3.2 Expended Materials

3.2 EXPENDED MATERIALS

3.2.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for expended materials is the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). With the exception of Cape Cleare on Montague Island located over 12 nautical miles (nm) (22 kilometers [km]) from the northern point of the TMAA, the nearest shoreline (Kenai Peninsula) is located approximately 24 nm (44 km) north of the TMAA's northern boundary. The approximate middle of the TMAA is located 140 nm offshore. Areas inland from the coastline, including United States (U.S.) Air Force (Air Force) air ranges and U.S. Army (Army) training lands, are addressed in the *Alaska Military Operations Areas EIS* (USAF 1995), *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007), *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999) and the *Transformation of U.S. Army Alaska FEIS* (Army 2004). These documents analyzed Navy training activities in the inland GOA training lands, and provide analyses of baseline conditions and future levels of training activities. Training activities on the inland training lands under the No Action Alternative, Alternative 1, and Alternative 2 for this EIS are within the scope of those estimates.

3.2.1.1 Expended Materials

This section addresses expended materials, both hazardous and nonhazardous, that result from Navy training activities in the TMAA. Definitions in this section are not based on a specific regulation, such as the Resource Conservation and Recovery Act (RCRA). For this analysis, definitions incorporate information from several environmental laws and regulations for hazardous materials. Hazardous materials addressed in this document are broadly defined as substances that pose a substantial hazard to human health or the environment by virtue of their chemical or biological properties. Hazardous materials may be solid, liquid, semi-solid, or gaseous materials that alone or in combination may 1) cause or contribute to an increase in mortality or illness; or 2) pose a substantial present or potential hazard to human health or the environment when improperly applied, handled, treated, stored, transported, or disposed. In general, the degree of hazard posed by these materials is related to their quantity, concentration, bioavailability, or physical state. Hazardous materials are regulated under a variety of federal and state laws (see Section 3.2.2, Environmental Consequences).

In this section, the phrase "hazardous materials" refers collectively to hazardous materials, hazardous wastes, and individual components and constituents of larger objects or processes (e.g., missile warheads and fuel) that may be hazardous. Hazardous materials often are used in small amounts in high-technology weapons, ordnance, and targets because they are strong, lightweight, reliable, long lasting, or low cost. For this analysis, hazardous constituents are defined as components of expended materials that may contain hazardous materials or substances. Nonhazardous expended materials are defined as parts of a device that are made of nontoxic metals (e.g., steel, iron, aluminum), polymers (e.g., nylon, rubber, vinyl, and various other plastics), glass, fiber, or concrete. Sources of these non-hazardous materials include bombs, shells, and targets. A portion of these non-hazardous items represent persistent seabed litter but, because of their strong resistance to degradation and their chemical composition, they do not chemically contaminate the surrounding environment by leaching heavy metals or organic compounds.

Open ocean areas are typically considered to be relatively pristine with regard to hazardous substances. Hazardous substances are anthropogenic sources of material that could negatively affect the marine and land environment, and organisms inhabiting those environments. Hazardous substances are present in varying concentrations in marine waters and sediments from past activities such as ocean dumping, military activities (e.g., bombing ranges during World War II), commercial activities, and chemical spills.

No information is available, however, on the types and quantities of hazardous substances present in the TMAA.

Table 3.2-1 provides information on the types of training items used in the TMAA that may contain hazardous constituents. All training materials listed therein will be used under the No Action Alternative, except for training materials used in Anti-Submarine Warfare (ASW) exercises. The potential environmental effects of expended Navy training materials are primarily associated with the toxicity of hazardous constituents to marine biota. Hazardous materials may be contained in several components of expended materials, including outer casings, propellants, batteries, explosives, and pyrotechnics.

Hazardous Materials

Heavy Metals

Some metals are necessary for biological organisms to function properly, such as iron, zinc, copper, and manganese in humans. Heavy metals commonly of concern include lead, cadmium, mercury, and chromium. Zinc, copper, and manganese also may be of concern when exposure levels are high. In the GOA study area, heavy metals are present in manned and unmanned aircraft, bombs, shells, missiles, bullets, sonobuoys, batteries, electronic components, and anticorrosion compounds coating exterior surfaces of ordnance, including missiles, small-caliber rounds, torpedoes, and bombs. Most of these materials are inert and dense, and will settle to the bottom. There they will eventually be covered by sediment, coated by chemical processes (e.g., corrosion), or encrusted by marine organisms (e.g., barnacles).

Propellants

Hazardous chemicals include fuels and other propellants, and combustion byproducts of those fuels and propellants. These materials are present or may be generated by the use of aircraft, vessels, ordnance, and unmanned aircraft. Toxic components of fuel oils include aromatic hydrocarbons, such as benzene, toluene, and xylene, and polycyclic aromatic hydrocarbons such as naphthalene, acenaphthene, and fluoranthene. Like commercial and recreational watercraft, Navy boat engines discharge petroleum products in their wet exhaust.

In general, the single largest hazardous constituent of missiles is solid propellant, such as solid double-base propellant, aluminum and ammonia propellant grain, and arcite propellant grain. The solid propellant is primarily composed of rubber (polybutadiene) mixed with ammonium perchlorate. In general, a surface-to-air missile typically consumes 99 to 100 percent of its propellant when it functions properly (Department of the Navy [DoN] 2009). Hazardous constituents, such as plastic-bonded explosives (PBX) high-explosive (HE) components, PBX-106 explosive, and PBX (AF)-108 explosive, are also used in igniters, explosive bolts, batteries (potassium hydroxide and lithium chloride), and warheads.

Explosives

Explosives are used in live bombs, spotting charges for training rounds, missiles, and sonobuoys. Ordnance constituents of concern include nitroaromatics—principally trinitrotoluene (TNT), its degradation products, and related compounds and cyclonitramines, including Royal Demolition Explosive (RDX, cyclotrimethylene trinitramine), High Melting Explosive (HMX, cyclotetramethylene tetranitramine), and their degradation products. Most new military explosives are mixtures of plastic or other polymer binders, RDX, and HMX. Pentaerythritoltetranitrate (PETN) is used in blasting caps, detonation cord, and similar initiators of explosions. When live ordnance functions properly, 99.997 percent of the explosives contained therein are converted to inorganic compounds (U.S. Army Corps of Engineers [USACE] 2003).

Explosives become a concern when ordnance does not function correctly, and fails to detonate (failure) or detonates incompletely (low-order detonation). In these cases, all or a portion of the explosive remains unconsumed. Table 3.2-2 provides the failure and low-order detonation rates of various ordnance items.

Table 3.2-1: Hazardous Constituents of Expendable Training Materials, by Training Item

Training Item		Hazardous Constituent				
		Heavy Metal	Propellant	Battery	Explosive	Pyrotechnic
Missiles	AIM-7 Sparrow missile	✓	✓	✓	✓	
	AIM-9 Sidewinder missile	✓	✓	✓	✓	
	AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM)	✓	✓	✓	✓	
	Standard Missile-1	✓	✓	✓	✓	
	AGM-65 Maverick	✓	✓	✓	✓	
	AGM-84 Harpoon	✓	✓	✓	✓	
	AGM-84K Standoff Land Attack Missile – Expanded Response (SLAM-ER)	✓	✓	✓	✓	
	AGM-88 High Speed Anti-Radiation Missile (HARM)					
	AGM-114 Hellfire	✓	✓	✓	✓	
	AGM-119 Penguin					
Bombs	BDU-45 Practice (inert)[2]	✓			✓	
	MK-82 500-pound (lb) bomb (192.2 Net Explosive Weight [NEW]), HE[3]	✓			✓	
	MK-83 1,000-lb bomb (415.8 NEW), HE[3]	✓			✓	
	MK-84 2,000-lb bomb (944.7 NEW), HE[3]	✓			✓	
Naval Gun Shells	5"/54-caliber (cal) gun shell (inert)	✓	✓			
	5"/54-cal gun shell (live)	✓	✓		✓	
	76- millimeter (mm) gun shell (inert)	✓	✓			
	76-mm gun shell (live)	✓	✓		✓	
	57-mm gun shell	✓	✓		✓	
	25-mm gun shell	✓				
	20-mm gun shell	✓				
Small Arms Rounds	0.50-cal machine gun	✓	✓			
	7.62-mm projectile	✓	✓			
Targets and Pyrotechnics	BQM-74E unmanned aerial target[5]	✓		✓		
	LUU-2B paraflare[1]	✓				✓
	MK-58 Marine Marker[1]	✓				✓
	MK-39 Expendable Mobile Anti-Submarine Warfare Training Target (EMATT)	✓		✓		
Sonobuoys	SSQ-36 Bathythermograph (BT)	✓		✓		
	SSQ-53 Directional Frequency Analysis and Recording (DIFAR)	✓		✓		
	SSQ-62 Directional Command Activated Sonobuoy System (DICASS)	✓		✓		
	SSQ-77 Vertical Line Array Directional Frequency Analysis and Recording (VLAD)	✓		✓		
	SSQ-110A Extended Echo Ranging (EER)	✓		✓	✓	
Torpedoes	MK-48 Advanced Capability (ADCAP) torpedo	✓	✓	✓	✓	
Chaff	ALE-43 Dispenser (Aluminized glass roll)[4]				✓	

Notes: (1) target not recovered, (2) may contain a spotting charge, (3) lb in terms of total weight, (4) chaff is deployed using an explosive charge, (5) target recovered. Training materials that do not contain hazardous materials are not included

Table 3.2-2: Failure and Low-Order Detonation Rates of Military Ordnance

Ordnance	Failure Rate (Percent)	Low-Order Detonation Rate (Percent)
Guns / artillery	4.68	0.16
Hand grenades	1.78	n/a
High-explosive ordnance	3.37	0.09
Rockets	3.84	n/a
Submunitions	8.23	n/a

Source: Rand 2005

These materials can release small amounts of hazardous substances into the water or sediment as they degrade and decompose. Table 3.2-3 provides a list of hazardous constituents typically present in components of expended training materials.

Table 3.2-3: Hazardous Constituents of Training Materials, by Component

Training Application/Ordnance Element	Hazardous Constituent
Casings, assemblies, projectiles	Chromium Lead Tungsten Nickel Cadmium
Pyrotechnics Tracers Spotting charges	Barium chromate Potassium perchlorate Chlorides Phosphorus Titanium compounds
Oxidizers	Lead oxide
Delay elements	Barium chromate Potassium perchlorate Lead chromate
Propellants	Ammonium perchlorate
Fuses	Potassium perchlorate
Detonators	Fulminate of mercury Potassium perchlorate
Primers	Lead azide

Source: USACE 2007

Pyrotechnics

Pyrotechnic materials are used in pyrotechnic devices such as flares and markers. Hazardous pyrotechnic materials include magnesium and white and red phosphorus, which do not explode, but burn at high temperatures once ignited. Metals such as barium, sodium, nickel, and titanium are often incorporated into pyrotechnic materials to produce specific visual characteristics, such as color, smoke, or both. Perchlorates may be used as oxidizers and to enhance the visual characteristics of the item. Residues from pyrotechnic items that function as designed include metallic compounds and residual perchlorate compounds. Pyrotechnic items also may include igniters and fuses.

Fates of Expended Materials

Expended training materials that come to rest on the ocean floor may:

1) Lodge in oxygen-poor sediments (DoN 2008c);
2) Remain on the ocean floor and corrode; or
3) Remain on the ocean floor and become encrusted by marine organisms.

Rates of deterioration depend on the material and on the conditions in the immediately surrounding marine and benthic environment. Materials buried deep in ocean sediments tend to decompose at much lower rates than when exposed to seawater. With the exception of sonobuoy parts (see Sonobuoys later in this section), sediment burial appears to be the fate of most ordnance used in marine warfare.

Metals exposed to seawater generally begin to oxidize (corrode). The rate at which corrosion occurs depends on many environmental factors, including temperature (Bayliss et al. 1988). An increase in water temperature increases the rate of metal corrosion. In cold waters like GOA, the cold waters reduce the rate of corrosion. Although materials take longer to break down, the rate of leaching from metals is also decreased.

This process creates a layer of corroded material around the object. This corrosion layer isolates the parent material from the corrosive seawater, a process that further slows movement of the metals into the adjacent sediments and the water column. In a similar fashion, as materials become covered by marine organisms, the direct exposure of the material to seawater decreases and the rate of corrosion decreases. Dispersal of these materials in the water column is controlled by physical mixing and diffusion, both of which tend to vary with time and location. A recent study of similar Canadian military operations in the Strait of Georgia concluded that, in general, the direct impact of expended material accumulation on the ocean floor appeared to be minimal, and had no detectable effects on wildlife or sediment quality (Canadian Forces Maritime Experimental and Test Ranges [CFMETR] 2005).

Studies at historic, deep-water munitions sea disposal sites have found minimal effects on the ocean environment from discarded military munitions (Bauer and Kendall 2010; National Defense Center for Energy and Environment 2010). Sampling from the Hawaii Undersea Military Munitions Assessment (National Defense Center for Energy and Environment 2010) focused on several aspects of expended military munitions, including whether munitions constituents could be detected near expended military materials, whether there were statistically different munitions constituent levels in sediment near expended materials compared to reference control sites, and whether munitions constituents posed an unacceptable risk to human health. In 159 samples (consisting of sediment, water, fish, and shrimp), no explosive material was detected. Elevated levels of arsenic and lead were found in a few biota samples, but the origin of those metals could not be tied to a specific source. Comparison of sediments from expended military materials sites to reference control sites did not show statistically significant differences in levels of munitions constituents. In addition, observations and data did not indicate any adverse effects on ecological health or risk to human health from consumption of organisms collected in the study area (National Defense Center for Energy and Environment 2010).

In general, ordnance constituents appear to pose little risk to the marine environment. Military-grade explosives generally have low water solubility, so they do not readily dissolve in water and are, therefore, relatively immobile in water (Table 3.2-4). The degradation and dissolution of these materials are slowed by the physical structure and composition of blended explosives, which contain several chemical compounds, often with additional binding agents. Ordnance constituents of concern include nitroaromatics—principally TNT, its degradation products, and related compounds and cyclonitramines, including RDX, HMX, and their degradation products. TNT degrades to dinitrotoluene (DNT) and to subsequent degradation products by bacterial activity (biodegradation). RDX is subject to photolysis and biodegradation once exposed to the environment.

