Comments on the
Final Proposed Plan for South Test Area/Bomb Test Area, LHAAP-001-R and
Ground Signal Test Area, LHAAP-003-R, Longhorn Army Ammunition Plant,
Karnack, Texas, June 2011

George Rice
June 27, 2011

These comments were prepared for the Caddo Lake Institute. They are based on
evaluations of the final Proposed Plan for South Test Area/Bomb Test Area, LHAAP-
001-R and Ground Signal Test Area, LHAAP-003-R, and supporting documents (see
references).

Site History and Setting

The Longhorn Army Ammunition Plant (LHAAP) is on the southwestern shore of Caddo
Lake, near the towns of Karnack and Uncertain, Texas. Between 1942 and 1997,
explosives (TNT, black powder), pyrotechnic devices (flares, photoflash bombs), and
propellants (rocket motors) were manufactured at LHAAP. Materials used to
manufacture these products included toluene, acids (hydrochloric, nitric, sulfuric),
ammonium perchlorate, powdered metals (e.g., aluminum, magnesium), sodium nitrate,
rubber binders, lubricants, PCBs, and solvents (e.g., methylene chloride, TCE).

LHAAP once occupied approximately 8400 acres. The Army has transferred
approximately 7200 acres to the U.S. Fish and Wildlife Service for use as a wildlife
refuge.

LHAAP-001-R, South Test Area/Bomb Test Area

LHAAP-001-R (aka LHAAP-027) is a 79 acre site in the south-central portion of
LHAAP. From 1954 until the early 1980s it was used to test photoflash bombs and
demilitarize (burn, detonate?) leaking illuminating devices, leaking white phosphorous
(WP) munitions, and, possibly, mines. Spent flares, 155-mm primer caps, and a 155-
mm WP round have been found on the site. The WP round was blown-in-place. The
site also contains a patch of distressed vegetation which, based on aerial photos,
appears to have persisted for several decades.

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1 EPA 2009b, page 2, and; Shaw Environmental, Inc., 2010a, page 1-3.
2 Shaw Environmental, Inc., 2010a, pages 1-3, 1-4, and figure 1-3; and Plexus Scientific Corporation,
2005, pages 6-103, 6-104, and 6-108.
3 EPA 2009b, page 1.
6 U.S. Army Corps of Engineers, 2008a, page 5. Note: the identification of the round as a white
phosphorous round has been questioned by the Army (ibid.).
7 U.S. Army Corps of Engineers, 1992a, pages 3-206 and 3-207.
LHAAP-001-R drains to Harrison Bayou, and Harrison Bayou discharges to Caddo Lake approximately two and a half miles northeast of the site\textsuperscript{8}.

The site is underlain by interbedded sands, silts, and clays\textsuperscript{9}. Some portions of the site, are covered by alluvium (silty sands) deposited by Harrison Bayou\textsuperscript{10}. Depth to groundwater ranges from less than a foot to approximately eight feet below ground surface\textsuperscript{11}. The Army does not appear to have determined the groundwater flow direction at this site.

**LHAAP-003-R Ground Signal Test Area**

LHAAP-003-R (aka LHAAP-054, LHAAP XX)\textsuperscript{12} is an 80 acre site in the southeastern portion of LHAAP\textsuperscript{13}. Beginning in 1963\textsuperscript{14} the site was used to test or destroy pyrotechnic munitions (e.g., flares, signal devices, Illuminating mortar rounds), rocket motors, button bombs, and, perhaps, mines\textsuperscript{15}. Expended mortar rounds, debris associated with pyrotechnic devices, and fuses have been found on the site. No high explosives have been found\textsuperscript{16}.

Approximately 70% of the site drains to Saunders Branch and the remainder drains to Harrison Bayou\textsuperscript{17}. Both of these streams discharge to Caddo lake, approximately 2 miles from the site\textsuperscript{18}.

The site is underlain by interbedded sands, silts, and clays\textsuperscript{19}. Groundwater occurs approximately 15 feet below land surface\textsuperscript{20}. The groundwater may discharge to Harrison Bayou. However, the Army does not appear to have determined the groundwater flow direction at this site.

\textsuperscript{8} U.S. Army Corps of Engineers, 1992a, page 3-212.
\textsuperscript{11} U.S. Army Corps of Engineers, 1992a, pages 3-211 and 3-213.
\textsuperscript{12} U.S. Army Corps of Engineers, 1992a, page 3-191.
\textsuperscript{13} U.S. Army Corps of Engineers, 2008b, appendix I, page 1-2.
\textsuperscript{14} U.S. Army Corps of Engineers, 1992a, page 3-191.
\textsuperscript{17} U.S. Army Corps of Engineers, 1992a, page 3-195.
\textsuperscript{18} U.S. Army Corps of Engineers, 1992a, page 3-195.
\textsuperscript{19} U.S. Army Corps of Engineers, 1992a, pages 3-192 and 3-195.
\textsuperscript{20} U.S. Army Corps of Engineers, 1992a, page 3-195.
Contamination

LHAAP-001-R, South Test Area/Bomb Test Area

Samples of soil, sediment, surface water, and groundwater have been collected on and near the site. The samples were analyzed for explosives, pesticides and other organics, perchlorate, metals, and common ions.

