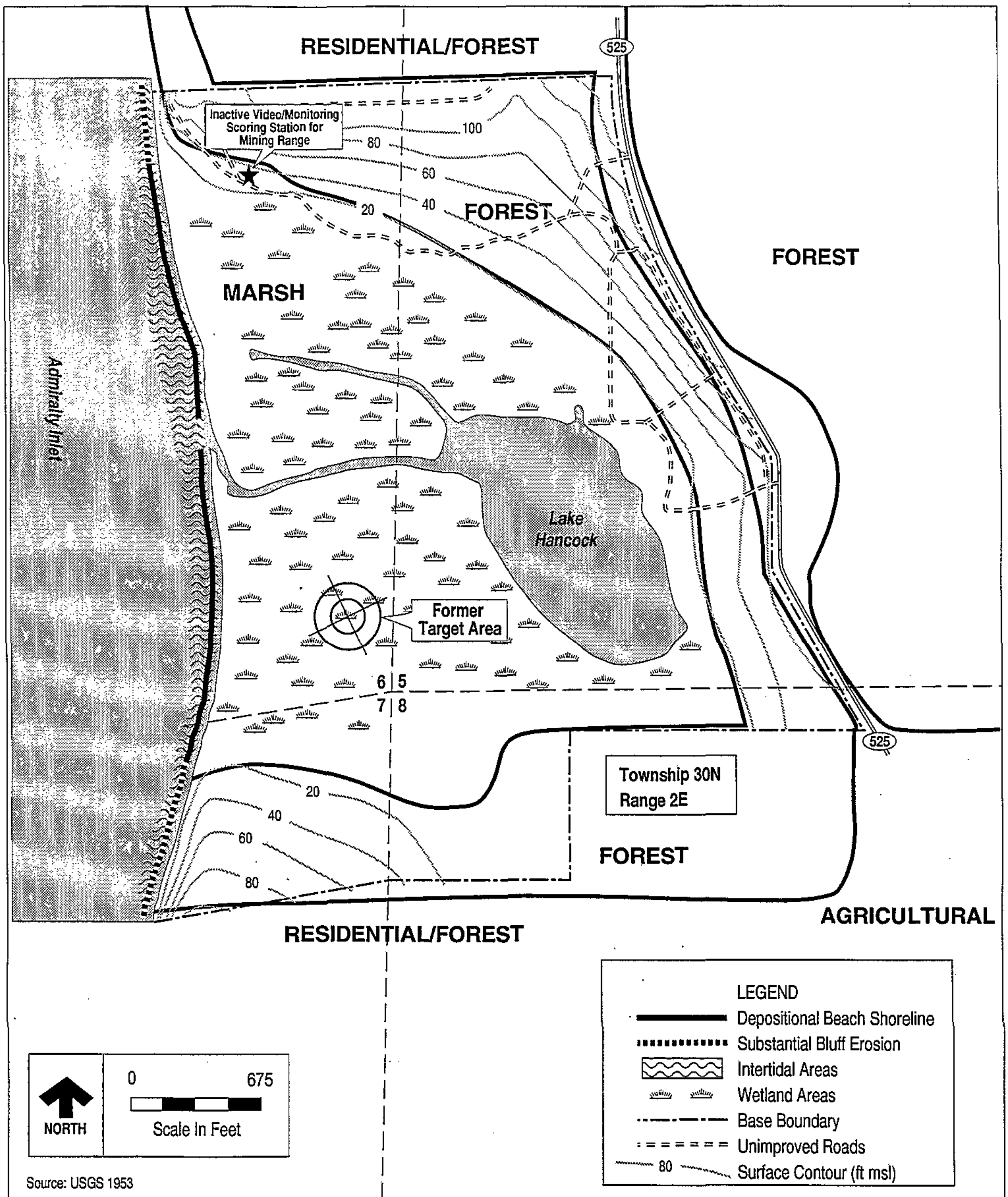


Figure 2

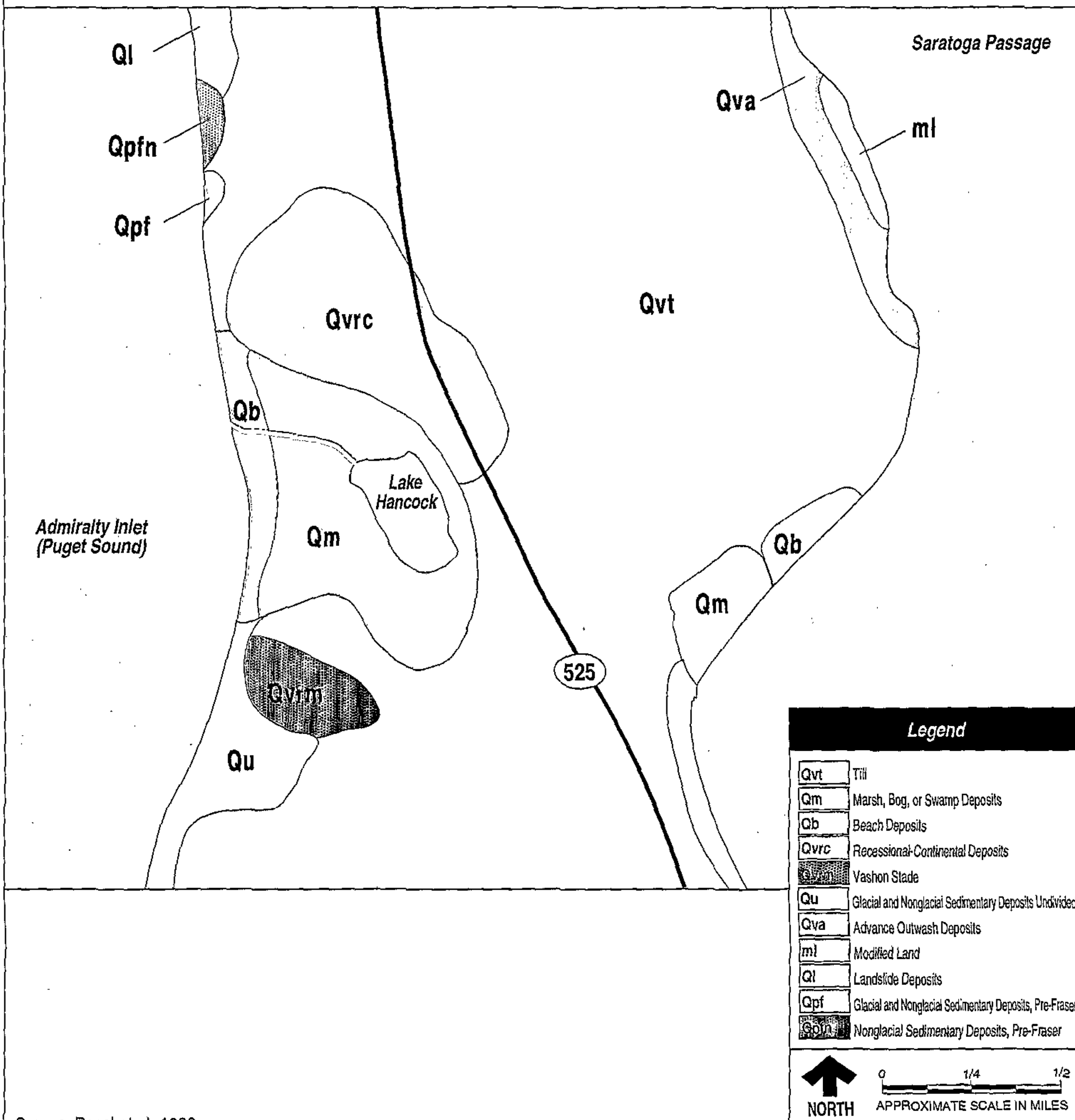
Data Gathered on
August 16th, 1996



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 2-2** **Regional Land Use Map**	CTO 0207 NAS Whidbey Island, WA LAKE HANCOCK SHA

