DEPARTMENT OF THE ARMY
UNITED STATES OF AMERICA

Proposed Plan for Landfills FLW-008, FLW-059, FLW-060

July 2010

Department of the Army Announces a Proposed Plan for Landfill 6 (FLW-008), Municipal Landfill on South of Roubidoux (FLW-059), and Landfill on a Branch to Big Piney (FLW-060) at Fort Leonard Wood, Missouri

INTRODUCTION

The Installation Restoration Program (IRP) at Fort Leonard Wood, Missouri, is charged with identifying, assessing, and remediating or controlling contamination from past hazardous substance operations and hazardous material spills at Fort Leonard Wood. The IRP is part of a U.S. Department of Defense (DoD) effort to identify and correct environmental contamination resulting from past practices. Established in 1986, the IRP identifies, evaluates, and remediates former disposal and spill sites at DoD facilities nationwide. The IRP is carried out in compliance with federal, state, and local laws and regulations, in particular the ***Comprehensive Environmental Response, Compensation, and Liability Act of 1980*** (CERCLA) and the ***National Oil and Hazardous Substance Pollution Contingency Plan*** (NCP).

This ***proposed plan*** addresses contamination associated with the landfill IRP sites FLW-008 (Landfill 6), FLW-059 (Municipal Landfill South of Roubidoux), and FLW-060 (Landfill on a Branch to the Big Piney) at Fort Leonard Wood. It provides the site background and characteristics, summary of risks, ***remedial action objectives*** (RAOs), the remedial alternatives considered during the ***feasibility study*** (FS), and identifies the ***preferred alternative***.

The FLW-008, FLW-059, and FLW-060 landfills qualify for the containment remedy outlined in the U.S. Environmental Protection Agency's (USEPA) ***presumptive remedy*** guidance document, *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills* (OSWER Directive No. 9355.0-67FS). The site characterization performed in the ***remedial investigations*** (RIs) shows that the landfills comply with the following prerequisites outlined in Highlight 2 of the guidance:

- Risks are at low-level.
- Treatment of wastes is impractical because of the volume and heterogeneity of the waste.
- Waste types include household, commercial, nonhazardous sludge, and industrial solid wastes.
- Quantities of hazardous wastes are smaller than those of municipal wastes.

The remedial alternatives considered during the FS include components of the containment remedy presented in the presumptive remedy guidance.

The Department of the Army, as the lead agency on behalf of the DoD, developed this proposed plan with

PUBLIC COMMENT PERIOD
August 12 to September 12, 2010

Comments on the proposed plan will be accepted at a

PUBLIC MEETING:
August 18, 2010

The Army will hold a public meeting to solicit comments from the public. Oral and written comments will be accepted at the meeting. Written comments may also be submitted within 30 days of release of the proposed plan to the address provided below:

Send Written Comments to:
Mr. Mark Lenox
Department of the Army
U.S. Army Maneuver Support Center and Fort Leonard Wood
IMNE-LNW-PWE
Building 2101, 1334 First Street
Fort Leonard Wood, MO 65473
Phone: 573-596-0882
Email: mark.lenox@us.army.mil

Information Repositories:
The proposed plan and other documents are available at the following location:

Fort Leonard Wood Administrative Record
Mr. Mark Lenox
Department of the Army
U.S. Army Maneuver Support Center and Fort Leonard Wood
IMNE-LNW-PWE
Building 2101, 1334 First Street
Fort Leonard Wood, MO 65473

input from the Missouri Department of Natural Resources (MDNR). This proposed plan has been issued to solicit public participation as required by CERCLA and NCP. An acronym list and glossary are provided at the end of this proposed plan to define terms and words that may be unfamiliar to the public.

OPPORTUNITIES FOR PUBLIC INVOLVEMENT

The Army will select a final remedy at FLW-008, FLW-059, and FLW-060 after reviewing and considering all comments submitted during the 30-day public comment period. The Army, in consultation with MDNR, may modify the preferred alternative or select another alternative presented in this plan based on new information or public comments. Therefore, the public is encouraged to review and comment on all the alternatives presented in this proposed plan.

Responses to substantive public comments will be provided in the ***Decision Document*** as part of the "Responsiveness Summary." The Decision Document will present the final selected remedy for the sites.

More detailed information regarding FLW-008, FLW-059 and FLW-060, including documents such as the RI report and FS reports, is available in the ***Administrative Record*** for the site available at Fort Leonard Wood. The public is encouraged to review that information.

SITE BACKGROUND

FORT LEONARD WOOD INSTALLATION

South-central Missouri is characterized by rugged terrain, narrow steep-walled valleys, highly dissected side slopes, and massive rock bluffs along major streams. Most of Fort Leonard Wood is located on a broad central ridge between the northerly flowing Big Piney River to the east and the northerly flowing Roubidoux Creek to the west. Tributary streams to the Big Piney River and Roubidoux Creek drain the upland areas and are deeply incised into the sides of the ridge. ***Karst*** features, such as sinkholes, springs, losing streams, caves, fractures, and solution-enlarged bedding planes are present at Fort Leonard Wood.

The geological units penetrated at FLW-008, FLW-059 and FLW-060 during historical investigations and the RIs include *residuum,* ***alluvium,*** the ***Roubidoux Formation (at FLW-008)***, and the ***Gasconade Formation***. The first ***bedrock*** unit underlying FLW-008 is the Roubidoux Formation whereas the first bedrock unit beneath FLW-059 and FLW-060 is the Gasconade Formation.

Fort Leonard Wood is located above the ***Ozark Aquifer***. The aquifer consists of a sequence of geologic formations that vary considerably in water-yielding capability but collectively function as the regional drinking water aquifer. Public water supply wells in the area generally are installed in the ***Potosi Dolomite***, which is below the Gasconade and ***Eminence dolomite***. The Eminence Dolomite, between the Gasconade and Potosi dolomite, is about 200 feet thick, and less permeable than the other two.

FLW-008 and FLW-060 are not within a mile of drinking water wells. FLW-059 is within a mile of five off-post drinking water wells. Drinking water wells in the area are screened at various depths, largely in the Gasconade and Eminence dolomite.

FLW-008, LANDFILL 6 (Rose Bowl)

FLW-008, also known as "Landfill 6" or the "Rose Bowl Landfill", is a closed sanitary landfill in the northeastern part of Fort Leonard Wood, just outside the cantonment area. The site is northeast of the intersection of Minnesota Avenue and Gas Street and occupies about 7 acres.

The landfill began operating between 1942 and 1955. Household waste and ash associated with waste incineration reportedly were deposited into the landfill. Written records indicate that wastes within FLW-008 were placed in an area-type manner, as opposed to trench-and-fill placement. The site includes an area that was disturbed south of the area of waste placement, which is a result of past tree removal (Figure 1). Soil was removed from this area for use as cover material over the waste. Based on aerial photography, the waste appears to have been burned before the landfill cover was applied. Hazardous constituents reportedly were not disposed of in the landfill.

The surface of FLW-008 is vegetated; also, piles of trees and stumps are stored on the site. Scattered surface debris, consisting of bottles and deteriorated black plastic bags, was observed on the eastern slope of the landfill and in the ***ephemeral stream*** below the toe of the slope, apparently the result of erosion along the eastern part of the landfill. Drainage generally is west to east, crossing the site along the north and south valley walls. ***Erosion gullies*** are on the face of the eastern slope. No seeps have been observed at the site. Figure 1 shows current site conditions.

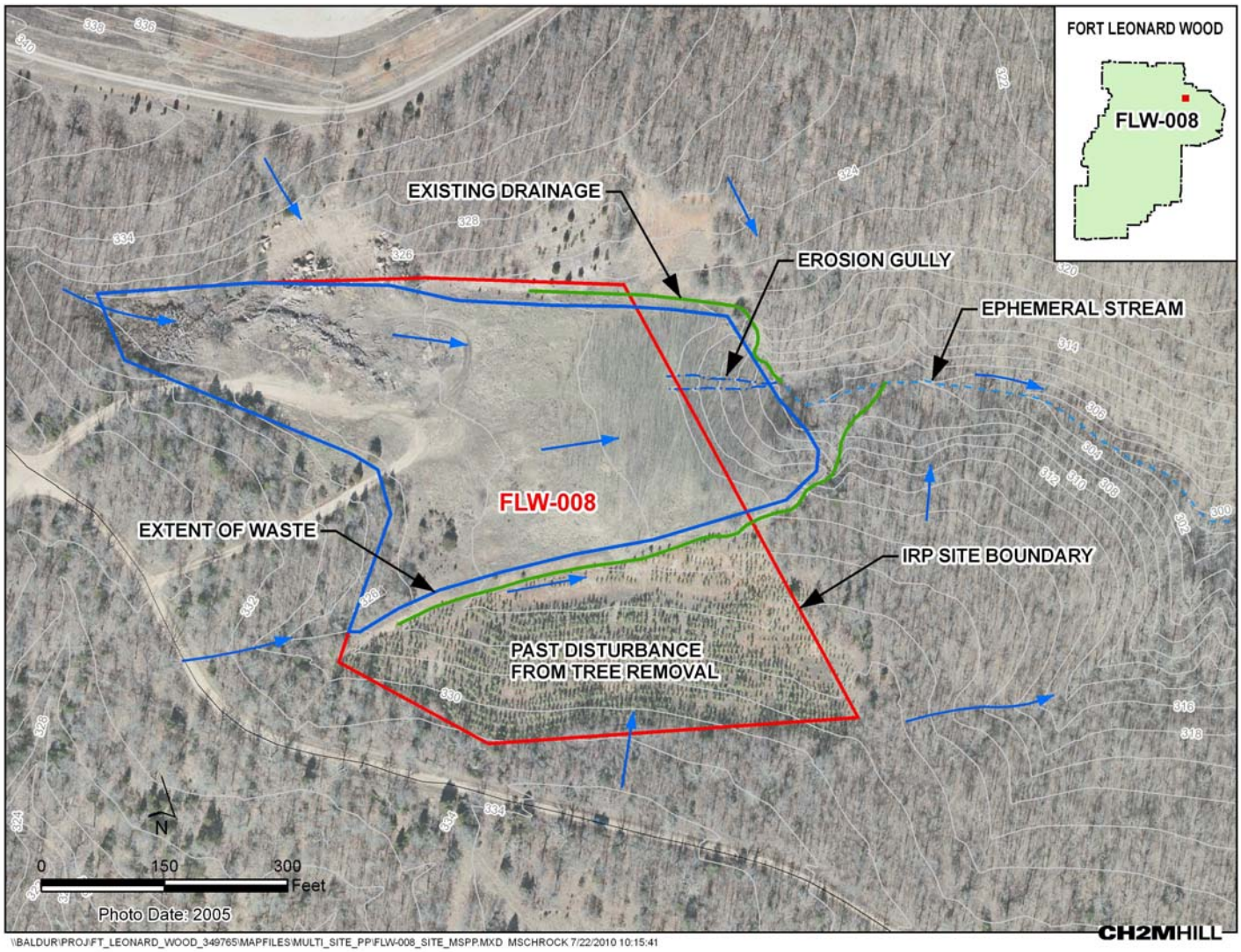

Figure 1. FLW-008, Landfill 6 (Rose Bowl)

The site is located at the head of an ephemeral stream valley. The ephemeral stream downgradient of FLW-008 extends eastward about 4,000 feet before reaching the northern boundary of FLW-060. The stream ultimately flows into the Big Piney River. The northern, western, and southern boundaries of FLW-008 are bounded by slopes rising to higher elevations. The western half of the site is relatively flat and slopes slightly to the east. The eastern half of the site slopes steeply down to the base of the landfill mass in the ephemeral stream valley. The toe of the slope marks the eastern extent of waste. Vegetation is sparse on the western half of the site, but small trees and brush are growing on the eastern slope, and mature trees cover the southern part of the site. Surface topography indicates that surface water drainage generally is west to east, with drainage crossing the site along the north and south valley walls.