Soil samples have been found to contain TNT, phthalates, perchlorate, and high concentrations of metals (arsenic, barium, beryllium, cadmium, nickel, and vanadium) and nitrate.

Sediment samples have been found to contain di-n-butylphthalate and high concentrations of barium.

Groundwater samples have been found to contain di-n-butylphthalate, explosives (nitrobenzene, RDX, and 2-amino-4,6-dinitrotoluene) and high concentrations of metals (beryllium, cadmium, chromium, lead, thallium) and perchlorate.

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21 U.S. Army, 2011b, figures 2-1 and 2-2.
22 U.S. Army, 2011b, pages 2-15 – 2-18 and appendix A.
26 In this report, high concentrations are concentrations which exceed levels established by the U.S. EPA (MCL, EPA, 2009a) or the State of Texas (GW-Ind, GWP-Ind, EcoPRG) to protect human health or the environment; or concentrations above LHAAP background levels (U.S. Army Corps of Engineers, 2004a, table ES-1). See appendix 2, Glossary, for definitions of terms and acronyms.
37 U.S. Army, 2011b, page 2-16.
38 U.S. Army, 2011b, page 2-16.
41 U.S. Army, 2011b, pages 2-16 and A-17.
43 U.S. Army, 2011b, pages 2-16 and A-17.
44 U.S. Army, 2011b, pages 2-16 and A-17.
LHAAP-003-R Ground Signal Test Area

Samples of soil, sediment, surface water, and groundwater have been collected on and near the site\(^46\). The samples were analyzed for explosives, pesticides and other organics, perchlorate, metals, and common ions\(^47\).

Soil samples have been found to contain organics (acetone\(^48\), trichloroethylene\(^49\), and methylene chloride\(^50\)), perchlorate, and high concentrations of metals (arsenic\(^51\), barium\(^52\), cadmium\(^53\)), and nitrate\(^54\).

Sediment samples have been found to contain phthalates\(^55\).

Groundwater samples have been found to contain explosives (3-nitrotoluene and 2-amino-4,6-dinitrotoluene), perchlorate\(^56\) and high concentrations of metals (arsenic\(^57\), cadmium\(^58\), chromium\(^59\), and thallium\(^60\)).

**Potentially Explosive items and Munition Debris**

The Army has conducted several searches for potentially explosive items and munitions debris at both sites\(^61\). The latest search occurred in 2008. During that search, 384 potentially explosive items and 22,139 pounds of munitions debris were found at site 001-R\(^62\). Twelve potentially explosive items and 6880 pounds of munitions debris were found at site 003-R\(^63\). The potentially explosive items were destroyed and the debris was removed\(^64\).

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\(^46\) U.S. Army, 2011b, figures 3-1 and 2-2.
\(^47\) U.S. Army, 2011b, pages 3-13 – 3-16 and appendix B.
\(^48\) U.S. Army, 2011b, pages 3-13 and B-4.
\(^49\) U.S. Army, 2011b, pages 3-13 and B-4.
\(^50\) U.S. Army, 2011b, pages 3-13 and B-5.
\(^51\) U.S. Army, 2011b, pages 3-13, B-10, and B-44.
\(^52\) U.S. Army, 2011b, pages 3-13, B-1, and B-44.
\(^53\) U.S. Army, 2011b, pages 3-13, B-10, and B-44.
\(^54\) U.S. Army, 2011b, pages B-3 and B-4.
\(^55\) U.S. Army, 2011b, pages 3-15 and B-23.
\(^56\) U.S. Army, 2011b, pages 3-14, B-34, and B-50.
\(^57\) U.S. Army, 2011b, pages 3-14 and B-49.
\(^58\) U.S. Army, 2011b, pages 3-14 and B-18.
\(^59\) U.S. Army, 2011b, pages 3-14, B-46 and B-49.
\(^60\) U.S. Army, 2011b, pages 3-14 and B-18.
\(^61\) U.S. Army, 2011a, pages 4, 5, 8, and 9.
\(^62\) U.S. Army, 2011a, page 5.
\(^64\) U.S. Army, 2011a, pages 5 and 9.
Proposed Cleanup Plan

The Army intends to maintain land use controls (LUCs) at both sites. Both sites will be accessible to the public. LUCs will include digging restrictions and the posting of unexploded ordnance warning signs around the perimeter of each site.\textsuperscript{55}

The Army will monitor groundwater at each site for perchlorate.

- At site 001-R, if perchlorate is not detected at concentrations higher than 72 μg/L\textsuperscript{66} after three rounds of sampling, groundwater monitoring will cease and the monitor wells will be plugged and abandoned\textsuperscript{67}.

- At site 003-R, if perchlorate is not detected at concentrations higher than 72 μg/L after one round of sampling, groundwater monitoring will cease and the monitor wells will be plugged and abandoned\textsuperscript{68}.

