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ENGINEERING AND ENVIRONMENTAL SERVICES

DRAFT FINAL
REMEDIAL INVESTIGATION ADDENDUM
AND FEASIBILITY STUDY REPORT

FOR

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS
KANSAS CITY DISTRICT

JOB No. 11-2536-0308
CONTRACT No. DACW41-92-D-9002
DELIVERY ORDER NO. 0008

MAY 22, 1995

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ENGINEERING AND ENVIRONMENTAL SERVICES

May 19, 1995

Mr. Bob Wieser (CEMRK-EP-EA)
U.S. Army Corps of Engineers, Kansas City District
700 Federal Building
601 East 12th Street
Kansas City, Missouri 64106-2896

Subject: Draft Final RI Addendum and FS Report
Pesticide Storage Facility (PSF) Residual Risk Assessment and Feasibility Study
Fort Riley, Kansas
Contract No. DACW41-92-D-9002, Delivery Order No. 0008, Mod. No. P00003
Law Environmental Project No. 11-2536-0308

Dear Mr. Wieser:

Enclosed is the Draft Final RI Addendum and FS Report. The document distribution list is also included for your information. This document has been checked and coordinated prior to submittal.

The report text and tables are also provided to CEMRK only on 3.5-inch computer disk. Figures presented in the report are not included on the computer disk, because they were prepared using either Autocad® Release 12, or the Adobe Illustration Version 5.5 and Claris Impact software packages in the MacIntosh Operating System. We understand these software packages are not compatible with CEMRK computers.

Written responses to the USEPA and KDHE comments on the December 14, 1994, draft report are not included as Fort Riley will distribute these directly to the reviewing agencies. Written responses to Army agency comments are only included in the distribution to CEMRK, as we discussed. Should you have any questions or comments, please call Ed Witkowski at (404) 499-6635.

Sincerely,

LAW ENVIRONMENTAL, INC.

Edward F. Witkowski Jr.

Edward F. Witkowski, Jr., P.E.
Project Manager

Keith A. Hansen with permission BCG

Keith A. Hansen, P.E.
Project Principal

EFW/KAH:dcl

Enclosure

2536-0308.21

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DRAFT FINAL REMEDIAL INVESTIGATION ADDENDUM AND FEASIBILITY STUDY REPORT

FOR

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
PESTICIDE STORAGE FACILITY

FORT RILEY MILITARY INSTALLATION
FORT RILEY, KANSAS

Prepared For:

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May 22, 1995

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LIST OF ACRONYMS AND ABBREVIATIONS

AKALs	Alternate Kansas Action Levels
AKNLs	Alternate Kansas Notification Levels
ARARs	Applicable or Relevant and Appropriate Requirement
ASTDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BLRA	Baseline Risk Assessment
CALs	Corrective Action Level
CEMRD	Corps of Engineers - Missouri River Division
CEMRK	Corps of Engineers - Missouri River Division, Kansas City District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CMP	corrugated metal pipe
cm/sec	centimeters per second
COC	Chemicals of Concern
CSFs	cancer slope factors
CWA	Clean Water Act
DEH	Directorate of Engineering and Housing
ECAO	Environmental Criteria and Assessment Office
EE/CA	Engineering Evaluation/Cost Analysis
ERA	Ecological Risk Assessment
FEMA	Federal Emergency Management Agency
FFA	Federal Facility Agreement

FS	Feasibility Study
FID	Flame Ionization Detector
ft/min	feet per minute
gpd	gallons per day
gpm	gallons per minute
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
HRS	Hazard Ranking System
IAG	Inter Agency Agreement
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
KALs	Kansas Action Levels
KDHE	Kansas Department of Health and Environment
kg	kilogram
KGS	Kansas Geological Survey
KNLs	Kansas Notification Levels
L	liter
LAW	Law Environmental, Inc., Government Services Division
LENL	Law Environmental National Laboratory
m	meter
MCL	Maximum Contamination Level
MCLG	Maximum Contaminant Level Goal

LIST OF ACRONYMS AND ABBREVIATIONS
(continued)

MDL	Method Detection Limit
mg	milligram
mgd	million gallons per day
mg/kg	milligram per kilogram
mg/L	milligram per liter
ML	Clayey silts - classification of soil under United Soil Classification System
MSL	mean sea level
MW	monitoring well
NA	not analyzed or not applicable
NAAQS	National Ambient Air Quality Standard
NCP	National Contingency Plan
ND	not detected (above method detection limits)
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List (Superfund List)
O&M	Operation and Maintenance
OHM	OHM Remediation Services Corp.
OSHA	Occupational Safety and Health Administration
OSR	on-site representative
OUs	Operable Units
PAHs	polyaromatic hydrocarbons
PC	Permeability Constant
PCB	Polychlorinated Biphenyl