Table 3.2-4: Water Solubility of Common Explosives

Compound	Water Solubility*
Salt (sodium chloride) [for comparison]	357,000
Ammonium perchlorate	249,000
Picric acid	12,820
Nitrobenzene	1,900
Dinitrobenzene	500
Trinitrobenzene	335
DNT	160-161
TNT	130
Tetryl	51
PETN	43
RDX	38
HMX	7
White phosphorus	4

Note: * Units are milligrams per liter (mg/L) at 20 degrees Celsius.
Source: DoN 2009

Additional sources of hazardous materials are expended training materials that are not completely consumed during use, such as flares and pyrotechnics, and explosives that fail to function properly. Explosives, which are designed to be consumed during use, have a high potential of environmental contamination because duds and low-order detonations account for a large percentage of hazardous materials due to the amounts of explosives used. Ordnance failure or low-order detonation means that hazardous materials, such as propellants, explosives, and batteries, are present in greater quantities because substances are not consumed during use. Expended training materials from ordnance that functions as designed are primarily metal casings.

Bombs

Bombing exercises typically involve one or more aircraft bombing a target that simulates a hostile surface vessel at sea. Bomb casings are made of steel, with fins of steel or aluminum. Based on standards established by American Society for Testing and Materials International, each steel bomb body or fin also may contain small percentages of carbon, manganese, phosphorus, sulfur, copper, nickel, chromium, molybdenum, vanadium, columbium, or titanium, although typically present at less than 1 percent by weight. The aluminum fins may also contain zinc, magnesium, copper, chromium, manganese, silicon, or titanium (DoN 2009). Bombs may be live or inert (so-called “practice” or “bomb dummy units”). The latter are bomb bodies filled with an inert material (e.g., concrete) and configured to have the same weight, size, center of gravity, and ballistics as a live bomb.

The main hazardous component of expended bombs is residual explosives. Most of the residual explosives result from incomplete (low-order) detonations or complete failure of the item to detonate. High-order detonations generally consume an estimated 99.997 percent of the explosives (USACE 2003). Bombs that are fail to function (i.e., “duds”) deposit large amounts of unconsumed explosives. The estimated failure rate for high explosives under test conditions is 3.37 percent (see Table 3.2-2), but the failure rate during training typically is higher because of operator inexperience. Most inert bombs contain a spotting charge, which is a small amount of explosive (usually two to three pounds [lb]) used to identify the point of impact.

Missiles

Missiles are fired by aircraft and ships at a variety of airborne and surface targets. Table 3.2-5 describes the explosives and propellants used in the types of missiles that will be used in the TMAA under all of the alternatives. Missiles may contain hazardous materials as normal parts of their functional components, including igniters, explosive bolts, batteries, warheads, and solid propellants. Chemicals released during missile launches are provided in Table 3.2-6, along with their estimated maximum concentrations.

Table 3.2-5: Explosives and Propellants in Selected Missiles – No Action Alternative

Type of Missile	Type of Propellant
AIM-7 Sparrow	Propellant is dual-thrust, solid-fuel rocket motor (Hercules MK-58); warhead is an 88-lb. (40-kilogram [kg]) WDU-27/B blast-fragmentation device.
AIM-9 Sidewinder	Propulsion system contains up to 44 lb. (20 kg) of solid double-base propellant; warhead contains approximately 10 lb. (4.5 kg) of PBX HE.
AIM-120 AMRAAM	Propellant is solid-fuel rocket motor (ATK WPU-6B booster and sustainer with RS hydroxyl-terminated polybutadiene solid propellant fuel); warhead contains 40 lb. (18 kg) of HE.
RIM-67A Standard Missile-1	Propellant is a two-stage, solid-fuel rocket (MK-30 sustainer motor and a Hercules MK 12 booster); warhead contains 137 lb (62 kg) of HE.

Source: Global Security 2008f

Table 3.2-6: Chemical Compounds Associated with Missile Launches

Resource	Chemical Compound	**Maximum Environmental Concentration** (mg/m^3)
Air	Al_2O_3 – alumina	0.021
	CO – carbon monoxide	39.11
	HCl – hydrochloric acid	0.012
	NO_x – oxides of nitrogen	0.009
Water	Jet propulsion fuel, Type 8	0.023

Notes: (mg/m^3) = milligrams per cubic meter
Source: USAF 1999

In general, the single largest hazardous constituent of missiles is the solid propellant. Missile propellants typically contain ammonium perchlorate (NH_4ClO_4), aluminum compounds, copper, and organic lead compounds. A surface-to-air missile typically consumes 99 to 100 percent of its propellant when it functions properly (DoN 2009). The remaining solid propellant fragments (less than one percent of initial propellant weight) sink to the ocean floor and undergo physical and chemical changes in the presence of seawater. Tests show that water penetrates only 0.06 inch (in) (0.14 centimeter [cm]) into the propellant during the first 24 hours of immersion, and that fragments slowly release ammonium and perchlorate ions (Fournier 2005). These ions rapidly disperse into the surrounding seawater, so local concentrations are extremely low.

For example, a Standard Missile-1 typically has 150 lb (68 kg) of solid propellant, resulting in less than 1.5 lb (0.7 kg) of propellant residual after training exercises. Assuming that all of the propellant on the ocean floor was in the form of 4-in (10-cm) cubes, only 0.42 percent of it would be wetted during the first 24 hours of immersion. If all of the ammonium perchlorate leached out of the wetted propellant, then approximately 0.01 lb (0.003 kg) would enter the surrounding seawater (DoN 2009). The leach rate would decrease over time as the concentration of perchlorate in the propellant declined. The aluminum in the propellant binder would eventually be oxidized by seawater to aluminum oxide. The remaining binder material and aluminum oxide would not pose a threat to the marine environment.

During aviation exercises, approximately 50 percent of missiles contain telemetry warheads (inert versions), and do not explode on contact with the target or ocean surface. Exploding warheads may be used in air-to-air missile exercises but, to avoid damaging the aerial target, the missile explodes in the air, disintegrates, and falls into the ocean. Live missiles used in air-to-surface exercises explode near the water surface. An estimated 99.997 percent of this material would be consumed in a high-order detonation. Missiles that are duds contain large amounts of unconsumed explosives, which are considered to be hazardous. The estimated failure rate for missiles is approximately the same as for bombs (3.37 percent).

Missile batteries are another possible source of contaminants. The batteries used for missiles are similar in type and size to those used for sonobuoys. Possible hazardous materials in batteries are described later in this section under Sonobuoys.

Targets

At sea, targets are usually remotely operated aerial, surface, or subsurface units, most of which are recovered for reuse. Targets and countermeasures proposed for the GOA study area are described below.

Aerial Targets

Aerial targets are used in several training warfare areas, and include targets used for both simulated and live-fire exercises. Possible expended or unrecovered targets include LUU-2B/B paraflares, Tactical Air Launched Decoy (TALDs), and BQM-74Es. LUU-2B/B and TALD targets are not recovered after training use. BQM-74E targets are normally recovered after training, but some individual BQM-74E targets may not be recovered for various reasons.

The LUU-2B/B is a flare that illuminates targets by burning magnesium at high temperature while suspended from a parachute. The LUU-2B is constructed of aluminum, and weighs about 30 lb (DoN 2001c). The flare material and portions of the assembly are usually consumed during flight (DoN 2001c). Hazardous materials in pyrotechnic compositions are discussed later in this section under Flares.

The TALD is an air-launched, gliding vehicle that emits signals to confuse air defense systems during aircraft Strike Warfare training. It is constructed of aluminum, and weighs about 400 lb (Global Security 2008a). TALDs contain two 38-volt thermal batteries, which are lost after training use. Thermal batteries may contain hazardous components similar to lithium batteries, and are discussed later in this section under Sonobuoys.

The BQM-74E is a remote-controlled, subsonic, jet-powered aerial target that can be launched from the air or surface, and recovered on land or at sea. The target generates signals for tracking purposes. It is powered by a jet engine, and thus contains oils, hydraulic fluid, batteries, and explosive cartridges. (DoN 2001b). Hazardous materials in aerial targets are mostly consumed during training use, and BQM-74E targets are recovered after training exercises, to the maximum extent possible.

Surface Targets

Surface targets are used for Anti-Surface Warfare exercises. MK-58 marine markers are pyrotechnic devices dropped on the water's surface during training exercises to mark a position on the ocean surface, primarily for Bombing Exercises. The chemical flame of a marine marker burns like a flare, but also produces smoke. The MK-58 marine marker is a tin tube that weighs about four lb, and produces a yellow flame and white smoke for 10 to 20 minutes. It contains a red phosphorous compound that is ignited by a seawater-activated battery (DoN 1996a). MK-58 marine markers are not recovered because they are mostly consumed during use. Hazardous materials in pyrotechnic compositions are discussed later in this section under Flares.

Other surface targets used during training exercises (Killer Tomatoes and Spar Buoys) do not contain hazardous materials. Killer Tomatoes are large inflatable vinyl balloons that float on the surface of the water. Spar Buoys are tall, cylindrical buoys, typically consisting of relatively inert metals, such as aluminum or iron. These surface targets are recovered after training use, to the maximum extent possible.

Underwater Targets

The MK-39 EMATT is an air- or surface-launched unmanned target that maneuvers underwater in the ocean, and emits magnetic or acoustic signals that are monitored by aircraft and surface vessels for training (see Appendix H for physical description of EMATT). The duration of EMATT activity is about three hours, and EMATTs are not recovered after training use. EMATTs use lithium-sulfur dioxide batteries, which may contain hazardous materials. Each EMATT contains a battery pack consisting of 15 "DD" size lithium-sulfur dioxide batteries, weighing approximately 6.2 lb (2.83 kg) (Peed et al. 1988).

Lithium batteries consist of an exterior nickel-plated steel jacket, sulfur dioxide, lithium metal, carbon, acetonitrile, and lithium bromide (DoN 2008a). The chemical reaction that generates electricity proceeds nearly to completion once the cell is activated, so only limited amounts of reactants are present when the battery life terminates. Lithium and bromine naturally occur in seawater. Lithium metal is extremely reactive with water, resulting in an exothermic reaction that generates soluble hydrogen gas and lithium hydroxide. Hydrogen gas enters the atmosphere, while lithium hydroxide ultimately disassociates into lithium ions and water (DoN 2008a). Sulfur dioxide ionizes in water, forming bisulfite. Bisulfite is easily oxidized into sulfate, which is present in large quantities in the ocean.

An evaluation of lithium-sulfide dioxide batteries in the marine environment (CFMETR 2005) concluded that: "The standard lithium-sulfur dioxide battery theoretically presents little or no acute or chronic danger to the marine environment. The battery consists of seven material components, and each has been considered in terms of environmental exposure. In each case, it was determined that immersion in seawater would result in the formation of either water-soluble or chemically inert waste products. These will be infinitely dispersible and virtually unsusceptible to significant accumulation." The ocean currents would greatly diffuse concentrations of the chemicals leached by EMATT batteries within a short period. Therefore, lithium batteries would not be expected to substantially affect water quality because of the low amount of reactants remaining after use and the low concentration of leaching materials.

The implementation of a Portable Undersea Training Range (PUTR) would be included under Alternative 1 and Alternative 2. The PUTR is a portable system with the capability to score, track, and provide feedback on underwater events. The PUTR consists of seven electronics packages to be temporarily installed on the ocean floor via concrete anchors. While the electronics packages would be recovered upon completion of training exercises, the concrete anchors would remain on the ocean floor. If electronics packages were lost, batteries would be the primary source of hazardous materials, which would have effects similar to batteries used in EMATTS. Each anchor is approximately 1.5 feet (ft) by 1.5 ft (0.46 meter [m] by 0.46 m), and would weigh approximately 3,000 lb (1,364 kg). Anchors would be constructed of either concrete or sand bags. Concrete and sand would be relatively inert in the marine environment, and would be covered with sand or sediment over time.

Flares

Flares are used as targets or markers; the previous section on surface targets describes their use and composition. Hazardous constituents are typically present in pyrotechnic residues, but are bound up in relatively insoluble compounds. Solid flare and pyrotechnic residues may contain, depending on their purpose and color, an average weight of up to 0.85 lb (0.4 kg) of aluminum, magnesium, zinc, strontium, barium, cadmium, nickel, and perchlorates (DoN 2009). As inert, incombustible solids with low concentrations of leachable metals, these residues typically are not characterized as hazardous materials. The perchlorate compounds present in the residues are relatively soluble, albeit persistent in the environment, and probably disperse quickly.

Chaff

Radiofrequency chaff is an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Chaff is released or dispensed from military vehicles in cartridges or projectiles that contain millions of chaff fibers. Chaff is composed of an aluminum alloy coating on glass fibers of silicon dioxide. The coating is about 99.4 percent aluminum by weight, and contains negligible amounts of silicon, iron, copper, manganese, magnesium, zinc, vanadium, and titanium (USAF 1997). Chaff fibers are similar to a human hair in diameter and shape (USAF 1997). These aluminum-coated glass fibers (about 60 percent silica and 40 percent aluminum by weight) range in length from 0.8 to 7.5-cm, with a diameter of about 40 micrometers. For each chaff cartridge used, a plastic end-cap and Plexiglas piston are released into the environment, but these materials are not hazardous. The end-cap and piston are both round, and are 1.3 inches in diameter and 0.13 inch thick (Spargo 2007).

When chaff is deployed, a diffuse cloud of fibers undetectable to the human eye is formed. Chaff is a very light material that can remain suspended in air anywhere from 10 minutes to 10 hours. It can travel considerable distances from its release point, depending on prevailing atmospheric conditions (Arfsten et al. 2002). For example, Hullar et al. (1999) calculated that a 4.97-mile by 7.46-mile area (37.1 square miles or 28 square nautical miles [nm^2]) would be affected by deployment of a single cartridge containing 150 grams of chaff. The resulting chaff concentration would be about 5.4 grams (g) per nm^2. This concentration corresponds to fewer than 179,000 fibers per square nautical mile, or about one fiber per 200 square feet, assuming that each canister contains five million fibers.