533207002-33-111998

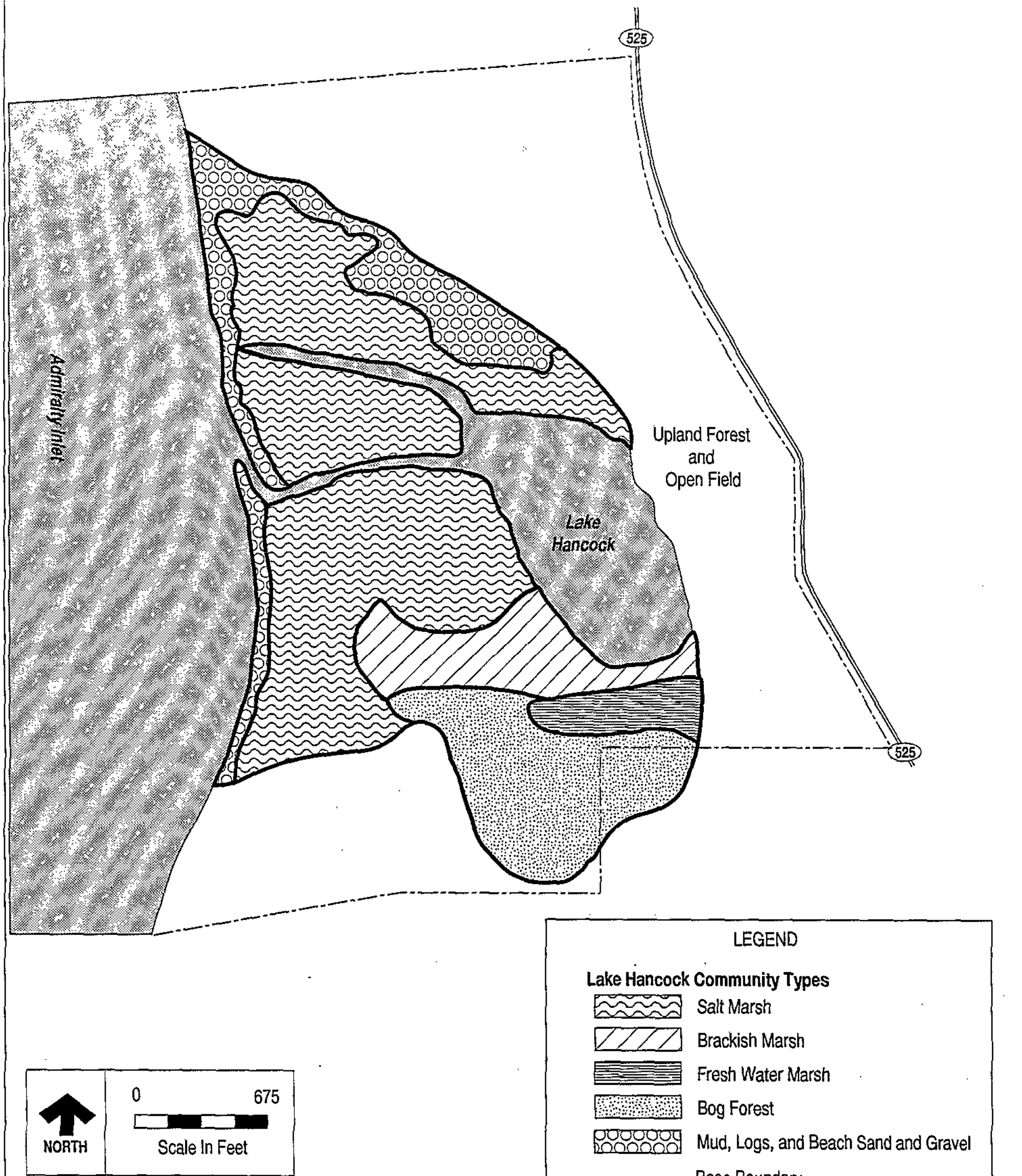
This figure was printed in color; information may be missing from black and white photocopies.



Source: Pessl et al. 1989

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 2-3** **Surficial Geology Map of Lake Hancock and Vicinity**	CTO 0207 NAS Whidbey Island, WA LAKE HANCOCK SHA