LIST OF ACRONYMS AND ABBREVIATIONS
(continued)

PSF	Pesticide Storage Facility
QA	Quality Assurance
QCSR	Quality Control Summary Report
RAOs	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RfCs	reference concentrations
RfDs	reference doses
RGs	remediation goals
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
RME	reasonable maximum exposure
ROD	Record of Decision
ROD/RD/RA	Record of Decision/Remedial Design/Remedial Action
RRA	Residual Risk Assessment
SC	Clayey sands - classification of soil under United Soil Classification System
SFL	Southwest Funston Landfill
SVOCs	semi-volatile organic compounds
SWMU	Solid Waste Management Unit
TBC	To Be Considered
TCE	trichloroethylene
UCL	upper confidence limit
μg/L	microgram per liter

LIST OF ACRONYMS AND ABBREVIATIONS
(continued)

USACE	United States Army Corp of Engineers
USAEHA	United States Army Environmental Hygiene Agency
USDASCS	United States Department of Agriculture - Soil Conservation Service
USEPA	United States Environmental Protection Agency
USFWS	U.S. Fish & Wildlife Service
USGS	United States Geological Survey
VOC	volatile organic compound

EXECUTIVE SUMMARY

This Executive Summary is a synopsis of the Draft Final Remedial Investigation and Feasibility Study Report for the Pesticide Storage Facility (PSF). This report, and consequently this executive summary, is divided into three main parts. The first part provides site history and summarizes previous studies performed at the site. The second part summarizes the Remedial Investigation (RI) Addendum, and the third part summarizes the Feasibility Study (FS) portion of this report. The reader is encouraged to review all sections of this report to gain a better understanding of the site.

The Department of the Army - Fort Riley, the U.S. Environmental Protection Agency (USEPA) Region VII, and the State of Kansas Department of Health and Environment (KDHE), negotiated a Federal Facility Agreement (FFA) for Fort Riley, Docket No. VII-90-F-0015 (FFA, 1991). This agreement, also referred to as the Interagency Agreement (IAG), was signed by the Army in August 1990 and by USEPA Region VII and KDHE in February 1991, and became effective on June 28, 1991. Under Section IX.A., paragraph 2 of the Agreement, the PSF was specifically addressed as a potential contaminant source, and a schedule for a site RI/FS and Remedial Action was established. Two pesticide monitoring studies and a closure at the site were completed between 1974 and 1990. RI/FS planning activities were conducted from 1990 to 1992. An RI/FS was initiated in 1992, and while the RI/FS was under development in 1993, Fort Riley conducted an Engineering Evaluation/Cost Analysis (EE/CA) which considered a non-time-critical removal action at the PSF (DEH, 1993a). Subsequently, a Removal Action Memorandum was completed in December 1993 (DEH, 1993b). The RI report was completed in April 1994. This report is prepared to complete the RI/FS reporting requirements at the site and contains both an RI Addendum and the Feasibility Study. The purpose of the RI Addendum is to present a revised (using both RI and removal action data) description of the site prior to the removal action, provide a description of the current site characterization, to complete a residual risk assessment to estimate site risks remaining following the removal action, and to incorporate the results of an additional round of groundwater sampling completed in September 1994. The purpose of the FS is to set remedial action objectives, develop remedial action alternatives, and evaluate the effectiveness of those alternatives in satisfying the remedial action goals and the requirements of the National Contingency Plan (NCP). The objective of the report in general is to identify and present technically sufficient information so that a feasible and cost-effective remedial alternative can be selected which is protective of human health and the environment.

Introduction and Background

The Fort Riley Military Installation was established in 1852 as an outpost near the confluence of the Smoky Hill and Republican Rivers in Geary and Riley Counties, Kansas (LAW, 1993a). Since its inception, Fort Riley has continuously served as a center of military education and readiness. Fort Riley has functioned as a small municipality and light industrial complex, at times having an installation population, including military and civilian residents, of over 20,000. Municipal activities on the installation include solid waste disposal (land filling), wastewater treatment, wastewater discharge and general infrastructure maintenance. Specific tasks associated with maintenance duties would include general construction activities, pesticide and herbicide application, fleet maintenance and general storage and repair services (LAW, 1993a).