Comments

Monitoring metals in groundwater

High concentrations (greater than the MCL) of metals have been found in groundwater at both sites since the early 1980s\textsuperscript{69}. In the most recent round of groundwater sampling (2009), high concentrations of beryllium and chromium were detected at site 001-R\textsuperscript{70}, and high concentrations of arsenic and chromium were detected at site 003-R\textsuperscript{71}.

However, the Army does not intend to monitor metals in groundwater at either site. This is despite the fact that the EPA sent the Army a letter that recommended monitoring metals in groundwater. Letters between the EPA and Army are reproduced in appendix 1\textsuperscript{72}.

The Army should monitor metals in groundwater at both sites.

\textsuperscript{65} U.S. Army, 2011a, page 11.
\textsuperscript{66} 72 μg/L is the State of Texas standard for industrial use (GWP-Ind, U.S. Army, 2011a, page 11).
\textsuperscript{67} U.S. Army, 2011a, page 11.
\textsuperscript{68} U.S. Army, 2011a, page 11.
\textsuperscript{69} U.S. Army, 2011b, pages A-17 and B-18.
\textsuperscript{70} U.S. Army, 2011b, pages A-47 and A-49.
\textsuperscript{71} U.S. Army, 2011b, pages B-46 and B-49.
\textsuperscript{72} In its reply to the EPA, the Army states that it will “address the path forward for metals separately.” (see appendix 2, letter of March 10, 2011 (letter 2)). However, the Army’s Proposed Plan does not include any provision for monitoring metals. The Army makes the following statement in U.S. Army, 2011b, pages 2-14 and 3-12. "USEPA, TCEQ, and U.S. Army have agreed to address the 2009 metals exceedances in the groundwater under a path separate from the MMRP. U.S. Army will address the metals constituents in the groundwater as stated in the U.S. Army letter dated March 10, 2011 under the 1998 IRP ROD (U.S. Army, 2011)." As can be seen in appendix 1, the March 10, 2011 letter (letter 2) does not address metals in groundwater in an informative manner.
Removal of contaminated soil, human health risk assessment

Soils at sites 001-R and 003-R are contaminated with a variety of metals (e.g., arsenic, barium, cadmium, lead)\textsuperscript{73}. However, the Army does not plan to remove contaminated soil from either site.

According to the Army, the contaminants do not represent a threat to human health. However, there are problems with the Army’s human health risk assessment (HHRA)\textsuperscript{74}.

First, many of the soil analyses are not useful because of high detection limits (see below).

Second, the HHRA was performed in 1997. Therefore, it did not use the most recent data. The more recent data shows that some metal concentrations are significantly higher than those used in the HHRA (table 1). Also, perchlorate was not included in the HHRA.

<table>
<thead>
<tr>
<th>Contaminant/Site</th>
<th>Old Maximum (mg/kg)\textsuperscript{75}</th>
<th>New Maximum (mg/kg)\textsuperscript{76}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barium/001-R</td>
<td>123</td>
<td>639</td>
</tr>
<tr>
<td>Copper/001-R</td>
<td>18.7</td>
<td>41.1</td>
</tr>
<tr>
<td>Lead/001-R</td>
<td>18</td>
<td>26.3</td>
</tr>
<tr>
<td>Nickel/001-R</td>
<td>2.41</td>
<td>18.6</td>
</tr>
<tr>
<td>Thallium/003-R</td>
<td>-\textsuperscript{77}</td>
<td>0.2</td>
</tr>
<tr>
<td>Perchlorate/001-R</td>
<td>-</td>
<td>28.9 (µg/kg)</td>
</tr>
</tbody>
</table>

The Army should remove contaminated soils from both sites.

Detection limits for metals in soil and sediment

In some cases, the Army used detection limits for metals in soil and sediment that are higher than the standards established to protect human health (see table 2). Thus, the Army cannot know whether these contaminants are present in concentrations that threaten human health.

\textsuperscript{73} U.S. Army, 2011b, pages 2-15 and 3-13.
\textsuperscript{74} U.S. Army Corps of Engineers, 1997a, chapters 4 and 5.
\textsuperscript{75} Value used in the HHRA (U.S. Army Corps of Engineers, 1997a, pages 4-50 and 5-47).
\textsuperscript{76} U.S. Army, 2011b, pages 2-15 and 3-13.
\textsuperscript{77} Contaminant not included in HHRA.
### Table 2
Detection Limits for Metals in Soil and Sediment

