EPA Superfund
Record of Decision:

MILAN ARMY AMMUNITION PLANT
EPA ID: TN0210020582
OU 18
MILAN, TN
07/06/2000
Operable Unit 4, Region 1 Groundwater
MILAN ARMY AMMUNITION PLANT

Milan, Tennessee

RECORD OF DECISION

FINAL DOCUMENT

July 2000

In accordance with Army Regulation 200-2, this document is intended to comply with the National Environmental Policy Act (NEPA) of 1969.
DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Milan Army Ammunition Plant, Operable Unit 4 Region 1 Groundwater, Milan, Tennessee.

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the contaminated groundwater migrating from Line X of Milan Army Ammunition Plant (MLAAP) in Milan, TN. The remedial action was selected in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR 300). This decision document explains the factual basis for selecting the remedy for the groundwater at MLAAP and the rationale for the final decision. This decision is based on the Administrative Record for the site.

The U.S. Environmental Protection Agency (USEPA), and the Tennessee Department of Environment and Conservation (TDEC) concur with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

This remedy addresses the explosives-contaminated groundwater emanating from Line X, which is located near the northwestern boundary of Milan Army Ammunition Plant (MLAAP). This area has been selected for a remedial action due to the presence of explosives compounds in groundwater, and the continuing off-post migration of these contaminants under the City of Milan.

The goal of this action is to reduce the overall risk posed by the contaminated groundwater downgradient of Line X and to control the migration of contaminated groundwater from the area. The remedial action consists of the extraction of groundwater using extraction wells, filtration of the water using granular media, treatment of the water using granular activated carbon (GAC) adsorption, and reinjection of the treated groundwater.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to this remedial action, and is a cost-effective application of public funds. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the extent practicable, and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element,
Because this remedy will result in hazardous substances remaining on site above health-based levels, a review will be conducted within five years after commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

APPROVING AUTHORITY

Paul A. Brough
Lieutenant Colonel, USA
Commanding Officer, Milan Army Ammunition Plant

12 Nov 99
Date

R. L. Van Antwerp
Major General, USA
Assistant Chief of Staff for Installation Management

4/4/00
Date
SUBJ: Operable Unit Four Region One Ground Water Record of Decision
Milan Army Ammunition Plant, TN, NPL Site

Dear Major General Van Antwerp:

The U.S. Environmental Protection Agency (EPA) has reviewed the Operable Unit Four, Region One Ground Water Record of Decision (ROD) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Re-authorization Act of 1986. EPA concurs with the finding and selected remedy presented in the Record of Decision for OU-4, Region 1 Ground Water.

If you have any questions regarding this action, please contact me at (404) 562-8651 or my staff, Pete Dao, at (404) 562-8508.

Sincerely,

Richard D. Green
Director
Waste Management Division

cc: James W. Haynes, Director
Tennessee Department of Environment and Conservation

Lieutenant Colonel Paul A. Brough, Commanding Officer
ATTN: SMCMI-IO (200-1a) Milan Army Ammunition Plant
April 14, 2000

Major General R. L. Van Antwerp  
Assistant Chief of Staff for Installation Management  
United States Army  
600 Army Pentagon  
Washington, DC 20310-0600

RE: Milan Army Ammunition Plant  
TDEC/DSF Site # 27-505  
Final Document: Record of Decision for Remedial Action for Operable Unit 4, Region 1 Groundwater

Dear Major General Van Antwerp:

The Tennessee Department of Environment and Conservation (TDEC) has received the Final Document: Record of Decision for Remedial Action for Operable Unit 4, Region 1 Groundwater, submitted on April 13, 2000. The document references the selected remedy to address the explosives-contaminated groundwater within Operable Unit 4, Region 1 at the Milan Army Ammunition Plant. The remedy calls for the installation and operation of a treatment system to remediate the groundwater to risk-based cleanup levels. The Department concurs with the findings and selected final remedial action stated in the Final Document: Record of Decision, dated April 2000.

If you have any questions regarding this matter, please contact me at (615) 532-0227 or Mr. J. Kevin Rice, TDEC Project Manager at (901) 661-6223.

Sincerely,

James W. Haynes  
Director  
Tennessee Department of Environment and Conservation

JWH/jkr

cc: TDSF/NCO  
    TDSF/JEAC  
    Mr. Peter Dao, USEPA Region IV
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1.0 SITE NAME, LOCATION, AND DESCRIPTION

Milan Army Ammunition Plant (MLAAP) is located in western Tennessee, immediately east of Milan, Tennessee, and 100 miles northeast of Memphis, Tennessee (as shown in Figure 1-1). MLMP is a government owned, contractor operated installation with American Ordnance, LLC, as the operating contractor. The facility was constructed in 1941 to produce and store fuzes, boosters, and small- and large-caliber ammunition. The facility is currently active and comprises 22,436 acres.

The contaminated medium that will be addressed by this remedial action is the groundwater emanating directly from Line X, which is located near the northwestern installation boundary (Figure 1-2). This area has been denoted as Operable Unit 4 (OU4), Region 1. Line X is an ammunition production line that has been used since 1941 for the load, assembly, and pack (LAP) of rockets, mortar rounds, and other types of ammunition. In the past, explosives-contaminated wastewater generated at Line X was discharged into sumps. The effluent from these sumps then flowed into Ditch E, which joins Wolf Creek near the installation boundary. Use of these unlined ditches, as well as overflows from the sumps, has led to the introduction of explosives compounds into the groundwater. Since 1981, wastewater from Line X and all of the other production lines has been treated before being released to the ditches.

MLAAP lies within the Coastal Plain Physiographic Province of the Mississippi Embayment. The elevation across MLAAP varies from 590 to 320 feet above mean sea level. OU4 is underlain by an unconsolidated and unconfined, primarily sand aquifer with a large lateral extent and a thickness of at least 225 feet. Within the OU4 area, groundwater flows northwest through this highly conductive aquifer toward regional discharge areas.

Current land use for the areas adjacent to the northern, eastern, and southern boundaries of MLAAP is primarily agricultural with scattered residences. The City of Milan is located at the western boundary of MLAAP. In the direction of groundwater flow from Line X (northwest) is the City Park, University of Tennessee Agricultural Research Station, and residential and light industrial areas of the City of Milan.
2.0 SITE HISTORY AND INVESTIGATION ACTIVITIES

The initial construction of the installation now known as MLAAP was completed in January 1941. During World War II, the mission of the installation included the production of fuzes, boosters, and complete rounds of both minor and major caliber ammunition; the storage and shipping of ammunition; and the operation of an ammonium nitrate plant. Peak employment reached approximately 1,100 people. Currently, MLAAP is a government owned, contractor operated military industrial installation operated by American Ordnance, LLC. Current employment is approximately 1,000 people.

Environmental studies of the facility have been conducted since the late 1970s to investigate and monitor the areas that have been affected by industrial operations. The results of these studies indicate that the O-Line Ponds area, facility drainage ditches that received industrial wastewater, and manufacturing and disposal areas have released explosives compounds into the environment. As a result of these studies, cleanup actions are currently underway at the O-Line Ponds area, the northeastern facility boundary, and the northern industrial areas to capture and treat contaminated groundwater and to remediate the explosives compounds in soil.

