

# Letter Health Consultation

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NAVAL AIR ENGINEERING STATION

LAKEHURST, NEW JERSEY

DECEMBER 21, 2016

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Agency for Toxic Substances and Disease Registry  
Division of Community Health Investigations  
Atlanta, Georgia 30333

## **Health Consultation: A Note of Explanation**

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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LETTER HEALTH CONSULTATION

NAVAL AIR ENGINEERING STATION

LAKEHURST, NEW JERSEY

Prepared By:

U.S. Department of Health and Human Services  
Agency for Toxic Substances and Disease Registry  
Division of Community Health Investigations



DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

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**SUBJECT: Letter Health Consultation Concerning the 2003 Public Health  
Assessment Recommendations.**

Dear Sir or Madam:

This letter is a follow-up to the 2003 Agency for Toxic Substances and Disease Registry (ATSDR), Public Health Assessment (PHA) for the Naval Air Engineering Station, Lakehurst, New Jersey (Lakehurst). The US Department of Navy and US Department of Defense (DoD) requested that ATSDR evaluate Lakehurst-related information that has become available since our 2003 PHA in order to update our findings and recommendations. Several DoD programs have addressed many of the issues brought up in our 2003 PHA. However, we continue to be concerned that the public or even some base-workers might not be fully aware of the hazards associated with older legacy munitions.

ATSDR has reviewed munitions response program reports, Congressional testimonies, and other writings from military and civilian leaders and used this information to update our 2003 public health findings and recommendations on munitions and explosives of concern (MEC). We will refer to chemical and conventional MEC used prior to the end of World War II as legacy munitions.

We have provided DoD representatives with several references that cite evidence of legacy munition use. On March 4, 2015, we conferenced with Joint Base McGuire-Dix-Lakehurst (JBMDL) and Air Force experts to discuss the base-activities that are related to that evidence and they provided additional reports published since 2003. We followed up on November 9, 2015 with suggestions on how the combined munitions-related information can be used by land-use experts.

Based on our review of the munitions-related information (Table 2), we remain concerned that contractors, construction crews, and others might inadvertently unearth legacy munitions or spread munition compounds to the environment. Some DoD reports include maps identifying areas where munitions are known along with other areas unmarked [JBMDL 2015; MMRP 2005; NESO 1982]; we do not want visitors to unmarked areas to assume that they are entirely risk free. ATSDR believes that individuals visiting those unmarked areas might be harmed from exposure to chemical or physical hazards and that the risk will be minimized with continued awareness.

## *Background and Statement of Issues*

Beginning in World War I, large areas at the base were used for munitions and chemical weapons storage, disposal, testing, or training. Since that time, Lakehurst was used for storage, training or testing of munitions by military and civilian organizations. The boundaries of some of these historical use or disposal areas are uncertain or unknown. MEC and/or hazardous chemicals might be released from legacy munitions and disposal sites. The following reports and actions were completed and taken into account: ATSDR published a PHA in 2003; the Military Munitions Response Program's (MMRP) preliminary assessments occurred in 2005 and 2006; and then Base Realignment and Closure (BRAC) of 2005 was implemented in 2009.<sup>1</sup> DoD protective work continues on site, including inspection of the former Lakehurst Proving Grounds and Bombing Targets [Tetra Tech; NAVFAC 2012].

## *Discussion*

### *What did we find?*

Since the 2003 PHA and the 2006 MMRP report, additional munitions have been found on-base. Newly found records identify three locations where munitions have been or might be found off base to the north, south, and west of the current JBMDL-Lakehurst area (see note of explanation under Figure 1). Additional military records and congressional testimony identify larger live-fire areas outside and inside the current base boundaries where munitions may potentially be encountered. The following figures and tables provide some details shared with our DoD liaisons and your munitions program experts:

- Figure 1 shows the current JBMDL-Lakehurst and the 1918 Lakehurst Proving Ground boundaries and the ATSDR Suggested Munitions Legacy Areas Awareness Zones.
- Figure 2 shows the result of the 2013 US Army Corps of Engineers reassessment of the 1918 proving ground boundaries.
- Figure 3 shows the current JBMDL sweep and caution areas.
- Table 1 lists the three recommendations from the 2003 PHA, actions taken, and results.
- Table 2 identifies areas of potential legacy munition areas of concern for 1915–2006.
- Table 3 provides additional references.

The 2008 radiation survey of the Boeing Michigan Aeronautical Research Center (BOMARC) transportation routes did not identify radiation impact and verified that no radiation at levels of health concern currently exist [Cabrea 2008]. Therefore, it is unlikely that deer meat will have plutonium at levels of health concern from the former BOMARC fire.