FLW-059, Municipal Landfill on South of Roubidoux

FLW-059, also known as "Municipal Landfill on South of Roubidoux", comprises a group of landfills east of Roubidoux Creek in the northwestern part of Fort Leonard Wood, outside the cantonment area (Figure 2). Based on historical aerial photographs and investigations, including a geophysical survey, three individual landfills have been identified within the FLW-059 IRP site boundaries. They are, from north to south:

- Possible Landfill (2.9 acres)
- Roubidoux Landfill (5.5 acres)
- Landfill 15 (4.1 acres)

The landfills at the site are inactive, municipal solid waste, trench-and-fill-type landfills that reportedly operated from the late 1950s until the early 1960s.

FLW-059 is nearly flat, sloping gently toward Roubidoux Creek west of the site (Figure 1). The stream val-

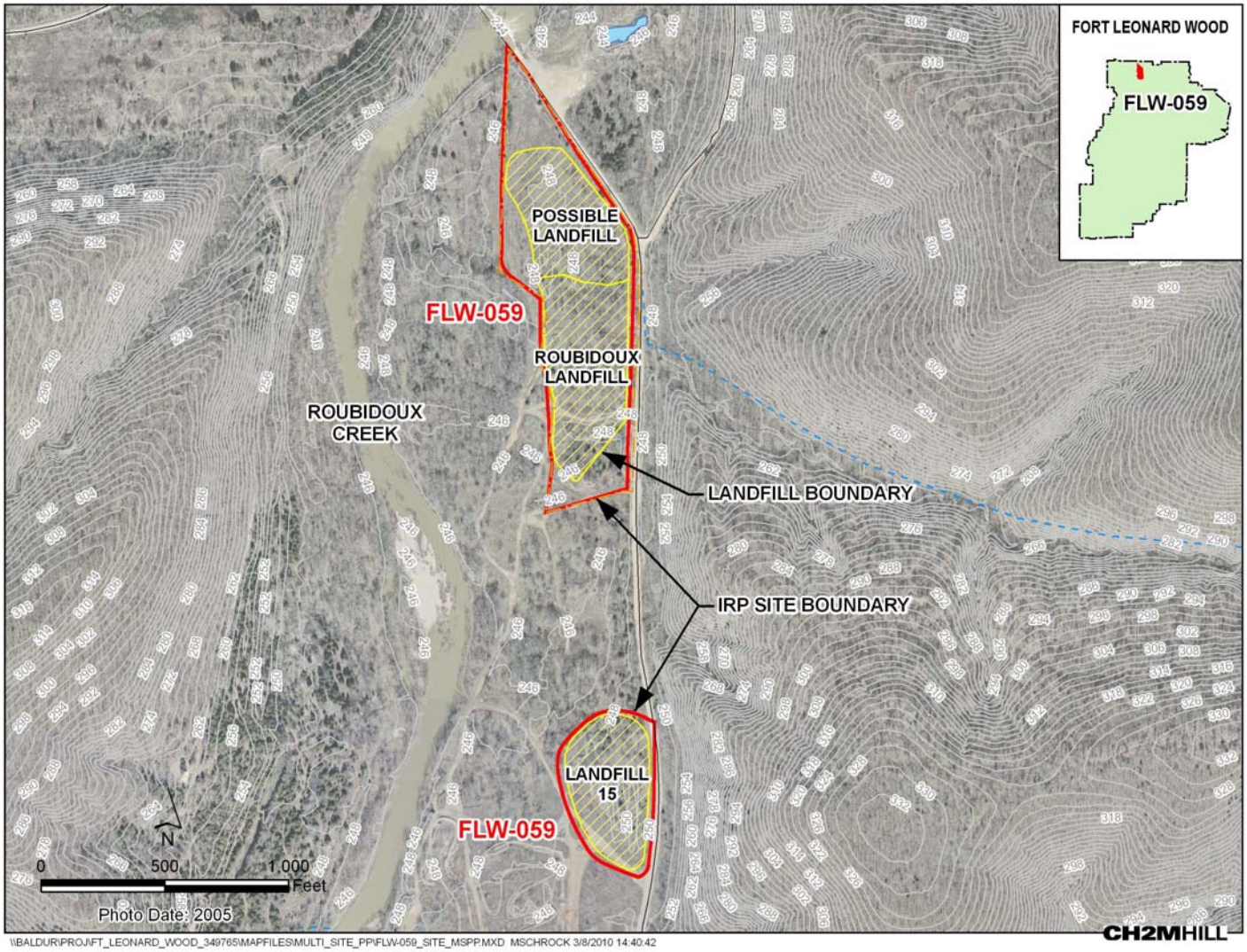

Figure 2. FLW-059, Municipal Landfill on South of Roubidoux

ley is surrounded by hills and ephemeral stream valleys that drain into Roubidoux Creek. The Roubidoux Creek valley is not incised as deeply as the Big Piney River valley; therefore, ground surface elevations are higher in the Roubidoux Creek valley. The floodplain at FLW-059 is about 1,250 feet wide. The landfills occupy the northern and eastern parts of the floodplain. Surface water runoff drains toward Roubidoux Creek. Roubidoux Creek is a losing stream until it is parallel to the southern end of the Roubidoux landfill, where Roubidoux Creek regains surface flow.

FLW-060, Landfill on a Branch to Big Piney

FLW-060, also known as the "Landfill on a Branch to Big Piney", is a closed sanitary landfill in the northeastern part of Fort Leonard Wood, outside the cantonment area (Figure 3). It likely was used for the disposal of household waste, but no written records of the landfill exist. The site is south of road FLW KA, and it occupies about 6 acres.

FLW-060 is flat and located within an ephemeral stream valley. The site is bounded on the north and south by steep slopes. Unnamed ephemeral streams are present along the northern and southern boundaries of the site. The northern stream drains IRP site FLW-008, also known as "Landfill 6" or the "Rose Bowl Landfill". Immediately east of FLW-060, the streams merge into a perennial stream known as the Boy Scout Tributary, which flows eastward into the Big Piney River.

A stream that drains areas to the north of FLW-060 merges into the same confluence just east of the site. The site is covered by grassy vegetation, and wooded vegetation lines the southern and eastern site boundaries along the southern ephemeral stream.

SITE CHARACTERIZATION

To evaluate the nature and extent of contamination at each of the sites, chemical concentrations were compared against screening levels described below.

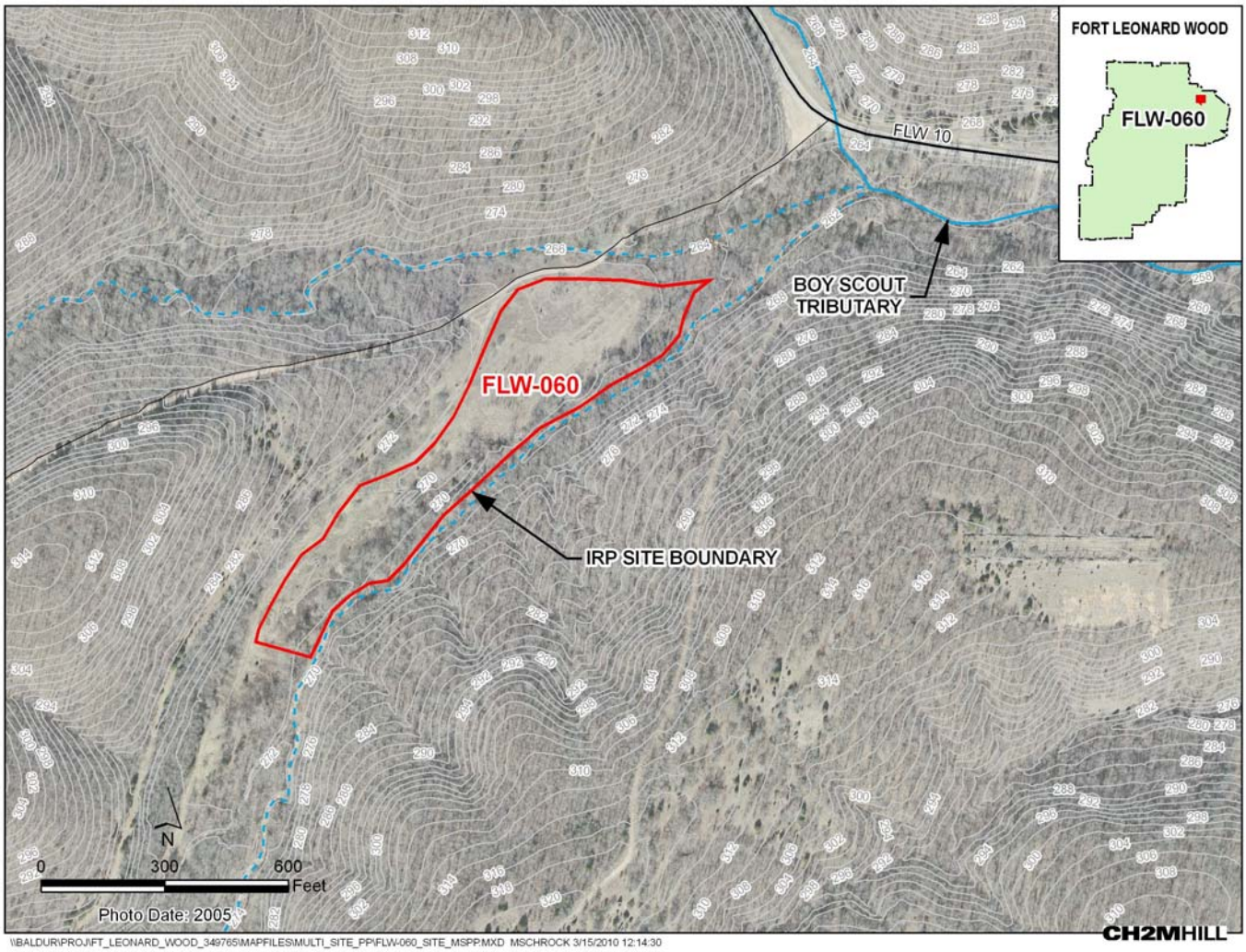

Figure 3. FLW-060, Landfill on a Branch to Big Piney

- **Soil and Sediment**—*Default Target Levels* (DTLs) in the **Missouri Risk-Based Corrective Action** (MRBCA) guidance were divided by 10 to adjust for an excess lifetime cancer risk of one in a million (or 1×10^{-6}) and a noncancer hazard index (HI) of 0.1.
- **Surface Water and Groundwater**—DTLs in MRBCA were adjusted downward by a factor of 10. When the most stringent water quality criterion was lower than the corresponding adjusted DTL, the Missouri Water Quality Standards (MWQSs) defined in Missouri ***Code of State Regulations (CSR)*** (10 CSR 20-7.031) were used.
- ***Soil Gas***—The lower of the MRBCA Tier 1 adjusted risk-based target level (RBTL) for Residential Land Use, Soil Type 1 (sandy), and Tier 1 adjusted RBTL (ambient air) for a construction worker scenario (any soil type) were used as the basis for conservative screening levels. These values were adjusted downward by a factor of 10.