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Site</th>
<th>Date</th>
<th>Detection Limit (mg/kg)</th>
<th>Standard (TCEQ GWP-Ind, mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
<td>001-R &amp; 003-R</td>
<td>1982</td>
<td>0.76(^{78})</td>
<td>0.6(^{79})</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>1993</td>
<td>1(^{80})</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>1994</td>
<td>1.1-1.3(^{81})</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>1996</td>
<td>10.3-10.9(^{82})</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>003-R 1996/1997</td>
<td></td>
<td>1.1-1.2(^{83})</td>
<td>&quot;</td>
</tr>
<tr>
<td>Arsenic</td>
<td>001-R &amp; 003-R</td>
<td>1982</td>
<td>0.3(^{84})</td>
<td>1(^{85})</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>1993</td>
<td>0.1 - 1(^{86})</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>1996</td>
<td>2.58 - 2.74(^{87})</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>003-R 1996/1997</td>
<td></td>
<td>0.596 - 58.7(^{88})</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>2003</td>
<td>0.52 - 0.54(^{89})</td>
<td>&quot;</td>
</tr>
<tr>
<td>Beryllium</td>
<td>001-R &amp; 003-R</td>
<td>1982</td>
<td>0.5(^{90})</td>
<td>0.4(^{91})</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>1997</td>
<td>0.62 - 0.77(^{92})</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>2003</td>
<td>0.20 - 0.22(^{93})</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

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86 U.S. Army, 2011b, pages A-9, B-6, and B-24.
Table 2 (concluded)
Detection Limits for Metals in Soils and Sediments

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Site</th>
<th>Date</th>
<th>Detection Limit (mg/kg)</th>
<th>Standard (TCEQ GWP-Ind, mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>001-R &amp; 003-R</td>
<td>1982</td>
<td>0.5&lt;sup&gt;94&lt;/sup&gt;</td>
<td>0.5&lt;sup&gt;95&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>001-R &amp; 003-R</td>
<td>1993</td>
<td>1&lt;sup&gt;96&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>001-R</td>
<td>1994</td>
<td>0.56 – 0.63&lt;sup&gt;97&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>001-R</td>
<td>1996</td>
<td>2.06-2.19&lt;sup&gt;98&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>003-R</td>
<td>1996/1997</td>
<td>2.22-2.38&lt;sup&gt;99&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>001-R &amp; 003-R</td>
<td>2003</td>
<td>0.25-0.27&lt;sup&gt;100&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Thallium</td>
<td>001-R &amp; 003-R</td>
<td>1982</td>
<td>3&lt;sup&gt;101&lt;/sup&gt;</td>
<td>0.2&lt;sup&gt;102&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>001-R &amp; 003-R</td>
<td>1993</td>
<td>0.2&lt;sup&gt;103&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>001-R</td>
<td>1994</td>
<td>0.55 – 1.2&lt;sup&gt;104&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>001-R</td>
<td>1996</td>
<td>15.5 – 16.4&lt;sup&gt;105&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>003-R</td>
<td>1996/1997</td>
<td>0.6&lt;sup&gt;106&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

The Army should re-sample soil and sediment at both sites. The samples should be analyzed using detection limits that are lower than the human health-based standards.

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<sup>94</sup> U.S. Army, 2011b, pages A-2 and B-2.
<sup>95</sup> U.S. Army, 2011b, page 3-13.
<sup>97</sup> U.S. Army, 2011b, page A-14.
<sup>98</sup> U.S. Army, 2011b, page A-16.
<sup>99</sup> U.S. Army, 2011b, page B-11.
<sup>100</sup> U.S. Army, 2011b, pages A-38 and B-38. Samples collected by U.S. Fish and Wildlife Service.
<sup>101</sup> U.S. Army, 2011b, pages A-2 and B-2.
<sup>104</sup> U.S. Army, 2011b, page A-14.
<sup>105</sup> U.S. Army, 2011b, page A-16.
<sup>106</sup> U.S. Army, 2011b, page B-11.
Groundwater flow directions

The Army does not appear to have done the work required to determine groundwater flow directions at either site. Effective and efficient groundwater monitoring cannot be performed unless groundwater flow directions are known.

The Army should produce maps showing groundwater flow directions at each site.

Sufficiency of monitor well coverage

There are six monitor wells at site 001-R, and four monitor wells at site 003-R. In addition, one-time grab samples were obtained from borings at each site.

The Army does not know whether there are a sufficient number of monitor wells at each site because it does not know whether the wells are down gradient of contaminated areas (see above comment on groundwater flow directions). The Army should evaluate the need for additional monitor wells after it has determined groundwater flow directions at each site.

Perchlorate standard for groundwater

The Army is using a groundwater standard for perchlorate of 72 µg/L. However, the EPA's health reference level (HRL) for perchlorate is 15 µg/L. In addition, the EPA has decided to establish a primary drinking water standard (MCL) for perchlorate. When established, the perchlorate MCL will probably be similar to the HRL.

If the Army abandons the monitor wells based on the 72 µg/L standard, it may have to re-install monitor wells when the EPA establishes an MCL for perchlorate.

Until the EPA establishes an MCL for perchlorate, the Army should use a standard that is no greater than 15 µg/L.