There are two general issues that can be used by DoD in developing education material and/or munitions awareness exercises:

- 1) **Legacy munitions awareness zones need to be broadened:** Since 1945, munitions have been found, especially when soil was disturbed. Response and removal at known locations have occurred, but new discoveries cannot be fully ruled out. Frost-heave has brought 75 millimeter shells and smaller munitions to the surface [Malcolm Pirnie 2006; Henry 2004]. Munitions were unexpectedly found in other areas expected to be cleared of munitions [Malcolm Pirnie 2005,

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<sup>1</sup> Naval Air Engineering Station Lakehurst was originally listed on the US Environmental Protection Agency's National Priorities List (NPL) as Naval Engineering Center Lakehurst. ATSDR's PHA for the site was finalized on July 20, 2003. As a result of the 2005 BRAC decision, the Naval Air Engineering Station became part of Joint Base McGuire-Dix-Lakehurst (JBMDL) on October 1, 2009.

2006; NEESA 1982]. JBMDL's current UXO Awareness Guide (Figure 3, [JBMDL 2015]) does not include all areas where munitions have been found-[JMDL 2012]; nor does it include all areas off base where LIDAR, aerial photos, and archived reports, indicate suspected munitions activities [USACE & SKY 2012a, MMRP 2015, etc. (see Table 2)]. We understand that Figure 3 provides an on-base focus, but it might inadvertently imply that areas outside the markings are entirely munitions free.

- 2) **Education outreach needs to include more stakeholders:** Because visitors and contractors can access many areas, they should be included in all education efforts. Community members and base personnel have access to on and off base legacy areas and should be informed of the potential hazards in both areas. Thus, we recommend that all persons who do any land disturbance activities be informed of the potential hazards, to include areas not currently requiring a dig permit. Figure 1 identifies ATSDR's recommendation for legacy munition awareness areas.

### *Who might be affected?*

Persons and groups who use or visit on-base or off-base legacy munitions areas (see Figure 1) are potentially at increased risk and include the following:

- Resident families and students;
- Anglers, hunters, hikers, campers, and other visitors;
- Military personnel and civilian staff;
- Contractors;
- Utility and landscape workers and road crews; and
- Explosive Disposal Ordnance (EOD) teams, emergency responders, and medical teams.

While not demonstrated to have occurred at Lakehurst to date, there is a future risk to persons using water drawn from locations near where legacy munitions have detonated or have released hazardous substances.

### *How might persons be harmed?*

Conventional munitions and debris continue to be found. No chemical agent releases or exposures are documented to have occurred since chemical warfare testing ended in 1921. Releases could occur from currently undiscovered munitions and disposal sites. If detonation or release occurs, there is a potential for these pathways of exposure:

- Direct contact;
- Soil and sediment;
- Outdoor and indoor air; and
- Under unique situations, surface water, ground water, drinking water, and food.

### *Here are the locations of potential risks*

All legacy areas are possible locations to find surface and buried intact chemical, explosive, and incendiary materials. We recognize that the risks in some areas are much lower and that the area involved is large, but these issues remain:

Documented legacy munition use extends beyond the six areas currently being investigated within the 2,617 acres of the 7,430+ JBMDL-Lakehurst. In fact, the Chemical Warfare Service used 17,345 acres during 1918–1921 [See Table 2 references]. Portions of the area were used before and after this period for one or more civilian and military legacy munition activities [NESO 1982;

Baldwin Locomotive Works, 1923]. The outer proving ground boundaries, which changed over time, were reportedly used as chemical warfare research and proving ranges and might also have been used by civilian organizations for munitions proving [Fries, 1922b, Siebert 1919]. Thus, MEC might be present within 1 mile north, south, and west of the identified boundaries (Figure 1).

Note that Figure 1 depicts similar 1918 proving ground boundaries as developed by the US Army Corps of Engineers (Figure 2, USACE 2013). Additional boundary differences are associated with the uncertainty we found in other references.

### Limitations and Unknowns

We have found several references with examples of legacy munitions use. In many cases the location identified is quite general (e.g., Lakehurst Proving Ground). Figure 1 is a map with an awareness zone that includes some of the known locations listed in Table 2. ATSDR created a buffer around the 1918 proving ground boundaries to address some uncertainty or discrepancies found in the specific references. Additional information/justification as to how the buffer was established is explained below the Figure 1. Figure 1 can be used to develop an awareness map that can be shared with all stakeholders, along with other education materials.

Three of the specific issues of additional uncertainty include:

- 1) There is a discrepancy in the actual size and shape of the legacy munitions use areas:

*For example, documents from the first Commanding Officer of the proving ground identify it (in 1918) as 4 miles wide and 5 miles long; and congressional testimony by the Chief of the Chemical Warfare Service describes it as also having various boundary ranges.*

The following is a list of command staff Congressional testimony which indicate munitions were released or fired onto property outside of the current base fence line [March 1919; Sibert 1919; [Fries, 1922a & b]:

- Major General Peyton March, Army Chief of Staff, March 1918 to June 30, 1921.
- Major General William Luther Sibert, 1st Chief of Chemical Warfare Service 1918 -1920.
- Major General Amos Alfred Fries, 2nd Chief of Chemical Warfare Service 1920 - 1929.