Specific release points tend to be random, and chaff dispersion in air depends on prevailing atmospheric conditions. After falling from the air, chaff fibers would be expected to float on the ocean surface for some period, depending on wave and wind action. The fibers would be further dispersed by ocean currents as they float and slowly sink toward the bottom. The fine, neutrally buoyant chaff streamers would act like particulates in the water, temporarily increasing the turbidity of the ocean's surface, while the end caps and pistons would sink. The chaff fibers would quickly disperse and turbidity readings would return to normal. The expended material could also be transported long distances before becoming incorporated into the bottom sediments.

A review of numerous toxicological studies indicated that the principal components of chaff are unlikely to have significant effects on humans and the environment, based on the general toxicity of the components, the dispersion patterns, and the unlikelihood of the components to interact with other substances in nature to produce synergistic toxic effects (USAF 1997). In addition, available evidence suggests that chaff use does not result in significant accumulation of aluminum in sediments after prolonged training. Sediment samples collected from an area of the Chesapeake Bay where chaff had been used for approximately 25 years indicated that aluminum concentrations in sediments were not significantly different than background concentrations (Wilson et al. 2002).

The small explosive cartridge used to eject the chaff from a small tube may contain hazardous materials (Global Security 2008b). Chaff deployment charges contain approximately 0.49 g (0.02 ounces [oz]) of pyrotechnic materials (USAF 2001). Hazardous materials in pyrotechnic materials are discussed earlier in this section under Flares.

Naval Guns and Small Arms Fire

Naval gunfire exercises use naval gun shells, including 5-in (HE and inert), 76-mm (HE and inert), 57-mm, 25-mm, and 20-mm shells, and small arms rounds. Hazardous materials from shells and small-arms rounds are unexploded shells and metals contained in shell casing, ammunition jackets, and ammunition cores. Shells are composed of steel, brass, copper, tungsten, and other metals, all of which are relatively inert. Live 5-in shells are typically fused to detonate within 3 ft (0.91 m) of the water surface. Shell fragments, unexploded shells, and non-explosive ordnance rapidly decelerate in the water and settle to the ocean floor. Small arms fire includes 0.50-cal machine gun rounds and 7.62-mm projectiles, both of which may contain a lead core. Less than one percent of these materials consist of toxic metals such as lead (DoN 2009).

The presence of shell casings in the sediments would not be expected to substantially affect water quality because brass would undergo slow corrosion, even in a salty environment, and leached substances would be quickly diluted by ocean currents. Most of the ammunition expended during activities involving small arms fire is comprised of steel, with small amounts of aluminum and copper. Steel practice bullets may release small amounts of iron, aluminum, and copper into the sediments and the overlying water column as the bullets corrode. All three elements are widespread in the natural environment, although elevated levels can cause toxic reactions in exposed plants and animals. Any elevation of metals in sediments would be restricted to a small zone around the bullet, and any release to the overlying water column would be quickly diluted.

Close-in weapons systems (CIWS) use 20-mm cannon shells composed of either depleted uranium (DU) or tungsten. DU is "depleted" in that it has only one-third of the isotopes of U^{235} and 60 percent of the radiation as natural uranium (World Health Organization 2009). Depleted uranium is not part of the Proposed Action for this EIS. The Nuclear Regulatory Commission approved the Navy's license application, which clearly stated that CIWS DU rounds would be fired at sea and not recovered. The Navy phased out use of DU rounds in favor of tungsten rounds because of the superior flight characteristics of tungsten and its performance against missile casings. The Navy's transition to tungsten began in 1989, and most rounds with DU have been replaced. None of the surface combatant ships stationed in the Pacific Northwest have DU onboard, and, in February 2009, Commander Pacific Fleet directed that all Pacific Fleet ships offload all DU rounds at the earliest opportunity.

Tungsten has replaced DU in CIWS 20-mm rounds. Tungsten used for munitions is typically a tungsten alloy, where pure tungsten powder is combined with binding materials, such as nickel, iron, copper, or cobalt, that makes the tungsten grains ductile and easy to machine. Tungsten is a naturally occurring element, but not as a pure metal. Tungsten is typically released into the environment via weathering or mining of wolframite and scheelite (Agency for Toxic Substances and Disease Registry [ATSDR] 2005).

In water, tungsten metal and metal alloys will exist as insoluble solids, while tungsten compounds will exist either as ions or insoluble solids (ATSDR 2005). Tungsten compounds typically adsorb to suspended soils and sediment in the water column. Tungsten ions in ocean water have an estimate residence time of approximately 1,000 years, before it is removed from the aquatic phase by sedimentation or other processes (ATSDR 2005). Metallic tungsten dissolves in water, reaching concentrations up to 475-500 mg/L. The dissolution of tungsten is associated with a decrease in dissolved oxygen and pH in both aqueous and soil matrices (Strigul et al. 2005). The corrosion rates of tungsten alloys increase as pH increases, and also increase with exposure to chloride ions, which are abundant in salt water, in aqueous solution (U.S. Army 1987).

Tungsten is a heavy metal that can have negative effects on humans and other biological organisms. Tungsten alloys may have additional health effects associated with the alloyed metals. The two primary exposures are though inhalation and ingestion. Bullets impacting a hard target may release tungsten particles into the air, but such releases would be small. Some respiratory issues from tungsten have been reported, but reports were in environments where people were exposed to several heavy metals over prolonged periods (ATSDR 2005). Inhalation of tungsten particles by humans or other biological organisms would not be likely because of the distance offshore that training takes place. Reports of oral consumption of tungsten and tungsten alloys by humans or other biological organisms are limited. Rats implanted with pellets of weapons-grade tungsten alloy developed aggressive tumors surrounding the pellets (Kalinich et al. 2005). A study on the use of tungsten in shot for waterfowl hunting, adult mallards (*Anas platyrhynchos*) were fed several types of shot, including tungsten-iron and tungsten-polymer shot. None of the ducks that were fed either tungsten shot died during the 150-day trial (Mitchell et al. 2001). Significant liver hemosiderosis was present in some ducks for all types of shot, but it was determined that neither type of tungsten shot had deleterious health effects based on mortality, body weights, organ weights and histology of the liver and kidneys (Mitchell et al. 2001).

Sonobuoys

Sonobuoys are used for ASW training exercises under both Alternatives 1 and 2. Sonobuoys are expendable metal cylinders launched from aircraft and ships that collect and generate information about the marine environment and potential threats and targets. Sonobuoys consist of two main sections, a surface unit that contains the seawater battery and a metal subsurface unit (see Appendix H for physical descriptions of sonobuoys). The seawater battery is activated upon contact with the water. The subsurface assembly descends to a selected depth, the sonobuoy case falls away, and sea anchors deploy to stabilize the hydrophone (underwater microphone) (Global Security 2008e).

Sonobuoys are designed to be expended upon completion of training exercises. Scuttled sonobuoys sink to the ocean floor, where they are subjected to the corrosion and sedimentation caused by ocean currents. Occasionally, an expended sonobuoy may become flotsam if it fails to be scuttled (sink to the ocean floor). Sonobuoys as flotsam move with ocean currents until they either sink or are washed ashore. Scuttled sonobuoys contain a small amount of hazardous materials, but do not pose a threat to public safety, water quality, or biological resources. Hazardous materials leach slowly, and are not expected to substantially affect the environment.

Sonobuoys contain other metal and nonmetal components, such as metal housing (nickel-plated, steel-coated with polyvinyl chloride [PVC] plastics to reduce corrosion), batteries, lead solder, copper wire, and lead ballast that, over time, can release hazardous constituents into the surrounding water. Most of the other sonobuoy components are either coated with plastic to reduce corrosion or are solid metal. The slow rate at which solid metal components corrode in seawater translates into slow release rates into the marine environment. Once the metal surfaces corrode, the rates at which metals are released into the environment decrease. Releases of chemical constituents from metal and nonmetal sonobuoy components are further reduced by encrustation of exposed surfaces by benthic organisms. Therefore, toxic components of the sonobuoy do not substantially degrade marine water quality. Hazardous constituent contents of sonobuoys are provided in Table 3.2-7, based on the composition of similar sonobuoys used by the Navy for training off San Clemente Island.

Table 3.2-7: Sonobuoy Hazardous Constituents

Constituent	Weight (lb) per Sonobuoy
Copper thiocyanate	1.59
Fluorocarbons	0.02
Copper	0.34
Lead	0.94
Tin/lead plated steel	0.06
Total	2.95

Source: U.S. Department of the Navy, San Clemente Island Ordnance Database [No Date]

Approximately 0.04 lb (20 g) of lead solder are used in the internal wiring (solder) of each sonobuoy, and 0.85 lb (425 g) of lead are used for the hydrophone and lead shot ballast. Lead in sonobuoys is in an un-ionized metallic form that is insoluble in water, so the lead shot and solder are not released into the seawater. Various lead salts, which have low solubilities, likely form on the exposed metal surfaces. For these reasons, lead components of the sonobuoy do not substantially degrade marine water quality.

Sonobuoys contain small amounts of FC-77 Fluorinert® Electronic Liquid in the sonobuoy compass. The perfluorinated portion of the electronic liquid is resistant to degradation in most environments. Fluorinert® Electronic Liquid has a low solubility and an insignificant toxicity to aquatic organisms, with the Lethal Level (where the material causes the death of 50 percent of a group of aquatic organisms) greater than 1,000 milligrams per liter (mg/L; 3M Company 2009).

Batteries

Sonobuoys may contain up to three different types of batteries (seawater, lithium, and thermal), depending on the type of sonobuoy. Regardless of type, each sonobuoy contains a seawater battery housed in the upper, floating portion that supplies power to the sonobuoy. These seawater batteries contain 0.7 lb to 0.9 lb (300 to 400 g) of lead (DoN 2008a). In cases where the upper portion of the sonobuoy is lost to the seabed, the lead batteries are also lost. Chemical reactions within sonobuoy batteries proceed almost to completion once the cell is activated, and only a small amount of reactants remain when the battery life ends. These residual materials slowly dissolve, and are diluted by ongoing ocean and tidal currents. In addition, the exterior metal casing can become encrusted by marine organisms or coated by corrosion, thus slowing the rate of further corrosion. Also, many of the components of concern are coated with plastic to reduce corrosion, providing an effective barrier to water exchange. In instances where seawater corrodes the sonobuoy, that corrosion takes at least 40 years (Klassen 2005).

The approach used to evaluate the environmental effects of seawater batteries involved comparing the expected concentrations of potentially toxic battery constituents with U.S. Environmental Protection Agency (USEPA) water quality criteria that have been established for the protection of aquatic life (USEPA 2006) or the best available literature values that established conservative toxicity thresholds (Table 3.2-8). This assessment applies the findings from a study reported by Naval Facilities Engineering Command (NAVFAC) (DoN 1993, Appendix D) in a sonobuoy training document developed for activities at San Clemente Island, California. The study involved a laboratory experiment where activated seawater batteries were held in a 64-liter (17-gallon) seawater bath for eight hours to provide an empirical estimate of expected leach rates for metals of concern. Water column concentrations of metals at the end of the exposure can be used to derive average leaching rates, and can then be interpreted in the context of minimum current velocities to estimate maximum field exposures. The exposure scenario applied in the NAVFAC report represents reasonable and conservative assumptions that have been retained for this analysis. It is assumed that only one seawater battery will occupy the test volume within its eight-hour operating life span. No vertical turbulence is applied, and the horizontal ocean current flow is set at two inches per second (in/sec) (five centimeters per second [cm/sec]).

Table 3.2-8: Threshold Values for Safe Exposure to Selected Metals

Metal	Criteria (µg/L)	
	Acute (1-hour exposure)	Chronic (4-day mean exposure)
Lead	210	8.1
Silver	1.9	NA
Copper	4.8	3.1
Lithium[1]	6,000	NA

Notes: NA = no chronic value is available; µg/L = microgram per liter. (1) No EPA criteria available; values shown are based on published literature (Kszos et al., 2003)

Source: USEPA 2006

The sonobuoy battery experiment employed lead chloride batteries over an eight-hour period. The concentration of lead at the end of the exposure in the bath was 0.2 mg/L (DoN 1993). Hence, the total amount of lead leached from the battery was (0.2 mg × 64 L =) 12.8 mg. As shown in Table 3.2-9, the rate is thus 1.6 milligrams per hour (mg/hr), or 0.000444 milligrams per second (mg/sec). Applying a highly conservative model, wherein all of the lead released in a single second is contained within 1 mL, the concentration would be 0.4 mg/L.

Table 3.2-9: Calculations to Characterize Maximum Lead Exposure Concentrations

Description of Calculation	Operation	Result
Total amount of lead leached from battery	0.2 mg/L x 64 L =	12.8 mg/8 hr
Per-hour rate	12.8 mg/8 hrs =	1.6 mg/hr
Per-second rate	1.6/hr/(60 min/hr × 60 sec/min) =	0.000444 mg/sec
Concentration into 1 mL	0.000444 mg/mL × 1,000 mL/L =	0.4 mg/L
Two-second dilution	0.4/2 =	0.2 mg/L or 200 µg/L

Source: DoN 2008b

Considering each milliliter as a discrete parcel, a reasonable dilution model at a current velocity of five cm/sec (two in/sec) assumes that the contaminated section is diluted by a factor of two per second. Thus, the lead released from the battery is diluted to 0.2 mg/L or 200 µg/L, in two seconds, which is less than the acute criteria of 210 µg/L, a criteria applied as a one-hour mean. Likewise, assuming the exponential factor of two dilutions, the concentration is less than the chronic limit (8.1 µg/L) in seven seconds. Therefore, lead chloride batteries will not substantially degrade marine water quality. Table 3.2-9 provides a description and summary of the calculations performed to determine the potential effects of scuttled lead chloride batteries.

The relatively large differences in the propensity of lead ions (Pb^{+2}) to solubilize relative to copper (Cu^{+2}) and silver (Ag^{+}) ions assures that the potential effects of batteries containing silver chloride or copper thiocyanate are substantially lower than those of a lead chloride battery. Sonobuoy batteries represent the greatest release of copper because copper thiocyanate is soluble. The peak concentration of copper released from a cuprous thiocyanate seawater battery was calculated to be 0.015 µg/L (DoN 1993), which is substantially lower than USEPA acute and chronic toxicity criteria. While the copper thiocyanate battery also would release cyanide, a material often toxic to marine organisms, thiocyanate is tightly bound, and will form a salt or bind to bottom sediments. Therefore, the risk from thiocyanate is very low.