Chemicals detected at concentrations that exceed screening levels in one or more samples in a given environmental medium are identified as ***preliminary chemicals of concern*** (PCOCs). PCOCs were evaluated in the ***human health risk assessment*** (HHRA), regardless of whether a comparison is made in the nature and extent evaluation to suggest that detected concentrations are not site-related or comparable to published Missouri soil concentrations. Chemicals exceeding ecological screening levels were retained for further evaluation in the ***ecological risk assessment*** (ERA).

FLW-008, LANDFILL 6 (Rose Bowl)

In 2007, an RI was conducted at FLW-008 to characterize contaminants in surface soil, sediment, ***groundwater***, and soil gas. The landfill cover material also was evaluated. Samples of surface soil, sediment, and groundwater were collected and analyzed

for parameters that included one or more of the following: ***volatile organic compounds*** (VOCs), ***semivolatile organic compounds*** (SVOCs), inorganics (also referred to as metals), pesticides, explosives, and ***total organic carbon*** (TOC). Soil cover thickness was recorded, and geotechnical samples were collected from borings advanced at specific locations at the FLW-008 landfill site.

To evaluate the nature and extent of contamination at FLW-008, chemical concentrations measured during the RI were compared against screening levels described above.

In surface soil (collected from 0 to 2 feet below ground surface), no pesticides or explosives were detected at concentrations above their screening levels. One VOC was detected in surface soil samples during the RI. Tetrachloroethene (PCE) was detected at a concentration exceeding its screening level but below its MRBCA DTL, which is 10 times greater than the screening level used in the RI. The low level concentrations of PCE in surface soil on top of FLW-008 may be attributed to landfill activities. The SVOCs 2,4-dinitrophenol, 4-nitrophenol, bis(2-chloroethyl)ether, benzo(a)pyrene, and naphthalene were detected at concentrations exceeding their screening levels in surface soil. The SVOCs identified in surface soil are used in pesticides, and low level concentrations of pesticides (below screening levels) were detected there. Their presence may be associated with historical application of pesticides at the landfill for vector control, but there are no records of such practice at the site.

Polycyclic aromatic hydrocarbons (PAHs) are a subset of SVOCs that are produced as a byproduct of burning. PAHs in surface soil likely are attributable to the burning of landfill waste before the landfill closed. PAHs also may be present because of the burning of wood as part of activities that may have occurred or the slag and cinders present from the apparent burning subsequent to operation of the landfill.

The inorganics aluminum, antimony, arsenic, beryllium, cadmium, copper, lead, manganese, mercury, molybdenum, selenium, silver, and thallium were detected in surface soils at concentrations exceeding their screening levels. Antimony, copper, manganese, molybdenum, selenium, and thallium were detected at concentrations below their respective MRBCA DTLs, which are 10 times greater than the screening levels used in the RI. Evidence indicates that the concentrations of these inorganics in soil most likely occur naturally and are not attributed to a release at the site. In one or more surface soil samples, concentrations of cadmium, lead, and mercury were more than 10 times greater than the published soil concentrations found in Missouri. The elevated concentrations were found in samples collected on the eastern slope of the site and may be related to landfilling.

In sediment, no VOCs, SVOCs, pesticides, or explosives were detected at concentrations exceeding their screening levels. Inorganics detected above the screening levels at the site consisted of arsenic, beryllium, and lead. These inorganics were detected at concentrations above screening levels in surface soil, but the chemical concentrations in sediment are comparable to published Missouri soil concentrations. This suggests that arsenic and beryllium concentrations in sediment are naturally occurring and not attributed to the site. Lead concentrations in sediment may be site-related, based on the elevated lead concentrations in surface soil on the site's eastern slope, upgradient of the sediment sample location. However, it is also possible that lead concentrations are naturally occurring and not attributed to the site, since concentrations in sediment are comparable to published Missouri soil concentrations. The absence of other chemicals in sediment at concentrations above screening levels indicates that contaminants present in surface soil at FLW-008, with the possible exception of lead, are not migrating into the ephemeral stream channel that drains the entire site.

In groundwater, no SVOCs, pesticides, or explosives were detected. The VOC carbon tetrachloride was detected in regional groundwater at a concentration exceeding its screening level. However, the detected concentration is lower than the ***maximum contaminant level*** (MCL) and MRBCA DTL for carbon tetrachloride, which is 10 times greater than the screening level. Carbon tetrachloride was not detected in grab groundwater samples collected at shallower depths of the regional groundwater table from the same monitoring well or in the other media sampled at the site, suggesting that its presence in regional groundwater is not site-related. Total lead exceeded its screening level in regional groundwater. Dissolved lead was not detected in the same groundwater sample. The screening level is the MWQS for lead, which is presented in MRBCA for determining whether further evaluation of ecological risks at the site is needed. The concentration of lead in groundwater is less than the adjusted DTL, which is the screening level sug-

gested in MRBCA to determine whether further evaluation of human health risks is needed.

The VOCs 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene were detected at concentrations exceeding screening levels at one location where a soil gas sample was collected. Soil gas concentrations exceeding screening levels are likely attributed to waste from the landfill that has not yet completely degraded.

Chemicals detected at concentrations exceeding screening levels in surface soil, groundwater, sediment, and soil gas were retained as PCOCs and evaluated in the HHRA, regardless of whether a comparison is made to show that detected concentrations exceeding screening levels in soil and sediment are comparable to published Missouri soil concentrations.

Landfill gas readings were collected at the soil boring locations where waste was encountered. No significant landfill gases were observed. The percent methane and carbon dioxide was 0.1 percent or less.

Landfill cover thickness was assessed by measuring the depth to landfill material. The cover thickness measured at FLW-008 ranged from 2 to 4 feet. The findings show that the cover thickness is relatively uniform. The cover material ranged from dry dark brown sandy silt with gravel and cobbles to dry light brown silty clay. The soil overlying waste material appeared to be fill occasionally intermixed with slag or cinders. The cover material over FLW-008 meets the intent of the current solid waste regulations (10 CSR 80-3010): to minimize fire hazards, minimize infiltration of precipitation, minimize odors and blowing litter, control gas venting and vectors, discourage scavenging, and provide a pleasing appearance.

FLW-059, Municipal Landfill South of Roubidoux

Environmental investigations were performed at FLW-059 between 1995 and 2007. Chemical concentrations measured during those investigations were compared against screening levels. To evaluate the nature and extent of contamination at FLW-059, chemical concentrations measured during environmental investigations were compared against screening levels described above.

Various investigations were completed prior to an RI to assess the nature and extent of contamination associated with the landfill and site characteristics such as the extent of waste and groundwater flow direction. Investigations performed between 1995 and 2006 provided initial site characterization of contaminants in soil, sediment, and groundwater.

Low level concentrations (below risk-based screening levels) of pesticides and PCBs (total) were detected in sediment collected in 1995. The source of the pesticides and PCBs detected in the sediment is unknown. Pesticides and PCBs were not detected in sediment during subsequent investigations.

Four temporary shallow wells were installed in 1997, and five permanent monitoring wells installed in 2003. The VOCs benzene and methylene chloride were detected at concentrations above screening levels at a temporary well (TW-002). There were no other detections of these chemicals. Methylene chloride is a common laboratory contaminant and is not likely associated with a site release, as it was not detected in the permanent monitoring wells. The concentration of benzene may be associated with a release at the site, but the occurrence was isolated, and benzene was not detected in the permanent monitoring wells. Pesticides were not found at concentrations above screening levels in temporary or permanent monitoring wells. The dissolved inorganics identified as PCOCs in groundwater during past investigations are ammonia, arsenic, barium, chromium, manganese, and nickel. Except for dissolved manganese and dissolved chromium, the inorganics that exceeded screening levels were found only in MW-5904, downgradient from part of the site historically documented as Possible Landfill.

In 2007, an RI was conducted at FLW-059 to characterize contaminants in surface soil, subsurface soil, sediment, surface water, groundwater, and soil gas. The landfill cover material also was evaluated. Samples were collected and analyzed for parameters that included one or more of the following: VOCs, SVOCs, inorganics, pesticides, explosives, and TOC. Pesticides detected in sediment during previous investigations were, in part, the reason for analyzing sediment and surface water for pesticides. In addition, soil cover thickness was recorded, and geotechnical samples were collected from borings advanced across the landfills at FLW-059.

In surface soil (collected from 0 to 2 feet below ground surface), no VOCs, pesticides, or explosives were detected in surface soil at concentrations exceeding their screening levels. The SVOCs 2,4-dinitrophenol and pentachlorophenol were detected at concentrations exceeding their screening levels in surface soil in one sample collected at Landfill 15. Landfill waste

material consisting of plastic, wood, and cinders was encountered at 2.8 feet below ground, below the depth of the sample collected. 2,4-Dinitrophenol and pentachlorophenol are used as wood preservatives, and so their presence may be attributed to wood disposed of in Landfill 15, where these chemicals were detected. Although those chemicals are also found in pesticides, it is unlikely they are associated with vector control, since pesticides were not detected in the surface soil where the SVOCs were present, and there is no documentation to indicate that pesticide application occurred there.

In surface soil, the inorganics aluminum, arsenic, beryllium, lead, and manganese were detected at concentrations exceeding their screening levels. The distribution of inorganics in soil across the site is relatively uniform. The surface and subsurface soil concentrations are within the range of published concentrations in Missouri soil. Therefore, the concentrations of inorganics in soil are most likely naturally occurring and not attributed to a release at the site.

In subsurface soil, no VOCs, SVOCs, pesticides, or explosives were detected at concentrations exceeding their screening levels. The inorganics aluminum, arsenic, beryllium, lead, and manganese were detected in subsurface soil at concentrations exceeding their screening levels. The distribution of inorganics across the site is relatively uniform. The subsurface soil concentrations are within the range of published concentrations in Missouri soil. The concentrations of inorganics in subsurface soil are likely naturally occurring and not attributed to a release at the site.

No VOCs, pesticides, or explosives were detected in sediment at concentrations exceeding their screening levels. 2,4-Dinitrophenol was detected at an estimated concentration exceeding its screening level in sediment. The concentration in the sediment sample is comparable to that detected in the surface soil sample collected at Landfill 15. The presence of 2,4-dinitrophenol in sediment may be a result of the concentration in surface soil displaced by overland runoff. In sediment, arsenic, beryllium, and lead concentrations exceeded screening levels. The inorganic concentrations in sediment are within the range of published concentrations in Missouri soil. Therefore, the concentrations of inorganics in sediment are most likely naturally occurring and not attributed to a release at the site.

In surface water, no VOCs, SVOCs, pesticides, or explosives were detected at concentrations exceeding their screening levels. Manganese was detected at an estimated concentration exceeding its screening level in surface water. It also was detected at concentrations above its screening level in surface soil. The concentration of manganese in surface water may be representative of water that has been in contact with limestone or the result of inorganics in surface soil displaced by overland runoff.