- 2) Proving-ground boundaries changed over time; which resulted in imprecise reporting of chemical release and artillery impact area locations:

*For example, there are documented chemical release points along the 1918 and 1921 boundaries. The Chemical Warfare Service used these areas during 1919–1921. The boundaries differed by at least 2000 acres between 1918 and 1921. A 1919–1921 Chemical Warfare Service 15,000 yard range (over 8.5 miles) as well as multiple 6 mile 16,000 acre boundary ranges were used for testing or research for legacy munitions. A total of 17,345 acres were controlled and used by the Chemical Warfare Service between 1918 and 1921. This included all current areas of JBMDL-Lakehurst, portions of JBMDL and a part of the current JBMDL-Fort Dix and off base areas. Furthermore, a more recent assessment estimates an additional 1,680 acre disparity to the 1918 boundary [USACE 2013]. We expect that the 1,680 acres is part of the 17,345 acres, but the disparity exists between the various references. Additionally, we expect that many areas were not fired upon, but those bounds are also uncertain. The 1921 proving ground boundary has not yet been identified by the Formerly Used Defense Sites (FUDS) program.*

3) Some landmarks change over time:

*For example, a cranberry bog and dam were reportedly damaged by white phosphorus in the 1920s with no other description of location. The locations of some roads used for legacy munitions movement on and off installation have changed as have locations of bogs and dams.*

Location of all MEC found has not been mapped. MMRP remedial investigation states that numerous discoveries of munitions debris and MEC throughout Lakehurst have been documented by installation personnel from 1945 through 2006. The exact number, location, type, amount and condition have not all been mapped or identified in references provided or found by ATSDR.

### Conclusions

- 1) A lot of work has been done to reduce the legacy munitions risk in many areas. However, no area should be considered entirely munitions free. Harm from chemical and physical hazards might result from one or more of the following: fragmentation, blast effects, fires, conventional munitions gases, and chemical warfare agents, tear gases or from encountering energetic materiel, incendiary chemicals, or toxic breakdown products during and after soil disturbance activities. A wide range of exposures are possible that might result in various potentially harmful health outcomes.
- 2) Many military programs within the DoD have taken several steps toward reducing risk from contaminated areas as well as several legacy munitions use areas, many of these are related to the areas cited in Table 2 [JBMDL 2012; 2014]. Table 1 lists updated recommendations and conclusions, including accomplishments relative to the 2003 PHA.

### Recommendations

ATSDR recommends specific actions to be incorporated into DoD's overall MEC (legacy munitions) risk reduction plan. We recognize that different military programs are responsible for specific actions. Our recommendations to the DoD should be carried out by the appropriate uniform service program.

1. ATSDR recommends that all stakeholders (on- and off-base) be aware of and prepared for the possibility of encountering chemical and conventional munitions in all legacy munitions use areas.
2. ATSDR recommends that JBMDL provide all the MEC risk awareness information on their website. Include that no area should be considered entirely risk free, but some areas with higher risk are known. Anyone who plans to use such areas, especially to dig, drill, dredge, or otherwise disturb soil, needs to consider the possible hazards.
3. ATSDR recommends that off-installation issues associated with Formerly Used Defense Sites (FUDS) eligible properties be referred to the US Army Corps of Engineers to address possible conventional and chemical MEC with off-installation stakeholders.
4. If a release from legacy munitions is suspected, ATSDR recommends that any nearby private and public water supplies be protected from and monitored for munitions-related compounds.
5. If a release from legacy munitions is suspected, ATSDR recommends that the local groundwater be protected and monitored as appropriate.

We understand that MMRP and NPL programs/activities are ongoing. ATSDR has provided additional information to the MMRP project managers and is available to continue to provide public health input throughout the cleanup and clearance process.

Thank you for including ATSDR in your site work. My point of contact for technical information in this letter is Charles Grosse. Please do not hesitate to contact him if you have any questions or concerns. He can be reached at (770) 488-0763 or by email at [CGrosse@cdc.gov](mailto:CGrosse@cdc.gov).