The AN/SSQ-62D and AN/SSQ-62E DICASS have been improved with the replacement of the standard lithium battery with a lithium iron disulfide thermal battery. An important component of the thermal battery is a hermetically sealed casing, which is Series 300 welded stainless steel 0.7- to 2.54-mm (0.03- to 0.1-in) thick and resistant to the battery electrolytes (DoN 2008b). The electrochemical system in the thermal battery includes an iron disulfide cathode and a lithium alloy anode. In addition, the electrolyte mixture includes chloride, bromide, and iodide salts of lithium and potassium. This mixture is inert and nonconductive until the battery is activated. Upon activation, the mixture becomes molten and highly conductive, allowing the cathode to interact efficiently with the anode. The thermal source is a mixture of iron powder and potassium perchlorate. In the case of extreme degradation of the battery housing on the ocean floor, risks from thermal batteries would be similar to those from lithium batteries (i.e., negligible) but less so because the iron alloy is less soluble.

Lithium batteries are used in DICASS sonobuoys but not in the explosive sonobuoy (AN/SSQ-110A). These batteries are contained within a metal casing housing sulfur dioxide, lithium metal, carbon, acetonitrile, and lithium bromide. The environmental fate of lithium batteries during and after training exercises has already been described in this section under Underwater Targets.

Detonation Byproducts

One type of explosive sonobuoy is proposed for use, the SSQ-110A. This sonobuoy is composed of two sections, an active (explosive) section and a passive section. The upper section is similar to the upper electronics package of the SSQ-62 DICASS sonobuoy, while the lower section consists of two payloads of explosive, weighing 4.2 lb (1.9 kg) each (Global Security 2008c). This explosive is composed of cyclo-1,3,5-tetramethylene-2,4,6-tetranitramine (HLX), which is 90-percent RDX, plus small amounts (less than 0.3 g) of PBX and hexanitrostilbene, a detonator component. Once in the water, the charges explode, creating a loud acoustic signal.

The explosion creates an air bubble of gaseous byproducts that travels to the surface and escapes into the atmosphere. Some of the gas, however, dissolves into the water column. The byproducts with the greatest toxicity are hydrogen fluoride compounds (H_xF_x), reaction byproducts associated with the binding agent used to stabilize the HLX. Natural exposure levels and effects in saltwater would need to be characterized to provide a basis for assessing effects on marine systems. Only a small percentage (0.63 percent) of the available H_xF_x explosion byproduct, however, dissolves in the water prior to the bubble reaching the surface, and the H_xF_x is rapidly diluted upon mixing with the adjacent water column (National Oceanic and Atmospheric Administration 2008).

Torpedoes

MK-48 ADCAP torpedoes would only be used in the TMAA under Alternative 2 (Preferred Alternative). Torpedoes typically contain hazardous materials such as propellants, petroleum products and lubricants, components of guidance systems and instrumentation, and explosives in warheads. The ADCAP torpedo is an acoustic homing torpedo used in force protection. It is 19 ft (5.8 m) long, with a 21-inch diameter, and weighs about 3,700 lb (1,680 kg). Although the hazardous materials list for the MK-48 is classified, the MK-48 torpedo contains approximately 851 lb (383 kg) of explosives and uses Otto Fuel II as a propellant. Most of the explosive is consumed upon detonation of the torpedo.

OTTO Fuel II propulsion systems are used in MK-48 torpedoes. Otto Fuel II is a liquid propellant composed of propylene glycol dinitrate and nitro-diphenylamine (76 percent), dibutyl sebacate (23 percent) and 2-nitrodiphenylamine as a stabilizer (2 percent), and may be toxic to marine organisms (DoN 1996b,c). There have been approximately 30,000 exercise test runs of the MK-48 torpedo over the last 25 years (DoN 1996c). Most of these launches have been on Navy test ranges, where there have been no reports of deleterious effects on marine water quality from OTTO Fuel II or its combustion products

(DoN 1996b,c). Furthermore, Navy studies conducted at torpedo test ranges that have lower flushing rates than the open ocean did not detect residual OTTO Fuel II in the marine environment (DoN 1996b,c). Thus, no adverse effects are anticipated from use of this fuel.

Exhaust products from the combustion of OTTO Fuel II include NO_x, CO, carbon dioxide (CO_2), hydrogen (H_2), nitrogen (N_2), methane (CH_4), ammonia (NH_3), and hydrogen cyanide (HCN) (DoN 1996b,c). These combustion products are released to the ocean, where they are dissolved, disassociated, or dispersed in the water column. These combustion products are not expected to substantially affect the marine environment. Except for HCN, combustion products are not a concern (DoN 1996b,c) because:

- Most OTTO Fuel II combustion products, specifically water, CO_2, N_2, CH_4, and NH_3, occur naturally in seawater.
- Several of the combustion products are bioactive. N_2 is converted into nitrogen compounds through nitrogen fixation by certain cyanobacteria, providing nitrogen sources and essential micronutrients for marine phytoplankton. CO_2 and CH_4 are integral parts of the carbon cycle in the oceans, and are taken up by many marine organisms.
- CO and H_2 have low solubility in seawater and excess gases bubble to the surface.
- Trace amounts of NO_x may be present, but they are usually below detectable limits. NO_x in low concentrations are not harmful to marine organisms, and are a micronutrient source of nitrogen for aquatic plant life.
- Ammonia can be toxic to marine organisms in high concentrations, but releases from OTTO fuel are quickly diluted to negligible levels.

HCN does not normally occur in seawater and, at high concentrations, could pose a risk to both humans and marine biota. The USEPA acute and chronic national recommendation for cyanide in marine waters is 1.0 μg/L, or 1 part per billion (ppb) (DoN 1996b,c). HCN concentrations ranging from 140 to 150 ppb will be discharged from MK-48 torpedoes (DoN 1996c). These initial concentrations are well above the level recommended by USEPA for cyanide. However, because it is very soluble in seawater, HCN will be diluted to less than 1 μg/L at 17.7 ft (5.4 m) from the center of the torpedo's path when first discharged, and thus should pose no substantial threat to marine organisms.

Each torpedo also deploys a guidance wire with a flex hose during each run. The guidance wire is composed of copper and cadmium within a plastic coating, and is about 0.04 inch in diameter (0.1 cm) (DoN 2008b). The MK-48 torpedo uses either a Strong Flexible Hose (SFH) or Improved Flexible Hose (IFH). The flex hose is typically 250-ft long and less than a half inch in diameter, and will sink rapidly to the ocean floor once expended. The IFH is a multi-component design that consists of a stainless-steel spring overlaid with a polyester braid and then a layer of lead tape (DoN 1996b). The entire assembly is then overlaid with a stainless-steel wire braid. The IFH contains 24 kg (53 lb) of metallic lead. The SFH is constructed primarily of stainless steel, and contains no lead or other materials that may pose a threat to the marine environment (DoN 1996b).

The potential for the release of lead into the ocean bottom environment immediately surrounding the IFH to have adverse effects on pelagic and benthic organisms was analyzed. Benthic marine organisms that are near the IFH may be exposed to low concentrations of lead slowly released over time from the IFH. In marine biota, lead residues are generally highest near sources (e.g., disposal sites, dredging sites, mining areas), but no significant biomagnification of lead occurs in aquatic food chains (Eisler 1988).

3.2.1.2 Current Requirements and Practices

Releases or discharges of hazardous wastes or materials are heavily regulated through comprehensive federal and state processes. In addition, the International Convention for the Prevention of Pollution from Ships (MARPOL) prohibits certain discharges of oil, garbage, and other substances from vessels. The MARPOL convention is implemented by national legislation, including the Act to Prevent Pollution from Ships (33 U.S. Code [U.S.C.] 1901, et seq.) and the federal Water Pollution Control Act (Clean Water Act [CWA]"; 33 U.S.C. 1321, et seq.). These and other requirements are implemented by Navy guidance documents and manuals (e.g., Chief of Naval Operations Instruction [OPNAVINST] 5090.1C, *Navy Environmental and Natural Resources Program Manual*) [DoN 2007]) that require hazardous materials to be stored and handled appropriately, both ashore and afloat.

At sea, Navy vessels are required to operate in a manner that minimizes or eliminates any adverse impacts to the marine environment. Environmental compliance policies and procedures applicable to shipboard activities afloat are defined in: the *Navy Environmental and Natural Resources Program Manual* (OPNAVINST 5090.1C), Chapter 4, "Pollution Prevention," and Chapter 22, "Environmental Compliance Afloat"; and Department of Defense (DoD) Instruction 5000.2-R (§C5.2.3.5.10.8, "Pollution Prevention") (DoN 2007). In addition, provisions in Executive Order (EO) 12856, *Federal Compliance With Right-To-Know Laws and Pollution Prevention Requirements*, and EO 13101, *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition*, reinforce the CWA prohibition against discharge of harmful quantities of hazardous substances into U.S. waters out to 200 nm (371 km), and mandate stringent hazardous waste discharge and storage, dumping, and pollution prevention requirements.

3.2.2 Environmental Consequences

As noted in Section 3.2.1, the ROI for expended materials includes the TMAA. Navy training activities that occur within the Air Force inland Special Use Airspace and the Army inland training lands were evaluated under previous National Environmental Policy Act (NEPA) documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). These documents are incorporated by reference. Environmental effects in the open ocean beyond the U.S. territorial seas (outside of 12 nm [22 km]) are analyzed in this EIS/OEIS pursuant to EO 12114.

3.2.2.1 Previous Analyses

Impacts related to expended materials and their hazardous constituents were previously evaluated in Section 1.6.2.2 of the *Alaska Military Operations Areas EIS* (USAF 1995); Section 3.0 of the *Improvements to Military Training Routes in Alaska Environmental Assessment* (USAF 2007); Sections 3.8, 3.9, 4.8, and 4.9 of the *Alaska Army Lands Withdrawal Renewal Final Legislative EIS* (Army 1999); and Sections 3.17, 4.4, 4.5, 4.6, 4.7, and 4.17 of the *Transformation of U.S. Army Alaska FEIS* (Army 2004).

3.2.2.2 Regulatory Framework

Expended materials and hazardous materials are regulated by international, federal, and state laws and regulations. Navy training in the TMAA occurs beyond 12 nm from shore, which is beyond the State seaward and the territorial seas boundaries. Only regulations on the high seas, in the U.S. Exclusive Economic Zone, and in the contiguous zone are applicable. Most Federal and all State regulations are not applicable to expended materials during Navy training exercises in the TMAA, and are provided only for informational purposes.

International Regulation - MARPOL 73/78

MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978, is the primary international marine environmental convention. It is intended to minimize pollution of the seas, including oil, sewage, garbage, and harmful substances. MARPOL limits the dumping from ships based upon the type of materials expended, with plastics as the primary concern. Discharge restrictions are also based on distances of ships from coastal waters.

Federal Laws and Regulations

Federal laws and regulations applicable to Navy training in the TMAA are the Marine Protection, Research, and Sanctuaries Act, and the Oil Pollution Act. The RCRA, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Toxic Substances Control Act (TSCA), the Hazardous Materials Transport Act, and the Emergency Planning and Community Right to Know Act are not applicable because training takes place outside of the U.S. territorial seas; these regulations are provided only for informational purposes.

Marine Protection, Research, and Sanctuaries Act

The Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), also known as the Ocean Dumping Act, was enacted to regulate materials dumped into ocean waters that could endanger human health, welfare, and amenities, and the marine environment, ecological systems, and economic possibilities. The Ocean Dumping Act regulates the disposal of any material in the U.S. territorial seas or contiguous zones, as well as the marine disposal anywhere of waste and other material that originated in U.S. territory or was transported on American vessels or aircraft.

The Navy currently holds a General Permit for Sinking Exercise (SINKEX) activities from the USEPA under the MPRSA (40 CFR §229.2, Transport of Target Vessels). This MPRSA permit allows the Navy to transport vessels in ocean waters with the purpose of sinking the vessel. Pursuant to the MPRSA permit, vessel sinkings must be conducted in water at least 6,000 ft (1,830 m) deep and at least 50 nm (93 km) from land. Regulations require that measures be taken to ensure that the vessel sinks to the bottom rapidly and permanently, and does not pose a hazard to marine navigation. In addition, the MPRSA permit requires the "appropriate measures be taken to remove, to the maximum extent practicable, all materials that may degrade the marine environment." This includes, but is not limited to, emptying all fuel tanks and fuel lines to the lowest point practicable and removal of trash, floatable materials, and mercury or fluorocarbon containing materials capable of contributing to chemical pollution.

The August 1999 SINKEX Letter of Agreement between USEPA and the Navy identifies polychlorinated biphenyls (PCBs) as a potential contaminant of concern that may be found in certain solid materials, such as insulation, wires, felts, and rubber gaskets, on SINKEX vessels. In the past, vessels used for SINKEX had most of the solid PCBs removed, leaving estimates of up to 100 lb of PCBs on board with sinking took place (USEPA 1999). The August 1999 Letter of Agreement created the following measures to the MPRSA permit for removal of materials that may degrade the marine environment:

1. Before engaging in a SINKEX, the Navy must conduct an inventory of each SINKEX vessel to ascertain the presence of PCBs. This inventory and list of items removed prior to sinking must be provided to USEPA in the annual report (see item 4 below). Before sinking a SINKEX vessel, qualified personnel at a Navy or other approved facility shall:
    a. Remove all transformers containing three lb or more of dielectric fluid and all capacitors containing three lb or more of dielectric fluid.
    b. Use all reasonable efforts to remove any capacitors and transformers containing less than three lb of dielectric fluid from the vessel. Reasonable efforts include, but are not

necessarily limited to, the removal of capacitors from electrical and control panels by using hand tools such as wire or bolt cutters or a screwdriver.

c. Drain and flush hydraulic equipment, heat transfer equipment, high/low pressure systems, cutting power machinery which uses cooling or cutting oil, and containers containing liquid PCBs at ≤ 50 parts per million.