In groundwater, no VOCs, pesticides, or explosives were detected at concentrations exceeding their screening levels. The SVOC bis(2-ethylhexyl)phthalate was detected at concentrations exceeding its screening level in groundwater. It was reported at estimated concentrations well below its MRBCA DTL. The chemical is a common laboratory contaminant according to the National Functional Guidelines. Although not specifically found in the blank sample associated with the groundwater sample, it is possible that the estimated concentration is an artifact that originated with plasticizer leaching from the sampling or laboratory apparatus, and that it is not present in groundwater. Except for its presence at low level concentrations (below its screening level) in subsurface soil, bis(2-ethylhexyl)phthalate is not present in the other media sampled.

Total aluminum, arsenic (total and dissolved), barium (total and dissolved), and manganese (total and dissolved) were detected at concentrations exceeding their screening levels in groundwater. Aluminum and barium were detected at concentrations below their MRBCA DTLs. The concentrations of barium and manganese in groundwater are comparable to those in historic groundwater samples at the site. The concentration of arsenic may be the result of reducing conditions in groundwater. The reducing conditions may be related to the Possible Landfill, located upgradient of the well. However, the concentrations of arsenic have been consistent over time and marginally above the MCL. Because of the presence of steady concentrations over time and their relatively uniform distribution, the concentrations of naturally occurring inorganics (with the exception of total arsenic) in groundwater are likely not attributed to the site.

In soil gas, 1,2,4-Trimethylbenzene, 1,3,5-trimethylbenzene, dichlorodifluoromethane, and m- and p-xylenes were detected at concentrations exceeding their screening levels. Soil gas concentrations exceeding screening levels are likely attributed to waste from the landfill that has not completely degraded yet.

Chemicals detected at concentrations exceeding screening levels were retained as PCOCs and evaluated in the HHRA, regardless of whether a comparison is made to show that detected concentrations exceeding screening levels in soil and sediment are comparable to published Missouri soil concentrations.

Landfill gas readings were collected at the soil boring locations where waste was encountered. Methane was detected at 0.1 percent in one sample. No significant landfill gas concentrations were observed.

Landfill cover thickness was assessed by measuring the depth to landfill material and the ***hydraulic conductivity***. The cover thickness measured at FLW-059 ranged from 2.8 to 9.5 feet. The findings show that the cover thickness is relatively uniform and the cover material ***permeability*** is between 3.7×10^{-8} and 6.5×10^{-7} cm/sec. Exposed waste was not encountered at the site. The cover material over FLW-059 meets the intent of the current solid waste regulations (10 CSR 80-3010): to minimize fire hazards, minimize infiltration of precipitation, minimize odors and blowing litter, control gas venting and vectors, discourage scavenging, and provide a pleasing appearance.

FLW-060, Landfill on a Branch to Big Piney

Environmental investigations were performed at FLW-060 between 1995 and 2007. To evaluate the nature and extent of contamination at FLW-059, chemical concentrations measured during environmental investigations were compared against screening levels described above.

In 1995, USGS collected 23 soil samples (combining them into 5 composite samples), 2 sediment samples, and 2 surface water samples. Soil samples were analyzed for inorganics; sediments were analyzed for SVOCs, pesticides, PCBs (total), and grain size; and surface water samples were analyzed for VOCs, pesticides, and inorganics. Inorganics in surface water were the only chemicals exceeding screening levels in the media sampled at the site. The inorganics exceeding screening levels in surface water were at low level concentrations (below MRBCA DTLs). In 2007, an RI was conducted at FLW-060 to characterize contaminants in surface soil, subsurface soil, sediment, groundwater, and soil gas. The landfill cover material also was evaluated. Samples of surface soil, subsurface soil, sediment, groundwater, and soil gas were collected and analyzed for parameters that included one or more of the following: VOCs, SVOCs, inorganics, pesticides, explosives, and TOC. In addition, soil cover thickness was recorded, and geotechnical samples were collected from borings advanced across the landfill.

In surface soil (collected from 0 to 2 feet below ground surface), no VOCs, SVOCs, pesticides, or explosives were detected at concentrations exceeding their screening levels. Arsenic, beryllium, lead, and manganese were detected at concentrations exceeding their screening levels in each of the surface soil samples, but aluminum exceeded its screening level in only one sample. With the exception of arsenic and lead, the inorganics were detected at concentrations below their respective MRBCA DTLs. The lateral and vertical distribution of inorganics is relatively uniform. The surface soil concentrations are within the range of published concentrations in Missouri soil. Thus, the concentrations of inorganincs in soil are likely naturally occurring and not attributed to a release at the site.

In subsurface soil, no SVOCs, pesticides, or explosives were detected at concentrations exceeding their screening levels. Benzene was detected at a concentration exceeding its screening level between 14 to 15 feet below ground at one location, but the sample was collected well outside the landfill footprint and hydraulically upgradient of the landfill's northwest boundary. Low level concentrations of VOCs in subsurface soil may be attributed to landfill activities. Naphthalene was detected at a concentration exceeding its screening level at one location. Naphthalene is a PAH associated with burning organic materials, such as wood. Slag and cinders are common in the landfill waste and were observed in the landfill material at the site.

Aluminum, arsenic, beryllium, lead, manganese, and silver were detected in subsurface soil at concentrations exceeding their screening levels. Arsenic, beryllium, and lead exceeded screening levels in each subsurface soil sample. With the exception of arsenic and lead, the inorganics were detected at concentrations below their respective MRBCA DTLs. The lateral and vertical distribution of inorganics is relatively uniform. The subsurface soil concentrations are within the range of published concentrations in Missouri soil. The concentrations of inorganics in subsurface soil likely are naturally occurring and not attributed to the site.

In sediment, no VOCs, SVOCs, pesticides, or explosives were detected at concentrations exceeding their screening levels. Arsenic, beryllium, and lead were detected at concentrations exceeding their screening levels in each sediment sample. Manganese exceeded its screening level in half of the sedi-

ment samples. With the exception of arsenic and lead, the remaining inorganics were detected at concentrations below their respective MRBCA DTLs. The range of chemical concentrations in sediment is comparable to those in site soil and published Missouri soil concentrations. The concentrations of inorganics in sediment likely are naturally occurring and not attributed to the site.

In groundwater, no SVOCs, pesticides, explosives, or inorganics were detected at concentrations exceeding their screening levels. The VOCs 1,3,5-trimethylbenzene, benzene, and chloromethane were detected in one groundwater sample collected at 4 feet below ground from a monitoring well in the ***perched-zone groundwater***. Benzene may be related to its presence in subsurface soil. Benzene was also detected in soil gas within the landfill area suggests that the site may be a source of the benzene observed there. Because of the proximity of the monitoring well to the site where these VOCs were detected above screening levels, low-level concentrations of VOCs in perched groundwater may be attributed to landfill activities. The three VOCs were detected at concentrations below their respective MRBCA DTLs and benzene was also detected below its MCL (there are no MCLs for 1,3,5-trimethylbenzene and chloromethane).

In soil gas, five VOCs were detected in soil gas at concentrations exceeding screening levels. 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene were detected at concentrations exceeding screening levels in each sample. Benzene was detected in soil gas at concentrations exceeding its screening level at two locations. M-xylene, p-xylene, and vinyl chloride were detected at concentrations exceeding screening levels at one sampling location. Soil gas concentrations exceeding screening levels likely are attributed to waste from the landfill that has not yet completely degraded.

Chemicals detected at concentrations exceeding screening levels were retained as PCOCs and evaluated in the HHRA, regardless of whether a comparison is made to show that detected concentrations exceeding screening levels in soil and sediment are comparable to published Missouri soil concentrations.

Landfill gas readings were collected at the soil boring locations where waste was encountered. Methane was detected at 0.1 percent in one sample. No significant landfill gas concentrations were observed.

Landfill cover thickness was assessed by measuring the depth to landfill material The soil cover ranged from 0.3 foot to 7.5 feet in thickness. Soil permeability was not quantified because of the loose surface soils encountered. Surface debris was encountered at three areas along the southern boundary of the landfill, but exposed waste was not encountered at the site. The cover material over FLW-060 meets the intent of the current solid waste regulations (10 CSR 80-3010): to minimize fire hazards, minimize infiltration of precipitation, minimize odors and blowing litter, control gas venting and vectors, discourage scavenging, and provide a pleasing appearance.

SUMMARY OF SITE RISKS

Chemicals of Concern (COCs) are chemicals in media that could pose risk to current or future human receptors. As part of the RI, an HHRA evaluated the potential human health risk posed by each site if no ***remedial action*** was performed.

Individual Excess Lifetime Cancer Risk (IELCR) is calculated for COCs that have a potential to cause cancer. The IELCR estimate is expressed as the increase in the probability that an individual will develop cancer (from site exposures) over the background risk (without site exposure). The current background risk in the United States for a person to develop cancer sometime during his or her lifetime is roughly one in three (33.33 percent). Exposure to COCs posing an estimated IELCR of 1 in 10,000 would increase the overall probability of developing cancer to 33.34 percent. Cleanup is normally required when the site-specific IELCR estimate exceeds 1 in 10,000.

Noncancer risk was evaluated by calculating an HI, which compares doses received by receptors to threshold doses called ***reference doses***. When the HI is 1 or less, adverse noncancer health effects are considered unlikely to occur. If the HI is greater than 1, then there is a possibility of adverse noncancer health effects.

USEPA and MDNR identify risk thresholds to provide a framework for determining whether a site or a specific chemical or individual exposure pathway at a site poses unacceptable risk to human health. USEPA's and MDNR's acceptable range for total receptor risk (from all chemicals and exposure pathways) is 1×10^{-4} to 1×10^{-6}, and the target IELCR level used by MDNR for individual pathways and chemicals is 1×10^{-5}. Acceptable levels of noncancer risk are defined by USEPA and MDNR as an HI of 1 or less.

An onsite residential exposure scenario was not evaluated at these sites because there are no plans for resi-

dential use and it is not a "reasonably foreseeable" land use per USEPA guidance. ***Land use controls*** (LUCs) will be placed on each site to prohibit construction of buildings (with the exception of storage units not used for human occupancy), excavation activities (which will limit direct contact exposures to buried wastes), and residential development. LUCs will also prohibit installation of potable water supply wells within the landfill boundary or in areas surrounding the landfill that would induce water withdrawal from the regional groundwater below the landfill.

There is uncertainty regarding the lack of subsurface soil samples within the fill boundaries at each landfill. Subsurface soil samples were not collected within the fill boundaries because of potential safety issues associated with drilling through landfilled materials and the presumptive remedy for the site. If actual subsurface soil concentrations are lower than the concentrations used in the HHRA at each site, potential risks were overestimated. If actual subsurface soil concentrations are higher than concentrations used in the HHRA at each site, potential risks were underestimated.

The uncertainty associated with evaluating subsurface soil and landfill material within each landfill boundary is precluded by the Army's commitment to implement LUCs as well as inspect and maintain the cover material at each site.

An ERA was conducted at FLW-008, FLW-059, and FLW-060 to evaluate the potential risks and hazards to sensitive ecological receptors (plants and animals). ERAs began with a screening level assessment to evaluate the potential for unacceptable ecological risks based upon conservative assumptions. If the results suggested that further ecological risk evaluation or data collection was warranted, the ERA process proceeded to a baseline ecological risk assessment (BERA), a more realistic site-specific phase of the ERA process.

FLW-008, LANDFILL 6 (Rose Bowl)

Human Health Risk Assessment

The northwestern part of FLW-008 is used for wood storage, some of which is used as firewood. The rest of the site is currently not used by human receptors. Current realistic receptors are wood cutters in the northwestern part of the site. There are no current plans for alternate future use of the area. Future realistic receptors are woodcutters and construction workers who may be present during remedy implementation. A possible future use may include military training (foot traffic only, such as for land navigation). There are no highly susceptible populations (daycares or hospitals) or public or domestic water supply wells within 1 mile of FLW-008.