To monitor the migration of explosives compounds from industrial areas, the groundwater monitoring wells at the boundary of the facility and in off-post areas have been sampled at regular intervals since the late 1970s. During the 1991-1992 Remedial Investigation Follow-On, explosives compounds were detected in a groundwater sample collected from a well located immediately downgradient of Wolf Creek at a total concentration of 42 micrograms per liter (µg/L). In addition, explosives compounds have been detected in the three City of Milan drinking water supply wells. Until use of the wells was discontinued in 1998, the Milan supply wells were sampled monthly by the Army since 1991. In 1993, the concentration of RDX in a single sample collected from Well No. 5 exceeded the USEPA Health Advisory of 2 µg/L. This well was immediately shut down.

During the Phase II Investigation of OU4, which was conducted from 1993-1994, additional monitoring wells were installed and groundwater samples were collected. The results of this additional sampling and analysis indicated that two distinct areas of contaminated groundwater exist at the site. One area contained relatively low concentrations of explosives compounds and is immediately downgradient of both Ditch E and Wolf Creek. The other area is downgradient of Line X and appears to be the result of discharge into the sumps and ditches at Line X. This area of contaminated groundwater contained high levels of explosives compounds (up to 3,880 µg/L) and has been denoted OU4 Region 1.

In 1996, additional monitoring well clusters (wells that are designed to allow sampling of groundwater at different depths) were installed. These wells were installed to confirm that the two areas of contaminated groundwater are separate and to better delineate the vertical and horizontal distribution of the explosives compounds in the aquifer. The results of chemical analysis of the groundwater samples collected from these wells confirmed that the area of contaminated groundwater emanating directly from Line X contains high concentrations of explosives compounds which are migrating through the aquifer in a northwesterly direction under the City of Milan.

In 1998, additional well clusters were installed in Milan City Park to better define the vertical and lateral limits of the contaminated groundwater downgradient of Line X. Within Milan City Park, explosives compounds were detected at depths of 125 and 175 feet below ground surface, and at a concentration as high as 1,820 µg/L. At the boundary between MLAAP and Milan City Park, the concentration of explosives compounds was 5,380 µg/L at a depth of 180 feet below ground surface.
3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The Proposed Plan for Operable Unit 4, Region 1 at MLAAP was released to the public on March 3, 1999. This document, as well as the Focused Feasibility Study Report for Operable Unit 4, Region 1, the Report on Line X Groundwater Investigation, and other information about environmental studies at MLAAP, is available in the Administrative Record for the site maintained at the U.S. Army Chief Engineer’s Office at MLAAP, and the Mildred G. Fields Library in Milan, TN. The notice of availability of these documents was published in the Milan Mirror-Exchange on March 2, 1999, in the Jackson Sun on March 3, 1999, and in the Gibson County News Leader on March 3, 1999. A public comment period was held from March 3 through April 1, 1999. In addition, a public availability session was held during the public comment period on March 18, 1999. At that meeting, representatives from the Army and the Tennessee Department of Environment and Conservation (TDEC) presented a summary of the project and answered questions about environmental conditions at the site and the remedial alternatives under consideration. Comments and responses from the March 18, 1999, public availability session, as well as written comments received during the public comment period, are included in the Responsiveness Summary (Appendix A).

This decision document presents the selected remedial action for contaminated groundwater at OU4 Region 1 of Milan Army Ammunition Plant in Milan, TN. The Remedial Action has been chosen in accordance with CERCLA, as amended by the SARA, and, to the extent practicable, the NCP. The decision for this site is based on information contained in the Administrative Record.
4.0 SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

As with many Superfund sites, the problems at Milan Army Ammunition Plant are complex. As a result, the Army has organized the work into several operable units. These are:

- OU1: Contaminated groundwater emanating from the O-Line Ponds in the north central portion of the installation;
- OU2: Contaminated soil and sediment within the O-Line Ponds area;
- OU3: Contaminated media within the northeastern portion of the installation;
- OU4: Contaminated media within the northwestern portion of the installation; and
- OU5: Contaminated media within the entire southern portion of the installation.

The Army, the USEPA, and the TDEC have already selected remedies for OUs 1, 2, groundwater at the northern boundary of OU3, and contaminated soil within the industrial areas of OU3 and OU4. The remedial actions for all of these OUs are underway.

The groundwater within OU4 has been subdivided into three regions. Region 1 is the contaminated groundwater emanating directly from the sumps and ditches within Line X. The contaminated groundwater within Regions 2 and 3 is defined as the groundwater in the areas to the south and north of Region 1, respectively. The remedial investigation and feasibility study for Region 2 has been completed. This area contains groundwater that was contaminated as a result of disposal into Ditch E and Wolf Creek. The volume of contaminated groundwater in Region 2 is greater than that of Region 1, but Region 2 contains much lower concentrations of explosives compounds. The groundwater contamination within Region 3 was most likely caused by operations within Line Z and the drainage ditch into which wastewater disposal occurred. The contaminant concentrations in this area are being monitored.

The contaminated groundwater within OU4 Region 1 has migrated laterally from the original source at Line X and presently extends more than 6,000 feet laterally within the City of Milan. The contaminated groundwater does not pose a threat to the residents of the City of Milan because they are provided with drinking water from the municipal water supply system. The potential threat posed by the OU4 Region 1 groundwater is the continued lateral migration toward the residents who live northwest of the City of Milan. These residents obtain drinking water from private wells. Should the contaminated plume reach the northwest city boundary at a concentration above health-based limits, there is the potential for adverse health effects to occur. One goal of this action is to reduce the concentration of contaminants to levels such that when the groundwater migrates to the northwest City of Milan boundary, the concentrations will not exceed health-based limits.

Although the contaminated groundwater within the City of Milan does not presently pose a threat to human health due to the lack of drinking water wells in the area, the TDEC has determined that the aquifer is a natural resource that must be maintained for maximum beneficial use. Therefore, a remedial action is required to reduce the concentrations of explosives compounds to health-based limits.
5.0 SUMMARY OF SITE CHARACTERISTICS

This section provides an overview of the site characteristics of OU4, including the hydrogeology and the nature and extent of contamination in groundwater. The information presented in this section has been summarized from information in the Administrative Record.

5.1 HYDROGEOLOGIC SETTING

At MLAAP, including OU4, the Memphis Sand of the Claiborne Group is the major aquifer. The primary controls on groundwater movement in this unconfined aquifer are the dip of the sediments, surface topography, and surface recharge and discharge patterns. The formation is recognized as sand with clay lenses and clay rich zones that may locally alter vertical groundwater flow. Stratification makes vertical hydraulic conductivities lower than horizontal hydraulic conductivities. Groundwater flow beneath OU4 is to the northwest, and is also downward through the aquifer due to the natural downward hydraulic gradient.