533207003-110-120398



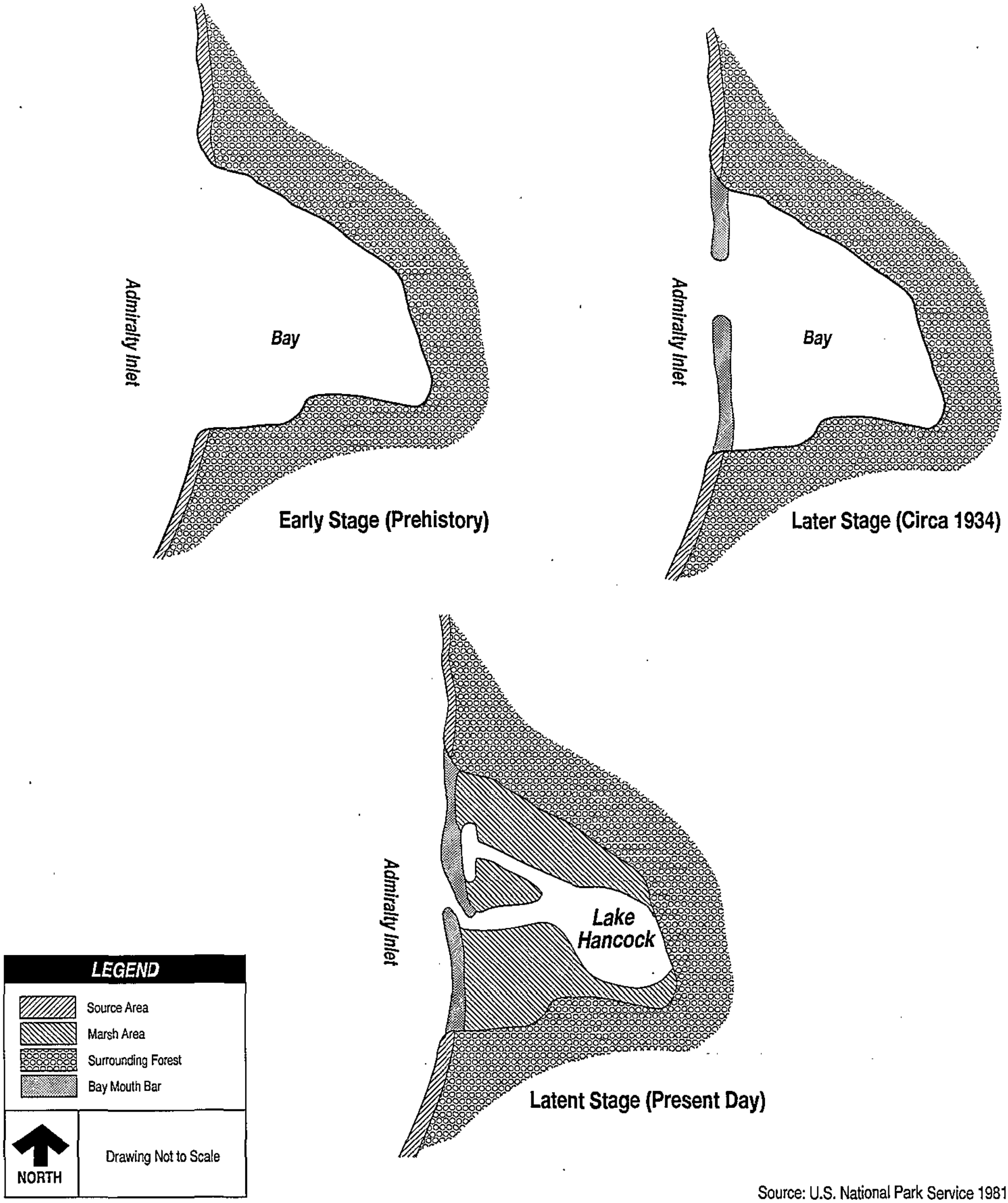
Source: USDA 1990

CLEAN
COMPREHENSIVE
LONG-TERM ENVIRONMENTAL
ACTION NAVY

Figure 2-4
Lake Hancock Vegetation Map

CTO 0207
NAS Whidbey Island, WA
LAKE HANCOCK SHA

533207002-19-111998



Source: U.S. National Park Service 1981

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 2-5** **Formation of Bay Mouth Bar**	CTO 0207 NAS Whidbey Island, WA LAKE HANCOCK SHA

533207002-14-111998

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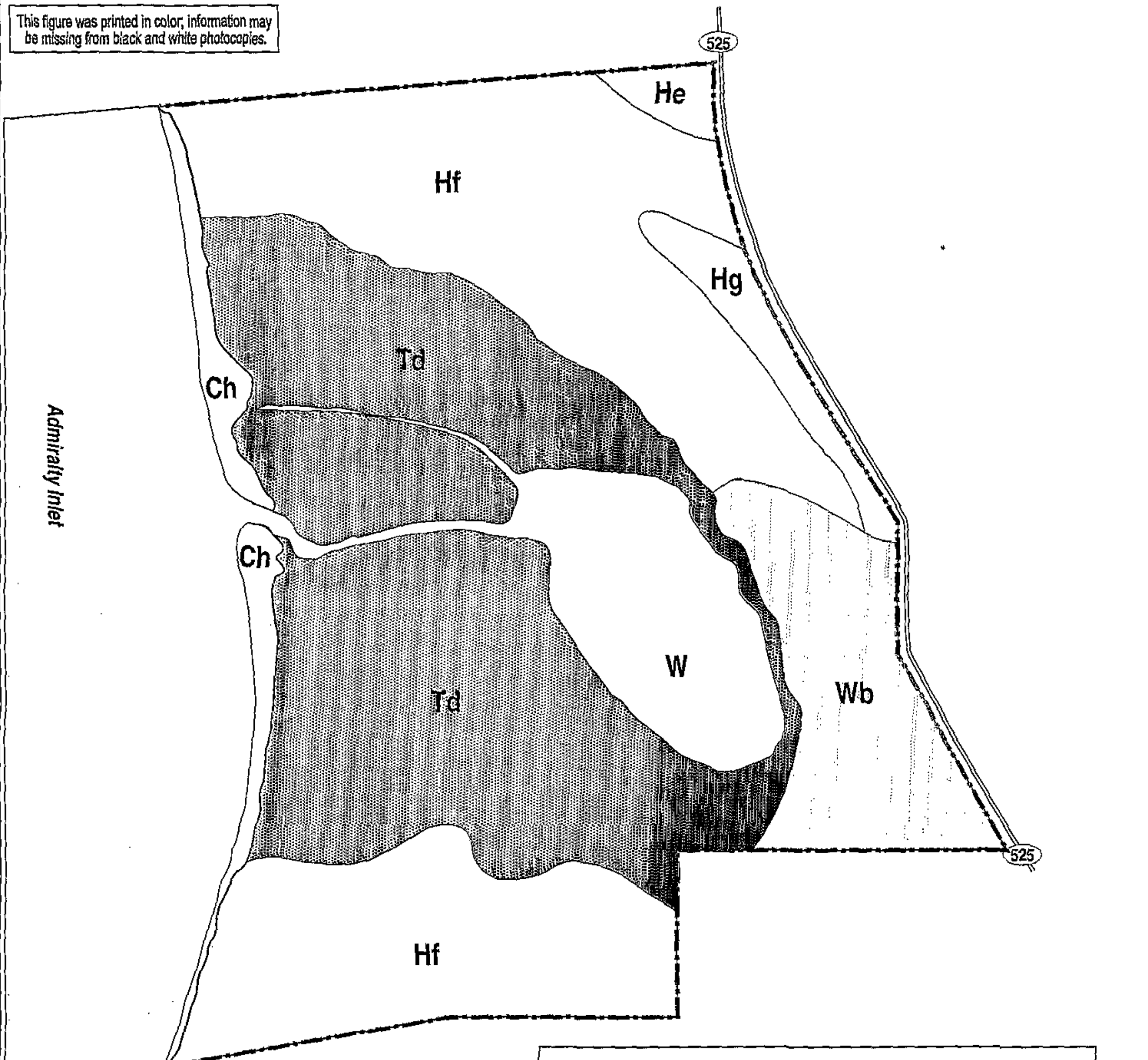


LEGEND

SYMBOL	SOIL NAME	SLOPE PHASE
Ch	Coastal Beach	0 to 2% Slopes
He	Hoypus Gravelly Loamy Sand	0 to 5% Slopes
Hf	Hoypus Gravelly Loamy Sand	5 to 15% Slopes
Hg	Hoypus Gravelly Loamy Sand	15 to 30% Slopes
Td	Tidal Marsh	0 to 2% Slopes
W	Water	0%
Wb	Whidbey Gravelly Loamy Sand	5 to 15% Slopes
	Base Boundary	

Source: USDA 1990

CLEAN
COMPREHENSIVE
LONG-TERM ENVIRONMENTAL
ACTION NAVY

Figure 2-6
Lake Hancock Soils Map

CTO 0207
NAS Whidbey Island, WA
LAKE HANCOCK SHA

533207002-18-120398

2.2.3 Surface Water

The land around Lake Hancock is mostly flat with a gentle to moderate slope to the east rising approximately 100 feet. Lake Hancock contains intertidal saltwater wetlands with adjacent freshwater wetlands, possibly with limited hydrologic connection to salt water. There are no stormwater conveyances from the highway into the lowland portions of the site.