Three potential human receptors were evaluated at FLW-008 for exposure to various media: current and future onsite nonresidential workers, future onsite construction workers, and current and future offsite groundwater users. Potential exposure to surface soil and sediment, soil gas (impacting outdoor air), construction zone soil, and groundwater was considered.

The estimated IELCRs from exposures to soil, sediment, soil gas, and groundwater fall within the range considered acceptable by USEPA and MDNR for nonresidential workers, construction workers, and offsite groundwater users. The noncancer HIs are below the USEPA and MDNR acceptable level of 1. The maximum lead concentrations in surface soil (220 milligrams per kilogram [mg/kg]) and sediment (67 mg/kg) are less than the generic MRBCA level for nonresidential land use (660 mg/kg) and are therefore acceptable.

Ecological Risk Assessment

A screening level ecological risk assessment (SLERA) was conducted for FLW-008 to evaluate the RI data and to determine whether a compelling reason exists to pursue additional ERA work at the site. The SLERA resulted in a set of PCOCs in surface soils (food web and direct exposure), sediment (direct exposure only), and groundwater (direct exposure only). This set of PCOCs included chemicals with HQs greater than or equal to 1 (based upon maximum exposures) and detected chemicals for which ecological screening values were not available.

Using less conservative and more realistic exposure modeling assumptions in the initial step of the BERA, fewer chemicals had HQs greater than 1 as compared to the potential risks identified in the SLERA.

Based on the limited amount of higher quality habitat, small number of chemicals with HQs greater than 1, small number of sample locations with HQs greater than 1, limited bioavailability of the chemicals, and similarity to regional background levels, risks to ecological receptors were considered negligible, and no further investigation was warranted.

FLW-059, Municipal Landfill South of Roubidoux

Human Health Risk Assessment

FLW-059 is a part of the Roubidoux Creek floodplain and is not actively used. There are no current plans for

alternate future use of the area. Current and future realistic receptors are navigators, hunters, and recreators who roam across the site, construction workers who may be present during remedy implementation, and anglers in Roubidoux Creek. There are no highly susceptible populations (daycares or hospitals) within 1 mile of FLW-059. Five public or domestic water supply wells are located within 1 mile of FLW-059.

Three potential human receptor groups were evaluated at FLW-059 for exposure to various media: current and future onsite nonresidential workers, future onsite construction workers, and current and future offsite groundwater users. Potential exposure to surface soil and sediment, construction zone soil, surface water, groundwater, and soil gas (impacting outdoor air) was considered.

The estimated IELCR from exposure to soil, sediment, surface water, and groundwater fall within the range considered acceptable by USEPA and MDNR for nonresidential workers, construction workers, and offsite groundwater users. The noncancer HIs are below the USEPA and MDNR acceptable level of 1. The maximum lead concentrations in soil (20 mg/kg) and sediment (9.6 mg/kg) are less than the MRBCA generic level for nonresidential land use (660 mg/kg) and are therefore acceptable.

Outdoor air risks for the construction worker exposure scenario initially were overestimated because concentrations detected in soil gas samples were used directly as outdoor air concentrations. A more realistic evaluation of outdoor air risk estimates was performed to account for the dilution of chemicals in soil gas as they are dispersed into the atmosphere. The evaluation provides more realistic outdoor air risk estimates; the IELCR falls within the range considered acceptable by USEPA and MDNR for construction workers. The noncancer HI is below the USEPA and MDNR acceptable level of 1.

Ecological Risk Assessment

A SLERA was conducted for FLW-059 to evaluate the RI data and to determine whether a compelling reason exists to conduct additional ERA work at the site. The SLERA resulted in a set of PCOCs in surface soils (food web and direct exposure) and sediment (direct exposure only). This set of PCOCs included chemicals with HQs greater than or equal to 1 (based upon maximum exposures) and detected chemicals for which ecological screening values were unavailable.

Using less conservative and more realistic exposure modeling assumptions in the initial step of the BERA, fewer chemicals had HQs greater than 1 as compared to the potential risks identified in the SLERA.

Based on the limited amount of higher quality habitat, small number of chemicals with HQs greater than 1, small number of sample locations with HQs greater than 1, limited bioavailability of the chemicals, and similarity to regional background levels, risks to ecological receptors were considered negligible, and no further investigation was warranted.

FLW-060, Landfill on a Branch to Big Piney

Human Health Risk Assessment

FLW-060 is a closed landfill. The site is unmaintained land that is not used for activities at the post. There are no current plans for alternate future use of the area. Current and future realistic receptors are navigators and hunters who roam across the site and future construction workers who may be present during remedy implementation. There are no highly susceptible populations (daycares or hospitals) or public or domestic water supply wells within 1 mile of FLW-060.

Three potential human receptors at FLW-060 were evaluated for exposure to various media: current and future onsite nonresidential workers, future onsite construction workers, and current and future offsite groundwater users. Potential exposures to surface soil and sediment, construction zone soil, groundwater, and soil gas (impacting outdoor air) were considered.

The estimated IELCR from exposure to soil, sediment, and groundwater fall within the range considered acceptable by USEPA and MDNR for nonresidential workers, construction workers, and offsite groundwater users. The noncancer HIs for these media are below the USEPA and MDNR acceptable level of 1. The maximum lead concentrations in surface soil (25 mg/kg) and sediment (23 mg/kg) are less than the MRBCA generic level for nonresidential land use (660 mg/kg) and are therefore acceptable.

Outdoor air risks for the construction worker exposure scenario initially were overestimated because concentrations detected in soil gas samples were used directly as outdoor air concentrations. A more realistic evaluation of outdoor air risk estimates was performed to account for the dilution of chemicals in soil gas as they are dispersed into the atmosphere. The evaluation provides more realistic outdoor air risk estimates; the IELCR falls within the range considered acceptable by USEPA and MDNR for construction

workers. The noncancer HI is below the USEPA and MDNR acceptable level of 1.

Ecological Risk Assessment

A SLERA was conducted for FLW-060 to evaluate the RI data and to determine whether a compelling reason exists to pursue additional ERA work at the site. The SLERA resulted in a set of PCOCs in surface soils (food web and direct exposure) and sediment (direct exposure only). This set of PCOCs included chemicals with HQs greater than or equal to 1 (based upon maximum exposures) and detected chemicals for which ecological screening values were unavailable.

Using less conservative and more realistic exposure modeling assumptions in the initial step of the BERA, fewer chemicals had HQs greater than 1 as compared to the potential risks identified in the SLERA.

Based on the limited amount of higher quality habitat, small number of chemicals with HQs greater than 1, small number of sample locations with HQs greater than 1, limited bioavailability of the chemicals, and similarity to regional background levels, risks to ecological receptors were considered negligible, and no further investigation was warranted.

REMEDIAL ACTION OBJECTIVES

RAOs specify the chemicals of concern (COCs), media of interest, and exposure pathways. Typically, RAOs are developed based on the exposure pathways found to pose potentially unacceptable risks according to the results of the HHRA and ERA and to satisfy ***Applicable or Relevant and Appropriate Requirements*** (ARARs).

The site-specific HHRAs for FLW-008, FLW-059, and FLW-060 found risk to be within acceptable levels for the realistic current and future exposure pathways evaluated. The ERAs found risk to be negligible. Since current land use is industrial and future land use is presumed to be the same, no COCs were identified for which risk-based ***preliminary remediation goals*** (PRGs) would be necessary for protection against direct contact exposures to media present at these sites. Because residential land use will be precluded per the RAOs, site-specific PRGs for residential land use are not required.

FLW-008, LANDFILL 6 (Rose Bowl)

The HHRA found risks to be within acceptable levels for current and future nonresidential workers and offsite domestic groundwater users, as well as future construction workers. Based on the current land use and reasonably expected future uses, the hypothetical onsite residential scenario was not evaluated. The ERA found risks to be negligible.

Because onsite residential risks were not evaluated, RAOs were developed to prohibit future residential uses and to limit activities to the scenarios that were evaluated and found to be within acceptable risk.

Exposed waste was not observed on top of the landfill during the remedial investigation, but scattered surface debris was observed on the eastern slope of the landfill. Drainage generally is west to east, with drainage crossing the site along the north and south valley walls, and erosion gullies were observed on the face of the eastern slope. Continued erosion along the eastern slope could result in future releases of waste material. Even though future residential land use and construction of buildings on the landfill are not reasonably expected future land uses at the site, RAOs were developed to prohibit these activities as a precaution to protect public health.

The evaluation of ARARs did not identify chemical-specific ARARs that would affect the development of RAOs.

FLW-008 Remedial Action Objectives:

- Enhance surface water drainage to reduce future erosion of landfill wastes.
- Control direct contact with subsurface landfill contents that could result in an unacceptable risk to human or ecological receptors.
- Prohibit future residential land use at the site.
- Prohibit future construction of buildings on the landfill surface.

FLW-059, Municipal Landfill South of Roubidoux

The HHRA found risk to be within acceptable levels for current and future nonresidential and offsite domestic groundwater users as well as future construction workers. Based on the current land use and reasonably anticipated future uses, the hypothetical onsite residential scenario was not evaluated. The ERA found risk to be negligible.

Because onsite residential risk was not evaluated, RAOs were developed to prohibit future residential use and to limit activities to the scenarios that were evaluated and found to be within acceptable levels.

The evaluation of ARARs did not identify chemical-specific ARARs that would affect the development of RAOs.

FLW-059 Remedial Action Objectives:

- Control direct contact with subsurface landfill contents that could result in an unacceptable risk to human or ecological receptors.
- Prohibit future residential land use at the site.
- Prohibit future construction of buildings on the landfill surface.

FLW-060, Landfill on a Branch to Big Piney

The HHRA found risk to be within acceptable levels for current and future nonresidential workers and off-site domestic groundwater users, and for future construction workers. Based on the current land use and reasonably expected future uses, the hypothetical on-site residential scenario was not evaluated. The ERA found risk to be negligible.

Because onsite residential risks were not evaluated, RAOs were developed to prohibit future residential uses and limit activities to those scenarios that were evaluated and found to be within acceptable levels.

The evaluation of ARARs did not identify chemical-specific ARARs that would affect the development of RAOs.

FLW-060 Remedial Action Objectives:

- Control direct contact with subsurface landfill contents that could result in an unacceptable risk to human or ecological receptors.
- Prohibit future residential land use at the site.
- Prohibit future construction of buildings on the landfill surface.

SCOPE AND ROLE OF RESPONSE ACTIONS

FLW-008, LANDFILL 6 (Rose Bowl)

The FS identified feasible remedial alternatives and evaluated them to choose a preferred remedy for FLW-008. The alternatives included components of the containment remedy presented in the presumptive remedy guidance.

The preferred alternative will be the final response action for FLW-008. It will prevent potential future unacceptable exposures to contamination by prohibiting residential land use, building construction, and activities that permanently expose waste. Ground disturbance will be monitored to prevent the potential future exposure of contaminants to humans. Surface drainage enhancements will improve the surface drainage to minimize erosion and exposure of landfill waste. The implementation of the remedies also will comply with ARARs and achieve the RAOs for the site (see *Remedial Action Objectives*).