5.2 CONTAMINATION ASSESSMENT

In 1996, 26 monitoring wells were installed in well clusters downgradient of Line X and Ditch E, which historically received wastewater from Line X. The chemical analysis of groundwater samples collected from the new and existing monitoring wells provided information regarding the nature and extent of contaminants in groundwater. It was found that in the shallow zone of the aquifer (less than 80 feet below ground surface), groundwater contains explosives compounds at a total concentration as high as 1,800 µg/L immediately downgradient of Line X. This shallow plume appears to begin within Line X and extends 2,500 feet downgradient from the northern Line X fence. At its widest point, the plume is approximately 1,600 feet wide.

Because of the downward hydraulic gradient in the aquifer, the plume is more extensive at intermediate and deeper depths. At an intermediate depth in the aquifer (from 80 to 130 feet below ground surface), the plume appears to extend 5,500 feet downgradient of the northern Line X fence and may be as wide as 4,000 feet. The highest concentration of explosives compounds detected in a groundwater sample collected from this depth range is 2,500 µg/L.

Deeper in the aquifer (greater than 130 feet below ground surface), the explosives plume appears to begin downgradient of Line X and extends a minimum of 6,000 feet toward the northwest. The true lateral extent of contaminated groundwater in the deeper portion of the aquifer is not known, as groundwater samples collected from the most downgradient monitoring wells screened within this depth range contain explosives compounds at concentrations above 2 µg/L. The highest concentration of total explosives measured in a groundwater sample collected at this depth range was 5,300 µg/L.

The water level measurements allow refinement of the understanding of groundwater flow direction and velocity in this area. The groundwater flow direction is toward the northwest. The area of contaminated groundwater has already traveled off site and the leading edge of the contaminated area is northwest of the Milan High School. An evaluation of the hydraulic gradient, effective porosity, and permeability indicates that the groundwater flow velocity is approximately 120-200 feet/year. The results of groundwater flow modeling indicate that the area of contaminated groundwater will continue to migrate to off-post locations if remediation of the plume does not occur.
6.0 SUMMARY OF SITE RISKS

A human health risk assessment was conducted to determine whether there could potentially be adverse health effects as a result of exposure to site-related compounds in groundwater within OU4 Region 1. To ensure that potential risks would not be underestimated, the most stringent future land use scenario, which would result in the highest risk to humans, was used in estimating risks. The most stringent future land use scenario consists of a residential exposure scenario including domestic use of water from the contaminated aquifer. Under these conditions, residents living both on-post and off-post could be exposed to explosives compounds through drinking the groundwater. Because there are currently no residents within the northwestern corner of MLAAP, and the residents of the City of Milan receive water from uncontaminated municipal wells, this scenario is not occurring. Therefore, these assumptions lead to very conservative estimates of potential risk.

The results of the risk assessment are provided in Table 6-1. The risk assessment results indicate that the levels of explosives compounds in groundwater at the northwestern boundary of MLAAP could potentially result in health problems if residents used the groundwater as a drinking water source. These health problems could include damage to the liver, prostate, or spleen, or the development of cancer. The risk assessment indicates that interception and cleanup of the groundwater is warranted in areas where the groundwater is being used as potable water.

The residents within the City of Milan are prevented from using contaminated groundwater as drinking water by a city ordinance that requires them to use the uncontaminated municipal water. Therefore, the presence of explosives compounds in the aquifer under the city does not pose a threat to human health or the environment. The presence of explosives compounds in groundwater may become a human health hazard when it migrates past the northwestern boundary of the City of Milan, where non-City residents use private wells to obtain drinking water. The contaminated groundwater has not yet reached this area, but is migrating toward it.

Because the scope of this ROD is only the affected groundwater within OU4 Region 1, there are no potential adverse ecological effects associated with the contaminants. The groundwater is migrating toward the northwest from Line X, and the affected zone is dropping in elevation as it moves laterally. The contaminated groundwater is not discharging to any wetlands, streams, or lakes, so ecological receptors are not at risk.

Actual or threatened releases from this site, if not addressed by implementing the remedial action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

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<th>Receptor</th>
<th>Individual Lifetime Cancer Risk</th>
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<tr>
<td>Adult Resident</td>
<td>$3 \times 10^{-3}$</td>
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<tr>
<td>Child Resident</td>
<td>$2 \times 10^{-3}$</td>
<td>200</td>
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6.1 DEVELOPMENT OF AQUIFER CLEANUP LEVELS

Past disposal practices for industrial wastewater at MLAAP (common at that time in military ammunition manufacturing and the civilian sector) have resulted in the presence of explosives compounds in groundwater downgradient of Line X. The risk assessment shows that if the highly-contaminated groundwater
downgradient of Line X is allowed to migrate to the northwestern boundary of the City of Milan, where residents use private wells to obtain potable water, then health problems could result from drinking the groundwater. To address this, various remedial alternatives have been selected to control the migration of the contaminated groundwater and to prevent human exposures to the explosives compounds, thereby reducing or eliminating the potential adverse health effects.

To ensure the protection of human health in the future, risk-based groundwater cleanup goals were developed for this remedial action in accordance with USEPA guidance. Chemical-specific cleanup goals for carcinogenic chemicals were calculated using three target cancer risk levels (i.e., excess lifetime cancer risk of $10^{-6}$, $10^{-5}$, and $10^{-4}$), while cleanup goals for noncarcinogenic chemicals were calculated using two target hazard index levels (1 and 3). The Army and the regulators have chosen the following cleanup goals for the affected areas:

- **Within MLAAP**, humans are not exposed to Line X groundwater under current land-use conditions because there are no groundwater production wells in the area. Even if MLAAP were closed or transferred to private ownership in the future, any potential future residents would most likely continue to use the existing water supply system, which obtains water from uncontaminated areas within MLAAP. Therefore, the establishment of aquifer cleanup goals for the groundwater within MLAAP is not needed.