Surface water direction in the lowland area varies according to the tidal cycle, toward the lake during the flood cycle and toward Admiralty Inlet during the ebb cycle.

2.2.4 Geology

There are three primary geologic units present at Lake Hancock. These units include a till unit to the south, marsh deposit unit near the lake, and a recessional-continental deposit unit to the north. In addition, there are beach deposits consisting of sand and gravel to the west of the site located on the berm separating the site from Admiralty Inlet. These units on a regional scale are shown in Figure 2-3. The soils at the site are low-permeability materials consisting of organic and alluvial peat type deposits.

2.2.5 Ecosystem

Figure 2-7 shows the locations of wetlands at Lake Hancock based on U.S. Department of Agriculture classifications (USDA 1990). The discussion below, however, is based on more recent field work at the site (WDNR 1995; Dames & Moore 1994). The following sections describe the various aquatic wetland types found at the site.

2.2.5.1 High-Salinity Lagoon

The lagoon pond is a shallow, permanent pond of approximately 37 acres (corresponding to the classification shown as E1OWL in Figure 2-7). It is currently connected with marine waters of Puget Sound by a single channel.

This lagoon system includes largely non-vegetated ponds and tidal channels, driftwood piles, and marsh vegetation. The entire lagoon system consists of 191 acres and incorporates four other element occurrences of specific types of estuarine marsh: sandy, high-salinity, low marsh; sandy, moderate-salinity, low marsh; silty, moderate-salinity, low marsh; and transition zone wetland. Two other types of marsh are present on the south side of the lagoon system: high-salinity, low marsh and low-salinity, low marsh.

The Lake Hancock lagoon system is protected from the open saltwater of Admiralty Inlet to the west by two sand spits that are nearly connected. A tidal channel cuts between the two spits and connects to the large high-salinity pond approximately 1,700 feet to the east. Two much smaller, shallow salty ponds occur just behind the spits near the base of each spit totaling 4 acres. At one time in the recent past, a second anthropogenic tidal channel breached the spits, but has since been occluded. The Lake Hancock lagoon system is dynamic, with large accumulations of driftwood covering approximately 12 acres along the northern edge of the system.

A freshwater wetland is located directly adjacent to the intertidal system and may be a minor source of freshwater influence in the intertidal system. There is no direct inflow of freshwater to the lagoon system. Forested, gentle to moderate slopes border the wetland system to the north, east, and south. A small cleared area borders a portion of the east side. The surrounding landscape is covered primarily with young conifers and deciduous broadleaf forest and secondarily with agricultural fields that are located 1,200 feet southeast of the lagoon.

The high-salinity, high marsh is intermediate between low and true high marsh. It is dominated by seashore saltgrass and non-native bentgrass that dominate approximately 6.5 acres. The low-salinity, high marsh is the highest elevation portion of the intertidal marsh. These areas are flooded during many high tides, are exposed on all low tides, and encompass approximately 6.2 acres. The vegetation is dominated by varying amounts of Pacific silverweed and Baltic rush. The non-native bentgrass is of secondary importance in some areas.

Vegetation in the high-salinity lagoon is mostly native saltmarsh species. Some of the tidal channels are a result of ditching activity by humans. Some of the salt pans may be a result of the impacts of shells associated with the aerial target practice. A narrow strip of fill has been placed along the east bank of the lagoon. The southern portion of the wetland has many rather small snags, the remains of trees that grew when the area had fresh water. A storm in 1914 breached the berm that protected the formerly freshwater lake from saltwater influences. The high-salinity lagoon system has developed in the time that has elapsed since this storm.

2.2.5.2 Sandy, Moderate-Salinity, Low Marsh and Sandy, High-Salinity, Low Marsh

High quality examples of these two types of intertidal marsh are located at Lake Hancock. They are described together because they are very similar in vegetation composition and difficult to delineate. The total extent of these two occurrences is 80.5 acres (E2EMN in Figure 2-7). The high-salinity marsh is probably more extensive than the moderate-salinity marsh. These are the most extensive types of marsh surrounding Lake Hancock.

These marshes are located within the lowest intertidal areas that are continuously vegetated. Salinity ranges from moderate to high (27 to 46 parts per thousand). The substrate is sand with minor quantities of silt. The lagoon system has little topographic relief and contains an extensive network of tidal channels that carry tidal waters throughout most of the marsh. Tidal channels and salt pans are numerous in this marsh. Along the south side of the lagoon system, the vegetation grades gradually from low intertidal marsh to a high intertidal marsh and transition zone wetland before shifting to purely upland vegetation. The sandy, high intertidal marsh has a wide range of salinities, ranging from polyhaline to brackish.

Vegetation in these marshes consists of nearly complete coverage by one or more of the three salt-tolerant species: pickleweed, seashore saltgrass, and jaumea. Generally, any one area is dominated either by saltgrass, or a mixture of saltgrass and one of the other two species. Other species of secondary importance include seaside arrowgrass, orache, Canada sandspurry, sea plantain, and saltmarsh dodder. The invasion of non-native cordgrass has established in recent years in the low marsh, primarily along the edge of tidal channels.

2.2.5.3 Silty, Moderate-Salinity, Low Marsh

A good example of a silty, moderate-salinity, low marsh occurs at Lake Hancock. Most of this transitional type of marsh is located farther away from the main tidal channel and lagoon than the sandy marsh on both the north and south sides of the site. This marsh is approximately 30.5 acres in extent.

Salinity is moderate at 27 to 28 parts per thousand. Substrate is predominantly silt and organic matter. A few small tidal channels penetrate this portion of the marsh. Vegetation is dominated by seaside arrowgrass, pickleweed, and seashore saltgrass. Species of secondary importance include orache, sea plantain, jaumea, and alkaligrass. The co-dominance of seaside arrowgrass is an indication of silty substrate.

2.2.5.4 Transition Zone Wetland

The transition zone wetland occurs as small patches and relatively narrow strips along the southern edge of the site totaling approximately 4.7 acres (E2EMP in Figure 2-7). It consists of a small transition between freshwater and saltwater marshes. The transition is mainly from fresh water to low-salinity, high intertidal marsh. Soils are organic and are saturated with standing water. The vegetation is dominated by cattail and Pacific silverweed. The ecological condition of the transition zone wetland is good with no non-native species present at these locations.

2.2.5.5 Low Elevation Freshwater

This 14-acre freshwater wetland occurs at the southeast end of the lagoon and intertidal wetland system (PSSC in Figure 2-7). It is separated from the intertidal wetlands only by a relatively narrow transition zone wetland and extends to the south beyond the property line.