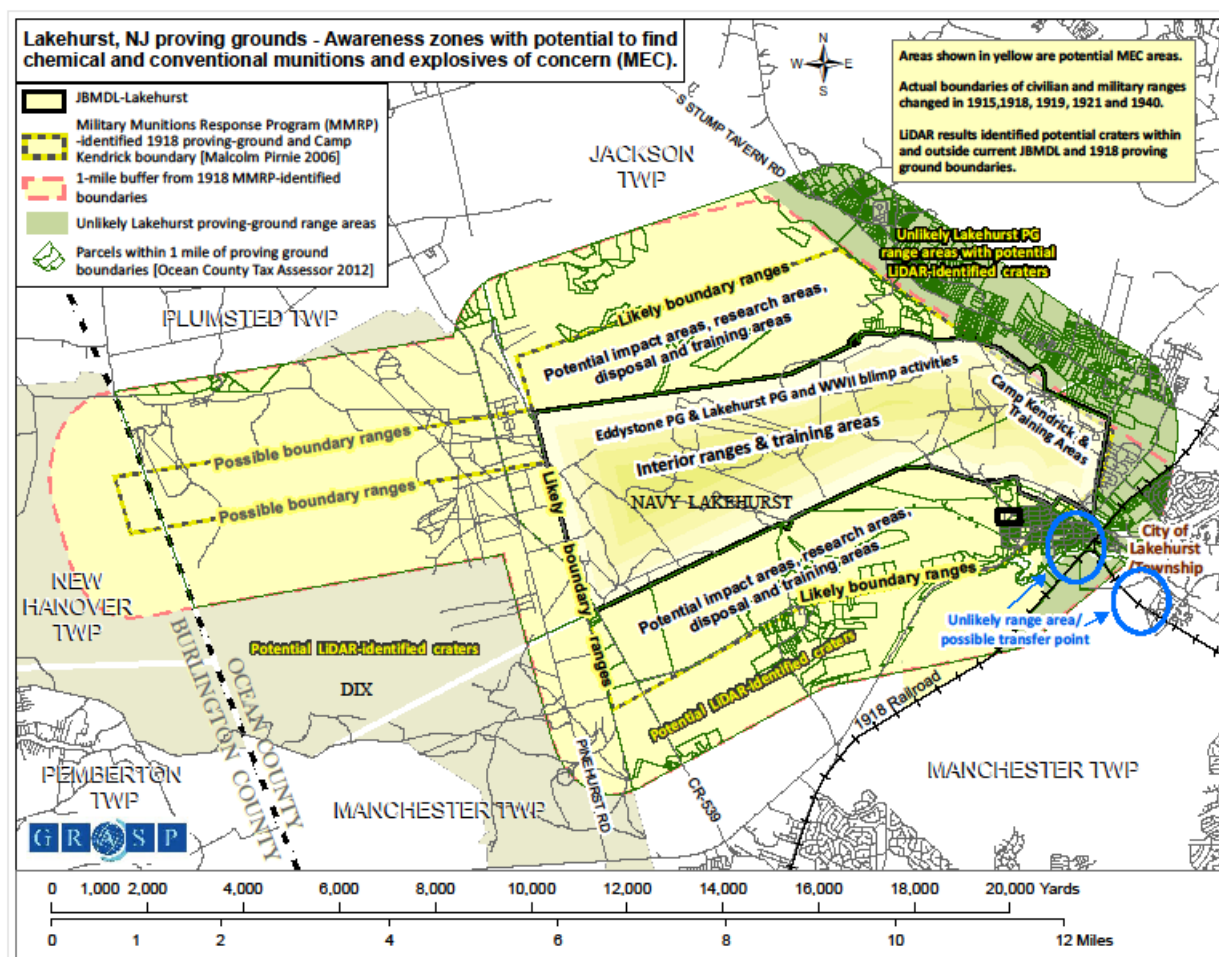
Sincerely,

A handwritten signature in blue ink, appearing to read "Ileana Arias (for)".

Ileana Arias, PhD

Director

Division of Community Health Investigations



**Figure 1 – Current and the 1918 Naval Air Engineering Station Lakehurst Boundaries and Agency for Toxic Substances and Disease Registry Suggested Munitions Legacy Areas Awareness Zones for the Lakehurst Proving Ground Areas Associated with Joint Base McGuire-Dix-Lakehurst (JBMDL), New Jersey.**