- **Within the City of Milan**, there is a city ordinance that prevents residents from installing wells to obtain drinking water. The existing private wells are not located within areas that will potentially be affected by Line X groundwater as it migrates toward the northwest. Therefore, there is not a complete exposure pathway for groundwater within the City of Milan. However, the TDEC has determined that the aquifer under the City of Milan is a natural resource that must be maintained for maximum beneficial use (i.e., use as drinking water.) For this reason, the aquifer cleanup goals established for areas within the City of Milan are the health-based limits corresponding to a cancer risk level of and a hazard index of 3. The chemical-specific limits are provided in Table 6-2.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Risk-Based Concentration (µg/L)</th>
<th>Rationale</th>
</tr>
</thead>
</table>
| 2,4-Dinitrotoluene        | 1.3                            | Adult cancer risk adjusted to $10^{-5}$ to achieve a cumulative cancer risk of $10^{-4}$.
| HMX                       | 78                             | Child hazard quotient adjusted to 0.1 to achieve a cumulative hazard index of 3 for the liver.
| Nitrobenzene              | 0.78                           | Child hazard quotient adjusted to 0.1 to achieve a cumulative hazard index of 3 for the liver.
| RDX                       | 77                             | Adult cancer risk of $10^{-4}$.
| 1,3,5-Trinitrobenzene     | 1400                           | Child hazard quotient of 3.
| 2,4,6-Trinitrotoluene     | 23                             | Child hazard quotient of 3.
Northwest of the City of Milan, residents use groundwater as drinking water and there are currently no institutional or engineering controls in place to protect these residents. It is anticipated that if no remedial action were taken, the groundwater plume will eventually migrate to this area. However, due to the natural downward hydraulic gradient in the aquifer, the contaminated plume is expected to sink in the aquifer as it moves toward the northwest boundary of the City of Milan. Based on available data, it has been projected that the contaminated plume may be as deep as 300 feet below ground surface by the time it reaches the City of Milan boundary. This is significantly deeper than the normal depth of potable water wells, which are generally no deeper than 150 feet below ground surface. Therefore, it is unlikely that any residential well would be directly affected by the contaminated groundwater. However, because the groundwater northwest of the City of Milan is currently being used as drinking water, more stringent cleanup limits were deemed necessary for this area. Cleanup limits corresponding to an individual excess cancer risk of 1 and a hazard index of 1 have been established for this area. These limits are also protective of secondary uses of groundwater (such as bathing or showering, watering a garden and ingestion of vegetables, swimming in a pool filled with the groundwater, etc.), and are shown in Table 6-3.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Risk-Based Concentration (µg/L)</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-Dinitrotoluene</td>
<td>1.3</td>
<td>Adult cancer risk adjusted to $10^{-5}$ to achieve a cumulative cancer risk of $10^{-5}$.</td>
</tr>
<tr>
<td>HMX</td>
<td>78</td>
<td>Child hazard quotient adjusted to 0.1 to achieve a cumulative hazard index of 1 for the liver.</td>
</tr>
<tr>
<td>Nitrobenzene</td>
<td>0.78</td>
<td>Child hazard quotient adjusted to 0.1 to achieve a cumulative hazard index of 1 for the liver.</td>
</tr>
<tr>
<td>RDX</td>
<td>77</td>
<td>Adult cancer risk of $10^{-5}$.</td>
</tr>
<tr>
<td>1,3,5-Trinitrobenzene</td>
<td>490</td>
<td>Child hazard quotient of 1.</td>
</tr>
<tr>
<td>2,4,6-Trinitrotoluene</td>
<td>2.8</td>
<td>Adult cancer risk adjusted to $10^{-5}$ to achieve a cumulative cancer risk of $10^{-5}$.</td>
</tr>
</tbody>
</table>

The Army's goal is to achieve the cleanup levels shown in Table 6-2 in the areas within the City of Milan where the groundwater is currently contaminated, while controlling the further migration of the contaminated plume. The concentrations of explosives compounds that will eventually reach the northwestern boundary of the City of Milan will be lower than the levels shown in Table 6-3.

During the implementation of this remedial action, the Remedial Investigation of this portion of the facility will continue. Should additional remedial actions be deemed necessary to address other areas, it is anticipated that the action selected for the northwestern boundary groundwater will be consistent and compatible with those actions.
7.0 DESCRIPTION OF ALTERNATIVES

The original draft Feasibility Study (FS) Report for the OU4 Region 1 groundwater (May, 1995) considered a variety of remedial alternatives (including in-situ treatment of groundwater) and remedial technologies (including potentially applicable physical, chemical, biological, and thermal treatment methods.) The updated FS report (October, 1999) also included consideration of a proprietary process that shows potential for treatment of explosives compounds in groundwater. Because of the high flow rate needed to capture the contaminated groundwater (approximately 1,300 gpm) and the low levels of explosives compounds due to the need to perform hydraulic gradient control near the leading edge of the area of affected groundwater, use of granular activated carbon (GAC) is the most cost-effective treatment technology. To simplify this discussion of remedial alternatives, only the most proven and cost-effective technology (GAC adsorption) was retained in the detailed analysis of alternatives for comparison against the alternatives required by the NCP.

7.1 ALTERNATIVE 1: NO ACTION

The No Action alternative, Alternative 1, has been developed to provide a basis for comparing active treatment alternatives. The NCP and CERCLA, as amended by SARA, require the evaluation of this alternative as a baseline for comparison of risk reduction achieved by each treatment alternative. Under this alternative, no further action will be taken at the site to address the migration of contaminants to the northwestern boundary of the City of Milan.

- Capital Cost: $0
- Annual O&M Costs: $0
- Months to Implement: None

7.2 ALTERNATIVE 2: LIMITED ACTION

The Limited Action alternative would include Army institutional controls to prevent future use of the on-site groundwater as drinking water. For the residents of the City of Milan, existing city ordinances will prevent the use of groundwater as drinking water. For the residents who live northwest of the City of Milan, no protection will be provided under this alternative except for the decrease in chemical concentrations that would occur through natural dispersion. Without the active removal of the highly contaminated groundwater near Line X, it is not believed that natural dispersion alone would be sufficient to protect these residents.

At regular intervals, groundwater sampling and analysis would occur to monitor the movement and natural dispersion of the contaminants in groundwater. These analytical data would be reviewed at a minimum of every five years to determine if additional remedial actions are required.

- Capital Cost: $64,000
- Annual O&M Costs: $180,000
- Months to Implement: None

7.3 ALTERNATIVE 3: GRANULAR MEDIA FILTRATION, GRANULAR ACTIVATED CARBON ADSORPTION, AND REINJECTION

This alternative includes all elements of the Limited Action alternative to ensure that people living within the City of Milan and possible future residents of MLAAP would not use the contaminated water as drinking water. In addition, extraction and treatment of the contaminated water would be performed to control...
the further migration of the explosives compounds and to reduce the concentrations of explosives compounds in groundwater to less than the aquifer cleanup goals.

The goal of this alternative is to use both active remediation (treatment of the groundwater) and natural dispersion to reduce the levels of explosives compounds within the plume to less than the cleanup goals shown in Table 1. Secondly, the goal is to achieve these cleanup levels far enough upgradient of the City of Milan northwest boundary that by the time the contaminated groundwater reaches the boundary, the levels of contaminants will have decreased to concentrations that correspond to risk-based goals of for carcinogenic compounds and a hazard index of 1 for noncarcinogenic compounds.

The implementation of this alternative would also include groundwater flow modeling and regular monitoring of the aquifer to allow frequent evaluation of the potential risks posed to residents. Additional monitoring wells would be installed to allow measurement of plume migration. If it appears that the concentrations of explosives compounds in groundwater would exceed the aquifer cleanup goals, then additional remedial actions would be taken to protect residents.

For this remedial alternative, the extracted water would first be filtered using a granular media filtration unit to remove solids that may reduce the efficiency of the subsequent GAC adsorption system.

GAC adsorption would then be used to remove explosives compounds from the extracted groundwater. The first adsorption unit would be the primary treatment unit that would remove the majority of the explosives compounds. The second GAC unit would remove the remaining explosives compounds to levels low enough for reinjection into the aquifer. The treatment system would also include a standby unit that would be put into service when necessary. Spent GAC would be disposed in accordance with all Federal and State of Tennessee environmental regulations.