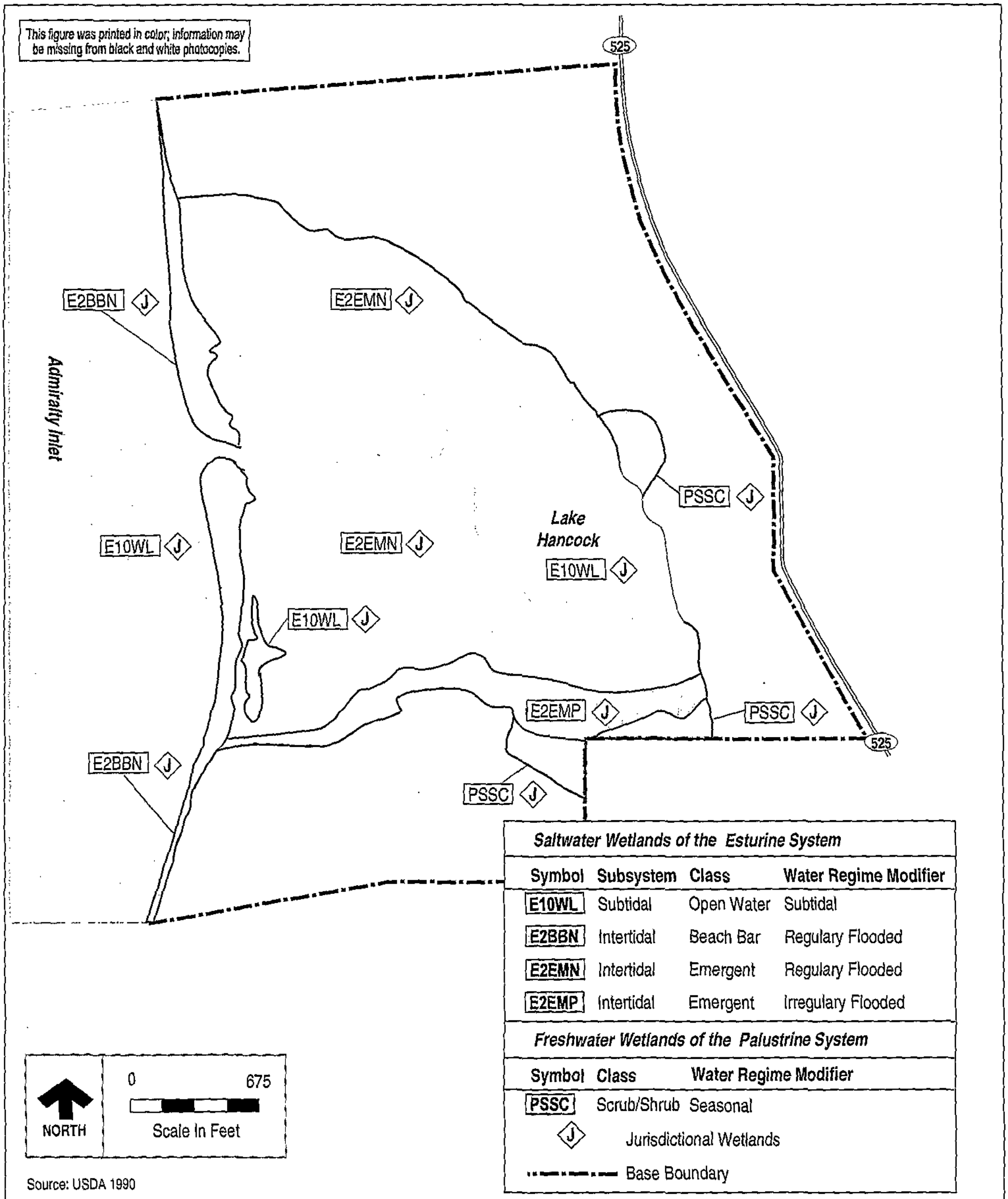
The area is flat with groundwater near the surface. It contains small, permanently flooded areas with the southern portions of this minerotrophic wetland grading into a sphagnum bog, where nutrients and pH are lower. Intertidal and transition zone wetlands border the freshwater wetlands to the north.

Vegetation is variable and is divided into two major types. Most of the area is dominated by an open tree canopy of mixed red alder, lodgepole pine, Sitka spruce, and western hemlock. The areas closest to the intertidal lagoon system are primarily dominated by the shrub sweet gale with a slight admixture of cattail. The understory layer is dominated by slough sedge with sweet gale becoming co-dominant at the north end. Several other species are important to varying degrees in this open forested wetland community including bog Labrador-tea, salal, black twinberry, water-parsley, and salmonberry. The bog Labrador-tea is indicative of areas transitional to the sphagnum bog located on adjacent properties.

2.2.6 Threatened and Endangered Species

A few endangered marine mammals including the gray whale, the green sea turtle, and the leatherneck turtle have been reported in Puget Sound. These species occur only rarely in Puget Sound and there are no breeding populations here.

Lake Hancock has been identified as a current and past nesting site for the bald eagle, which is listed as a threatened species. In addition, wintering populations of peregrine falcon have recently been reported in the Puget Sound area. Although there are no known nesting pairs on Whidbey Island, sightings at Lake Hancock were reported during the ecological survey (URS 1996b).



Saltwater Wetlands of the Esturine System

Symbol	Subsystem	Class	Water Regime Modifier
E10WL	Subtidal	Open Water	Subtidal
E2BBN	Intertidal	Beach Bar	Regulary Flooded
E2EMN	Intertidal	Emergent	Regulary Flooded
E2EMP	Intertidal	Emergent	Irregulary Flooded

Freshwater Wetlands of the Palustrine System

Symbol	Class	Water Regime Modifier
PSSC	Scrub/Shrub	Seasonal

J Jurisdictional Wetlands

Base Boundary

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 2-7** **Lake Hancock Wetlands Map**	CTO 0207 NAS Whidbey Island, WA LAKE HANCOCK SHA

533207002-17-120398

Table 2-1
Features of Glacial and Interglacial Geologic Units, Whidbey Island

Geologic Unit	Thickness	Permeability	Age
Recent (post-glacial) Deposits: stream alluvium (organic-rich sand, silt, clay); beach deposits (sand, gravel); post-glacial marine and nonmarine silt, clay, peat, sand, landslides; unconsolidated.	Up to 30 feet	Low to very high	Less than 10,000 years old
Everson Glaciomarine Drift: Sandy or clayey silt, silty clay with minor sand and gravel; may be stratified or till-like; some marine shells locally present; deposited in marine environment beneath floating ice; moderately to very consolidated.	Up to 40 feet	Very low to moderate	13,000 to 11,000 years old
Vashon Recessional Outwash: sand and gravel with silt layers; may include some marine deposits; usually well-stratified; deposited by meltwater from retreating glacier; generally poorly consolidated.	Up to 150 feet, usually fairly thin as a veneer on till	Very high	15,000 to 13,000 years old
Vashon Till: clayey, gravelly, sandy silt or silty sand; typically looks like pebbly concrete and is referred to as "hardpan"; generally poorly sorted and unstratified; deposited on land directly under a glacier; usually highly consolidated.	Up to 200 feet; typically 10 to 100 feet	Extremely low to moderate	16,000 to 15,000 years old
Vashon Advance Outwash (in part, the Esperance Sand): clean to silty, pebbly sand, with a minor silt layers; commonly coarsens upward; local cross-bedding; well stratified; deposited by meltwater from advancing glacier; well consolidated.	Typically 20 to 150 feet	Usually very high	18,000 to 16,000 years old
Olympia Nonglacial Sediments (in part, "transitional beds"): silt, clay, sand, peat, gravel; some cross-bedding; deposited in a floodplain and lacustrine environment during a nonglacial interval.	Up to 150 feet, typically 25 to 65 feet	Low to moderately high	28,000 to 20,000 years old
Possession Drift: includes very discontinuous till and glaciomarine drift, as well as outwash sand, gravel, and clay; locally fossiliferous; deposited during the Possession glaciation and the later Oak Harbor substage; very consolidated.	Variable, and usually thin; typically 10 to 100 feet	Generally low to moderate	90,000 to 70,000 and 50,000 to 35,000 years old
Whidbey Formation: sand (some pumiceous), silt, peat, clay; some cross-bedded sand; deposited in a floodplain environment during the last major interglacial period; well-consolidated.	50 to 200 feet	Low to moderately high	110,000 to 90,000 years old
Double Bluff Drift: includes till, glaciomarine drift, sand, gravel, silt, clay; some cross-bedded sand; deposited during the Double Bluff glaciation; very consolidated.	10 to 100 feet	Low to moderately high	250,000 to 140,000 years old