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107 The Army makes the following statement regarding groundwater flow at LHAAP-003-R (U.S. Army, 2011b, page 3-6): The wells are located adjacent to the three surface water features that drain the entire Ground Signal Test Area. Because the shallow groundwater flow pattern is heavily influenced by surface flow in this climate, the wells represent groundwater from the entire site. This statement is not supported by any data or analysis. It would be true only if all the groundwater at the site converged on the wells. Such a convergence, however, is unlikely.
108 U.S. Army, 2011b, figure 2-1.
109 U.S. Army, 2011b, figure 3-1.
110 U.S. Army, 2011b, tables 2-4 and 3-4.
112 EPA, 2011a, page 7764.
113 EPA, 2011a, page 7762. This reverses a 2008 decision to not regulate perchlorate (EPA, 2011b).
Dinitrotoluene isomers

The Army has analyzed soil and water samples for two isomers of dinitrotoluene (DNT): 2,4-DNT and 2,6-DNT\textsuperscript{114}. These are the most common isomers in technical grade DNT\textsuperscript{115}. However, there are four other isomers of DNT (2,3-DNT; 2,5-DNT; 3,4-DNT; and 3,5-DNT)\textsuperscript{116}. All of the isomers are toxic\textsuperscript{117}.

At the Badger Army Ammunition Plant\textsuperscript{118}, high concentrations of the other isomers have been found in groundwater\textsuperscript{119}. In some cases, concentrations of the other isomers are significantly higher than the concentrations of 2,4-DNT and 2,6-DNT\textsuperscript{120}.

The Army should analyze soil and water samples for all isomers of DNT, not just the 2,4-DNT and 2,6-DNT isomers.

Conceptual site models

The Army has developed source-receptor conceptual site models for munitions constituents and OE\textsuperscript{121} at LHAAP sites 001-R and 003-R\textsuperscript{122}. The Army should also develop source-receptor conceptual site models for metals at both sites.

Documents not in Administrative Record

The following documents were listed as primary reference documents in the Final Proposed Plan\textsuperscript{123}. However, they do not appear to have been included in the Army’s Administrative Record\textsuperscript{124}.

- CAPE, 2007b, Final Engineering Evaluation/Cost Analysis Action Memorandum Revision 1, Longhorn Army Ammunition Plant, Karnack, Texas, Signed by Thomas Lederle, BRAC Division, ACSIM, United States Army, 5 December.

- Environmental Protection Systems, Inc. (EPS), 1984, Longhorn Army Ammunition Plant Contamination Survey, June.

\textsuperscript{114} U.S. Army, 2011b, appendices A and B.
\textsuperscript{117} Knobeloch, L., 2007, page 5.
\textsuperscript{118} The Badger plant is in Wisconsin (CSWAB, 2011, page 1).
\textsuperscript{119} CSWAB, 2011, page 2.
\textsuperscript{120} CSWAB, 2011, page 2.
\textsuperscript{121} U.S. Army, 2011b, figure 4-2. The term ‘OE’ does not appear to be defined in the document.
\textsuperscript{122} U.S. Army, 2011b, pages 4-1 – 4-3.
\textsuperscript{123} U.S. Army, 2011a.
\textsuperscript{124} U.S. Army, 2010a.
EODT Technology, Inc., (EODT), 2009, Final Site Specific Final Report for the MEC Removal Action at the Former Longhorn Army Ammunition Plant, LHAAP-001-R (Site 27) and LHAAP-003-R (Site 54), Karnack, Texas, September.

The Army should ensure that all documents referred to in the Proposed Plan are included in the Administrative Record. If any document has been misfiled or mislabeled in the Administrative Record, the Army should so indicate when referring to that document.

References


EPA, 2009b, Longhorn Army Ammunition Plant, Harrison County, Texas, November 2009.


Shaw Environmental, Inc., 2010a, Final Feasibility Study, LHAAP-29, Former TNT Production Area, Group 2, Longhorn Army Ammunition Plant, Karnack, Texas, April 2010.


Appendix 1

Letters Between EPA and Army Regarding Metals in Groundwater

Letter 1 (June 11, 2010): EPA to Army


Letter 3 (June 3, 2011): EPA response to Army letter of March 10, 2011
Letter 1

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Rateliff, AR 72951

Re: Munitions Constituents Data Summary Report
    Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler,

The U.S. Environmental Protection Agency (EPA) has reviewed: the Army Response to Comments Pertaining to Data Gap Issues, Munitions Constituents Data Summary Report, Longhorn Army Ammunition Plant, Karnack, Texas, dated August 2009; the EPA Monitoring Results Evaluation, Munition Sites 27 and 54, dated December 2009; and the Army Presentation of Longhorn Army Ammunition Plant’s Perspective on Perchlorate at MRS LHAAP-001-R-01, South Test Area/South Bomb Area, dated February 2010.