Fort Riley serves in a military capacity as a training, equipment supply, and military maintenance center and, therefore, has historically required management and disposal of wastes associated with these activities. Pesticides (including insecticides and rodenticides), herbicides, fungicides, insect repellents, and soil fumigants have been used at Fort Riley for a variety of applications, and are referred to herein collectively as "pesticides and herbicides" (LAW, 1993a). Historically, the types of pesticides and herbicides used at Fort Riley have also been generally available to the public at the time of use.

The PSF area of investigation is located in the Main Post cantonment area. The site is an area around Building 348 of about two-thirds of an acre in size. Building 348 was constructed in 1941 as a general purpose warehouse and has since stored pesticides and herbicides and other products used at the base. Fort Riley records do not state when pesticides were first stored in Building 348. However, discussions with Fort Riley personnel indicate that Building 348 has been used for pesticide storage since at least 1973.

Prior to the late 1970s, the maintenance yard area east of and adjacent to Building 348 was used to wash down vehicles and spray equipment used for pesticide applications. Spills of pesticides and dumping of excess formulations may have also occurred and, due to the topography at the site, would tend to flow toward the east. Furthermore, electrical transformers containing polychlorinated biphenyls (PCBs) were once stored outside the southeast corner of Building 348. Other items previously stored at the site include paint, pesticides/herbicides, pressure-treated lumber, and various general improvement materials and equipment. Since at least 1976, the majority of pesticide application has been performed by outside contractors not allowed to use the PSF for formulation or mixing of pesticides.

Discussions with Army employees familiar with past operations at the PSF confirmed that grading and trenching activities had been carried out across the site over the years. Grading activities included the use of fill material to maintain suitable PSF topography and restore areas eroded from run-off over the years. Additional inquiry into the site history revealed that two trenches were constructed and backfilled during different time periods within the area of investigation to the east of the chain link fence at the site. These trenches were unlined and uncovered during the times they were operational, and because they impounded surface-water run-off, they probably served as accumulation points for contaminants. A floor drain inside Building 348 reportedly emptied into the sanitary sewer, and pesticide spills or use of this drain for disposal was not witnessed. The sewer lateral from this drain was found during the removal action.

The PSF has been investigated on several different occasions, and a closure and removal action have been completed at the site. Previous investigations and actions at the PSF site are as follows:

- Pesticide Monitoring Study, 1974
- Pesticide Monitoring Study, 1986
- Closure Plan Wipe Samples, 1987
- Finalization on the NPL, August 30, 1990
- Closure of two CONEX containers, and a portion of Building 292 (now Building 348), finalized on December 3, 1990
- Fort Riley and U.S. Army Corps of Engineers RI/FS Planning Activities 1990 to 1992
- Development of Work Plan for the RI/FS 1991-1992
- Remedial Investigation 1992 to 1993
- Feasibility Study under development in 1993
- Engineering Evaluation/Cost Analysis 1993
- Removal Action Memorandum signed, December 1993
- Pesticide-contaminated soils were excavated and disposed off site by the removal action, March-June 1994
- Five rounds of groundwater samples have been collected from the PSF wells from July 1992, November 1992, February 1993, May 1993, and September 1994

Brief descriptions of these activities are presented in this report. The previous RI activities resulted in a site characterization and interpretation of the nature and extent of contamination, based on the available data at the time, and are documented in the RI Report (LAW, 1993a). In general, the results of the RI field activities and baseline risk assessment (BLRA) are summarized in this report.

Results of analyses from soil samples collected at the site indicated that three distinct areas of pesticide contamination were present. Several pesticides were detected in soil samples, including DDT and its metabolites (DDD and DDE), alpha- and gamma-chlordane, heptachlor, dieldrin, methoxychlor, endrin, Ronnel (Fenchlorphos), and malathion. Of the metals analyzed, arsenic, barium, chromium, and lead were routinely found in detectable concentrations in both background and PSF site samples. These metals are naturally occurring components of the earth's crust that are found in most soils and waters. Elevated concentrations of lead were detected in two soil samples and elevated levels of arsenic was detected in two samples. Several PAHs were detected in some samples. PAHs detected include acenaphthene, anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, and pyrene. The patterns of PAH concentrations followed surface runoff patterns. Constituents of asphalt paving activities, treated lumber, and asphalt stored in areas around the PSF are potential sources. Toluene and benzene were detected in some of the soil samples and are present in gasoline.

Four rounds of groundwater sampling were performed as part of the RI activities. The first (July 1992) served as the baseline, and the remainder (November 1992, February 1993, and May 1993) were part of a site sampling program. Analytical results of the samples collected to establish baseline data showed metals and inorganics as the main constituents of the groundwater around the PSF, with the alkali earth metals (calcium, magnesium, potassium and sodium) exhibiting the highest concentrations. Antimony was not detected in the baseline samples. Concentrations (total and dissolved) of four metals (barium, beryllium, chromium and selenium) were consistent with background conditions. Only the metals total aluminum, total iron and total zinc occurred slightly above background concentrations. Manganese exceeded the secondary Maximum Contaminant Level (MCL) in two samples but was detected at concentrations consistent with background levels.