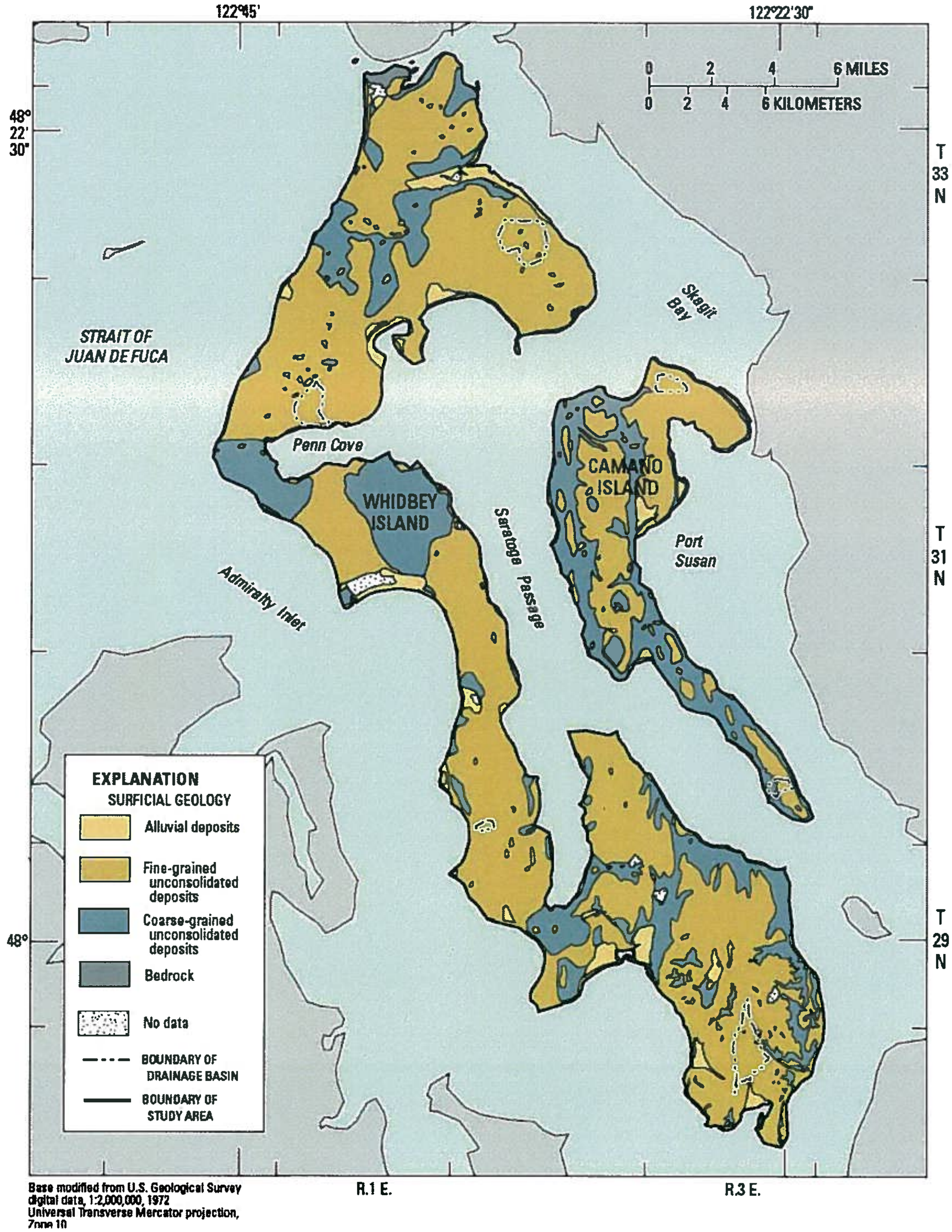


Figure 3.3-1: Generalized surficial geology of Whidbey Island
(USGS, 2004)

MEC remaining on site and due to the biological diversity within the wetland area. In addition, the Navy has informally limited its use of the property to ecological and environmental surveys and infrequent training events that do not include the use of weapons.

5.3.11. Conceptual Site Model

This CSM was developed following guidance documents issued by the USEPA for hazardous waste sites and the USACE for OE sites. Guidance documents included the USEPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA/540/G-89/004) and the *Final USACE CSM Guidance Development of Integrated Conceptual Site Models for Environmental Ordnance and Explosives Sites* (USACE, 2003).

The CSM describes the site and its environmental setting. The CSM presents information regarding: 1) MEC and/or MC known or suspected to be at the site; 2) current and future reasonably anticipated or proposed uses of the real property; and 3) actual, potentially complete, or incomplete exposure pathways linking them. The CSM is the basis for the prioritization and remediation cost estimate.

The CSM is presented in a series of information profiles that provide information about the site. The information profiles are included in Table 5.3-1.

Table 5.3-1: CSM Information Profiles – Lake Hancock Target Range

Profile Type	Information Needs	PA Findings
Range/Site Profile	Installation Name	NAS Whidbey Island
	Installation Location	Whidbey Island, Island County, Washington
	Range/Site Name	Lake Hancock Target Range
	Range/Site Location	Approximately 20 miles south of NAS Whidbey Island and 1 mile north of Greenbank, immediately west of State Route 525

Table 5.3-1: CSM Information Profiles – Lake Hancock Target Range		
Profile Type	**Information Needs**	**PA Findings**
	Range/Site History	The Lake Hancock Target Range was used as a target area for aerial bombing and rocketry training between 1943 and 1971. Aircraft on training runs would typically approach from the east, make a steep diving approach over the target area, and after releasing the practice bombs, continue over Admiralty Inlet to the west. The range was rebuilt in March 1953 after damage caused by a fire in 1951 made it nonoperable. Munitions clearances were conducted at the site in 1972 and 1973. Approximately 15 tons of inert munitions debris were removed from the site.
	Range/Site Area and Layout	The Lake Hancock Target Range consisted of a triangular shaped yellow target with a white bull's-eye, radar screen, range and deflection observation shacks, a harp house, and an observation post with radio transmitter and receiver. In 1981, a scoring building was constructed along the beach, in the northwest corner of the property. A microwave tower and building were constructed on the north end of the property, approximately 1,500 feet inland and approximately 200 feet east of the scoring station. Lake Hancock totals approximately 423 acres in size. Vegetated wetlands cover roughly 33% of the site.
	Range/Site Structures	The target area, deflection observation shacks, harp house, and observation post are no longer present on the range. The former video/monitoring scoring station and microwave tower remain on the north end of the site.
	Range/Site Boundaries	N: Wetland areas littered with debris (creosote logs) and mature forests; private property consisting of a few homes and forested areas lie beyond the property boundary S: Continuous vegetation, including wetlands and mature forests E: Continuous vegetation, including wetlands and forest areas; State Route 525 runs adjacent to the fence line W: Admiralty Inlet
	Range/Site Security	The site is fenced on the east side with locked gates. The site is not actively patrolled by base security. Warning signs have been placed at various locations across the site to deter public access. However, trespassers can gain entry to the site, as it is not entirely fenced.