2. USEPA believes it is often practicable to remove non-liquid PCBs, including air handling system gaskets, rubber; plastic, dried applied paint that is flaked-off, electrical cable insulation, and other non-liquid coatings and material, before sinking the vessel. To the extent that their removal is practicable, these non-liquid PCBs are required to be removed under the MPRSA permit. However, when such objects cannot be practicably removed or their removal threatens the structural integrity of the vessels so as to impede the SINKEX, the Navy may leave such items in place (e.g., felt materials that are bonded in bolted flanges or mounted under heavy equipment, certain paints and adhesives).

3. Navy shall dispose of all removed PCBs or items containing PCBs in accordance with the TSCA PCB regulations.

4. Navy shall report annually to USEPA the efforts taken to clean each vessel prior to SINKEX and an estimate of the weight of PCBs present on board at the time of sinking; the locations of all SINKEX vessels sunk that year, presented as the vessels' location on the bottom within 500 yards; and the water depth at which the vessel rests. This information shall be included in the annual report to USEPA that is required by the MPRSA permit.

Oil Pollution Act

The Oil Pollution Act requires oil storage facilities and vessels to submit plans to the federal government describing how they will respond to the unplanned release of oil and other hazardous materials (33 U.S.C. 2701, et seq.). The OPA provides regulations for the prevention of the discharge of oil into the ocean waters out to the limits of the contiguous zone. Oil and hazardous releases are also reported and remediated according to current Navy policies.

Resource Conservation and Recovery Act

RCRA applies only to solid wastes, as those materials are defined in 40 Code of Federal Regulations (CFR) §261.2. RCRA defines a hazardous waste as a solid waste that can cause, or substantially contribute to, an increase in mortality or serious illness due to its quantity, concentration, or physical, chemical, or infectious characteristics, or which can pose a hazard to human health or the environment when improperly transported, managed, treated, stored, or disposed of (42 U.S.C. 6901, et seq.).

The Military Munitions Rule (MMR) identifies when military munitions become solid wastes under RCRA. Under the MMR, military munitions include: confined gaseous, liquid, and solid propellants; explosives; pyrotechnics; and chemical and riot agents. The MMR provides that the use of these munitions to train military personnel on a designated military range constitute the normal use of the product, so they are not solid wastes and are not subject to RCRA regulation. As defined by the MMR, a used or fired military munition is considered to be a solid waste only if "… the munition lands off-range and is not promptly rendered safe or retrieved" (40 CFR §266.202). Under the MMR, wholly inert items and non-ordnance training materials are not defined as military munitions.

Hazardous materials are considered solid wastes if they are used in a manner constituting disposal rather than for their intended purpose. Expended materials are considered solid waste under the RCRA when discarded materials are "abandoned." A material is abandoned if it is disposed of; burned or incinerated; or accumulated, stored, or treated before or instead of being disposed of.

Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA – the Superfund program – defines hazardous material as any substance that, due to its quantity, concentration, or physical and chemical characteristics, poses a potential hazard to human health and safety or to the environment. CERCLA has established national policies and procedures to identify and clean-up sites contaminated by hazardous substances, including military installations. No CERCLA sites are located in the TMAA.

Toxic Substances Control Act

The TSCA requires reporting, record-keeping, and testing requirements, and restrictions related to chemical substances or mixtures. TSCA also address the use and disposal of specific chemicals, such as polychlorinated biphenyls (PCBs). PCB production was banned in 1973, but PCBs may be present in products manufactured before the ban. PCBs may be found in PVC coatings of electrical wiring, transformers, and hydraulic fluids.

Hazardous Materials Transportation Law

For air, sea, or land transportation, the U.S. Department of Transportation defines a hazardous material as a substance or material that is capable of posing an unreasonable risk to health, safety, and property when transported in commerce (49 U.S.C. 5101, et seq.; 49 C.F.R. 172.101, Appendix B). This law regulates the preparation, identification, and transportation process for hazardous materials.

Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right to Know Act requires federal, state, and local governments and industry to report on their use of hazardous and toxic chemicals (42 U.S.C. 116, et seq.).

State Laws and Regulations

Alaska regulations on expended and hazardous materials are not applicable to Navy training in the TMAA because no training activities take place within State waters (up to three nm from shore). The following discussion of regulations is for informational purposes only.

Solid wastes and hazardous materials are regulated by the Alaska Department of Environmental Conservation (ADEC). Alaska has adopted the federal MMR by reference, but has not developed any state-specific military munitions regulations. The provisions of the MMR are regulated by the Waste Management Division of the ADEC. Solid waste regulations are established by Alaska Administrative Code Title 18, Chapter 60: Solid Waste. The Waste Management division enforces the State of Alaska's hazardous waste regulations, which can be found in Alaska Statutes Title 46, Chapter 3 (e.g., Section 296 [Hazardous Waste Disposal], Section 299 [Hazardous Waste Regulations]; and Section 308 [Transportation of Hazardous Waste], and in Chapter 9 [Hazardous Substance Release Control]). The Navy complies with applicable state regulations under EO 12088, *Federal Compliance with Pollution Control Standards*; DoD Directive 4165.60, *Solid Waste Management*; and Navy guidelines for hazardous materials and wastes management.

Alaska oil pollution control regulations are found in the Alaska Statutes Title 46, Chapter 5 and Chapter 8. These regulations address issues with transportation and liability of petroleum products. Alaska has developed contingency plans for the State that describe the strategy for a coordinated federal, state, and local response to a discharge or substantial threat of discharge of oil or a release of a hazardous substance from a vessel, offshore facility, or onshore facility.

3.2.2.3 Approach to Analysis

Data Sources

Relevant literature was systematically reviewed to complete this analysis of expended materials in the GOA. The review included journals, DoD reports and operational manuals, natural resource management plans and other technical reports published by government agencies, prior environmental documents for facilities and activities in the GOA, and work conducted by private businesses and consulting firms.

Assessment Methods

For each alternative, this document characterizes and quantifies the total amount of training materials, both hazardous and nonhazardous, that are expended annually during Navy training in the TMAA. Hazardous material weights are calculated based on assumptions identified in Section 3.2.1.1 for each expended training material. This analysis does not include materials expended during Navy training in the inland lands of the GOA because those activities are covered by Army and Air Force documents identified in Section 3.2.2.1.

This analysis assumes that expended training materials are deposited on 20 percent of the available training area (TMAA) (DoN 2009). The TMAA consists of an ocean area of approximately 42,146 nm^2 (145,482 square kilometers [km^2]). Deposition of expended materials across 20 percent of the training area would affect an area of approximately 8,430 nm^2 (29,100 km^2). This is a conservative assumption that is based on Navy personnel experience, which indicates that the distribution of training exercises within ocean training areas is not uniform.

Aircraft overflights occur under all of the alternatives. Aircraft overflights between the TMAA and the Alaska inland training areas would not involve expenditures of training materials. Therefore, aircraft overflights in the GOA will not be addressed further in this section.

3.2.2.4 No Action Alternative

The No Action Alternative is the baseline condition for Navy training in the TMAA. This section analyzes current levels of Navy training for annual expenditure of training materials and their hazardous constituents. Table 3.2-1 summarizes the training items that may present issues related to expended materials. The amounts and types of training materials expended under the No Action Alternative are described below. Table 3.2-10 provides the annual numbers and weights of expended materials under the No Action Alternative.

Table 3.2-10: Summary of Expended and Hazardous Training Materials – No Action Alternative

Type of Training Material	Number of Items	Material Weight (lb)		Hazardous Content (%)
		Total Expended	Hazardous	
Bombs	120	54,000	395	0.73
Missiles	22	6,770	56.4	0.83
Targets & pyrotechnics	252	3,610	27.2	0.75
Naval gun shells	10,564	10,700	1,320	12.3
Small arms rounds	5,000	180	1.80	1.00
Sonobuoys	24	936	70.8	7.56
Total	**15,982**	**76,200**	**1,870**	**2.45**

Notes: Numbers of training items are estimates. Weights and percentages are rounded to a maximum of three significant digits.

Bombs

Under the No Action Alternative, 120 bombs will be expended annually during training, of which 72 (about 60 percent) will be inert. Expended bombs will deposit approximately 54,000 lb (24,300 kg) of training materials per year, distributed over the TMAA at an average density of 6.4 lb per nm^2 (0.83 kg per km^2), assuming deposition of expended materials over 20 percent of the TMAA (42,146 nm^2 [145,482 km^2]). The primary hazardous material from bombs is residual explosives. Most of the residual explosives will result from bombs that are duds. Approximately 395 lb (180 kg) of explosives will be left unconsumed, which will deposit about 0.05 lb per nm^2 (less than 0.01 kg per km^2) of hazardous material in the TMAA. Practice bombs contain a small amount of explosives for use as a spotting charge. Upon impact, spotting charges will combust and be consumed, producing smoke in the process. Explosives are generally insoluble in water, and will leach slowly into the marine environment. Explosive material will break down on the ocean floor, and will not accumulate over time. Ocean currents will disperse leaching materials quickly. Bomb casings may contain anti-corrosion coatings and metals, but these substances typically constitute less than one percent of the casing's weight. Bomb casings will degrade slowly, and leaching will be further slowed by encrusting and sedimentation. The environmental fate of expended bombs is described in greater detail in Section 3.2.1.1. Due to the low areal density of expended materials and the low amount of hazardous material, expended bombs will have a minimal impact on the benthic environment.

Missiles

Twenty-two missiles will be used annually under the No Action Alternative. Approximately 50 percent of missiles used during aviation exercises are inert versions, and do not explode on contact with the target or ocean surface. Exploding warheads may be used in air-to-air missile exercises but, to avoid damaging the aerial target, the missile explodes in the air, disintegrates, and falls into the ocean. Live missiles used in air-to surface exercises explode near the water surface. Approximately 6,770 lb (3,050 kg) of expended materials from missiles will be deposited annually on the ocean floor, resulting in an average density of 0.8 lb per nm^2 (0.1 kg per km^2) per year. Hazardous materials from expended missiles consist of residual missile propellants and unconsumed explosives from missiles that are duds. Under the No Action Alternative, expended missiles will annually result in approximately 56.4 lb (25.6 kg) (approximately 38 lb [17 kg] of explosives and 18 lb [8.1 kg] of propellant) in the TMAA. These amounts of hazardous materials are not expected to have a substantial effect because of the large deposition area and subsequent dispersal by ocean currents. The deposition of the missile body in the water will have minimal effects on water quality because it will become encrusted through chemical processes and the growth of benthic organisms, slowing leaching.

The principal source of potential impacts on water and sediment quality will be unburned solid propellant residue and batteries. Solid propellant fragments will sink to the ocean floor and will undergo changes in the presence of seawater. The propellant concentration will decrease over time as the leaching rate decreases and further dilution occurs. The aluminum will remain in the propellant binder, and eventually will be oxidized by seawater to aluminum oxide. The remaining binder material and aluminum oxide will pose no threat to the marine environment.

Targets and Pyrotechnics

Table 3.2-11 summarizes the types and numbers of targets and pyrotechnics that will be used annually under the No Action Alternative. Targets used in training exercises will be recovered, unless otherwise noted.

Table 3.2-11: Targets and Pyrotechnics – No Action Alternative

Type of Target or Pyrotechnic	Number of Items
Targets	
TDU-34 towed target	2
TALD*	8
BQM-74E unmanned aircraft	2
Killer Tomato surface target	10
SPAR	10
Pyrotechnics	
LUU-2B/B*	12
MK-58 Marine Marker*	20
Chaff*	212
Total number used	**276**
Total not recovered	**252**
Total expended weight (lb)	**3,610**

*Not recovered

Under the No Action Alternative, LUU-2B/B illuminating flares, TALDs, chaff, and MK-58 marine markers will not be recovered, resulting in approximately 3,610 lb (1,640 kg) of expended training materials per year. Illuminating flares and marine markers are consumed during use. Flares typically contain approximately 0.85 lb of residual pyrotechnic material, which is considered to be hazardous. Flare use under the No Action Alternative will deposit approximately 27.2 lb (12.4 kg) of hazardous materials annually in the TMAA. Smoke from marine markers rapidly diffuses by air movement. The marker itself is not designed to be recovered, and will eventually sink to the bottom and become encrusted or incorporated into the sediments. Phosphorus contained in the marker will settle to the ocean floor, where it will react with the water to produce phosphoric acid until all phosphorus is consumed. Combustion of red phosphorus produces phosphorus oxides, which have a low toxicity to aquatic organisms. Red phosphorus released during training is not anticipated to substantially affect the marine environment (DoN 2006).

TALDs will result in approximately 16 expended thermal batteries per year, which contain chemicals considered to be hazardous. Expended thermal batteries will not have a substantial impact to the environment because chemical reactions in batteries continue until battery life ends, with only a small amount of reactants remaining. Remaining chemicals, most of which are abundant in the ocean, will leach slowly, and will be diluted by ocean and tidal currents. The environmental fates of batteries are described in Section 3.2.1.1.

Chaff will only be used during Electronic Combat exercises. Approximately 540 lb (245 kg) of chaff will be expended under the No Action Alternative. The environmental fate of chaff is described in Section 3.2.1.1. Chaff fibers will be widely dispersed and will not result in harmful concentrations. The only hazardous material associated with chaff is the pyrotechnic deployment charge (approximately 0.02 oz [0.48 g] of pyrotechnic material for each charge) (USAF 2001). This amount of pyrotechnic material will not affect water or sediment quality because most of the material will be consumed during combustion and the remaining amounts will be dispersed over a large area.

Infrequently, a recoverable target may be lost. In those cases, the hazardous materials of concern include propellant, petroleum products, metals, and batteries. Small concentrations of fuel and ionic metals released during battery operation could enter the water and contaminate limited areas; however, they are not a source of substantial environmental degradation. The potential impact of expended batteries is discussed in Section 3.2.1.1.

Most target fragments will sink quickly in the ocean. Expended material that sinks to the ocean floor will gradually degrade, be overgrown by marine life, or be incorporated into bottom sediments. Floating nonhazardous expended material may be lost from target boats, and will either degrade over time or wash ashore as flotsam. An extensive study conducted at CFMETR near Nanoose, British Columbia concluded that, in general, the direct impact of expended material accumulation on the ocean floor appeared to be minimal, and had no detectable effects on wildlife or sediment quality (CFMETR 2005). Under the No Action Alternative, no measurable impact on the environment will occur within the study area because the majority of targets will be recovered after use and the majority of expended materials are inert, and will be buried in bottom sediments.