FLW-059, Municipal Landfill on South of Roubidoux

The FS identified feasible remedial alternatives and evaluated them to choose a preferred remedy for FLW-059. The remedial alternatives considered in the FS include components of the containment remedy presented in the presumptive remedy guidance.

The preferred alternative will be the final response action for FLW-059. It will prevent potential future unacceptable exposures to contamination by prohibiting residential land use, building construction, and activities that permanently expose waste. Ground disturbance will be monitored to prevent the potential future exposure of contaminants to humans. The implementation of the remedies also will comply with ARARs and achieve the RAOs for the site (see the *Remedial Action Objectives*).

FLW-060, Landfill on a Branch to Big Piney

The FS identified feasible remedial alternatives and evaluated them to choose a preferred remedy for FLW-060. The remedial alternatives considered in the FS include components of the containment remedy presented in the presumptive remedy guidance.

The preferred alternative will be the final response action for FLW-060. It will prevent potential future unacceptable exposures to contamination by prohibiting residential land use, building construction, and activities that permanently expose waste. Ground disturbance will be monitored to prevent the potential future exposure of contaminants to humans. The implementation of the remedies will comply with ARARs and achieve the RAOs for the site (see *Remedial Action Objectives*).

SUMMARY OF ALTERNATIVES

FLW-008, LANDFILL 6 (Rose Bowl)

Three alternatives were retained for detailed evaluation in the FS report.

Alternative 1: No Action

The NCP requires Alternative 1 so that a baseline set of conditions can be established against which other remedial actions may be compared. Five-year site reviews would be conducted as required by NCP.

Estimated ***Capital Cost***:	$0
Estimated ***Operations and Maintenance*** (O&M) ***Cost***:	$0

Estimated ***Periodic Cost***:	$150,000
Estimated ***Present Value Cost:***	**$73,000**

Alternative 2: Land Use Controls

Alternative 2 includes implementing LUCs to prohibit future residential land use at FLW-008 of the landfill surface. The Army would establish LUCs to prevent future residential land use and construction of buildings on the landfill surface. LUCs also would control construction activities, including excavation and drilling at the site, which would ensure waste material and adjacent soil remain undisturbed, or if disturbed, Army approval would be required before disturbance. Installation of potable water supply wells within the landfill boundary or in areas surrounding the landfill that would induce water withdrawal from the regional groundwater below the landfill would be prohibited. Before a land use could be changed from restricted (industrial) to unrestricted (residential), approval would need to be obtained from the Fort Leonard Wood Directorate of Public Works (DPW)–Environmental and other appropriate Army personnel, in consultation with the MDNR.

The site surface would be monitored as part of the implementation of the LUCs. The LUC boundary encompasses the landfill waste areas and a 50-foot buffer around the waste area that would be documented in the Installation Master Plan by a survey.

O&M activities would be conducted as part of the LUC implementation and would include annual landfill soil cover inspections and mowing within the LUC boundary. If soil cover deficiencies with the potential to expose waste material are observed, appropriate and timely repairs would be made. Trash and miscellaneous debris found within and adjacent to the landfill would be collected and contained with the landfill or removed offsite as solid waste. Five-year site reviews would be conducted as required by NCP.

Estimated Capital Cost:	$6,000
Estimated O&M Cost:	$35,000
Estimated Periodic Cost:	$300,000
Estimated Present Value Cost:	**$1,050,000**

Alternative 3: Land Use Controls and Surface Water Drainage

Alternative 3 includes LUCs as presented in Alternative 2. It also includes implementing surface water drainage enhancements deemed necessary to reduce erosion and exposure of landfill wastes.

Engineering controls including surface water drainage enhancements would reroute surface water runoff from the landfill to the drainageway on the north side of the site away from areas of buried waste material. The erosion gullies on the east edge of the landfill would be repaired by filling them with clean soil and seeding the filled area to promote vegetative growth. Clean fill would be imported from an approved offsite borrow source and existing soil from the landfill would be placed and used to construct berms or to modify grading as needed to reroute the surface water runoff to the north side of the site to minimize erosion in the area of the two existing gullies downgradient of the landfill from surface water runoff.

Before land disturbance takes place, appropriate erosion control measures would be established. Site restoration would include reseeding with native vegetation. Temporary or degradable erosion control material would be placed as needed until vegetation is established. Five-year site reviews would be conducted as required by NCP.

Estimated Capital Cost:	$158,490
Estimated O&M Cost:	$35,000
Estimated Periodic Cost:	$300,000
Estimated Present Value Cost:	**$1,200,000**

FLW-059, Municipal Landfill South of Roubidoux

Two alternatives were retained for detailed evaluation in the FS report.

Alternative 1: No Action

The NCP requires Alternative 1 so that a baseline set of conditions can be established against which other remedial actions may be compared. Five-year site reviews would be conducted as required by NCP.

Estimated Capital Cost:	$0
Estimated O&M Cost**:**	$0
Estimated Periodic Cost:	$150,000
Estimated Present Value Cost:	**$73,000**

Alternative 2: Land Use Controls

Alternative 2 consists of implementing LUCs to prevent future residential land use and construction of buildings on the landfill surface at Site FLW-059. LUCs would control construction activities, including excavation and drilling, ensuring that waste material and adjacent soil remain undisturbed, or if disturbed, Army approval would be required before disturbance. Installation of potable water supply wells within the landfill boundary or in areas surrounding the landfill that would induce water withdrawal from the regional groundwater below the landfill would be prohibited. Before a land use could be changed from restricted

(industrial) to unrestricted (residential), approval would need to be obtained from the Fort Leonard Wood DPW–Environmental and other appropriate Army personnel, in consultation with the MDNR.

The LUC boundary encompasses the landfill waste areas and a 50-foot buffer around the waste area that would be documented in the Installation Master Plan by a survey.

O&M activities would be conducted as part of the LUC implementation and include annual landfill soil cover inspections and mowing within the LUC boundary. If soil cover deficiencies that could expose waste material are observed, appropriate and timely repairs would be made. Trash and debris found within and adjacent to the landfill would be collected and contained within the landfill or removed offsite as solid waste. Monitoring wells MW-5901 through MW-5905 would be abandoned. Five-year site reviews would be conducted as required by NCP.

Estimated Capital Cost:	$26,300
Estimated O&M Cost:	$32,000
Estimated Periodic Cost:	$250,000
Estimated Present Value Cost:	**$970,000**

FLW-060, Landfill on a Branch to Big Piney

Two alternatives were retained for detailed evaluation in the FS report.

Alternative 1: No Action

The NCP requires Alternative 1 so that a baseline set of conditions can be established against which other remedial actions may be compared. Five-year site reviews would be conducted as required by NCP.

Estimated Capital Cost:	$0
Estimated O&M Cost**:**	$0
Estimated Periodic Cost:	$150,000
Estimated Present Value Cost:	**$73,000**

Alternative 2: Land Use Controls

Alternative 2 includes implementing LUCs to prohibit future residential land use and construction of buildings on the landfill surface at FLW-060. LUCs would control construction, including excavation and drilling at the site, which would ensure waste material and adjacent soil remain undisturbed, or if disturbed, Army approval would be required prior to disturbance. Installation of potable water supply wells within the landfill boundary or in areas surrounding the landfill that would induce water withdrawal from the regional groundwater below the landfill would be prohibited. Before a land use could be changed from restricted (industrial) to unrestricted (residential), approval would need to be obtained from the Fort Leonard Wood DPW–Environmental and other appropriate Army personnel, in consultation with the MDNR.

The LUC boundary encompasses the landfill waste areas and a 50-foot buffer around the waste area that would be documented in the Installation Master Plan by a survey.

O&M activities would be conducted as part of the LUC implementation and include annual landfill soil cover inspections and mowing within the LUC boundary. If soil cover deficiencies that have the potential to expose waste material are observed, appropriate and timely repairs would be made. Surface cleanup of trash and miscellaneous debris found on the landfill would be performed as part of the first annual inspection and disposed of as solid waste. Five-year site reviews would be conducted as required by NCP.

Estimated Capital Cost:	$5,500
Estimated O&M Cost:	$30,000
Estimated Periodic Cost:	$250,000
Estimated Present Value Cost:	**$900,000**

EVALUATION OF ALTERNATIVES

Alternatives were evaluated in detail using the nine NCP criteria identified below. The first two cleanup evaluation criteria—overall protection of human health and the environment and compliance with ARARs—are threshold criteria that must be met by the selected remedy. The remaining criteria are used to help select the preferred alternative.

The relative performance of each alternative is evaluated against the nine criteria, noting how it compares to the other alternatives under consideration. Because similar remedial alternatives were developed for FLW-008, FLW-059 and FLW-060, the results of the evaluation for these sites are the same except where noted below. The items below represent the comparison of alternatives proposed for FLW-008, FLW-059 and FLW-060 against the nine criteria. A detailed analysis of the alternatives for FLW-008, FLW-059 and FLW-060 can be found in the FS report.

1. Overall Protection of Human Health and the Environment

With the exception of Alternative 1 (No Action), the alternatives provide protection of human health and the environment by meeting RAOs; thus, the alternatives rate high in this category. Since Alternative 1

does not provide protection of human health and the environment, it is rated low in this category.

2. Compliance with ARARs
Alternative 1 would not meet ARARs because no action would be taken to protect human health and the environment from unacceptable exposure from landfill material. Alternative 2 for each site (as well as Alternative 3 for FLW-008) would be implemented in accordance with ARARs.

3. Long-Term Effectiveness and Permanence
Alternative 2 for FLW-059 and FLW-060 and Alternative 3 for FLW-008 would provide long-term effectiveness and permanence through LUCs and LTM to meet RAOs. LUCs would be implemented to protect human health and the environment. Alternative 2 for FLW-008 does not include surface water drainage enhancements to reduce erosion and exposure of waste for FLW-008, so it is rated satisfactory in this category in comparison to Alternative 3, which is rated high. Alternative 1 takes no action and does not address risk of exposure from contaminants to human health and the environment; thus, it rates low in long-term effectiveness and permanence.

4. Reduction of Toxicity, Mobility, or Volume through Treatment
All alternatives are rated low in this category, because the technology identification and screening step was eliminated from the FS since a presumptive remedy approach is appropriate for these sites.

5. Short-Term Effectiveness
Alternative 1 would be rated high in short-term effectiveness. Alternative 2 would not expose contaminated soil at the surface and is quickly implemented to minimize time before protection is achieved and therefore would be rated high in short-term effectiveness. Short-term effectiveness considers the effectiveness of alternatives in protecting human health and the environment as well as the reliability of mitigative measures taken during construction and implementation activities to control short-term risks. Therefore, the short-term effectiveness for Alternative 3 at FLW-008 would be high because of the mitigative measures that will be taken during construction of the surface water drainage enhancements air monitoring, dust suppression as required, and use of appropriate personal protective equipment).

6. Implementability
Alternative 2 for each site (as well as Alternative 3 for FLW-008) have high implementability. Required materials and services are readily and commercially available to implement the alternatives, and administrative feasibility would be moderate. Alternative 1 is rated low because this criterion does not apply to it.