Table 5.3-1: CSM Information Profiles – Lake Hancock Target Range		
Profile Type	**Information Needs**	**PA Findings**
Munitions/ Release Profile	Munitions Types	Practice bombs, rockets, pyrotechnics and other small ordnance, including the following: • MK 89 practice bombs • MK 76 practice bombs • MK 43 practice bombs • MK 23 practice bombs • 2.75-inch rockets • 2.25-inch SCARs • 5-inch HVARs • 100-pound water sand fill bombs • 250-pound water sand fill bombs • 500-pound water sand fill bombs • MK 25 smokes • MK 58 smokes • MK 6 smokes
	Maximum Probability Penetration Depth	As ordnance items were fired and dropped at the site, a maximum penetration depth of 10 feet (based on a 500-pound bomb) is expected. Munitions debris was found in salt pans from the surface to approximately 6-8 inches below the water line around the target area, on the beach, and in the surf along the beach.
	MEC Density	The highest concentration of practice 2.75-inch rocket motors and warheads was recovered from around the target area. It is also possible that the pilots would have overshot the target area during practice bombing, resulting in ordnance items scattered around the target area or further downrange to the west. Several rocket motors were found 900 feet or more from the center of the target, on or just off of the beach.
	Munitions Debris	Practice rocket motors and warheads Though practice bombs and pyrotechnics have been used at the site, these items were not observed during the site walk.

Table 5.3-1: CSM Information Profiles – Lake Hancock Target Range		
Profile Type	**Information Needs**	**PA Findings**
	Associated MC	MC may include filler materials (spotting charges or propellants) that were not completely consumed during munitions use, as well as metals associated with munition casings. <u>Filler Materials</u> • Potassium perchlorate • White phosphorus • Red phosphorous • Cellulose nitrate • Nitrocellulose • Nitrate camphor • Diphenylamine • Amyl acetate • Vinylidene fluoride • Hexafluoropropylene • Manganese dioxide • Zinc oxide • Magnesium • Boron • Barium chromate • Cupric oxide • Lead dioxide <u>Munition Casings</u> • Magnesium • Titanium • Vanadium • Mercury Sampling of sediments and surface water, including the former target center, was conducted at the site during the SHA investigation. None of the MC identified above were detected during the sampling effort (white phosphorus and potassium perchlorate were not analyzed in the samples). Only metals were identified as contaminants of concern at the various anomalous areas identified during the SHA investigation. Given the sampling results, MC, if present, are likely present at minimal concentrations at the former range.

Table 5.3-1: CSM Information Profiles – Lake Hancock Target Range		
Profile Type	**Information Needs**	**PA Findings**
	Migration Routes / Release Mechanisms	Migration of MEC may occur naturally through surface soil erosion or due to tidal cycles. Exposed MEC could be carried by tidal action into Admiralty Inlet. MEC present along the shoreline could be removed and carried off site by trespassers walking along the beach. Limited MC transport could occur by the above mechanisms; MC could also potentially leach through soil to groundwater and discharge into Admiralty Inlet. However, the rate of infiltration through the soil would be slow due to the low permeability of the soils at the site. Biological uptake of MC by ecological receptors in various media is also a possible, but limited, migration mechanism.
Physical Profile	Climate	The climate is characterized by relatively dry, mild winters with prevailing winds from the south and southwest and dry, warm summers with prevailing winds from the west and northwest. Wind velocities are typically less than 10 miles per hour. The mean annual precipitation is between 17 and 22 inches. The mean summer maximum temperature is 73°F, averaging 59°F, and the mean winter minimum temperature is 33°F, averaging 39°F. The mean annual temperature is 50°F. Seawater temperatures in Admiralty Inlet near the site range from a low of 46°F in early March to 53°F in August.
	Topography	The Lake Hancock site ranges in elevation from sea level to approximately 140 feet above msl. The northern and eastern boundaries of the site slope gently to the southwest and west, respectively. The wooded zone in the southwest corner of the range slopes to the northeast. Bluffs approximately 100 feet in height are present on the northern and southern beach areas. The rest of the site is virtually flat, and much of it receives regular tidal flooding.
	Geology	There are three primary geologic units present in Lake Hancock. These units include a till unit to the south, marsh deposit unit near the lake, and recessional-continental deposit unit to the north. In addition, there are sand and gravel beach deposits west of the site, on the berm separating the site from Admiralty Inlet.
	Soil	The soils at the site, primarily within the wetlands, are low permeability materials consisting of organic and alluvial peat type deposits. The soils are glacial in origin and include parent materials of glacial till, glacial outwash, glacial drift, and glacio-lacustrine and glacio-marine sediments. Soil units have been identified as coastal beach, tidal marsh, Hoypus gravelly loam, Hoypus gravelly loamy sand, and Whidbey gravelly sandy loam.

Table 5.3-1: CSM Information Profiles – Lake Hancock Target Range		
Profile Type	**Information Needs**	**PA Findings**
	Hydrogeology	Five major aquifers of varying extent and depth have been identified on Whidbey Island. These units have been labeled A through E, from bottom to top, although the lower two (A and B) are very deep and not well defined. These occur in layers of unconsolidated sand and gravel deposits that formed during glacial and interglacial periods. Groundwater recharge is primarily through infiltration of precipitation; therefore, recharge is greatest during the rainy winter and spring months. Regionally, these aquifers do not correlate to any specific geologic units, and depths to water vary significantly over the Whidbey Island area. Aquifer elevations generally reflect the surface topography. In addition to the aquifers, perched saturated zones (i.e., perched aquifers) exist above till or other clay-and-silt rich units in the vicinity. The primary source of water for residents of central Whidbey Island is groundwater production wells. Multiple domestic wells are located on private property surrounding the range.
	Hydrology	Lake Hancock contains intertidal saltwater wetlands with adjacent freshwater wetlands, possibly with limited hydrologic connection to the salt water. The Lake Hancock lagoon is a shallow, high salinity permanent pond that covers approximately 37 acres. It is connected to the marine waters of Puget Sound by a single channel. Two sand spits separate the Lake Hancock lagoon system from the open salt water of Admiralty Inlet. Surface water directions in the lowland area vary according to the tidal cycle, toward the lake during the flood cycle and toward the Admiralty Inlet during the ebb cycle. There are no storm water conveyances from the highway into the lowland portions of the site.
	Vegetation	Vegetated wetland areas at Lake Hancock cover roughly 33% of the site. The wetlands support five major plant community types: high salt marsh, low salt marsh, scrub-shrub wetland, freshwater marsh, and Sitka spruce bog. Upland areas include coniferous and deciduous forests, as well as an open grassland area that has been planted with coniferous trees. Upland forest cover types total 38% of the area and include Douglas fir forest, mixed forest, and red alder.