For this alternative, treated water would be reinjected into the aquifer. Reinjection was selected because it is more economical than implementation of the groundwater pretreatment that would be required for discharge into the streams or ditches. The reinjected water would be periodically sampled to evaluate whether adequate removal of explosives compounds was occurring. The maximum-allowed reinjection limits are shown in Table 7-1.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-Dinitrotoluene</td>
<td>0.5</td>
</tr>
<tr>
<td>HMX</td>
<td>78</td>
</tr>
<tr>
<td>Nitrobenzene</td>
<td>0.78</td>
</tr>
<tr>
<td>RDX</td>
<td>10</td>
</tr>
<tr>
<td>1,3,5-Trinitrobenzene</td>
<td>20</td>
</tr>
<tr>
<td>2,4,6-Trinitrotoluene</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 7-1
Reinjection Limits for Explosives Compounds

These reinjection limits are identical to those applied to the OU1 groundwater treatment system within MLAAP (where reinjection of treated water is currently taking place), with the exception of the reinjection limits for HMX and nitrobenzene. For the OU1 remedial action, the reinjection limit of 2,000 µg/L for HMX...
is based on the USEPA Health Advisory, where exposure to HMX is limited to the ingestion pathway. For the OU4 Region 1 remedial action, the reinjection limit is identical to the aquifer cleanup goal of 78 µg/L. For nitrobenzene, the OU1 discharge limit of 17.5 is based on the reference dose and assumed adult ingestion of groundwater. For the OU4 Region 1 remedial action, the reinjection limit is based on a child hazard index of 0.1 to achieve a cumulative hazard index of 1 for the liver.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost:</td>
<td>$11,300,000</td>
</tr>
<tr>
<td>Annual O&amp;M Costs:</td>
<td>$980,000</td>
</tr>
<tr>
<td>Months to Implement:</td>
<td>18 to 24 months</td>
</tr>
</tbody>
</table>
8.0 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

This section evaluates and compares each of the alternatives described in Section 7.0 with respect to the nine criteria used to assess remedial alternatives as outlined in Section 300.430 (e) of the NCP. Each of the nine criteria is briefly described below. To aid in identifying and assessing relative strengths and weaknesses of the different remedial alternatives, this section provides a comparative analysis of the alternatives. As previously discussed, the alternatives are as follows:

- Alternative 1: No Action;
- Alternative 2: Limited Action; and
- Alternative 3: Groundwater Extraction, Treatment, and Reinjection

8.1 NINE EVALUATION CRITERIA

Section 300.430 (e) of the NCP lists nine criteria by which each remedial alternative must be assessed. The acceptability or performance of each alternative against the criteria is evaluated individually so that relative strengths and weaknesses may be identified.

The detailed criteria are briefly defined as follows:

- Overall Protection of Human Health and Environment is used to denote whether a remedy provides adequate protection against harmful effects and describes how human health or environmental risks are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

- Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of Federal and State environmental statutes or if the remedy provides a basis for invoking a waiver.

- Long-term Effectiveness and Permanence refers to the magnitude of residual risk and the ability of a remedy to maintain reliable protection of human health and the environment, over time, once clean-up goals have been met.

- Reduction of Toxicity, Mobility, or Volume through Treatment is the anticipated performance of the treatment technologies employed in a remedy.

- Short-term Effectiveness refers to the speed with which the remedy achieves protection, as well as the potential to create adverse impacts on human health and the environment during the construction and implementation period.

- Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution.

- Cost includes both capital and O&M costs

- Regulatory Acceptance indicates whether, based on its review of the RI/FS Report and Proposed Plan, the USEPA and the TDEC concur with, oppose, or have no comment on the preferred alternative.

- Community Acceptance is assessed following a review of the public comments received on the Proposed Plan.
The NCP (Section 300.430 (f)) states that the first two criteria, protection of human health and the environment and compliance with ARARs, are "threshold criteria" that must be met by the selected remedial action. The next five criteria are "primary balancing criteria", and the trade-offs within this group must be balanced. The preferred alternative will be that alternative which is protective of human health and the environment, is ARAR-compliant, and provides the best combination of primary balancing attributes. The final two criteria, regulatory and community acceptance, are "modifying criteria" which are evaluated following the public comment period.

8.2 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Current levels of explosives compounds in groundwater pose unacceptable levels of human health risk if the groundwater were used as drinking water. Even though this is not occurring due to use of municipal water as drinking water by City of Milan residents, homeowners who live northwest of the city obtain their drinking water from private wells. These residents may in the future be exposed to elevated levels of explosives compounds as the area of contaminated groundwater migrates toward the northwest. Alternative 1 (No Action) would not meet the criterion of overall protection of human health and the environment because no actions would be taken to eliminate, reduce or control exposure pathways.

Alternative 2, Limited Action, provides some protection from contaminated groundwater by implementing land use restrictions within MLAAP and beginning regular groundwater sampling and analysis. Because actions would be taken to prevent exposures to contaminated groundwater and to monitor the distribution and mobility of the explosives compounds, Alternative 2 would meet the criterion of overall protection of human health and the environment under current conditions. However, implementation of Alternative 2 would not reduce the concentrations of explosives compounds in groundwater, except as would occur through natural dispersion. Because Alternative 2 would also not prevent the further migration of explosives compounds, residents who live northwest of the City of Milan could potentially be exposed to health-threatening levels of explosives compounds in the future.

Alternative 3 would protect human health and the environment by extracting the contaminated groundwater downgradient of Line X, controlling the migration of the explosives compounds, and reducing the concentrations of explosives compounds in groundwater. In combination with land use restrictions that would prevent usage of contaminated groundwater as drinking water, implementation of this alternative would result in the overall protection of human health and the environment.

8.3 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

For this action, there are no chemical-specific ARARs because there are no Federal or State promulgated standards for explosives compounds in groundwater. The cleanup goals established for the project are based on acceptable risk levels for potential users of groundwater within the City of Milan and areas outside of the City of Milan.

There are also no location-specific ARARs for the OU4 Region 1 project. Alternative 1 (no action) and Alternative 2 (limited action) do not involve actions that would require consideration of location-specific ARARs. The treatment plant that would be constructed under Alternative 3 would not be located in a wetland, floodplain, or coastal zone, so location-specific ARARs would not apply to this alternative.

Because no actions other than institutional controls and monitoring would be performed under Alternatives 1 and 2, there are no action-specific ARARs for these alternatives. Under Alternative 3,
groundwater would be removed from the contaminated areas of the aquifer and treated using GMF and GAC. The treated effluent would be injected into the aquifer. The effluent would not contain explosives compounds at concentrations higher than the limits shown in Table 7-1, and all other aspects of reinjection would be performed in accordance with the substantive requirements of the State of Tennessee regulations on underground injection (Rule 1200, Division 4, Chapter 6), which is an action-specific ARAR for Alternative 3. The spent carbon would contain explosives compounds, but would not meet the definition of a listed hazardous waste because groundwater, rather than water derived from TNT operations, was the source of the explosives compounds. The spent carbon generated by the OU1 and OU3 groundwater treatment plants has never exhibited the characteristic of reactivity, so the OU4 spent carbon would also not be a hazardous waste by characteristics. Therefore, the spent carbon and drying bed sludges would be a solid waste and would be handled and disposed in accordance with the State of Tennessee solid waste regulations (Rule 1200-1-7), which is an action-specific ARAR for Alternative 3.