Naval Gun Shells

Under the No Action Alternative, 10,564 shells will be fired annually, with only 40 HE shells (10 76-mm shells and 30 5-inch shells). The majority of expended shells will be 20-mm and 25-mm shells. The total weight of expended naval shells will be approximately 10,700 lb (4,860 kg) per year. Navy training in the TMAA will annually deposit approximately 1,320 lb (600 kg) of hazardous material from shells in the TMAA, which will be approximately 0.16 lb per nm^2 (0.02 kg per km^2). Hazardous materials of gun shells are explosive materials (from duds) and heavy metals in projectiles. Most of the hazardous material is from tungsten in CIWS 20-mm shells. Under the No Action Alternative, approximately 1,200 lb (545 kg) of tungsten will be expended. Tungsten alloys will be in insoluble forms, and will settle to the ocean floor and be covered by sediment. Metals will leach slowly, but the amounts of other metals associated with tungsten alloy (copper, cobalt, nickel, iron) will be too small to have a substantial effect on the marine sediment. The degradation of tungsten could increase pH in the surrounding sediment but, with less than one expended 20-mm round per nm^2 (0.27 rounds per km^2) in 20 percent of the TMAA, would not have substantial effects. Hazardous materials are discussed in detail in Section 3.2.1.1.

Live 5-in shells are typically fused to detonate within 3 ft (0.9 m) of the water surface. Shell fragments rapidly decelerate through contact with the surrounding water, and settle to the ocean floor. The impact of naval shells on the environment under the No Action Alternative will be negligible because of the relatively small sizes of the training materials and their broad distribution within the TMAA. The environmental fate of naval gun shells on the ocean bottom will be similar to that of bombs (see discussion above).

Small Arms Rounds

Under the No Action Alternative, 5,000 rounds of small-caliber ammunition (7.62-mm and 0.50-cal) will be expended per year. The combined weight of these expended small arms will be approximately 181 lb (81 kg). Eighty percent of the small-caliber ammunition will be 7.62-mm rounds. Hazardous materials from small arms rounds (heavy metals in projectiles) will weigh less than two lb (less than one kg), which will not have an effect on the marine environment. Hazardous materials are discussed in detail in Section 3.2.1.1. Expended materials from small-caliber ammunition are relatively inert in the marine environment. Expended rounds may release small amounts of lead, antimony, iron, aluminum, and copper into the sediments and the overlying water column as they corrode. The rate of corrosion will be low, however, and releases to the overlying water column will be diluted by ocean and tidal currents.

Sonobuoys

The SSQ-36 BT sonobuoy will be used under the No Action Alternative. The SSQ-36 BT is designed to record the thermal gradient of the water at various depths (Global Security 2008d). The impacts of sonobuoys on the environment are described in Section 3.2.1.1. Under the No Action Alternative, 24

SSQ-36 BT sonobuoys will be expended per year. The estimated weight of expended materials from sonobuoys will be 936 lb (421 kg). Table 3.2-12 provides the weight of hazardous materials for sonobuoys expended under the No Action Alternative. Hazardous materials are discussed in detail in Section 3.2.1.1.

Table 3.2-12: Hazardous Materials from Expended Sonobuoys – No Action Alternative

Constituent	Hazardous Material Weight (lb)	
	Per Sonobuoy	Total
Copper thiocyanate	1.59	38.1
Fluorocarbons	0.02	0.48
Copper	0.34	8.16
Lead	0.94	22.6
Tin/lead plated steel	0.06	1.44
Total	**2.95**	**70.8**

Note: Under the No Action Alternative, 24 sonobuoys would be expended

Approximately 71 lb (32 kg) of hazardous materials from sonobuoys will be deposited in the TMAA under the No Action Alternative. Sonobuoys contain other metal and nonmetal components, such as metal housing (nickel-plated, steel-coated with PVC plastics to reduce corrosion), batteries, lead solder, copper wire, and lead used for ballast that, over time, can release hazardous constituents into the surrounding water. This level of deposition will not affect marine conditions because most of the hazardous materials are in insoluble forms.

Sonobuoys contain the greatest amount of hazardous materials per expended item. Leaching from metals, however, will be slow, and concentrations of hazardous materials will not exceed State or federal water quality standards. Lead has a low solubility in water and leaching is further decreased by encrusting through chemical and natural processes. Lead from expended sonobuoys will degrade slowly, and will not exceed USEPA's maximum acute concentration (210 µg/L) or maximum chronic concentration (8.1 µg/L) for lead (USEPA 2006). Electronics liquids used in the sonobuoy compass would release small amounts of fluorocarbons into the marine environment (Table 3.2-12). The volume of ocean water surrounding expended sonobuoys would quickly dilute fluorocarbons to non-toxic concentrations (less than 1,000 mg/L). Although fluorocarbons are resistant to degradation, they would not be expected to concentrate in any areas of the TMAA.

Sonobuoy batteries represent the greatest release of copper from expended materials because copper thiocyanate is soluble. The peak concentration of copper released from a cuprous thiocyanate seawater battery was calculated to be 0.015 µg/L (DoN 1993), which is substantially lower than USEPA acute and chronic toxicity criteria. While the copper thiocyanate battery also would release cyanide, a material often toxic to marine organisms, the amount of copper thiocyanate in sonobuoys is very low. Thiocyanate is tightly bound, and will form a salt or bind to bottom sediments. The concentration of available thiocyanate released from sonobuoys will be similar to the concentration of copper, which is below the USEPA's maximum acute and chronic toxicity for free cyanide (1 µg/L; USEPA 2006). Therefore, the risk from thiocyanate will be very low. The quality of the water and sediments immediately surrounding an expended sonobuoy may be affected by chemicals leached from the item, but ocean currents will quickly disperse chemicals to nontoxic levels. Thus, expended sonobuoys under the No Action Alternative will not have a substantial effect on the environment.

Summary – No Action Alternative Effects

Under the No Action Alternative, Navy training exercises will annually expend an estimated 15,982 training items or 76,200 lb (34,600 kg) of training materials in the TMAA (see Table 3.2-10). Over 97 percent of the expended items will be naval gun shells or small arms rounds. The density of expended materials distributed over 20 percent of the TMAA will be approximately 1.92 items per nm^2 (0.55 items per km^2) or 9.0 lb per nm^2 (1.2 kg per km^2) per year. Assuming Navy training under the No Action Alternative would remain consistent over periods of 5 and 20 years, the Navy will expend approximately 191 tons (45.2 lb per nm^2 [5.9 kg per km^2]) and 762 tons (181 lb per nm^2 [23.8 kg per km^2]) of training materials in the TMAA, respectively. Most of these materials are relatively inert in the marine environment, and will degrade slowly. Only a small amount of annually expended materials are considered to be hazardous. The density of hazardous materials within the affected areas will be approximately 0.22 lb per nm^2 (0.03 kg per km^2) per year. The majority of these materials will be residual explosive, which break down slowly. Any leaching chemicals will be quickly dispersed by ocean currents, and will not be present in harmful concentrations. Thus, expended materials under the No Action Alternative will not substantially affect marine resources.

3.2.2.5 Alternative 1

This section describes the annual amounts and types of training materials proposed under Alternative 1, compared to annual amounts under the No Action Alternative. Alternative 1 would increase training tempo and introduce ASW training in the TMAA, which would increase in the amount of expended materials. The numbers and weights of training materials that would be expended annually under Alternative 1 are provided in Tables 3.2-13 and 3.2-14.

Table 3.2-13: Numbers and Weights of Expended Training Materials – Alternative 1

Type of Training Material	Quantities of Training Materials by Alternative				Increase under Alternative 1 (%)	
	Alternative 1		No Action Alternative			
	Number	Weight (lb)	Number	Weight (lb)	Number	Weight
Bombs	180	79,900	120	54,000	50	48
Missiles	33	10,200	22	6,770	50	50
Targets and pyrotechnics	322	5,610	252	3,610	28	55
Naval gun shells	13,188	13,800	10,564	10,700	25	28
Small arms rounds	5,700	210	5,000	180	14	17
Sonobuoys	793	30,900	24	936	3,200	3,200
PUTR	7	2,100	NA	NA	NA	NA
Total	**20,223**	**143,000**	**15,982**	**76,200**	**26**	**87**

Note: Numbers of training items are estimates. Weights and percentages are rounded to a maximum of three significant digits.

Table 3.2-14: Expended Materials Considered Hazardous – Alternative 1

Type of Training Material	Weight of Material (lb)[1]		Hazardous Content (%)
	Expended	Hazardous	
Bombs	79,900	617	0.77
Missiles	10,200	84.5	0.83
Targets and pyrotechnics	5,610	190	3.39
Naval gun shells	13,800	1,650	12.0
Small-caliber rounds	210	2.10	1.00
Sonobuoys	30,900	2,340	7.57
PUTR	2,100	0	0
Total	**143,000**	**4,890**	**3.42**

Notes: Weights of expended materials and hazardous contents (%) are estimates, and are rounded to three significant digits. (1) Weights of hazardous materials are based on available information and may not include hazardous weight of all expended materials.

Bombs

Under Alternative 1, an additional 60 bombs would be expended annually, a 50-percent increase over the No Action Alternative. A 48-percent increase (from 54,000 lb [24,300 kg] to 79,900 lb [36,000 kg]) in the weight of training materials expended annually would occur under Alternative 1. The amount of unconsumed explosives would increase from 390 lb (176 kg) per year under the No Action Alternative to 617 lb (278 kg) per year under Alternative 1. This level of deposition would result in approximately 0.07 lb per nm^2 (0.01 kg per km^2) per year of hazardous material in the TMAA. Residual explosive materials would break down slowly, and would not be expected to accumulate. Sixty percent of the bombs used during training exercises would be inert. While inert bombs would contain a small amount of explosives (spotting charge), this amount would be negligible because it would be consumed upon contact with land or water. Given the potential impacts of bombs, as described for the No Action Alternative, and the low amount of hazardous materials, this increase over the No Action Alternative would not have measurable effects in the TMAA.

Missiles

Under Alternative 1, an additional 11 missiles (33 total) would be used over the No Action Alternative, a 50-percent increase over the No Action Alternative. The weight of expended materials would increase by the same percentage (from 6,770 lb [3,050 kg] to 10,200 lb [4,590 kg] per year). Expended hazardous materials would also increase by 50 percent, with 85 lb (38 kg) (57 lb [26 kg] of explosives and 28 lb [13 kg] of propellants being deposited annually in the TMAA. Explosives would leach slowly in the marine environment, and would not be expected to affect water or sediment quality because of the low quantity of material. Missile casings would have a minimal effect on the environment because their relatively inert materials would corrode, and become encrusted by benthic organisms and chemical processes. Hazardous materials would be deposited on the TMAA when missiles suffer ordnance failure or low-order detonations. The small increase in the weight of hazardous materials under Alternative 1 would not have a substantial effect on the environment because of its low density in the TMAA. Contaminants would leach slowly, and would be dispersed rapidly by ocean and tidal currents.

Targets and Pyrotechnics

Table 3.2-15 shows the types and numbers of targets and pyrotechnics that would be expended annually in the TMAA under Alternative 1.

Of the targets and pyrotechnics that would be used under Alternative 1, 322 items would not be recovered annually, which would be a 28-percent increase over the No Action Alternative. Unrecovered targets would deposit 5,610 lb (2,520 kg) of expended materials per year on the ocean floor, a 55-percent increase over the No Action Alternative. Most of the remaining targets and countermeasures are recovered after use, and these are constructed of relatively inert materials. If targets were lost, they would become buried in bottom sediments or wash up onshore.

Table 3.2-15: Targets and Pyrotechnics – Alternative 1

Types of Targets and Pyrotechnics	Number of Items		Increase Under Alternative 1	
	Alternative 1	No Action Alternative	Number	Percent (%)
Targets				
TDU-34 towed target	3	2	1	50
TALD*	12	8	4	50
BQM-74E unmanned aircraft	2	2	0	0
Killer Tomato surface target	12	10	2	20
SPAR	12	10	2	20
MK-39 EMATT*	20	0	20	NA
Pyrotechnics				
LUU-2B/B*	18	12	6	50
MK-58 Marine Marker*	60	20	40	200
Chaff*	212	212	0	0
Total number used	**351**	**276**	**75**	**27**
Total not recovered	**322**	**252**	**70**	**28**
Total expended weight (tons)	**5,610**	**3,610**	**2,000**	**55**

* Not recovered, NA = Not applicable

Pyrotechnics would mostly be consumed by chemical reactions that produce smoke. Residual pyrotechnic materials from flares would weigh approximately 66 lb (30 kg). This amount of material, spread over 20 percent of the TMAA, would have minimal impacts on the marine environment. Ocean currents would quickly disperse materials, reducing concentrations below harmful concentrations. The use of chaff would not increase under Alternative 1 from that under the No Action Alternative. Chaff would not affect water or sediment quality, as described under the No Action Alternative.

TALDs used during training exercises would expend 24 thermal batteries per year. Thermal batteries would have effects on the marine environment similar to those of lithium batteries. Most of the hazardous materials in batteries would be consumed during activation. The steel casing would become encrusted through natural processes, further slowing any leaching of hazardous materials. This amount of expended batteries would not be expected to affect the marine environment.

The use of EMATTs for ASW exercises would deposit 120 lb (56 kg) of expended lithium batteries per year in the TMAA. As described in Section 3.2.1.1, lithium batteries would not have substantial effects on marine conditions because most of the chemical components are abundant in seawater. The leaching rate of chemicals through the steel casing would be further slowed by encrusting from benthic organisms and natural processes. Thus, Under Alternative 1, no measurable impact on the environment would occur from the use of targets and countermeasures.

Naval Gun Shells

Under Alternative 1, there would be a 25-percent increase in expended shells compared to the No Action Alternative. HE shells would slightly increase to 56 shells from 40 under the No Action Alternative. Alternative 1 would deposit 13,800 lb (6,270 kg) of expended materials per year on the ocean floor, an increase of 28 percent over the No Action Alternative. Approximately 1,650 lb (750 kg) of this material would be hazardous. Hazardous materials would be heavy metals in projectiles and residual explosives, but any effect would be limited to the immediate surroundings of the expended round.