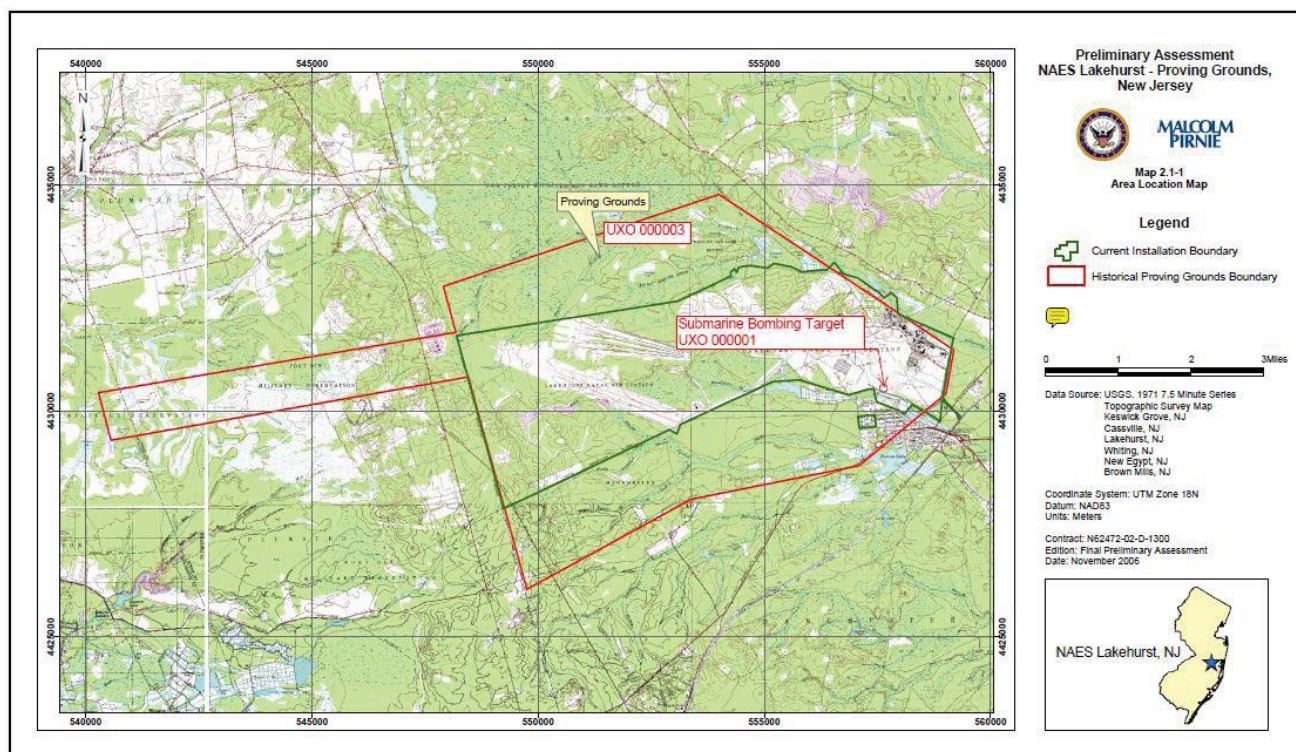
Note of Explanation: The ATSDR's suggested munitions legacy area awareness zone was created by taking the 1918 Lakehurst Station boundary [USACE 2013] and then adding a 1-mile buffer around it, including portions of what is now Fort Dix. The one-mile buffer was selected in part because of the reported incidences of munitions landing beyond the 1918 station boundary:

- Fire caused by a booster was reported 1 mile west of the "former proving ground boundary" [NYT 1940].
- A white phosphorus round resulted in a June 2, 1920 cranberry bog fire some distance beyond the proving ground boundary [US Congress 1922; US Congress 1923].

In addition, General Sibert testified that artillery shells containing chemical agents were fired at the upwind edge of the 1918 proving ground boundary so the resulting chemical agent plume could drift no more than 6.5 miles to avoid having the gas drift into the Lakehurst community [Sibert 1919]. The

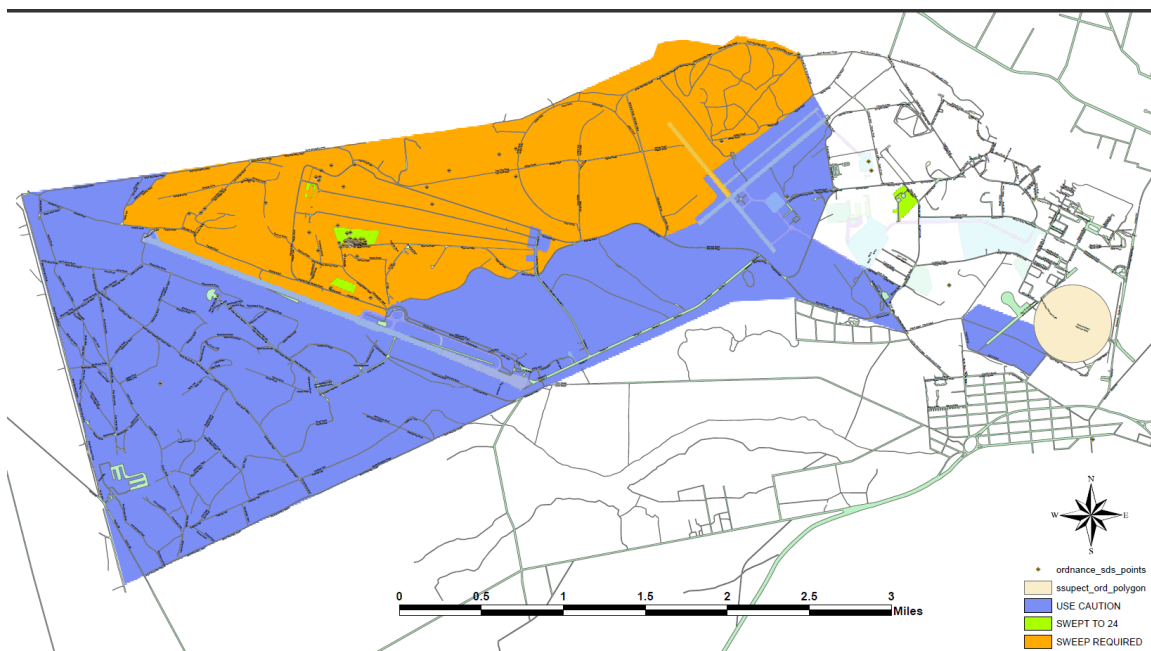
northwest and southwest edges of the ATSDR suggested one-mile awareness buffer is roughly 6.5 miles from Lakehurst.