8.4 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternatives 1 and 2 would not provide long-term effectiveness and permanence because the explosives compounds in groundwater would continue to migrate toward the northwest.

Alternative 3 would consist of the installation and operation of a groundwater extraction and treatment system that would provide effective, permanent treatment of explosives compounds in groundwater. The spent carbon that would be generated by this alternative would be handled and disposed in accordance with all Federal and State of Tennessee environmental regulations.

8.5 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME OF CONTAMINANTS THROUGH TREATMENT

Alternatives 1 and 2 do not include any active treatment of the groundwater, so this criterion would not be met. Implementation of Alternative 3 would result in the reduction of toxicity, mobility, and volume of the explosives compounds through treatment. The volume of contaminants in the aquifer would be reduced through the removal of contaminated groundwater from the aquifer and treatment to remove the explosives compounds prior to reinjection. The contaminants would be transferred to the GAC media and would be permanently destroyed by the GAC regeneration process. Controlling the rate of migration of contaminated groundwater would reduce the mobility of explosives compounds. The GAC units would reduce the toxicity of the groundwater by removing explosives compounds.

8.6 SHORT-TERM EFFECTIVENESS

Alternatives 1 and 2 would be effective in the short term because the contaminated groundwater is presently not being used. Alternative 3 would also be effective in the short term because construction of the extraction system, treatment facility, and discharge system would be completed with standard construction equipment and would not entail additional risks to workers beyond those risks inherent in construction projects. Likewise, employees and the community located within the vicinity of the site would be unaffected by the construction of the treatment facility.

The length of time required to design and construct the treatment system for the implementation of Alternative 3 would be from 18 to 24 months. This time estimate includes the treatment system design and review, preparation of bid packages, selection of contractors and equipment suppliers, construction and equipment installation, and start-up.
8.7 IMPLEMENTABILITY

Alternatives 1 and 2 are readily implementable. Under Alternative 1, no action would be taken. Under Alternative 2, the only actions to be taken consist of periodic groundwater sampling and analysis to evaluate the migration and natural dispersion of the explosives compounds in groundwater.

The treatment processes that are proposed in Alternative 3 are commonly used in water and wastewater treatment systems and are commercially available. Explosives compounds in extracted groundwater would be adequately removed through the combination of treatment processes. Electricity is the only utility that is required to operate these treatment systems, and it can be made available at the site.

8.8 COST

The cost under Alternative 1 would be $0 because no actions would be taken. Alternative 2 would be the next least expensive alternative, with estimated capital costs of $64,000 and annual operation and maintenance costs of $180,000. Because Alternative 3 consists of the design, installation, and operation of a groundwater treatment system, this alternative is more costly. The capital costs would be approximately $11,300,000, and annual operation and maintenance costs would be approximately $980,000. The cost estimate was developed for a treatment system with a capacity of 1,300 gallons per minute (gpm). The flow rate range, and consequently the size of the system, is considered to be an estimate. These estimates are preliminary and are subject to change.

8.9 REGULATORY ACCEPTANCE

The USEPA and the TDEC concur with the preferred remedy.

8.10 COMMUNITY ACCEPTANCE

Community acceptance of the preferred alternative has been addressed in the Responsiveness Summary (Appendix A.)
9.0 THE SELECTED REMEDY

Alternative 3, which combines groundwater extraction, treatment, and reinjection of treated water, has been identified as the preferred alternative based on currently available information. In summary, Alternative 3 would achieve the desired risk reduction by extracting the contaminated groundwater from the aquifer, thereby controlling the migration of explosives compounds and reducing the concentrations of explosives compounds in off-site groundwater. Based on the best information that is currently available, the Army, USEPA, and TDEC believe that the preferred alternative would be protective of human health and the environment, would comply with all State and Federal laws, and would be cost-effective. This alternative would permanently treat groundwater using proven treatment methods.

9.1 EXIT STRATEGY

This section specifies the conditions under which the remedial action for groundwater at OU4 Region 1 will be considered to be complete.

9.1.1 Definitions

$10^{-4}$ risk level: Specified concentrations of explosives compounds that correspond to a cumulative lifetime excess cancer risk of $10^{-4}$ and a hazard index of 3. The specified risk-based concentration for each analyte of concern is provided in Table 6-2.

$10^{-5}$ risk level: Specified concentrations of explosives compounds that correspond to a cumulative lifetime excess cancer risk of $10^{-5}$ and a hazard index of 1. The risk-based concentration for each analyte of concern is provided in Table 6-3.

Affected area: That volume of the off-post aquifer, as delineated using the most recent groundwater quality data at the time of ROD signature, known to contain explosives compounds in groundwater at concentrations above the $10^{-4}$ risk level. The affected area boundary may be re-delineated during the course of the remedial action as new data are collected and analyzed.

Monitored area: The entire affected area plus the aquifer volume between the MLMP boundary and the northwestern boundary of the City of Milan through which the contaminated plume will move as it migrates in the direction of groundwater flow.

Upgradient area: The contaminated volume of the aquifer within MLAAP that lies immediately upgradient of the affected area.

9.1.2 Purpose of the Action

The purpose of this remedial action is to reduce the concentrations of explosives compounds in off-post groundwater to concentrations that correspond to a risk level of and to prevent the migration of contaminated groundwater to the northwestern boundary of the City of Milan at concentrations that would exceed the risk level at the boundary. These goals will be achieved by extracting groundwater from the MLAAP boundary and at off-post locations within the City of Milan and/or the University of Tennessee Agricultural Research Station. The pumping of the extraction wells will create a cone of depression within the affected area and will remove contaminants from the aquifer. Once begun, the remedial action will be performed in a manner that will result in continuous aquifer cleanup and control of plume migration.
9.1.3 Remedial Action Changes and Enhancements

The Army reserves the right to add or replace extraction and/or injection wells, install additional extraction and/or injection wells, pump the extraction wells at rates that may not be constant over the life of the remedial action, and to remove extraction and/or injection wells from operation as needed to meet the remedial objectives. The Army may elect to go to intermittent or pulsed operation if that is deemed by the Army to continue or improve aquifer remediation. The Army will inform the TDEC and the USEPA of major changes to system operation. The final determination that remediation of a subarea of the affected area is complete will be made in consultation with both the TDEC and the USEPA.

9.1.4 Remedial Action Requirements

The following requirements shall be met continuously through the life of the remedial action:

1. The Army will maintain a positive inward gradient of the potentiometric surface within the affected area, as demonstrated by water level measurements made at monthly intervals in all wells within the affected area.

2. At periodic intervals (beginning with three-month intervals), the Army will collect groundwater samples from monitoring wells within the affected area and analyze the samples for explosives compounds.

3. Annually, the Army will collect groundwater samples from wells within the monitored area and the upgradient area and analyze those groundwater samples for explosives compounds.

9.1.5 Completion of the Remedial Action

The remedial action will be considered to be complete when the following requirements have both been met:

Requirement 1. Within the affected area, explosives compounds are not detected in groundwater samples collected from monitoring wells at concentrations that exceed the risk level for two consecutive monitoring periods.