Our decision to move forward on LHAAP-001-R (LHAAP-27) and LHAAP-003-R (LHAAP-54) is as follows:

- On LHAAP-001-R (LHAAP-27), the following must take place:
  - Replacement of stainless steel monitoring wells
  - Three annual ground water sampling events before the issuance of the Record of Decision or the next Five Year Review for these constituents:
    - Perchlorate
    - All Metals

- On LHAAP-003-R (LHAAP-54), the following must take place:
  - Redevelopment of existing monitoring wells and one ground water sampling event before the issuance of the Record of Decision or the next Five Year Review for these constituents:
    - Perchlorate
    - All Metals

- For both sites, if the sampled constituents are not detected above the EPA Maximum Contaminant Level or the TCEQ Risk Reduction Rule Industrial Standard, then a no action Record of Decision can be issued or a recommendation of completion for the limited ground water sampling remedy can made at the Five Year Review. Otherwise,
for both sites, the same monitoring frequency identified above will remain in effect between consecutive Five Year Reviews, as part of an overall limited ground water monitoring remedy.

Referenced documents from this letter are enclosed for your information. Please feel free to contact me at (214) 665-8409, or by email at tzhone.stephen@epa.gov, if there are any questions or comments.

Sincerely,

Stephen L. Tzhone
Remedial Project Manager

Enclosures (3)

cc: Ms. Fay Duke, TCEQ
    Mr. Paul Bruckwicki, FWS
    Mr. Richard Mayer, EPA
Letter 2

DAIM-ODB-LO

Mr. Stephen Tzhone
US Environmental Protection Agency
Superfund Division (6SF-AT)
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Army response to EPA Letter of June 2010
Munitions Constituents Data Summary Report Response to Comments (RTCs)
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Mr. Tzhone,

In response to EPA’s letter June 11, 2010 regarding Munitions Constituents Data Summary Report RTCs, the Army is in agreement with the following path forward with respect to perchlorate:

- On LHAAP-001-R (LHAAP-27), the following will take place:
  o Redevelopment of existing monitoring wells
  o Three annual ground water sampling events before the next Five Year Review (post-ROD)

- On LHAAP-003-R (LHAAP-54), the following will take place:
  o Redevelopment of existing monitoring wells
  o One annual ground water sampling event before the next Five Year Review (post-ROD)

The ROD document will proceed as a No Further Action Record of Decision with limited monitoring. Army will address the path forward for metals separately.

The point of contact for this action is the undersigned. I may be contacted at 479-635-0110, or by email at rose.zeiler@us.army.mil.

Sincerely,

[Signature]

Rose M. Zeiler, Ph.D.
Longhorn AAP Site Manager
Copies furnished:
Fay Duke, TCEQ, Austin, TX
Paul Bruckwicki, Caddo Lake NWR, TX
Aaron Williams, COE – Tulsa District, OK
John Lambert, COE – Tulsa District, OK
Marilyn Pliitnik, AEC
Praveen Srivastav, Shaw – Houston, TX (Administrative Record)
Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Army Response to EPA Letter of June 2010
Munitions Constituents Data Summary Report Response to Comments (RTC)
Longhorn Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler,

The U.S. Environmental Protection Agency (EPA) has reviewed the Army Response to EPA Letter of June 2010, dated March 10, 2011, and has the following comments:

1) EPA agrees with the Army’s response on wells redevelopment and sampling path forward as it relates to perchlorate. However, EPA does not agree with a potential ROD that is No Further Action with Limited Monitoring. The rationale is that the ROD should either specify a Limited Ground Water Monitoring remedy or a No Action/No Further Action remedy. Conditions for a potential No Action/No Further Action ROD or a future recommendation of completion (at a Five Year Review juncture) for a Limited Ground Water Monitoring ROD are specified in the EPA June 11, 2011 letter.

2) EPA is unclear on Army’s intent on the path forward for metals. A path forward proposal for metals must be identified by the Army and agreed to by EPA before EPA approves of the Munitions Constituents Data Summary Report or any potential LHAAP-001-R (LHAAP-27) and LHAAP-003-R (LHAAP-54) MMRP RODs.

Please feel free to contact me at (214) 665-8409, or by email at tzhone.stephen@epa.gov, if there are any questions or comments.

Sincerely,

Stephen L. Tzhone
Remedial Project Manager

cc: Ms. Fay Duke, TCEQ
Mr. Paul Bruckwicki, FWS
Mr. Richard Mayer, EPA
Appendix 2

Glossary

**Administrative Record**: a collection of documents that contains all the information used to select a remedial action at a Superfund site.

**Aquifer**: A saturated geologic formation capable of transmitting an economically significant quantity of water.

**Background water quality**: The water quality that would exist if it were not affected by the area in question. Background groundwater quality is usually established by collecting samples immediately up-gradient of the area. Background surface water quality is usually established by collecting samples immediately upstream of the area. It is not necessarily the same as native water quality (see below). Background water quality may be affected by human activity.

**Biodegradation (biologic decay)**: The destruction of organic contaminants (e.g., TCE, toluene) by microorganisms. This process may convert one contaminant into another, e.g., TCE biodegrades to DCE, which biodegrades to vinyl chloride.

**Bulk density**: The density of a material, usually soil or rock, including pore spaces. The in-place or undisturbed density. For example, the density of the minerals that make up a soil may be 170 pounds per cubic foot. But the bulk density of the soil; including pore spaces, organic matter and minerals, may be 110 pounds per cubic foot.