Given that the range of a 155 millimeter gun was about ten miles [War Office 1921] and the distance from the known firing points to the known range edges is two to nine miles, there was a potential for overshoot beyond the historical range boundaries. Photographic and LIDAR overflight results may indicate the presence of craters beyond the 1918 Lakehurst Station boundary [Malcolm Pirnie 2006 and USACE & Sky 2012a & b).



**Figure 2 - 1918 Lakehurst Proving Grounds, New Jersey, Boundaries, as Identified in 2013 by the US Army Corps of Engineers [USACE 2013].**

Note of Explanation: The red line is the reconstructed 1918 proving-ground boundary and the green line is the current boundary. There are over 8,000 acres outside the current boundary that were proving grounds in 1918. The outside area includes two State of New Jersey Wildlife Management Areas (WMA), Colliers Mills WMA and Manchester WMA to the south. The south parcel also includes residential areas in the town of Lakehurst. Residential buildings are located along the north, east, and south boundaries [USACE 2013]. The 1919-1921 16,000 acre boundaries have not been identified, but is larger than in 1918 [Fries 1922a]. The small green rectangle outside of main base is a contractor managed military housing area. Recent MEC reports of former Lakehurst proving grounds and bombing targets did not identify boundaries of all munitions use sites [Tetra Tech, NAVFAC 2012; Malcolm Pirnie 2006].



**Figure 3 - Current Joint Base McGuire-Dix-Lakehurst (JBMDL), New Jersey, Map that Identifies Lakehurst Sweep and Caution Areas March 2015 [JBMDL 2015]**

1. A Geobase System, maintained by 87th Air Base Wing, is a geographic information system (GIS) containing all the information amenable to presentation in map format for JBMDL.
2. The Dig Permit process at JBMDL is accomplished through the generation of a Base Civil Engineering Work Clearance Request (Form AF IMT 103). Section 8F, "Environmental" of AF IMT 103 provides opportunity for the Environmental Division to review environmental constraints, particularly the location of known contaminated sites. The facility has posted warning signs along the main roads and paths entering areas suspected to contain munitions.
3. Contractors and workers whose work involves intrusive activities like excavation or digging on areas suspected to contain munitions must obtain permits requiring qualified explosive ordnance disposal (EOD) personnel to survey and clear areas before any digging or excavations begins.
4. Hunters (only) are required to attend a UXO training course every year before obtaining a hunting license for the facility.

**Table 1: 2003 Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment (PHA) Recommendations and Whether Department of Defense (DoD) Follow-Up Has Addressed those Recommendations or Whether New Information has Resulted in a Change to ATSDR's Original 2003 Conclusions**

**Joint Base McGuire-Dix-Lakehurst (JBMDL), Lakehurst, New Jersey**

#	Original ATSDR Recommendations	Was DoD Action Taken? By Whom? When?	Has the information Obtained Since the 2003 PHA Resulted in a Change in ATSDR's Conclusions and Recommendations? If Yes, Explain.
1	As new information becomes available, NAES Lakehurst should continue to update materials used to inform base residents about the hazards associated with disturbing unexploded ordnance (UXO) and chemical warfare materiel (CWM).	Yes, NAES Lakehurst and JBMDL have met ATSDR's recommendations by continuing to update munitions and explosives of concern (MEC), educational materials and educational programs.	No, for on base areas  Yes, for off base areas  All legacy areas, including areas not within the current JBMDL boundaries, should have educational programs in place. Only six on-base areas are being investigated by the Air Force Military Munitions Response Program. Off-base investigations have recently begun and FUDs recognized that off base areas are within their program.
2	NAES Lakehurst should continue administrative controls indefinitely for all portions of the base that have not been otherwise cleared as safe for unlimited access and use.	Yes, for some of the areas on base. The Air Force investigated six sites and is prioritizing as appropriate. Actions have been taken for six sites on 2,617 acres of the 7,430+-acre Lakehurst portion of MDL Navy and Air Force (site lead w/EPA and NJ oversight); ongoing.	No, for current on base areas  Yes, for current off base areas  All legacy areas (on and off base) should have administrative programs in place. Six on base areas are being investigated by the Air Force Military Munitions Response Program
3	Persons concerned about plutonium exposures from eating deer meat should receive health education. (This recommendation in the 2003 PHA was due to public concern).	Yes, Navy and Air Force (site lead w/EPA and NJ oversight); ongoing  NAES Lakehurst has met and exceeded the recommendations by their educational materials. ATSDR continues to recommend that people concerned with metals exposure should not consume certain organs (liver, kidney) and/or eliminate the use of bones (in stews and soups).	Yes, the 2008 Lakehurst radiation survey of the BOMARC transportation routes found no impact of radiation and verified that no radiation at levels of health concern currently exist. This also reinforces that deer meat is unlikely to have plutonium at levels of health concern.  While plutonium in deer continues not to be a concern, ATSDR continues to recommend that the public follow NAES Lakehurst guidelines for not consuming certain organs and bones, as it should reduce potential exposures to any possible heavy metals.