Requirement 2. Within the monitored area, explosives compounds are not detected in groundwater samples collected from monitoring wells that, when the plume travels to the northeastern boundary of the City of Milan, will exceed the risk level at the boundary.

9.1.6 Continued Monitoring and Actions in the Event of a Rebound

Extraction and treatment of the groundwater will continue until both Requirements 1 and 2 above have been met. Following the achievement of both requirements, monitoring will continue at the specified frequency. Should either Requirement 1 or 2 not be met during subsequent sampling, then the Army will restart the remedial action within two months of making this determination.
10.0 STATUTORY DETERMINATIONS

Executive Order 12580 delegates the authority for carrying out the requirements of CERCLA Sections 104(a), (b), and (c)(4) and 121 to the Department of the Defense, to be exercised consistent with Section 120 of the Act. Therefore, under its legal authorities, the Army's primary responsibility at MLAAP, OU4 Region 1, is to undertake a remedial action that achieves adequate protection of human health and the environment while continuing to conduct the Remedial Investigation and Feasibility Study for Regions 2 and 3. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete, the remedial action for OU4 Region 1 must comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws unless an interim statutory waiver is justified. The remedy must also be cost effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances as their principal element.

10.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 3 would protect human health and the environment by extracting the contaminated groundwater downgradient of Line X, thus controlling the migration of the explosives compounds and reducing the concentrations of explosives compounds in groundwater. The contaminants remaining in groundwater under the City of Milan after the active portion of the remedial action is complete would be monitored and modeled and are expected to naturally attenuate to safe levels before reaching the northwestern boundary of the city. The combination of land use restrictions that would prevent usage of contaminated groundwater as drinking water and the implementation of this alternative would result in the overall protection of human health and the environment.

10.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Alternative 3 would be operated in compliance with all Federal and State ARARs that apply to groundwater treatment facilities. Under this alternative, contaminated groundwater would be removed from the affected area. The treated effluent would be reinjected into the aquifer.

10.3 COST EFFECTIVENESS

The selected remedy is cost effective because it has been determined to provide overall effectiveness proportional to its costs. The capital cost of Alternative 3 would be in the range of approximately $11,460,000 to $13,180,000, and annual operation and maintenance costs would range from approximately $878,000 to $992,000. This cost estimate was developed for a treatment system with a capacity of 1,300 gpm to 2,000 gpm. This flow rate range is considered to be an estimate and is subject to change. By implementing groundwater extraction and treatment with reinjection, the selected remedy represents the best cost/benefit ratio.

10.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES (OR RESOURCE RECOVERY TECHNOLOGIES) TO THE MAXIMUM EXTENT PRACTICABLE

The Army, the USEPA, and the TDEC have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective
manner for this remedial action of the contaminated groundwater at the northwestern boundary of MLAAP. The Army, the USEPA, and the TDEC have also determined that this selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, cost, while considering the statutory preference for treatment as a principal element and regulatory and community acceptance.

10.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

By treating the explosives contaminated groundwater using granular media filtration and subsequent GAC adsorption system technology, the selected remedy addresses one of the principal threats posed by the site through use of treatment technologies. Therefore, the statutory preference for remedies that employ treatment as a principal element is satisfied.
11.0 DOCUMENTATION OF SIGNIFICANT DIFFERENCES

The Proposed Plan for OU4 Region 1, Milan Army Ammunition Plant, was released for public comment on March 3, 1999. The Proposed Plan identified Alternative 3, Granular Media Filtration, Granular Activated Carbon Adsorption, and Reinjection, as the preferred alternative. The Army, the USEPA, and the TDEC reviewed and considered all comments received during the Public Meeting and the public comment period. Upon review of these comments, it was determined that no significant changes to the remedy, as it was originally identified in the Proposed Plan, were necessary.
APPENDIX A
RESPONSIVENESS SUMMARY

Comments received from COL James D. Knipp (US Army, Retired) dated 10 March 1999.


The following are my written comments on the “Proposed Plan for Contaminated Groundwater Within Operable Unit 4, Region 1 Milan Army Ammunition Plant”.

With Regard to Ref. A: This public notice stated “four alternatives are being evaluated...“; however, only three were described. The following comments are therefore directed at those three enumerated in the newspaper.

RE Alternative 1: No action

I recognize that this alternative is required, although certainly not reasonably applicable to this problem; I do not consider it acceptable.

RE Alternative 2: Limited action

This alternative is described as “Limited Action”, but it appears to be Monitored Natural Attenuation (MONA). I find it unacceptable for the following reasons:

a. At the meeting on 3-4 February 1999 of the Defense Environmental Response Task Force (DERTF) a speaker representing the Department of Defense presented a request for funding. In his request he stated (about institutional controls off the installation) “...in an increasing number of cases, the courts have ruled that ‘institutional controls’ are not legally enforceable”. Therefore, they would be ineffective in insuring that the public is not exposed to the Army’s pollution.

b. At this same meeting, a (different) DoD spokesman stated that, in States with Full Disclosure laws (I do not know if Tennessee is one of such States) the private landowner whose underground water was contaminated ‘...must, on selling his land, advise the prospective buyer in writing as to the nature and extent of the contamination”. If this were the case, the DoD, having given up sovereign immunity, would be subject to expensive and protracted legal action for having depressed the value of private property.

c. A third DoD spokesman (an attorney) at this meeting stated that he believed that such contamination on privately-held land, if not immediately eliminated, would constitute an unconstitutional “taking”, and make the DoD the subject of lawsuits that “are unlikely to be resolved in the DoD’s favor”.

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RE Alternative 3: Extraction, treatment, and reinjection

Of the three alternatives presented, I believe that this one is the most desirable. Until such time as operations are completed, however, the legal objections to this alternative would be the same as Alternative 2.

With regard to Reference B:

Paragraph 5, page 6 (end of first column and start of second column) states "If it appears that the concentrations of explosive compounds in groundwater would exceed the risk-based limits shown in Table 1, then additional remedial actions would be taken to protect residents". I believe that:

a. These "additional remedial actions" must be clearly defined and included as part of the proposed Plan, to include the exact thresholds that, when exceeded, would cause their initiation, and

b. the positive knowledge that, should such actions be required, equipment, supplies, manpower, and funds would be available in a timely manner so as to assure protection to inhabitants.

I further believe that such "risk-based limits" are inadequate to return the water in the aquifer to the drinking-water levels that existed prior to the Installation's contamination. "Clean-up" requires that the RDX levels should be reduced below the 2 parts-per-billion limit that was the criterion for closing Milan's Well #5; Table 1 cites a clean-up goal for RDX that is 38.5 times the 2 ppb level previously considered acceptable by both DoD and EPA.

I conclude that a fourth alternative should be considered. This fourth alternative is one that might proceed as in Alternative 3 (i.e., using the same technique, although other approaches may well be more appropriate) but with such additional equipment as would be required to complete within a much shorter time (e.g., 10 years). Although the legal objections would be the same, the sense of urgency demonstrated by the DoD might mitigate, if not eliminate, the frustration on the part of the private landowners so adversely affected and thus also mitigate against legal action.