**Capillary fringe**: A zone immediately above the water table. The water in this zone is held by capillary forces and cannot flow freely. Portions of the capillary fringe may be saturated.

**COC**: Chemical of concern. A chemical that has the potential to adversely affect human health or the health of other organisms. At contaminated sites, COCs are the contaminants that are to be cleaned-up. That is, the remedial action is designed to reduce COC concentrations to acceptable levels, e.g., MCLs.

**COPC**: Chemical of potential concern.

**Dehalogenation**: The removal of a halogen atom (e.g., chloride, fluoride) from a molecule.

**Discharge**: The movement of water out of a groundwater system. Water may be discharged naturally through springs and evapotranspiration, or through man made structures such as wells and drains.

**Dispersion**: The dilution of a contaminant due to spreading of the contaminant plume. The spreading occurs in all directions; parallel to the flow (longitudinal dispersion) and
perpendicular to flow (transverse dispersion). It is caused by variations in groundwater flow directions and speeds. An analogous processes is the spreading (dispersion) of a plume of smoke from a smokestack.

**DNAPL:** Dense Non-Aqueous Phase Liquid. Liquids that are more dense than water. Hence, they tend to sink to the bottom of aquifers. Most chlorinated solvents (e.g., TCE, DCE) are DNAPLs. DNAPLs are liquids, sometimes referred to as 'pure product'. They should not be confused with solutes - contaminants that are dissolved in the groundwater. For example, TCE may be exist as a pure product (DNAPL) or as a solute dissolved in the water.

**EcoPRG:** Ecological preliminary cleanup level.

**Effective porosity (also-see porosity):** The amount of interconnected porosity available for the transmission of fluids. Effective porosity is expressed as a ratio or percentage. In most materials, effective porosity and total porosity are nearly equal. However, some materials, such as clays, have high total porosities but low effective porosities because the pore spaces are too narrow to allow water to flow freely. In other materials, such as volcanic rocks, the pore spaces may not be interconnected.

**Graphical User Interface (GUI):** A computer program. Pre-processor and post-processor tools that allow modelers to automate some aspects of model design (e.g., grid generation, calibration), integrate optimization tools with models, and create maps of model results.

**GWP-Ind:** State of Texas health-based standard. Groundwater concentration limit for industrial use. When applied to soils, it is the concentration limit to prevent unacceptable concentrations of contaminants from leaching from soils into underlying groundwater.

**HI:** Hazard index. A measure of the health risk associated with all non-carcinogenic COCs at a site. The HI is the sum of the hazard quotients for all COCs to which an individual is exposed. A HI value of 1.0 or less indicates that no adverse non-cancer human health effects are expected to occur.

**HQ:** hazard quotient. A measure of the health risk associated with a single non-carcinogenic COC at a site. Each HQ is a comparison of an estimated chemical intake (dose) with a reference dose level below which adverse health effects are unlikely. The HQ is expressed as the ratio of the estimated intake (numerator) to the reference dose (denominator). The value is used to evaluate the potential for non-cancer health effects, such as organ damage, from chemical exposures.

**Hydraulic conductivity:** A measure of the ability of a material allow water to flow through it. The higher the hydraulic conductivity of a material, the easier it is for water to flow through it. Hydraulic conductivity is expressed as length per unit time (e.g., feet per day, centimeters per second).
**Hydraulic head:** The elevation of water in a well. Groundwater flows from areas of higher hydraulic head to areas of lower hydraulic head. Hydraulic head is a measure of the energy of groundwater and is the sum of two components: elevation head and pressure head.

**Isomers:** Chemical compounds with the same molecular formula but different structures. For example, the molecular formula for both 2,4-DNT and 2,6-DNT is $\text{C}_6\text{H}_3(\text{CH}_3)(\text{NO}_2)_2$. Their structures, however, are different. In 2,4-DNT, the nitro groups ($\text{NO}_2$) are attached to the second and fourth carbons of the carbon ring. In 2,6-DNT, the nitro groups are attached to the second and sixth carbons.

**LNAPL:** Light Non-Aqueous Phase Liquid. Liquids that are less dense than water. Hence, they float on the water table. Common LNAPLs include oil, gasoline, and diesel fuel. LNAPLs are liquids, sometimes referred to as 'pure product'. They should not be confused with solutes - contaminants that are dissolved in the groundwater. For example, gasoline may exist as a free product floating on the water table. Some of the components of gasoline (e.g., benzene, toluene) may also exist as solutes dissolved in groundwater.

**LUC:** Land use control.

**MCL:** Maximum contaminant level. The US EPA drinking water standard. The maximum concentration of a contaminant allowed in drinking water. MCLs are legally enforceable limits.

**MDL:** Method detection limit. The minimum concentration of an analyte that the laboratory can measure and report with 99% confidence that the analyte concentration is greater than zero. The MDL is determined by the laboratory for each analyte in a given matrix (water, soil, or vapor. It is a measure of the concentration an instrument can detect or ‘see’ in a given matrix.