Table 5.3-1: CSM Information Profiles – Lake Hancock Target Range

Profile Type	Information Needs	PA Findings
Land Use and Exposure Profile	Current Land Use	The Lake Hancock Target Range site is no longer in use by the Navy. However, Navy personnel may access the site occasionally for nonordnance training exercises or biological surveys. The scoring building and microwave tower and building in the northern portion of the site are currently inactive. Access to the beach and lake by the general public is restricted by the Navy, although there are no physical barriers to prevent access to the beach or lake. Hunting is not authorized within Lake Hancock; however, hunting by trespassers has been documented at the site. Land use surrounding Lake Hancock consists primarily of forest to the north and south, with several residential homes present in these forested areas. An interpretive kiosk for Lake Hancock and a parking turnout are along State Route 525, just east of the site.
	Current Human Receptors	Navy personnel, including security personnel and public works / environmental personnel conducting environmental/ecological surveys; trespassers accessing the area; and recreational users fishing/diving in Admiralty Inlet to the west
	Current Activities (frequency, nature of activity)	Current activities at the range are limited to occasional use by the Navy for helicopter search and rescue training and occasional environmental/ecological, wildlife, and wetland study surveys. Trespassers also hike and hunt infrequently within the property.
	Potential Future Land Use	Given the potential for MEC remaining on site and the site's designation as an important natural resource area, there are no plans for redevelopment; therefore, no change in future land use is planned.
	Potential Future Human Receptors	Potential future human receptors consist of the current receptors, as no change in land use is planned.
	Potential Future Land Use Related Activities:	Future activities will be similar to current activities. In addition, NAS Whidbey Island environmental department indicates that efforts to remove drift logs from the Lake Hancock beach area are scheduled in the future.
	Zoning / Land Use Restrictions	No zoning was identified. Hunting is not authorized within Lake Hancock; however, hunting by trespassers has been documented at the site. No other land use restrictions were identified.
	Demographics/ Zoning	Lake Hancock is not inhabited and there are no personnel conducting regular work at the range. Residential housing near Lake Hancock is located approximately 100 feet from the northern boundary of the range. According to a 1997 figure, Central Whidbey Island has a population of 8,208.

Table 5.3-1: CSM Information Profiles – Lake Hancock Target Range		
Profile Type	**Information Needs**	**PA Findings**
	Beneficial Resources	Lake Hancock is an exceptionally large and diverse coastal lagoon system listed on the Washington Register of Natural Areas. These communities have been recognized by The Nature Conservancy and the WDNR as unique and valuable natural resources as identified under the Natural Heritage Program.
Ecological Profile	Habitat Type	Vegetated wetlands cover roughly 33% of the site. The wetlands support five major plant community types: high salt marsh, low salt marsh, scrub-shrub wetland, freshwater marsh, and Sitka spruce bog. Upland areas include coniferous and deciduous forests, as well as an open grassland area that has been planted with coniferous trees. Upland forest cover types total 38% of the area and include Douglas fir forest, mixed forest, and red alder. Lake Hancock has been identified as a current and past nesting site for the bald eagle, a threatened species. The threatened marbled murrelet has been documented offshore at the site; however, suitable nesting habitat is not present at Lake Hancock. Wintering populations of peregrine falcon (delisted from endangered status) have been reported in the Puget Sound area, though there are no known nesting pairs on Whidbey Island. Endangered marine animals have been reported in the Puget Sound area, including the gray whale, the green sea turtle, and the leatherneck turtle. In addition, transitory endangered species, including the Chinook salmon, bull trout, and southern resident killer whale, may be present offshore during certain periods of the year.
	Degree of Disturbance	Current and anticipated future activities at the range provide a low degree of disturbance to habitat and/or ecological receptors within the boundary of the Lake Hancock Target Range site. The wetland areas are not likely to be disturbed by these activities.
	Ecological Receptors and Species of Special Concern	Common fauna/flora, including mammals (rats, Douglas squirrels, voles, moles, opossums, black-tailed deer, red fox, coyote, long-tailed weasels, European weasels, shrews, and bats), reptiles/amphibians, birds, and fish Several endangered marine mammals have been reported in Puget Sound, including the gray whale, the green sea turtle, and the leatherneck turtle. These species occur only rarely in Puget Sound, and there are no breeding populations present. In addition, transitory endangered species, including the Chinook salmon, bull trout, and southern resident killer whale, may be present offshore during certain periods of the year.

Table 5.3-1: CSM Information Profiles – Lake Hancock Target Range		
Profile Type	**Information Needs**	**PA Findings**
	Relationship of MEC/MC Sources to Habitat and Potential Receptors	Terrestrial and amphibious receptors may directly contact MEC/MC in surface and/or subsurface soil, surface water, and sediment while foraging or burrowing. Aquatic ecological receptors may be exposed to MEC/MC in surface water and sediment of Lake Hancock and Admiralty Inlet via direct contact (e.g., ingestion, foraging activities). Terrestrial and aquatic receptors may also be exposed to MC that have assimilated into plants and/or bioaccumulated in prey species.

A key element of the CSM is the exposure pathway analysis. For MEC, a complete or potentially complete exposure pathway must include the following components: 1) a source (e.g., locations where MEC are expected to be found); 2) access (e.g., controlled or uncontrolled access, items on the surface or within the subsurface); 3) an activity (e.g., nonintrusive grounds maintenance, intrusive construction); and 4) receptors (e.g., Navy personnel, construction workers, recreational users, authorized visitors). It is important to recognize that environmental mechanisms (e.g., erosion) and/or human intervention may result in the repositioning of MEC.

For MC, a complete or potentially complete exposure pathway must include the following components: 1) a source (e.g., locations where MC are expected to be found); 2) an exposure medium (e.g., surface soil); 3) an exposure route (e.g., dermal contact); and 4) receptors (e.g., Navy personnel, construction workers, recreational users, authorized visitors). If the point of exposure is not at the same location as the source, the pathway may also include a release mechanism (e.g., erosion) and a transport medium (e.g., surface water).

The potential interactions between the source and receptors are assessed differently between MEC and MC. For MEC, interaction between the potential receptors and an MEC source has two components. The receptor must have access to the source and must engage in some activity that results in contact with individual MEC items within the source area. For MC, interaction between the source and receptors involves a release mechanism for the MC, an exposure medium that contains the MC, and an exposure route that places the receptor into contact with the contaminated medium.

MEC Pathway Analysis

The exposure pathway analysis for MEC is shown on Figure 5.3-7. The potential exists for MEC to be present in surface and subsurface soil and sediment, based on the former use of the site as a

APPENDIX E

PHOTOGRAPH LOG

Photograph 1. View facing northwest toward Lake Hancock

Photograph 2. View facing west toward Lake Hancock DU 1, DU 2 and DU 3

Photograph 3. Sample locations at DU 4

Photograph 4. View facing south toward DU 2

Photograph 5. MEC avoidance at Lake Hancock

Photograph 6. Submerged MEC at DU 3

Photograph 7. View facing south toward DU 3