Approximately 1,500 lb of hazardous materials from expended shells would be tungsten in CIWS 20-mm projectiles. Tungsten alloys in 20-mm rounds would not be expected to substantially affect marine water or sediment quality because the 20-mm rounds would have an areal density of less than 1.2 rounds per nm^2 (0.34 per km^2). Hazardous materials are discussed in detail in Section 3.2.1.1. This amount of hazardous materials would have an insignificant effect on marine resources. Given the inert nature of the majority of expended materials and the wide distribution across the training area, Alternative 1 would not have a measurable impact on the environment.

Small Arms Rounds

Under Alternative 1, 14 percent more small-caliber rounds (from 5,000 to 5,700 rounds) would be expended per year compared to the No Action Alternative. Expended small arms round would result in approximately 210 lb (95 kg) of expended material, but hazardous materials would only account for approximately 2.1 lb (0.9 kg) of the annually expended materials. Hazardous materials are discussed in detail in Section 3.2.1.1. Leached lead and antimony would increase the concentration of toxic chemicals in the immediate vicinity of expended small-caliber rounds, but these substances would quickly be dispersed by ocean and tidal currents. Given the generally inert nature of these materials, their low amounts of hazardous materials, their small size, and their wide distribution across the TMAA, the increase under Alternative 1 would not have a measurable impact on the environment.

Sonobuoys

Alternative 1 would introduce new ASW training exercises to the TMAA. ASW training would introduce a new target (MK-39 EMATT) and new types of sonobuoys. Table 3.2-16 summarizes the types and numbers of sonobuoys proposed for use under Alternative 1.

Table 3.2-16: Types and Numbers of Sonobuoys – Alternative 1

Type of Sonobuoy	Number of Items		Increase under Alternative 1 (%)
	Alternative 1	No Action Alternative	
SSQ-36 BT (passive)	60	24	150
SSQ-53 DIFAR (passive)	500	0	NA
SSQ-62 DICASS (active)	133	0	NA
SSQ-77 VLAD (passive)	60	0	NA
SSQ-110A IEER (explosive) or SSQ-125 AEER (Tonal)	40	0	NA
Total number used	**793**	**24**	**3,200**
Total weight (lb)	**30,900**	**936**	**3,200**

Notes: Numbers and weights of training items are estimates, and weights and percentages are rounded to three significant digits, NA = Not applicable. IEER - Improved Extended Echo Ranging Sonobuoy. AEER - Advanced Extended Echo Ranging Sonobuoy

Under Alternative 1, 793 sonobuoys would be expended annually. An even distribution of expended training materials over 20 percent of the TMAA would result in approximately 0.1 expended sonobuoys per nm^2 per year. Sonobuoys used during training would result in approximately 30,900 lb (13,900 kg) of expended material. Their annual density by weight would be about 3.7 lb per nm^2 (0.5 kg per km^2). The hazardous materials in the expended sonobuoys would weigh approximately 2,340 lb (Table 3.2-17).

Table 3.2-17: Hazardous Materials Content of Expended Sonobuoys – Alternative 1

Constituent	Hazardous Material Weight (lb)		Increase under Alternative 1 (%)
	Alternative 1	No Action Alternative	
Copper thiocyanate	1,260	38.1	3,200
Fluorocarbons	15.9	0.48	3,200
Copper	270	8.16	3,200
Lead	745	22.6	3,200
Tin/lead plated steel	47.6	1.44	3,200
Total	2,340	70.8	3,200

There would be a substantial increase in hazardous materials under Alternative 1, but the density would remain low (approximately 0.28 lb per nm^2 [0.04 kg per km^2] per year). This level of deposition of expended sonobuoys would have a minimal impact on ocean water resources under Alternative 1. Lead concentrations would not be expected to exceed USEPA standards because of the large area within which sonobuoys would be deployed and the dilution of leached lead by ocean currents. Detonation byproducts from explosive sonobuoys used under Alternative 1 would not have a substantial impact because of the large training area and the low number of explosive sonobuoys used during training exercises.

Electronics liquids used in the sonobuoy compass would release small amounts of fluorocarbons into the marine environment (Table 3.2-12). The volume of ocean water surrounding expended sonobuoys would dilute fluorocarbons to non-toxic concentrations (less than 1,000 mg/L). Although fluorocarbons are resistant to degradation, they would not be expected to concentrate in any areas of the TMAA.

Expended batteries would not substantially affect the marine environment because most of the hazardous constituents are consumed during use. Sonobuoy batteries would represent the greatest release of copper from expended materials because copper thiocyanate would be soluble. The peak concentration of copper released from a cuprous thiocyanate seawater battery was calculated to be 0.015 µg/L (DoN 1993), which would be substantially lower than USEPA acute and chronic toxicity criteria. While the copper thiocyanate battery also would release cyanide, a material often toxic to marine organisms, the amount of copper thiocyanate in sonobuoys would be very low. Thiocyanate would be tightly bound, and would form a salt or bind to bottom sediments. The concentration of available thiocyanate released from sonobuoys would be similar to the concentration of copper, which would be below the USEPA's maximum acute and chronic toxicity for free cyanide (1 µg/L; USEPA 2006). Therefore, the risk from thiocyanate would be very low. The remaining hazardous materials would slowly leach, and would quickly be dispersed by ocean currents, resulting in concentrations of hazardous materials below harmful concentrations.

Portable Undersea Training Range

The PUTR would require the installation of seven anchors for the electronic components. Upon completion of training, these anchors would remain on the ocean floor. Each anchor weighs approximately 300 lb, which would result in approximately 2,100 lb of expended materials. Anchors would be made of concrete or sand bags, which would be covered by sand or sediment over time. There would be no hazardous materials associated with anchors and, thus, there would be minimal effects on the marine environment.

Summary –Alternative 1 Effects

Under Alternative 1, 20,223 items would be expended each year, with a deposition rate of 2.40 items per nm^2 (0.69 items per km^2) per year (see Table 3.2-13). Over 93 percent of the expended items would be naval gun shells or small arms rounds. Under Alternative 1, Navy training exercises would result in approximately 143,000 lb (65,000 kg) of expended materials per year in the TMAA. The density of expended materials distributed over 20 percent of the TMAA would be about 16.9 lb per nm^2 (2.23 kg per km^2) per year. Assuming Navy training under Alternative 1 would remain consistent over periods of five and 20 years, the Navy would expend approximately 358 tons (84.8 lb per nm^2 [11.2 kg per km^2]) and 1,430 tons (339 lb per nm^2 [44.7 kg per km^2]) in the TMAA, respectively. Most of these materials would be relatively inert in the marine environment, but would degrade slowly.

Only a small amount of expended materials would be considered hazardous (Table 3.2-14). Alternative 1 would result in an increase in the hazardous material of about 160 percent, but would only deposit approximately 0.58 lb per nm^2 (0.08 kg per km^2) of hazardous material across 20 percent of the TMAA. The majority of these materials would be residual explosives, which break down slowly. Any leaching chemicals would be quickly dispersed by ocean currents, and would not be expected to result in harmful concentrations. Thus, expended materials under Alternative 1 would not substantially affect marine resources.

3.2.2.6 Alternative 2

Table 3.2-1 summarizes the types of training items that could present issues related to hazardous materials under Alternative 2. The numbers and weights of materials expended annually under Alternative 2 are provided in Table 3.2-18 and Table 3.2-19. Additionally, Alternative 2 would include two SINKEX events, with one occurring during each Carrier Strike Group exercise. During SINKEX, a decommissioned surface ship is towed to a deep-water location and sunk using a variety of ordnance. Each SINKEX event may include the use of one MK-48 ADCAP torpedo, which is only used at the end of SINKEX if the target is still afloat. The following discussion compares the numbers and types of training materials that would be expended annually under Alternative 2, the Preferred Alternative, to those under the No Action Alternative.

Table 3.2-18: Numbers and Weights of Expended Training Materials – Alternative 2

Type of Training Material	Quantity of Training Materials				Increase under Alternative 2 (%)	
	Alternative 2		No Action Alternative			
	Number	Weight (lb)	Number	Weight (lb)	Number	Weight
Bombs	360	160,000	120	54,000	200	200
Missiles	66	20,300	22	6,770	200	200
Targets/Pyrotechnics	644	11,200	252	3,610	160	210
Naval gun shells	26,376	27,500	10,564	10,700	150	160
Small arms rounds	11,400	420	5,000	180	130	130
Sonobuoys	1,587	61,900	24	936	6,500	6,500
PUTR	7	2,100	0	0	NA	NA
SINKEX[1]	858	70,000	0	0	NA	NA
Total	**41,298**	**352,000**	**15,982**	**76,200**	**160**	**360**

Notes: Weights of expended materials are estimates, and weights and percentages are rounded to three significant digits. (1) Due to the variability in weight of available ship hulks, the expended weight for SINKEX does not incorporate ship hulks, NA = Not applicable

Bombs

Under Alternative 2, an additional 240 bombs, for a total of 360, would be used per year, a 200-percent increase over the No Action Alternative. Approximately 160,000 lb (72,000 kg) of bombs would be deposited on the ocean floor. This level of deposition would result in a density of approximately 19 lb per nm^2 (2.5 kg per km^2) of expended material per year over 20% of the TMAA. Eighty-two percent of the bombs would be inert, and the small amount of explosives contained in the spotting charge would be minimal. The amount of hazardous materials expended would increase from 390 lb per year under the No Action Alternative to 1,130 lb per year under Alternative 2. Alternative 2 would deposit approximately 0.13 lb per nm^2 (0.02 kg per km^2) per year of hazardous material in the TMAA. Hazardous materials are discussed in detail in Section 3.2.1.1. Explosives would leach slowly, and ocean currents would disperse leaching materials. Hazardous materials from bombs would be spread over a large area, and would break down. Explosive material would not accumulate on the ocean floor. Although this level of deposition would be a measureable increase over the No Action Alternative, the low areal density of hazardous materials would not be expected to affect water or sediment quality in the TMAA. Given the potential impacts of expended bombs under the No Action Alternative, this increase would have no measurable impact on the environment.

Table 3.2-19: Expended Materials Considered Hazardous – Alternative 2

Type of Training Material	Weight of Material (lb)[1]		Hazardous Content (%)
	Total Expended	Hazardous	
Bombs	160,000	1,130	0.70
Missiles	20,300	169	0.83
Targets and pyrotechnics	11,200	381	3.40
Naval gun shells	27,500	3,310	12.0
Small-caliber rounds	420	4.20	1.00
Sonobuoys	61,900	4,680	7.56
PUTR	2,100	0	0
SINKEX	70,000	850	1.25
Total	**352,000**	**10,500**	**2.98**

Notes: Weights of expended materials are estimates, and are rounded to three significant digits. (1) Weights of hazardous materials are based upon available information, and may not include hazardous weight of all expended materials, NA = Not applicable

Missiles

Under Alternative 2, an additional 44 missiles (66 total) per year would be used over the No Action Alternative, a 200-percent increase. The weight of expended materials from missiles would increase at the same rate, resulting in 20,300 lb (9,140 kg) of expended materials from missiles, or 2.4 lb per nm^2 (0.3 kg per km^2), deposited per year in the TMAA. Hazardous material would make up 169 lb [77 kg] per year of the expended material from missiles. The density of hazardous materials would be approximately 0.02 lb per nm^2 (less than 0.01 kg per km^2). Hazardous materials would consist of explosives from dud missiles and missile propellants. Hazardous materials are discussed in detail in Section 3.2.1.1. Explosives from missiles would not be expected to affect water or sediment quality because of the small amount of hazardous material and its low density within the training area. Since most missiles (approximately 50 percent) would not employ explosive warheads, the increase over the No Action Alternative would not have measurable effects on the TMAA marine environment.

Targets and Pyrotechnics

Table 3.2-20 shows the types and numbers of targets and pyrotechnics that would be used annually under Alternative 2.

Seventy-nine percent of the targets and pyrotechnics used under Alternative 2 would not be recovered. Unrecovered targets would deposit approximately 11,200 lb (5,040 kg) per year of expended materials in the TMAA. The density of expended targets and pyrotechnics within the affected areas would be approximately 1.3 lb per nm^2 (0.2 kg per km^2). Of the unrecovered expended materials, a large portion (about 68 percent) of expended materials would be pyrotechnics, which are mostly consumed by chemical reactions. Most of the expended materials would be relatively inert in the marine environment, with only 380 lb (170 kg) per year of expended materials considered to be hazardous, consisting of approximately 130 lb (59 kg) of residual pyrotechnic materials and 250 lb (113 kg) of batteries from EMATTs per year.

This annual increase in the amounts of hazardous materials deposited in the TMAA would be expected to have minimal effects on the marine environment because of its density (0.05 lb per nm^2 [less than 0.01 kg per km^2]). Hazardous materials would be dispersed by ocean currents, and would not be expected to be at harmful concentrations.

Table 3.2-20: Targets and Pyrotechnics – Alternative 2

Type of Target or Pyrotechnic	Number of Items		Increase Under Alternative 2	
	Alternative 2	No Action Alternative	Numerical	Percent (%)
Targets				
TDU-34 towed target	6	2	4	200
TALD*	24	8	16	200
BQM-74E unmanned aircraft	4	2	2	100
Killer Tomato surface target	24	10	14	140
SPAR	24	10	14	140
MK-39 EMATT*	40	0	40	NA
Pyrotechnics				
LUU-2B/B*	36	12	24	200
MK-58 Marine Marker*	120	20	100	500
Chaff*	424	212	212	100
Total number used	**702**	**276**	**426**	**150**
Total not recovered	**644**	**252**	**392**	**160**
Total expended weight (lb)	**11,200**	**3,610**	**7,610**	**210**

Notes: * Not recovered, NA = Not applicable. Percentages are estimates, and are rounded to two significant digits

TALD targets would not be recovered after training exercises. Under Alternative 2, TALDs would result in 48 expended thermal batteries per year (information on weight of batteries was not available). The effects of thermal batteries would be similar to those identified for lithium batteries. Batteries may contain hazardous materials, but would not be expected to have an effect on the marine environment because most hazardous constituents would be consumed during battery activity. Remaining hazardous materials would be leached slowly through the steel shell, and would not result in harmful concentrations because leached materials would be dispersed quickly by ocean currents.