**Table 2 Areas of Potential Conventional and Chemical Munitions and Explosives of Concern (MEC)**

*Identified and unidentified boundaries indicate the need for awareness and vigilance during soil disturbance activities. This includes all areas in the Former Proving Ground and the Training Camp Legacy Munitions Areas on and off Joint Base McGuire-Dix-Lakehurst (JBMDL), New Jersey.*

<b>Year</b>	<b>Group, organization, or command for legacy munitions or chemical agent use</b>	<b>Potential Use Area Location (Please See Maps in [Malcolm Pirnie 2005; 2006; NEESA/OESO/WES, ND]; [NESO, 1982 and ATSDR 2003 PHA for land areas with known locations and possible boundaries].)</b>	<b>Reference</b>
Leased in 1915 to December 1917	Eddystone Ammunition Corporation (EAC)	Malcolm Pirnie (2005; 2006) identifies areas leased from Manchester Land Company. Lease areas 1, 2, and 4.  Last shot was fired December 24, 1917.	[Baldwin Locomotive Works, 1923] [Malcolm Pirnie 2005;2006] [NEESA/OESO/WES, ND] [NESO, 1982] <a href="#">[PSM,1918] Popular Science Monthly.</a> [Knight, 1919]
1915 to December 1921	Eddystone Ammunition Corporation (EAC), Trench Warfare Service (TWS), Chemical Warfare Service (CWS).	14,000+ acres, including Eddystone lease areas, are suggested as use area locations in Congressional testimony. The 2000-acre Eddystone lease # 3 appears to extend into Fort Dix Areas. Eddystone lease # 3 might have been used by Eddystone and Bureau of Mines/TWS and CWS.	[Malcolm Pirnie, 2005;2006]
Early 1918– June 25, 1918	Bureau of Mines (BM) and Trench Warfare Section (TWS), Army Ordnance Department, Edgewood Arsenal Experimental Grounds, Lakehurst	14,000+ acres (14,950), including 303 acres of damaged land within the Manchester Land Company-leased area and 35 acres of damaged trees near trench number 2.	<a href="#">[Le Sueur, 1918]</a> <a href="#">[Manning, 1919]</a> <a href="#">[Bacon, 1919]</a> <a href="#">[Bacon, 1919–1920]</a> <a href="#">[Hampton, 1918]</a> <a href="#">[Grier, 1919]</a> <a href="#">[Knight, 1919]</a> [Malcolm Pirnie, 2005; 2006]
July–Oct 1918; April 15, 1919	CWS and groups listed above	There were 1,500 men operating the 14,000 acre Lakehurst Proving Ground. Camp Kendrick areas, including 733.56-acre area used first by 1,300 and then 3,400 men for offensive and defensive training and then demobilization of American Expedition Force (AEF) CWS combat troops. Reportedly, 300 men from 1918 Camp Dix participated repeatedly in gas mask test that used chemical warfare agents, 40 were hospitalized in one test with toxic smoke but all recovered.  Major General William Luther Sibert, 1st Chief of Chemical Warfare Service identified that chemical agents were released along the proving ground boundaries. Chemical agents from artillery shells and cylinders were blown by the wind outside of proving ground boundaries during the war according to Testimony of General March, Army Chief of Staff.	<a href="#">[Sibert, 1919]</a> <a href="#">[Fries, 1921b]</a> <a href="#">[Fries 1922a]</a> <a href="#">[Crowell,1919]</a> <a href="#">[March, 1919]</a> <a href="#">[War Department, 1917]</a> <a href="#">[USACE 1918a]</a> <a href="#">[USACE, 1918b]</a> <a href="#">[Le Sueur, 1918]</a> <a href="#">[CWS, 1918]</a> <a href="#">[The Sun 1919]</a> <a href="#">[War Department, 1920]</a> <a href="#">[Snowden and Cutler, 1920]</a> <a href="#">[Yale, 1922]</a> <a href="#">[CCA,1948]</a> <a href="#">[War College, 1949]</a>
1918–1919 (reference date incorrectly listed as 1918 instead of 1920.)	CWS Lakehurst Proving Ground and CWS Camp Kendrick Areas	1,345.5 acres of land purchased Navy Department's Dirigible Balloon Experimental Station, including 733.56 acres from Bricksburg Land and Improvement Company and 611.94 acres from Manchester Land Company	<a href="#">[War Department, 1920]</a> [Malcolm Pirnie, 2005; 2006]