Concentrations (total and dissolved) of eight metals (barium, beryllium, calcium, iron, magnesium, manganese, selenium and zinc) detected in first, second and third quarter groundwater samples were consistent with the baseline concentrations. Total antimony was only detected in two wells in the second quarter sampling event: at 0.022 mg/L in the upgradient well and at 0.032 mg/L in one downgradient well. Antimony was analyzed using USEPA Method 6010 with a detection limit of 0.022 mg/L in the first through third rounds. Arsenic was detected in one downgradient well during all quarters and in another downgradient well only during the second quarter. Arsenic did not exceed the MCL (0.050 mg/L). Total cadmium was detected only during the third quarter sampling event in the background well at 0.004 mg/L, and in two downgradient wells at 0.004 mg/L and 0.006 mg/L. The federal MCL for cadmium (0.005 mg/L) was exceeded once in a downgradient sample. Total chromium was detected in two baseline samples and again during the third quarter at 0.014 mg/L. The chromium MCL was never exceeded. Dissolved copper and total copper were detected in both background and downgradient wells at concentrations not exceeding 0.012 mg/L. During the second and third quarters, dissolved and/or total copper were detected in each well. Total lead was detected in two downgradient wells, PSF92-03 (0.0021 mg/L) and PSF92-04 (0.002 mg/L), only during the third quarter sampling event. In one downgradient well, both aluminum and iron increased during the first quarter, then showed large decreases in the second quarter, and were below detection in the third quarter.

Thallium was analyzed for during all sampling events and was not detected during the baseline, first quarter, and second quarter sampling events. During these sampling events, USEPA Method 6010 (USEPA, 1986), with a detection limit from 0.063 to 0.100 mg/L, was used in the analysis. After the second quarter event, the MCL for thallium was lowered to 0.002 mg/L, and USEPA Method 6010 no longer produced a detection limit below the MCL. The third quarter samples were analyzed and reanalyzed using USEPA Method 7841 with a detection limit of 0.001 mg/L. Thallium was reported in two downgradient wells during this quarter at concentrations of between nondetect and 0.0029 mg/L in well PSF92-02, and between 0.0013 and 0.0025 mg/L in well PSF92-03. Thallium was not detected in the background well. Considerable uncertainty pertaining to these reported thallium concentrations near the detection limit was due to interferences from high levels of calcium, magnesium, and sodium present at

Fort Riley, which may positively bias the results. The federal MCL for thallium was exceeded by the maximum reported concentrations in both samples.

Of the inorganic constituents analyzed, first quarter and third quarter concentrations of nitrate were consistent with the baseline concentrations. During the second quarter, nitrate showed an increase from two to five times in all samples with the exception of the background well. During this sampling quarter, nitrate exceeded the MCL (10 mg/L as N) in all site wells with the exception of the background well (PSF92-01). The nitrate results for a quality assurance sample were not confirmed by the CEMRD QA lab (CEMRD, 1993), which reported, "The extremely large discrepancy for nitrate analysis seems anomalous." Thus, uncertainty pertaining to these elevated second quarter results exists.

Volatile organic compounds were not detected in the groundwater samples, with the exception of 0.003 mg/L of trichloroethylene (TCE) in one downgradient sample detected once during the baseline sampling event. Pesticides and semi-volatile organics were analyzed for but not detected in the groundwater during these sampling events.

Analytical results of surface-water samples indicated that only total metals and inorganic constituents commonly found in surface waters and soils were detected in the surface-water samples upstream and downstream from the PSF site. Total concentrations of aluminum, iron, and zinc increased immediately downstream of the PSF. Sulfates were observed to increase immediately downstream from the site.

Analytical results of sediment samples indicated that samples collected in the lined drainage ditch east of the PSF contained pesticides, VOCs, PAHs and metals. Pesticide concentrations increased immediately downstream of the PSF facility, and then gradually decreased further downstream.

Several VOCs were detected in the sediments, including toluene, carbon disulfide, 1,2-dichloropropane and 1,1,2,2-tetrachloroethane. Carbon disulfide, 1,2-dichloropropane and 1,1,2,2-tetrachlorethane were only found in one sample each.