Response to COL Knipp's Comments

Public Notice (Ref. A). The public notice mistakenly referred to four alternatives. Only three alternatives have been considered by the Army and the regulators, as listed in the public notice and the Proposed Plan.

Limited Action. The Army did not select this alternative because, among other reasons, it offers insufficient protection of the nearby residents' health. It should be noted, however, that the alternative relies on very strong institutional controls. The first institutional control is that within MLAAP, a production well for potable water will not be installed within the contaminated Line X plume. The protracted review and planning process that is required before a new well is sited automatically precludes the installation of a new well in a contaminated area.

Within the City of Milan, the city ordinance requiring residents to use the public water supply is based on economics. With all city residents hooked up to the municipal water supply, the city can charge for water usage in order to pay for operation of the sewage treatment plant and other services. Therefore, it is unlikely that this city ordinance will ever change.
Alternative 3 (Ref. B). The Army agrees that the "additional remedial actions" must be identified prior to operation of the treatment system. We do not agree that such measures should be included in the Proposed Plan, which is the document for informing the public about the problem and the proposed solutions. The Army's goal of reducing the risk posed by the contaminated groundwater to USEPA-acceptable levels by removing contaminants from the aquifer and controlling the migration of the plume to the northwest side of the City of Milan is clearly spelled out in the Proposed Plan. Additional information on the specific goals of the remedial action is included in Section 9.1 of this document. When the design phase begins, more contingency plans will be developed.

Risk-Based Limits. The 2 part per billion limit for RDX to which Col. Knipp refers is the USEPA Health Advisory for the compound. The Health Advisories were developed in the 1980s using then-available toxicity information. Conservative safety factors consisting of orders of magnitude were used to account for the fact that the data were developed from animal studies, the data used were not conclusive, the compound is a suspected carcinogen, people could potentially be exposed to the compound via multiple pathways, etc. The USEPA Health Advisories are considered to be a less accurate measurement of the toxicity of a particular compound than the USEPA cancer slope factors and reference doses, which were used in the OU4 Region 1 risk assessment. These parameters are based on the latest toxicological information, are peer-reviewed, and are updated as new data become available. In addition, the latest toxicological methodologies have been used to develop the aquifer cleanup goals listed in Section 6 of this document. The National Contingency Plan states that the acceptable risk level for site remediation is an individual excess lifetime cancer risk of $10^{-4}$ to $10^{-6}$. The risk-based cleanup levels for the groundwater under the City of Milan, where people are not drinking the groundwater, correspond to a risk level of $10^{-4}$. For areas outside of the City of Milan, where there is the slight chance that people could be exposed to the groundwater as drinking water, the risk-based levels correspond to a risk level of $10^{-5}$.

Fourth Alternative. Col. Knipp's fourth alternative is to design the remedial action such that it will be complete within a much shorter timeframe, such as 10 years. The goal of shortening the remedial action is one that the Army shares. However, we are required by law to screen remedial alternatives based on cost-effectiveness. Designing a system that would complete the remediation in a shorter timeframe would require a larger pumping rate, a larger treatment system, and a higher capital cost. Because the operation of the treatment plant is not very expensive, even the fact that the remedial action would be complete in a fewer number of years would not make up the cost difference at the beginning. Therefore, the most cost-effective configuration has been adopted. This design will establish a large enough capture zone within the aquifer to control the migration of the affected area. The concentration of explosives compounds in the off-site groundwater will be gradually reduced as a result of the pumping.

Comment Taken at Public Meeting, 18 March 1999.

I'm Bob Parkins, Milan, Tennessee. I've been following this remedial cleanup program for many years and I try to keep an update. It appears to me that extensive progress has been made and millions-untold millions of dollars spent and it seems to have reached a point that it's under control. No one's drinking the water, so, I feel that the most economical programs that could be implemented would be in the best interest of the public and the taxpayers. Further, there's no scientific evidence that RDX ever killed anyone, and I'd like to see more research pertaining to that before the alarm continues to go out about the hazards of RDX. I'm sure it's hazardous to a point but no one seems to know what point, and people ingested this water many years ago and no one ever died. I think the Army is to be commended for their efforts and I personally feel they've gone beyond their line of duty in trying to bring the situation under control.
Response to Mr. Parkins’ Comment

The results of the risk assessment indicate that the concentrations of explosives compounds that have migrated off site are high enough to require remediation. The Army feels that they have selected and will install a highly cost-effective system for remediation of the area. The treatment system will achieve the goals stated in this Record of Decision using the most economical pumping rate, and is therefore a cost-effective expenditure of public funds.

We agree that the data on the carcinogenicity of RDX are incomplete with respect to the effect on humans. However, the limited animal studies that have been performed indicate that exposure to RDX causes tumors in rats. As is done with many other compounds, these data have been extrapolated to a cancer slope factor for humans. This is the most accurate evaluation that can be made using existing data, and one that is unlikely to underestimate the potential human health effects.

Comment Received from COL James D. Knipp at Restoration Advisory Board Meeting on 15 July 1999

Cost isn’t a big motivator to the average citizen; the media shows Congress and Clinton arguing vehemently about how to spend ‘excess’ money. Arguing ‘low cost’ breeds skepticism in me, anyway. This is a problem, but the Army’s problem is getting a big enough slice of the pie to do this job. I think this is a good approach so far as I can see. I only regret that it took 21 years.

Response to COL Knipp’s Comment

Because the contaminated groundwater within OU4 Region 1 has migrated from Milan Army Ammunition Plant and is presently under the City of Milan, the project to remediate the groundwater is one of the Army’s high priorities. However, the projected size of the Army’s overall environmental budget does not allow for the construction of the treatment system to occur in one year. The Army has committed to fund the construction in phases, extending from Government fiscal years 2000 through 2002. Because this funding situation has been anticipated by the installation environmental staff and the US Army Corps of Engineers, the design phase will take into account the amount of time that will elapse prior to beginning operation of the treatment system.

Comment Received at 29 July 1999 Public Meeting from Mr. Jerry McKinney, Milan Park Director

Just a couple comments and suggestions that I’m asking is: On the reinjection wells that’s going to be around the walking track and crossing over the walking track and the ones up in the picnic area, my concern is with the daily inspections and weekly and monthly and yearly clean-out is the mud and the drive and if you’re going to have to take a vehicle right to the well. My concerns are there is what the grass is going to look like and we might want to consider just in those areas some kind of drive or something to these wells. Also, my other comment is about the power cables and electricity. We need to consider that the electricity is tied in from the primary lines up around the walking track and that everything is underground for safety and not to go down by the primaries inside the park because we have a lot of outages with the trees and with the ice storms and stuff that would knock the wells out. Thank you.
Response to Mr. McKinney's Comment

We understand Mr. McKinney's concerns regarding the continued appearance of the park. The Army plans to design the extraction wells, reinjection wells, and the piping system consistent with the good stewardship techniques practiced by Mr. McKinney in the following ways:

- Asphalt roadways will be built leading to each of the wells, or the grassy areas through which vehicles travel will be repaired;

- Electricity will be run underground as much as possible. Piping and signal cables will be run underground to each well.