Under Alternative 2, 1,080 lb (490 kg) of chaff would be used per year, an increase of 100 percent from the No Action Alternative. Chaff is generally nontoxic, and relatively inert in the marine environment. The constituents of chaff and their environmental fates are described in Section 3.2.1.1. Most of the remaining targets and countermeasures would be recovered after use, and these are constructed of mostly inert materials. Should they be lost at sea, they would become buried in bottom sediments or wash up onshore. Under Alternative 2, no measurable impact on the marine environment would result from expended chaff within the TMAA.

Naval Gun Shells

Under Alternative 2, the number of gun shells used would increase from 10,564 shells per year in the No Action Alternative to 26,376 shells per year under Alternative 2. The number of HE shells would increase from 40 under the No Action Alternative to 112 under Alternative 2. Alternative 2 would deposit 27,500 lb (12,500 kg) per year of expended materials on the ocean floor, with approximately 3,310 lb (1,500 kg) per year of that material considered to be hazardous. Approximately 3,000 lb (1,360 kg) of hazardous materials from expended shells would be tungsten in CIWS 20-mm projectiles. Hazardous materials are discussed in detail in Section 3.2.1.1.

This amount of material would be expected to have negligible effects on the marine environment because effects would be limited to the immediate vicinity of the expended rounds. Annual increases in the amounts of hazardous materials would not cause harmful concentrations of heavy metals in the surrounding water column because of their low density (0.39 lb per nm^2 [0.05 kg per km^2]) and dispersal of leaching material by ocean currents. Tungsten rounds would not have substantial effects on the marine environment because expended 20-mm rounds would have an areal density of approximately 2.4 rounds per nm^2 (0.69 rounds per km^2). Given the inert nature of these materials and their wide distribution across the study area; these increases would not have measurable effects on the environment.

Small Arms Rounds

Alternative 2 would increase the deposition rates of small arms rounds by 130 percent, from 5,000 to 11,400 rounds per year. Expended small arms rounds would weigh 420 lb (190 kg). Hazardous materials would account for approximately 4.2 lb (1.9 kg) per year of expended small arms materials. Hazardous materials from small arms rounds would have a negligible effect on the marine environment. Hazardous materials are discussed in detail in Section 3.2.1.1. Leached lead and antimony would increase the concentrations of toxic chemicals in the immediate vicinity of expended small-caliber rounds, but these substances would quickly be dispersed by ocean and tidal currents. Given the relatively inert nature of these materials, with the exceptions of lead and antimony, their small size, and their wide distribution across the study area, this increase would have no measurable impact on the environment.

Sonobuoys

Under Alternative 2, 1,587 sonobuoys would be used per year. Assuming deposition of expended materials over 20 percent of the TMAA, the increase in their annual density would be approximately 0.2 sonobuoy per nm^2 (0.1 per km^2). Sonobuoys expended during training would deposit approximately 61,900 lb (27,900 kg) of material within the TMAA each year. About 4,680 lb (2,108 kg) of expended sonobuoys would be considered hazardous materials, which would result in approximately 0.56 lb per nm^2 (0.07 kg per km^2) of hazardous material per year. Hazardous materials are discussed in detail in Section 3.2.1.1. Table 3.2-21 compares the types and numbers of sonobuoys proposed under Alternative 2 to those under the No Action Alternative. Table 3.2-22 provides the weights of hazardous constituents for sonobuoys used under Alternative 2.

Under Alternative 2, there would be a 6,500-percent increase in the amount of expended and hazardous materials from sonobuoys. However, this level of deposition of sonobuoys would have a minimal impact on marine environment because of the low density of hazardous materials (less than one lb per nm^2) per year. These materials would leach slowly, and would not result in harmful concentrations because of dispersion by ocean currents. Hazardous materials are discussed in detail in Section 3.2.1.1. As previously discussed for the No Action Alternative and Alternative 1, expended sonobuoys and their hazardous constituents would not result in adverse effects on the marine environment.

Table 3.2-21: Types and Numbers of Sonobuoys – Alternative 2

Type of Sonobuoy	Number of Items		Increase under Alternative 2 (%)
	Alternative 2	No Action Alternative	
SSQ-36 BT	120	24	400
SSQ-53 DIFAR (passive)	1,000	0	NA
SSQ-62 DICASS (active)	267	0	NA
SSQ-77 VLAD (passive)	120	0	NA
SSQ-110A IEER (explosive) or SSQ-125 AEER (Tonal)	80	0	NA
Total number used	**1,587**	**24**	**6,500**
Total weight (lb)	**61,900**	**936**	**6,500**

Notes: Numbers and weights of training items are estimates, and weights and percentages are rounded to three significant digits, NA = Not applicable

Table 3.2-22: Hazardous Materials from Expended Sonobuoys – Alternative 2

Constituent	Hazardous Material Weight (lb)		Increase under Alternative 2 (%)
	Alternative 2	No Action Alternative	
Copper thiocyanate	2,520	38.1	6,500
Fluorocarbons	31.7	0.48	6,500
Copper	540	8.16	6,500
Lead	1,490	22.6	6,500
Tin/lead plated steel	95.2	1.44	6,500
Total	**4,680**	**70.8**	**6,500**

Portable Undersea Training Range

Under Alternative 2, PUTR would require the same number of anchors (seven) to be placed on the ocean floor as under Alternative 1. Anchors would be made of concrete or sand, and would not contain any hazardous materials. Any effects on the marine environment would be the same as under Alternative 1.

SINKEX

Under Alternative 2, two SINKEX would occur, with one occurring with each summertime activity. Table 3.2-23 provides a list of ordnance used during SINKEX.

Ordnance use during SINKEX would vary, based on training requirements and training conditions. For example, a MK-48 ADCAP torpedo would only be used at the conclusion of SINKEX if the target vessel was still afloat. This analysis assumes that the greatest number of each type of ordnance would be used during 2 SINKEX events under Alternative 2. Therefore, an estimated 858 ordnance items would be expended annually during 2 SINKEX events under Alternative 2.

Table 3.2-23: Ordnance Expended Annually during SINKEX Events

Ordnance Category	Ordnance Type	Number of Items
Missiles	AGM-65 Maverick	6
	AGM-84 Harpoon	10
	AGM-88 HARM	4
	AGM-114 Hellfire	2
	AGM-119 Penguin	2
	Standard Missile-1	2
	Standard Missile-2	2
Bombs	MK-82 (inert)	6
	MK-82 (live)	14
	MK-83	8
Naval Gun Shells	5-in gun shells	800
Torpedoes	MK-48 ADCAP torpedo	2
Targets	Surface Ship Hulk	2
	Total	**858**
	Total Expended Weight (lb)	**70,000**[1]
	Total Hazardous Weight (lb)	**850**

Notes: Numbers are cumulative for two separate SINKEX events.(1) Due to the variability in weight of available ship hulks, the total expended weight does not incorporate ship hulks

These expenditures would result in approximately 70,000 lb (31,500 kg) per year of expended materials. These materials would be used in a small area, resulting in a high density of expended materials, relative to other training events. For example, if each SINKEX activity were contained within 8 nm^2 (assuming an 8-hour event and a 1.0-nm-per-hour current), then the density of deposited materials on the ocean floor would be about 4,238 lb (1,926 kg) per nm^2. Each year, two of these relatively high-density areas of expended training materials would be created.

Most of these expended training materials would be relatively inert, with approximately 850 lb (380 kg) per year of hazardous material, or approximately 425 lb (190 kg) per SINKEX event. Hazardous materials from expended ordnance would be residual explosives, propellant, and heavy metals (mostly lead). In the past, vessels used for SINKEX had most of the solid PCBs removed, leaving estimates of up to 100 lb of PCBs on board each vessel when sinking took place (USEPA 1999). These materials would be in solid forms, and would leach slowly because of their low solubility. Ocean currents would disperse leaching materials to non-toxic concentrations. Therefore, this amount of hazardous materials would not be expected to affect the marine environment.

Under Alternative 2, two MK-48 ADCAP torpedoes would be expended during SINKEX events. Most of the expended material would be relatively inert in the marine environment. Hazardous materials information on MK-48 ADCAP torpedoes is confidential, but torpedoes (in general) could contain explosives, heavy metals, and propellants (OTTO Fuel II). Explosives and propellant would be mostly consumed during torpedo activation and detonation. Heavy metals would be in solid forms, and would leach at a slow rate because of natural processes (encrusting). The low number of torpedoes used under Alternative 2 would not result in substantial effects to the marine environment.

Alternative 2 would expend two surface vessels per year during SINKEX events. For SINKEX, the vessels used as targets are selected from a list of U.S. Navy approved vessels that have been cleaned in accordance with USEPA guidelines. By rule, SINKEX can only be conducted at least 50 nm (93 km) offshore and in water at least 6,000 feet (1,830 m) deep (40 CFR §229.2). USEPA considers the contaminant levels that would be released during the sinking of a target to be within the standards of the

Marine Protection, Research, and Sanctuaries Act (16 U.S.C. 1341, et seq.). As with other inert materials, the vessel would become encrusted by chemical processes and biological organisms. Therefore, vessels used as targets would not pose a hazard to ocean water resources.

Summary –Alternative 2 Effects

Under Alternative 2, there would be an increase in the number and weight of expended materials in the TMAA. Over 91 percent of the expended items would be naval gun shells or small arms rounds. The weight of expended materials under Alternative 2 would increase to 352,000 lb (160,000 kg) per year (360-percent increase over the No Action Alternative), with the largest percentage increase from expended sonobuoys. Navy training under Alternative 2 would deposit approximately 41 lb of expended material per nm^2 (5.4 kg per km^2) per year over 20 percent of the TMAA. Assuming Navy training under Alternative 2 would remain consistent over periods of five and 20 years, the Navy would expend approximately 880 tons (209 lb per nm^2 [27.5 kg per km^2]) and 3,520 tons (835 lb per nm^2 [110 kg per km^2]) of training material in the TMAA, respectively. Expended bombs would account for most of the weight of expended materials, but the majority of this weight would be relatively inert material used as filler for practice bombs, such as concrete or sand. Under Alternative 2, approximately 10,500 lb (4,770 kg) per year of hazardous material would be expended (Table 3.2-19). Assuming deposition of expended materials on 20 percent of the TMAA, the density of deposited hazardous materials would be approximately 1.2 lb per nm^2 (0.2 kg per km^2) per year.

Alternative 2 would also include up to two SINKEX training activities per year. Materials expended annually during both SINKEXs are provided in Table 3.2-23. Target vessels expended during training would be cleaned according to USEPA standards, and would be relatively inert in the marine environment. Approximately 70,000 lb (31,500 kg) of ordnance would be expended annually, with approximately one percent consisting of hazardous materials. The majority of materials expended during SINKEX training would be inert in the marine environment. Solid PCBs would be removed to the maximum extent practicable, but some vessel materials with PCBs would remain on board when the vessel in sunk (approximately 100 lb per vessel [USEPA 1999]). SINKEX training would result in a relatively high areal density of expended and hazardous materials, within those portions of the TMAA used for this activity, compared to the overall areal density within the TMAA that would result from all other training exercises under Alternative 2.

3.2.3 Mitigation

As summarized in Section 3.2.4, the alternatives would contribute small amounts of hazardous materials to the environment. Given the large size of the training area and the expected fate and transport of the constituents, hazardous materials released to the environment by the Proposed Action are not likely to be present at detectable concentrations. Current Navy protective measures, such as hazardous waste management procedures, identified in Section 3.2.1.2, would continue to be implemented. No additional mitigation measures would be required under the Preferred Alternative.

3.2.4 Summary of Effects

Table 3.2-24 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 in terms of expended materials, including hazardous materials, under both NEPA and EO 12114.

Table 3.2-24: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	Executive Order 12114 (Non-U.S. Territorial Seas, >12 nm)
No Action Alternative	• Current Navy activities were considered and are consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). No significant impacts related to expended materials will occur. • Aircraft overflights will not involve expenditures of training materials.	• Approximately 76,200 lb (34,600 kg) of training materials will be expended per year, with a density of 9.0 lb per nm^2 (1.2 kg per km^2) per year. Over 97 percent of the expended items will be naval gun shells or small arms rounds. • Approximately 1,870 lb (850 kg) of hazardous materials would be distributed at an estimated 0.22 lb per nm^2 (0.03 kg per km^2) per year. • Expended materials under the No Action Alternative will not have a substantial effect on the environment.
Alternative 1	• Under Alternative 1, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). No significant impacts related to expended materials would occur. • Aircraft overflights would not involve expenditures of training materials.	• Increase in training would deposit approximately 143,000 lb (65,000 kg) of expended materials, with a density of 16.9 lb per nm^2 (2.23 kg per km^2) per year. Over 93 percent of the expended items would be naval gun shells or small arms rounds. • Approximately 4,890 lb (2,220 kg) of hazardous materials would be distributed at an estimated 0.58 lb per nm^2 (0.08kg per km^2) per year. • Expended materials under Alternative 1 would not have a substantial effect on the marine environment.

Table 3.2-24: Summary of Effects by Alternative

Alternative	NEPA (U.S. Territorial Seas, 0 to 12 nm)	Executive Order 12114 (Non-U.S. Territorial Seas, >12 nm)
Alternative 2 (Preferred Alternative)	• Under Alternative 2, Navy activities were considered and would be consistent with those analyzed in the previous environmental documentation (USAF 1995, USAF 2007, Army 1999, Army 2004). No significant impacts related to expended materials would occur. • Aircraft overflights would not involve expenditures of training materials.	• There would be an increase in the weight of expended materials (352,000 lb [160,000 kg]). Over 91 percent of the expended items would be naval gun shells or small arms rounds. • Hazardous materials would account for 2.98 percent (10,500 lb [4,770 kg]) per year of expended material, but density of these materials would be approximately 1.2 lb per nm^2. • SINKEX training would result in approximately 70,000 lb per year of expended materials, of which one percent would be considered hazardous. SINKEX would result in a relatively high areal density of expended materials on portions of the TMAA. • Expended materials under Alternative 2 would not have a substantial effect on the marine environment.

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