The metals arsenic, barium, cadmium, chromium and lead were found in the sediments both upstream and downstream. Of these, only lead showed an increase downstream from the PSF.

A BLRA and ecological risk assessment were completed in the RI. The BLRA concluded that exposure to site soils, sediment, and hypothetical groundwater ingestion evaluated for information only may present limited risks to on-site workers and future residents. The primary chemicals of concern evaluated in soils and sediment were chlorinated pesticides, and in the groundwater were arsenic, beryllium, manganese, nitrate, and thallium. The ecological risk assessment concluded that negative impact to fauna and flora was not readily apparent. More favorable habitat is locally available and species are more likely to select these higher quality habitat areas, minimizing the impacts from past site activities. Also, downstream impacts from contaminated surface water and sediments would be minimized due to the intermittent nature of the surface flow in the lined channel adjacent to the PSF site. Pesticides were not detected in downstream surface water (Kansas River) at the Southwest Funston Landfill site.

While the RI, BLRA, and an FS were under development, Fort Riley completed an EE/CA which considered a non-time-critical removal action at the site to address pesticide-contaminated soils. The public comment period for the EE/CA was August 17 to September 16, 1993, and a public meeting was held at Fort Riley on September 7, 1993, and no members of the public attended. Subsequently, the Removal Action Memorandum (DEH, 1993b) was signed in December 1993.

The Removal Action Memorandum specified excavation and off-site disposal of pesticide-contaminated soils, based on the extent of contamination interpreted from the RI field sampling results. Additional PSF soil sampling was then performed as a part of removal action planning activities to better define the extent of contamination and to establish the initial limits of excavation. These removal action sampling results identified a larger area of contamination at the PSF site than interpreted from the RI field sampling, and the initial limits of the removal action excavation were expanded.

During the removal action, site areas were excavated based on established soil contaminant concentrations (action levels) for pesticides with areas exceeding these contaminant levels removed. Excavated soils were not listed hazardous wastes and did not exhibit a characteristic of hazardous waste and were classified as nonhazardous. The excavated soils were disposed by direct burial in a Subtitle C landfill because several discrete samples had elevated concentrations of pesticides. The excavations were backfilled with fill material obtained locally to approximately their original elevations, and the removal action activities were completed in June 1994 (OHM, 1994). The planning and completion of the removal action resulted in a revised understanding of the nature and extent of soil contamination at the PSF, as the observed conditions differed from those anticipated from the RI field investigation. The revised nature and extent of soil contamination, based on data from both the RI and removal action activities are presented in Section 2.

An additional round of groundwater samples was collected from the PSF monitoring wells in September 1994, and the sample analysis results were presented in a separate Quality Control Summary Report (QCSR) (LAW, 1994c). Groundwater sampling results are presented in Section 3.

RI Addendum

The RI Addendum is presented in Sections 2 through 4 of this report. These sections are summarized below.

A limited background soil sampling effort was completed during the removal action. Twenty-two soil samples were collected and analyzed for arsenic, barium, beryllium, lead, thallium, and nitrate (CEMRK, 1994). These samples were collected from locations believed representative of three specific geologic and hydrogeologic regimes at Fort Riley. The three regimes were the river valley alluvium, the river valley terrace deposits and the upland areas. Six of these samples collected from the terrace deposits are believed to approximate the natural background levels at the PSF site and provided additional information for comparison.

As part of the RI activities, the surface soils (less than 2-foot depth) and subsurface soils (2-foot and greater) were sampled at the PSF site. Extensive additional sampling of the PSF soils was performed during removal action activities to further define the areas of pesticide contamination for the excavation. Following the soil excavation and disposal activities, confirmatory sampling was performed for the soils remaining at the site following completion of the soil excavation and disposal activities. Analytical results of soil samples collected during the RI and the removal action were evaluated in order to characterize the site. The additional information obtained from these removal action activities indicated that site conditions differed significantly from the interpretations presented previously in the RI report.

The revised pre-removal action nature and extent of soil contamination is based on data collected during the RI and removal action. In surface soils, four distinct areas of chlordane concentrations above 1.0 mg/kg were indicated from the sampling results, and seven surface soil samples exceeded the removal action remediation goal (RG) concentration of 1.58 mg/kg. Five areas of surface soil with DDT and metabolites above 1.0 mg/kg were identified which generally were located in the same areas as the chlordane contamination, and four soil samples exceeded the removal action RG (1.73 mg/kg). Dieldrin was detected in four surface soil samples at concentrations exceeding the removal action RG concentration of 0.127 mg/kg in areas which generally followed patterns similar to the DDT and chlordane contamination. Heptachlor was detected infrequently in surface soils at or below 0.031 mg/kg, which was below the removal action RG of 0.05 mg/kg for this constituent.