NCP Evaluation Criteria

1. **Overall protection of human health and the environment** addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled.
2. **Compliance with ARARs** addresses whether or not a remedy will meet all applicable federal and state environmental laws and/or provide grounds for a waiver.
3. **Long-term effectiveness and permanence** refers to the ability of a remedy to provide reliable protection of human health and the environment over time.
4. **Reduction of toxicity, mobility, or volume through treatment** refers to the preference for a remedy that reduces health hazards, the movement of contaminants, or the quantity of contaminants at the site through treatment.
5. **Short-term effectiveness** addresses the period of time needed to complete the remedy and any adverse effects to human health and the environment that may be caused during the construction and implementation of the remedy.
6. **Implementability** refers to the technical and administrative feasibility of the remedy, including the availability of materials; services needed to carry out the remedy; and coordination of federal, state, and local governments to work together to clean up the site.
7. **Cost** evaluates the estimated capital and O&M costs of each alternative in comparison to other equally protective measures.
8. **State agency acceptance** indicates whether the state agrees with, opposes, or has no comment on the preferred alternative. (This assessment will not be completed until state agency comments on the proposed plan are received.)
9. **Community acceptance** includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. (This assessment will not be completed until public comments on the proposed plan are received.)

7. Cost

The present value cost of Alternative 1 is much less than that for the other alternatives and thus rated high. Although Alternative 1 is the least costly of the remedial alternatives, it is not protective of human health and the environment. The present value cost of Alternative 2 is less costly than Alternative 3 for FLW-008 and is protective of human health and the environment, so it also is rated high in this category. Alternative 3 for FLW-008 is rated moderately high, since the cost is higher than the other alternatives for that site.

8. State Agency Acceptance

Final acceptance from MDNR of the preferred alternative will be evaluated after the public comment period ends and will be described in the Decision Document for this action.

9. Community Acceptance

Community acceptance of the preferred alternative will be evaluated after the public comment period ends and will be described in the Decision Document for this action.

SUMMARY OF PREFERRED ALTERNATIVES

The preferred alternative for FLW-008 is Alternative 3, Land Use Controls and Surface Water Drainage Enhancements. It will prohibit future residential land use and construction at the site, ensure the soil cover is adequate and maintained, control the potential for exposure to landfill contents, and enhance surface water drainage to minimize erosion of landfill wastes.

The preferred alternative for FLW-059 and FLW-060 is Alternative 2, Land Use Controls, which will prohibit future residential land use and construction at the site, ensure the soil cover is adequate and maintained, and control the potential for exposure to landfill contents.

The preferred alternatives for FLW-008, FLW-059, and FLW-060 are presented in Figures 4, 5, and 6, respectively. The preferred alternatives were selected over other alternatives because they are expected to most effectively meet RAOs.

Based on information currently available, the Army believes the preferred alternative meets the threshold criteria and provides the best balance of tradeoffs of all alternatives with respect to balancing and modifying criteria.