**MNA:** Monitored natural attenuation.

**MSC:** Medium-specific concentration.

**NPL:** National Priorities List. The list of hazardous waste sites eligible for remedial action under the federal Superfund program. US EPA regulations outline a formal process for assessing hazardous waste sites and placing them on the NPL. The list is based primarily on the score a site receives from the Hazard Ranking System. Only sites that are on the NPL may be cleaned-up using money from Superfund.

**NAPL:** Non-Aqueous Phase Liquid. General term that includes DNAPLs and LNAPLs. NAPLs are liquids, sometimes referred to as 'pure product'.

**Native water quality:** Water quality unaffected by affected by human activity. Not necessarily the same as background water quality (see above).
Organic: Derived from plant or animal materials.

Organic carbon: Carbon derived from organic sources (e.g., plant material). Distinguished from carbon derived from non-organic sources (e.g., atmospheric carbon dioxide, carbonate minerals). Organic carbon sorbs organic contaminants.

Oxidation: The addition of oxygen to an atom or molecule, or the removal of electrons from an atom or molecule.

Partition coefficient: A measure of the degree to which a solute is adsorbed. Solutes with higher partition coefficients (e.g. TCE) are more strongly adsorbed (i.e., bound to the solid material of the aquifer) and migrate more slowly (are more retarded) than contaminants with lower partition coefficients (e.g., vinyl chloride). For organic contaminants, the partition coefficient increases as the amount of solid organic carbon in an aquifer increases.

Porosity: A measure of void space in a material. The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment. Voids may be spaces between sand grains, fractures, or solution cavities. In the saturated zone, the void spaces are completely filled with water. In the unsaturated zone, the voids are filled with water and air.

Precipitation (chemical): The combination of solutes to form a solid material. Metals often precipitate, as when dissolved iron and carbonate combine to form the mineral siderite. Precipitation reactions are often not reversible, and the precipitated contaminant is permanently removed from the groundwater.

Recharge: The entry of water into a groundwater system. Recharge often occurs along streambeds, mountain fronts, and through the bottoms of playas.

RA: Remedial action.

RD: Remedial design.

Reduction: The addition of electrons to an atom or molecule.

Retardation: Due to sorption, most contaminants move more slowly than the groundwater which transports them. Their movement is said to be retarded with respect to the groundwater.

Retardation coefficient: A measure of retardation - the rate at which a solute travels through a groundwater system, compared to the velocity of the groundwater. The ratio of the groundwater velocity to the solute velocity. A solute with a retardation coefficient of 2 moves at 1/2 the velocity of the groundwater that is transporting it.
**RI/FS:** Remedial investigation/feasibility study.

**ROD/DD:** Record of decision/decision document.

**SAI-Ind:** State of Texas health-based standard for soil. Concentration for industrial use based on inhalation, ingestion, and dermal contact.

**Saturated zone:** A zone where the void spaces are completely filled with water or some other liquid.

**SDL:** Sample detection limit (aka SQL: sample quantitation limit). The MDL adjusted to reflect sample-specific actions, such as dilution or use of smaller aliquot sizes than prescribed in the analytical method, and taking into account sample characteristics and sample preparation. It is a measure of the concentration an instrument can detect or 'see' in a given sample.

**Sensitivity study:** A test of a model's response to changes in parameter values or assumptions (e.g., hydraulic conductivity, boundary conditions).

**Sink, groundwater:** See discharge.

**Solute:** A substance dissolved in a liquid.

**Sorption:** A process that binds, usually temporarily, a contaminant to a mineral surface or to organic matter. This temporary binding acts to reduce (retard) the contaminant migration rate with respect to the groundwater. Sorption is a general term used to encompass the processes of absorption and adsorption.

**Source, groundwater:** See recharge.

**SPLP:** Synthetic precipitation leaching procedure. A chemical test in which a liquid (synthetic precipitation) is passed through solid materials (e.g., soils, wastes). The liquid is then analyzed to determine what the concentrations of constituents (e.g., metals, pesticides) it picked up (leached) as it passed through the solids. SPLP tests are often performed to determine whether infiltrating precipitation could carry contaminants in soils to underlying groundwater.

**Storage coefficient:** A measure of the ability of an aquifer to store and release water. The volume of water an aquifer releases from or takes into storage, per unit surface area of the aquifer, per unit change in hydraulic head.

**SVOC:** Semi-volatile organic compound.

**Unsaturated zone:** A zone where the void spaces are not completely filled with water or some other liquid.
**Vadose zone**: The unsaturated zone plus the capillary fringe immediately above the water table. The capillary fringe may be saturated.

**VOC**: Volatile organic compound.

**Volatileization/Vaporization**: The formation of gasses that may emerge from soil or water as vapors.

**2-D model**: A model that simulates flow or contaminant transport in two space dimensions. The dimensions may be horizontal or vertical (cross section).

**3-D model**: A model that simulates flow or contaminant transport in three space dimensions.