In subsurface soils, chlordane distributions exceeding 1.0 mg/kg were identified at depths of 2 to 3 feet, 4 to 5 feet, and 6 to 7 feet. At depths from 2 to 6 feet, 22 soil samples exceeded the removal action RG of 1.58 mg/kg. No samples collected at depths of 6 feet and greater exceeded the RG. From the sampling data, three areas of subsurface contamination were predicted. An area of contamination east of the fence may have identified the location of a former trench at the site reported to have been approximately 4 feet deep and running the length of Building 348. Areas of DDT and metabolite concentrations exceeding 1.0 mg/kg were generally located in the same areas as the chlordane contamination and were detected at a greater depth within the area that may identify a former trench than the chlordane contamination. At depths from 2 to 7 feet, 15 samples exceeded the RG concentration (1.73 mg/kg). At depths exceeding 8 feet, no samples exceeded the RG. In some areas, detected concentrations increased with depth, confirming the irregular pattern of contamination believed due to site grading activities over the years. Dieldrin and heptachlor contamination were only detected at the 2- to

3-foot depth each in one sample exceeding the removal action RG concentrations near the northeast corner of Building 348. Dieldrin and heptachlor were detected infrequently at concentrations less than the RG in other areas of the site. Arsenic in subsurface soils exceeded the maximum background concentration in four samples in separate areas of the site.

The site characterization for the PSF in its current, post-removal action state is based on analytical data for soils left remaining in place after the removal action excavation activities. Only soils were addressed by the removal action. Therefore, surface water and sediment site characterizations presented in the RI report are still relevant. Surface water and sediment characterization data fully described in the RI report are not repeated in this report. The most recent groundwater sampling round (September 1994) was performed following completion of the RI. Groundwater results discussed in Section 3 include the previous groundwater sampling results and incorporate the September 1994 sampling results.

Following the removal action, chlordane levels in surface soil did not exceed the removal action RG. DDT and metabolites and dieldrin in surface soil each exceeded their removal action RGs in one sample. Heptachlor concentrations were less than the removal action RG concentration.

In subsurface soils after completion of the removal action, nine chlordane samples, one DDT sample, and two heptachlor samples exceeded the removal action RG concentrations which were based on surface soil exposure. Of the metals, lead was found to occur in subsurface samples at elevated concentrations at two locations. For each subsurface soil sample analyzed for metals, arsenic was detected, typically at low concentrations. Arsenic, chromium, and lead were found to exceed the high-end Fort Riley background soil concentrations in some PSF soil samples. However, none of these metals were found individually to cause excessive risk as determined by the residual risk assessment discussed in Section 4.

PAHs were detected in a small number of subsurface samples. The greatest number and highest concentrations of these compounds were found in two subsurface soil samples. PAHs accounted for less than 2 percent of the risks calculated in the BLRA. The PAHs detected in subsurface soils during the RI field investigation occurred mostly in the areas where soil has been removed and replaced by clean fill during the removal action, significantly reducing residual risks from PAHs.

Four rounds of groundwater sampling from the five PSF wells were conducted during RI activities, and a fifth sampling round was conducted in September 1994. Groundwater analytical results indicated that inorganics and metals were the main constituents detected during these sampling events. As discussed in Section 3.2, ten constituents of potential concern were identified in the BLRA. These constituents were antimony, arsenic, barium, beryllium, cadmium, chromium, manganese, nitrate, thallium, and vanadium. In general, in comparing the September 1994 analytical results to the previous results, the results were consistent with the low concentrations of these constituents of concern previously detected. Reported total and dissolved concentrations were comparable and exhibited variations within expected differences (plus or minus 10 percent). In downgradient wells, arsenic, barium, and chromium did not exceed the MCL in any samples, and vanadium did not exceed its RG in any sample; antimony, beryllium, and cadmium exceeded the respective MCLs on one occasion over the five sampling rounds; thallium equaled or exceeded its MCL two times; manganese exceeded the secondary MCL five times out of the 20 samples obtained during the five sampling events; and nitrate exceeded the MCL on 17 out of 20 occasions. Antimony was detected in the upgradient well and one downgradient well only during the second round at comparable concentrations and was not detected above the 0.005 mg/L detection limit in any wells in September 1994 and is likely naturally occurring. Beryllium was detected at comparable concentrations in upgradient and downgradient wells and the detections consistently occurred at the same time in upgradient and downgradient wells, and reflects likely naturally occurring background. Manganese was detected consistently in background and downgradient wells during the first four sampling events, but was not detected in the upgradient well or two downgradient wells during the September 1994 event. Manganese levels were variable but consistent with background conditions and reflect naturally occurring conditions.