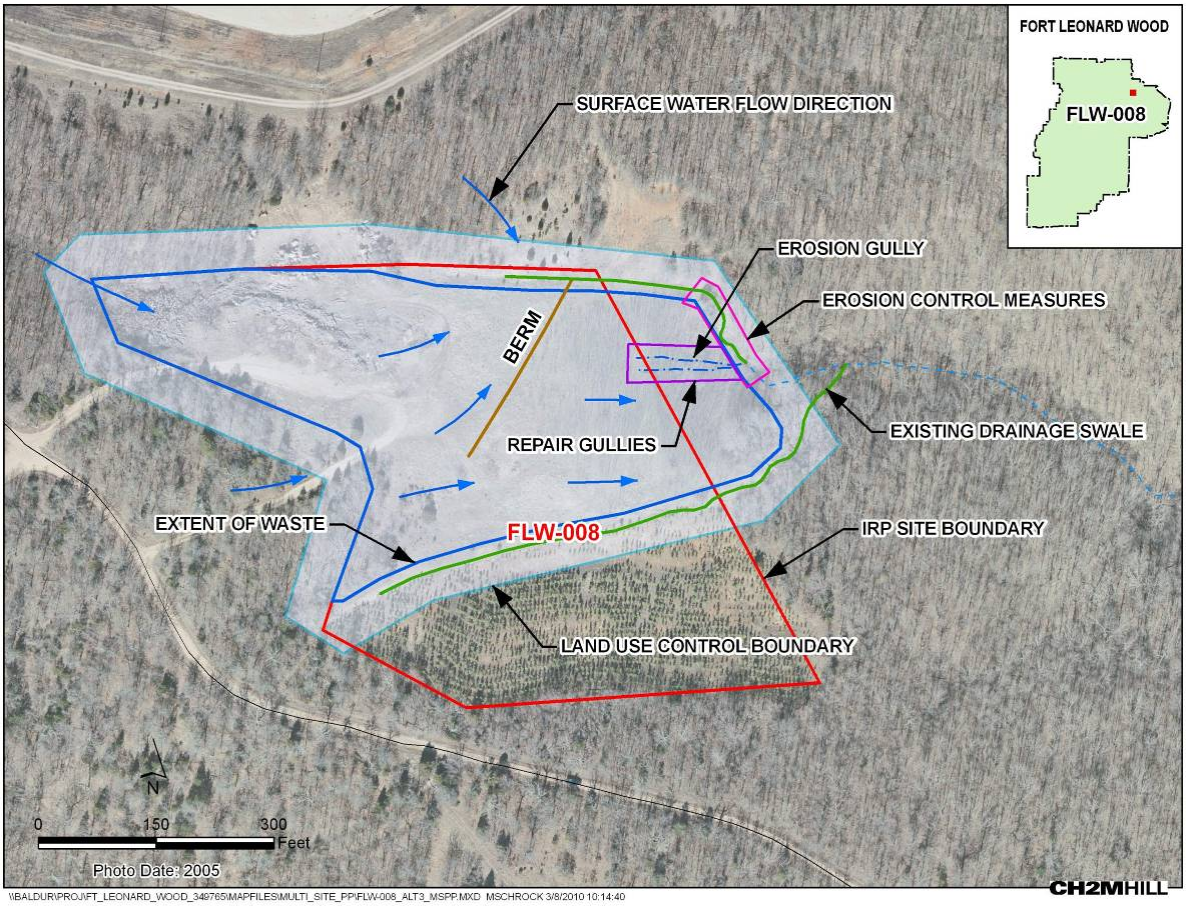

Figure 4. Preferred Alternative: FLW-008

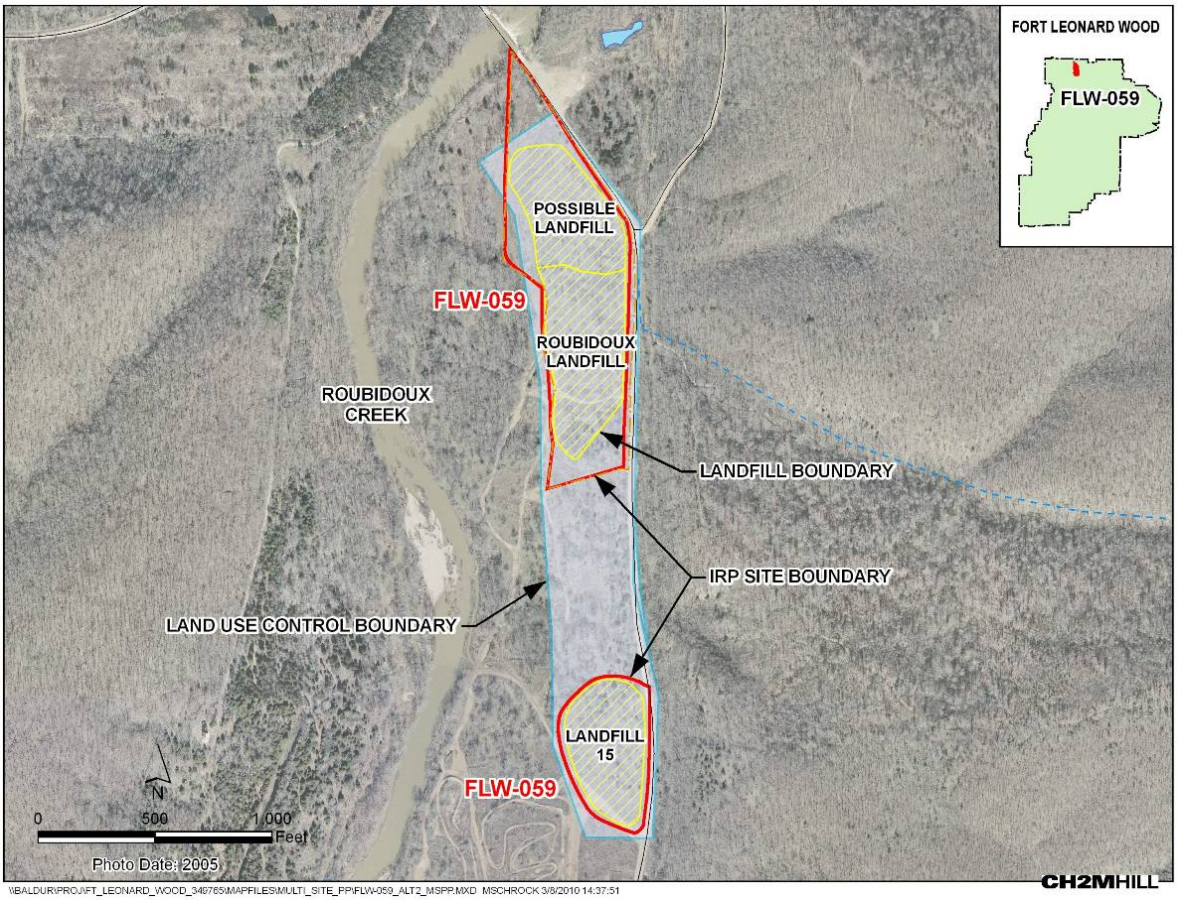

Figure 5. Preferred Alternative: FLW-059

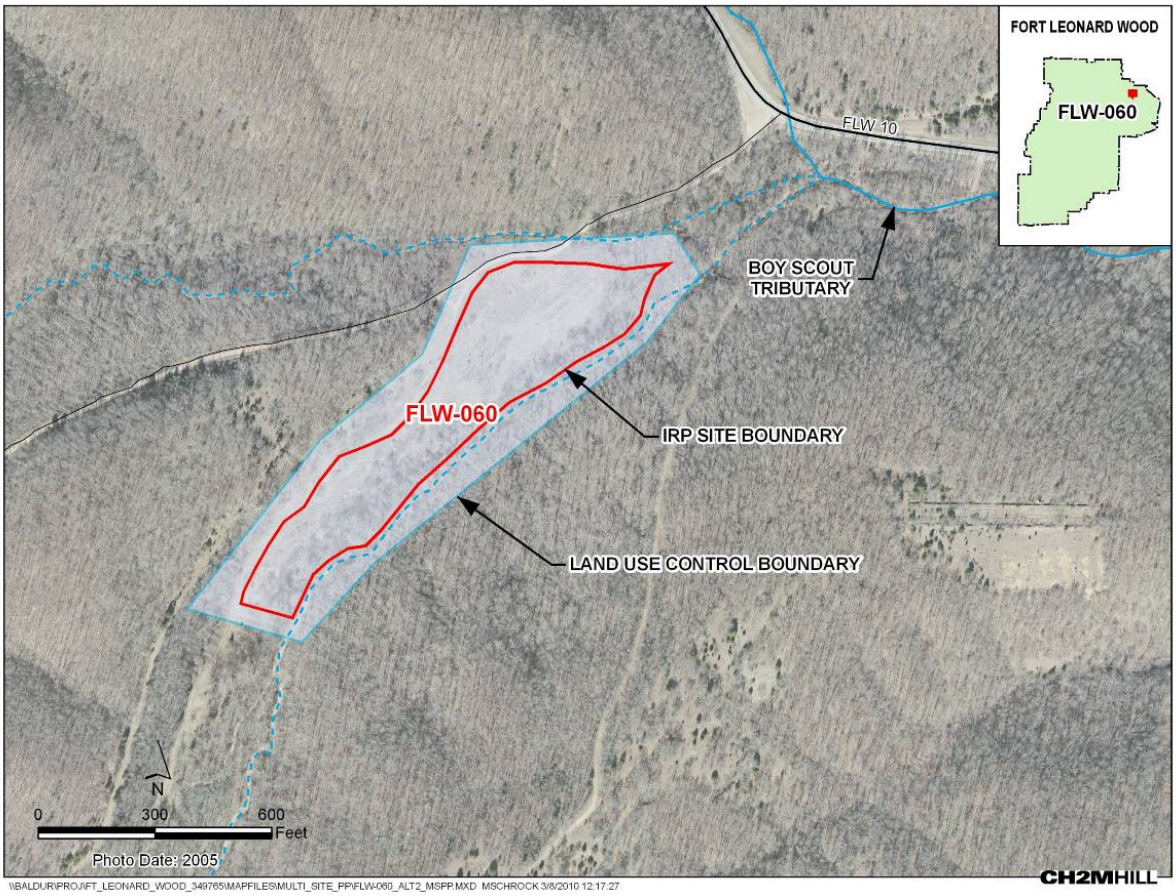

Figure 6. Preferred Alternative: FLW-060

1. The Army expects the preferred alternatives to satisfy the following statutory requirements of the CERCLA § 121(b):
2. Be protective of human health and the environment.
3. Comply with ARARs (or justify a waiver).
4. Be cost-effective.
5. Use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum practical extent.
6. Satisfy the preference for treatment as a principle element, or explain why the preference for treatment will not be met.

COMMUNITY PARTICIPATION

The Army will provide information regarding the remedial action for FLW-008, FLW-059 and FLW-060 to the public through a public meeting, the Administrative Record for the sites, and announcements published in the local newspapers. Fort Leonard Wood encourages the public to gain a more comprehensive understanding of the sites and the RI/FS activities that have been conducted.

Verbal or written comments may be submitted during the public meeting, or written comments may be sent to Mark Lenox, Fort Leonard Wood DPW, postmarked or e-mailed no later than 30 days from the proposed plan announcement. After the public comments are received, the Army, in consultation with MDNR, will make its final decision followed by publishing a Decision Document that will provide a rationale for the final decision and will respond to MDNR and public comments.

The dates for the public comment period; the date, location, and time of the public meeting; and the locations of the Administrative Record files are provided on the front page of this proposed plan.

For further information please contact:

Mr. Mark Lenox, Project Manager
DPW-Environmental Division, Fort Leonard Wood
Tel.: 573-596-0882
e-mail: mark.lenox@us.army.mil

Mr. Mark Ort, Project Manager
Missouri Department of Natural Resources
Tel.: 573-751-1968
e-mail: mark.ort@dnr.mo.gov
MDNR Toll Free Number: 800-361-4827

ACRONYMS

ARAR	applicable or relevant and appropriate requirement
Army	United States Department of the Army
BERA	baseline ecological risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSR	Code of State Regulations
COC	chemical of concern
DoD	United States Department of Defense
DPW	Directorate of Public Works
DTL	default target level
ERA	ecological risk assessment
FS	feasibility study
HHRA	human health risk assessment
HI	hazard index
IELCR	individual excess lifetime cancer risk
IRP	Installation Restoration Program
LUC	land use control
MCL	maximum contaminant level
MDNR	Missouri Department of Natural Resources
mg/kg	milligrams per kilogram
MRBCA	Missouri Risk-Based Corrective Action
MWQS	Missouri Water Quality Standard
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
O&M	operations and maintenance
PAH	polycyclic aromatic hydrocarbon
PCE	tetrachloroethene
PCOC	potential chemical of concern
PRG	preliminary remediation goal
RAO	remedial action objective
RBTL	risk-based target level
RI	remedial investigation
SLERA	screening level ecological risk assessment
SVOC	semivolatile organic compound
TOC	total organic carbon
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	volatile organic compound

GLOSSARY

Administrative Record: The body of documents the Army uses to form the basis for selection of a response.

Alluvium: Sediment deposited by flowing water.

Applicable or relevant and appropriate requirements (ARAR): Federal and state requirements for cleanup, control, and environmental protection that a selected remedy for a site will meet.

Aquifer: A water-bearing geological material that transmits water in sufficient quantities to supply a well.

Bedrock: The solid rock that underlies soil and other superficial materials.

Chemical of Concern (COC): Chemicals in media at a site that could pose risk to current or future human receptors.

Capital costs: Expenses related to the labor, equipment, and material costs of construction.

Code of State Regulations: Rules set forth by the State of Missouri.

Comprehensive Environmental Response, Compensation, and Liability Act: CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites, provided for liability of persons responsible for releases of hazardous waste at these sites, and established a trust fund to provide for cleanup when no responsible party can be identified.

Decision Document: A document that is a consolidated source of information about the site, the remedy selection process, and the selected remedy for cleanup under the CERCLA process.

Default Target Level (DTL): A compilation of the lowest risk-based contaminant concentrations for any exposure route. DTLs are based on a 1×10^{-5} excess lifetime cancer risk level and a noncancer HI of 1.0 for residential exposure to the chemicals, as well as protection of domestic use of groundwater. Because the value is the lowest of all exposure pathways, the remediating party must characterize the site, but does not need to determine exposure paths and receptors if the maximum concentrations are below DTLs.

Ecological risk assessment (ERA): A study of the actual or potential danger to the environment from hazardous substances at a specific site. The ERA estimates nonhuman health risk if no response action is taken.

Ephemeral stream: A stream or portion of a stream that flows only in direct response to precipitation, drying up shortly after precipitation ceases.

Erosion gullies: Landforms created by running water eroding sharply into soil, typically on hillsides.

Explosive: A substance that decomposes rapidly under certain conditions with the production of gases that expand by the heat of the reaction. The energy released is used in firearms, blasting, and rocket propulsion.

Feasibility study (FS): The FS identifies and evaluates the most appropriate technical approaches to address contamination problems at a CERCLA site.

Gasconade Dolomite: A bedrock unit found in the subsurface. This unit is primarily composed of dolomite and is generally where groundwater below the zone of saturation is encountered. Major caves and springs in the area are generally formed in this formation.

Groundwater: Water occurring within the subsurface.

Hazard index (HI): A measure of the risk adverse health effects associated with exposure to chemicals not known to cause cancer. An HI of 1 or less is considered highly unlikely to cause noncancer adverse effects even if exposure continues for a lifetime.

Human health risk assessment (HHRA): A study of the actual or potential danger to human health from hazardous substances at a specific site. The HHRA estimates the risk to human health at a site if no response action is taken.

Hydraulic conductivity: The property of vascular plants, soil, or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and on the degree of saturation.

Individual Excess Lifetime Cancer Risk: Cancer risks are probabilities usually expressed in scientific notation (such as 1×10^{-4}). An excess carcinogenic risk of 1×10^{-4} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 10,000 chance of developing cancer as a result of a site-related exposure.

Inorganic: Chemical compounds that do not contain carbon.

Karst: Landscape shaped by the dissolution of a layer or layers of soluble bedrock, usually carbonate rock such as limestone or dolomite.

Land use controls (LUCs): Actions taken by the Army that help minimize the potential for human exposure to contamination by ensuring appropriate land or resource use.

Maximum Contaminant Level (MCL): The highest concentration of compounds that present risk to human health allowed by the EPA in drinking water.

Missouri Risk-Based Corrective Action guidance: Policy for remediation decisions at contaminated sites.

National Oil and Hazardous Substance Pollution Contingency Plan (NCP): USEPA's regulations governing all cleanups under the Superfund program.

Noncancer risk: For noncancer health effect, an HI is calculated. The key concept is that a "threshold level" (measured usually as an HI of less than 1) exists below which noncancer health effects are no longer predicted.

Operations and maintenance cost: The cost and timeframe of operating labor, maintenance, materials, energy, disposal, and administrative components of the remedy.

Ozark Aquifer: A sequence of geologic units in the subsurface of several states, including southern Missouri, that vary considerably in water-yielding capability but collectively function as a regional drinking water aquifer.

Perched-zone groundwater: Groundwater separated from the underlying main body of groundwater by unsaturated rock.

Permeability: Ability of porous rock, sediment, or soil to transmit water; the rate at which water moves through rocks or soil.

Periodic cost: Capital or O&M costs that occur only once every few years. Because of their periodic nature, these costs are usually considered separately in the estimating process from initial capital or annual O&M costs.

Pesticide: A substance, usually synthetic although sometimes biological, used to contain the activities of pests (i.e., animal, fungi, insect, plant, or any unwanted species).

Potential Chemical of Concern (PCOC): Chemicals present at concentrations that exceed screening levels in one or more samples in a given environmental medium.

Polycyclic aromatic hydrocarbons: A subset of semivolitile organic compounds characterized by multiple interconnected ring structures. Vapor pressure is the pressure exerted by a compound in a two phase equilibrium. Thus more volatile compounds have higher vapor pressure.

Potosi Dolomite: A bedrock unit found in the subsurface. This unit is composed of dolomite and is a major water-producing formation for public water wells.

Preferred alternative: The preferred alternative, of all the alternatives considered, is the alternative proposed by the Army to remediate the site.

Preliminary remediation goal (PRG): Numerical goals set for a contaminated media to help meet the RAOs.

Present value cost: The present value of a future investment or payment that is calculated using a predetermined discount or interest rate. Present value cost is the amount of money which, if invested in the current year, would be sufficient to cover all the costs over time associated with a remedial action.

Presumptive remedy: Preferred technology or technologies for common categories of sites, based on historical patterns of remedy selection and USEPA's scientific and engineering evaluation of performance data on technology implementation.

Proposed plan: A document requesting public input on a proposed remedial alternative.

Reference dose: A known safe dose of contamination used to determine risk for adverse noncancer health effects.

Remedial action: Action taken to cleanup contamination at a site to acceptable standards.

Remedial action objectives (RAOs): Medium-specific objectives for protecting human health and the environment (for example, soil and groundwater).

Remedial investigation (RI): A detailed study of a site. The RI may include an investigation of air, soil,

surface water, and/or groundwater to determine the source(s) and extent of contamination at a site.

Residuum: A soil formed in place by the weathering of rocks like those below it.

Roubidoux Formation: A bedrock unit found in the subsurface. This unit is primarily composed of sandstone and dolomite. This unit is generally weathered and may contain perched groundwater.

Seep: Water flowing out of the ground because of the elevated piezometric head within the soil.

Semivolatile organic compound (SVOC): A carbon based chemical with low vapor pressure, usually found in the solid or liquid state; most likely to be transferred by direct dermal contact or ingesting or inhaling contaminated dust.

Soil gas: Vapors that exist within the pore (open) spaces between soil particles or void spaces within rock in the subsurface.

Total Organic Carbon (TOC): The amount of carbon bound in an organic compound and is often used as a nonspecific indicator of water quality.

Volatile organic compound (VOC): A carbon based compound with sufficiently high vapor pressure that it can be easily transferred from soil or water to air; most likely transferred by inhalation.