**Table 2 Areas of Potential Conventional and Chemical Munitions and Explosives of Concern (MEC)**

*Identified and unidentified boundaries indicate the need for awareness and vigilance during soil disturbance activities. This includes all areas in the Former Proving Ground and the Training Camp Legacy Munitions Areas on and off Joint Base McGuire-Dix-Lakehurst (JBMDL), New Jersey.*

<b>Year</b>	<b>Group, organization, or command for legacy munitions or chemical agent use</b>	<b>Potential Use Area Location (Please See Maps in [Malcolm Pirnie 2005; 2006; NEESA/OESO/WES, ND]; [NESO, 1982 and ATSDR 2003 PHA for land areas with known locations and possible boundaries].)</b>	<b>Reference</b>
November 1918–1921	CWS	Post-war 16, 000 acres, including some of 14,000+ WWI areas.  Major General Amos Alfred Fries, 2nd Chief of Chemical Warfare Service identified that 16,000 acre boundaries were used so that chemical agents could drift 6 miles.	<a href="#">[Fries, 1922a &amp; b]</a>
1920 or 1921	CWS	Currently unidentified cranberry bog and dam inadvertently damaged by white phosphorus associated with Lakehurst CWS testing.	<a href="#">[US Congress, 1922]</a> <a href="#">[US Congress, 1923]</a>
1940	Not known	Unidentified 1940 UXO-initiated off-installation area forest fire- one mile west of 1940 Navy Lakehurst west of the old proving ground.	<a href="#">[NYT, 1940]</a>
1940–1942	American Armament Corporation (AAC)	Northern and southern boundaries not identified. Might have been within the 17,345 acres boundaries used previously by CWS during 1918–1921.	[Malcolm Pirnie, 2005; 2006] [NEESA/OESO/WES, ND] [NESO, 1982]
1942	Eddystone Ammunition Corporation (EAC), Bureau of Mines and Trench Warfare Section, CWS, American Armament Corporation, Navy	5,892 acres of proving ground purchased for Naval Air Station (NAS) Lakehurst	<a href="#">[NAES L, 2009b]</a>
1939–1945	Navy	Currently unidentified munitions use areas to support training, combat, and defensive operations of blimps to patrol the Atlantic coast and to escort convoys.	[NEESA/OESO/WES, ND] [NESO, 1982]
1997	Eddystone Ammunition Corporation (EAC), Bureau of Mines and Trench Warfare Section, Chemical Warfare Service, Navy	MEC was found in an area documented to be used as a transportation corridor for military personnel.  Residential area southeast of installation ranges identified in the 2006 report outside of the installation but in the 14,000+ acre legacy boundary.	[Malcolm Pirnie, 2006] Map 5-1.3
2003	CWS or American Armament Corporation (AAC)	NJDEP identified crater locations on and off installation craters locations. Location identified inside and outside of the WWI 14,000+ acre legacy boundary.	[Malcolm Pirnie, 2006] Map 5-1.2

Table 3. References

**A**

- [Air Force 2003] Secretary of the Air Force. May 29, 2003. Air Force Manual 10-2602: Operations, Nuclear, Biological, Chemical, And Conventional (NBCC) Defense Operations And Standards. Available digitally on the AFDPO WWW site at: <http://www.e-publishing.af.mil> .
- [ATSDR 2003] Agency for Toxic Substances and Diseases Registry. July 7, 2003. [Public Health Assessment for Naval Air Engineering Center, Lakehurst \(a/k/a Naval Air Engineering Station, Lakehurst\), Lakehurst, Ocean County, New Jersey. Atlanta, GA: US Department of Health and Human Services. http://www.atsdr.cdc.gov/hac/pha/navalengineering070703nj/naionalengineering062403.pdf](http://www.atsdr.cdc.gov/hac/pha/navalengineering070703nj/naionalengineering062403.pdf)
- [Bacon, 1919] Bacon WS.1919. Colonel, CWS Chief, Proving Division, [Contributions from the Chemical Warfare Service, U.S.A.](#) In: The Journal of Industrial and Engineering Chemistry. Pp. 513–516. Received April 1919, published June 1919. American Chemical Society Legacy Archives.

**B**

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