First quarter, third quarter, and September 1994 nitrate concentrations were consistent with baseline concentrations. During the second quarter, nitrate showed an increase from two and one-half to five times in all samples except PSF92-01, and the second quarter nitrate results were not confirmed by the Corps of Engineers - Missouri River Division (CEMRD) QA lab (CEMRD, 1993). Thus, uncertainty pertaining to these elevated second quarter results exists. The September 1994 results for nitrate confirmed that the high levels of nitrates observed during the second quarter (February 1993) are not consistently present in the PSF aquifer.

Inorganic chloride exceeded the maximum detected background concentrations of 147 mg/L in three of the five samples collected from well PSF92-02 during the five sampling rounds. The maximum detected background concentration for inorganic chloride was not exceeded by samples collected from wells PSF92-03, PSF92-04, and PSF92-05 during the five sampling rounds. The maximum detected background concentration for sulfate was 160 mg/L collected from PSF92-01 during the September 1994 sampling round. This background concentration was not exceeded by samples collected from PSF92-04 or PSF92-05 during the five sampling rounds, but was exceeded by five of five samples from PSF92-02 and four of five samples from PSF92-03.

Thallium was not detected during the baseline, first quarter, and second quarter sampling rounds. After the second quarter samples were collected, the method of analysis for the third quarter and September 1994 sampling rounds was changed to USEPA Method 7841, and total thallium was observed in two downgradient wells during the third quarter sampling event at maximum reported concentrations of 0.0029 mg/L and 0.0025 mg/L). Interferences and variable analysis results during reanalyses of these samples was noted previously. During September 1994, total thallium was detected in only the upgradient well at a concentration of 0.0024 mg/L. Similar concentrations of thallium near the detection limit were observed in background wells at Building 354 and the Southwest Funston Landfill area. These results indicated that thallium is likely naturally occurring background in the area. Total vanadium has been detected at concentrations ranging from nondetect to 0.027 mg/L in downgradient wells, and vanadium remained consistent with background conditions. Pesticides were analyzed but not detected in groundwater above the detection limits during any sampling rounds.

After completion of removal action activities, a Residual Risk Assessment (RRA) was conducted to estimate the risks associated with current and future site conditions. This RRA includes a human health risk assessment and consideration of ecological risks due to potential exposures at the PSF site. Because the RI contains an extensive risk assessment, the RRA was conducted as a streamlined version of a BLRA. Residual risks to human health were recalculated only for pathways for which risks were estimated to be equal to or greater than 1×10^{-6} (for carcinogens) or 1.0 (for noncarcinogens) in the RI. Hypothetical risks to human health due to potential use of the uppermost aquifer beneath the site as a source of potable water are considered separately from the risks due to residual soil and sediment contaminants. The groundwater exposure scenarios and associated risks are presented for information purposes only.

Potential contaminants of concern based on their known or suspected toxic properties which were evaluated in the RRA are listed on Table ES-1 for soil. These constituents were initially evaluated to identify contaminants of concern. As detailed in the residual risk assessment, the evaluation for the PSF site presents scenarios which include exposure to soil by future site workers.

The RRA evaluated the health effects which could potentially result from exposure by ingestion, inhalation, and dermal contact with constituents detected in soil or sediment at the site. Risks were estimated for the following potential, current, and/or future exposure scenarios:

Medium	Receptor	Significant Exposure Route[1]
Surface Soil	Current Landscaper	Dermal Contact
	Current Site Worker	Dermal Contact, Incidental Ingestion
	Current Utility Worker	Dermal Contact
	Future Construction Worker	Dermal Contact, Incidental Ingestion
	Future Landscaper	Dermal Contact
	Future Recreational Child	Dermal Contact
	Future Site Worker	Dermal Contact, Inhalation of Fugitive Dust, Incidental Ingestion
	Future Utility Worker	Dermal Contact
Subsurface Soil	Current Landscaper	Dermal Contact
	Current Utility Worker	Dermal Contact
	Future Construction Worker	Dermal Contact
	Future Landscaper	Dermal Contact
	Future Utility Worker	Dermal Contact
Sediment	Future Site Worker	Dermal Contact

[1] Pathways which exceeded 10^{-6} cancer risk or hazard index of 1 in the BLRA.

TABLE ES-1

CHEMICALS DETECTED IN SOIL SAMPLES
DETECTION FREQUENCIES AND CONCENTRATION RANGES
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER	Frequency of Detection	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)
SURFACE SOIL SAMPLES:			
Chlorinated Pesticides:			
Chlordane	17/52	0.0207	1.12
DDD	7/18	0.0237	0.454
DDE	12/18	0.0356	0.847
DDT	35/52	0.012	1.29
Dieldrin	20/52	0.007	0.158
Heptachlor	2/52	0.004	0.0093
SUBSURFACE SOIL SAMPLES:			
Metals:			
Arsenic	31/31	0.4	20
Barium	29/29	35	190
Chromium	29/29	4.6	20
Lead	25/29	4.7	770
Mercury	1/29	--	0.1
Silver	3/29	0.9	1.2
Chlorinated Pesticides:			
Chlordane	41/126	0.0051	10.2
DDD	16/100	0.0013	0.925
DDE	31/101	0.0104	0.666
DDT	42/126	0.011	1.95
Dieldrin	12/126	0.007	0.077
Heptachlor	8/126	0.0012	0.3
Volatile Organics:			
Benzene	2/29	0.0059	0.0066
Methylene chloride	13/29	0.011	0.031
Toluene	7/29	0.0059	0.038
Semi-Volatile Organics:			
Benzo(a)anthracene	3/29	0.11	0.33
bis(2-Ethylhexyl)phthalate	3/29	0.41	1.2
Chrysene	3/29	0.11	0.29
Diethylphthalate	1/29	--	0.43
Fluoranthene	3/29	0.18	0.53
Phenanthrene	2/29	0.23	0.25
Pyrene	5/29	0.11	0.57

Note: Information presented is based on site conditions following the removal action. Values reported are for total chlordane which includes the sum of alpha-chlordane and gamma-chlordane.

None of the exposure pathways for which risks were assessed in the Residual Risk Assessment exceeded a cancer risk of 1 x 10^{-6}. Similarly, none exceeded a hazard index of 1. Risk estimates for two pathways, dermal exposure to surface soils by current and future site workers, were approximately equivalent to 1 x 10^{-6}. Because the potential increased risk at the site resulting from exposure to site-related constituents (including soil, surface water, and sediment pathways not reevaluated in this Residual Risk Assessment) is less than or equal to the most conservative point of departure, risks at the site are considered within acceptable limits. For surface water and sediment exposures at the PSF, risk estimates were calculated to be below 1 x 10^{-6} and 1.0 for carcinogenic and noncarcinogenic risks, respectively.

The results of the risk assessment for hypothetical exposures to the groundwater in the uppermost aquifer at the site were considered for information purposes only. This is because the uppermost aquifer at the site is not currently being used as a source of potable water, and because its future use for this purpose is considered unlikely. The PSF site is served by a water distribution system, and Fort Riley's water distribution system is currently operating at about 42 percent of capacity. The risk assessment approach used to evaluate these potential impacts to human health is consistent with the approach presented in the USEPA "Risk Assessment Guidance for Superfund" document (USEPA, 1989a) and with the risk assessment conducted as part of the RI report (LAW, 1993a). Potential contaminants of concern considered in the groundwater risk evaluation are listed in Table ES-2. Antimony and cadmium were not considered in the risk assessment because they were only detected in a single sampling round at levels consistent with the upgradient well.

Conclusions of the RRA for groundwater indicate that at the present time, risks due to exposure to the groundwater beneath the site do not exist because the exposure pathway is not complete. However, if residential water supply wells were installed at the site in the future, the possibility of adverse human health effects is indicated.

Prior to the Rapid Response soil removal action, the ecological risks due to potential exposures at the site were judged to be minimal. The soil removal action replaced contaminated surface and subsurface soil with clean backfill and included the removal of soil from the area where stressed vegetation had been observed. Therefore, based on current site conditions, it is expected that ecological risks are not a concern at the PSF site.

Development and Description of Alternatives

To develop remedial alternatives, RG concentrations are developed for the site. The RGs are compared with the residual levels of contamination to identify requirements for remedial action which are the remedial action objectives (RAOs). Remedial alternatives are then developed to address the identified RAOs.

TABLE ES-2

CHEMICALS DETECTED IN GROUNDWATER SAMPLES
DETECTION FREQUENCIES AND CONCENTRATION RANGES
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER	Frequency of Detection	Minimum Detected Concentration (mg/L)	Maximum Detected Concentration (mg/L)	Maximum Detected Background Concentration (mg/L)
Metals:				
Aluminum	10/20	0.11	0.8	0.26
Antimony	1/20	ND	0.032	0.022
Arsenic	5/20	0.0027	0.016	ND
Barium	20/20	0.042	0.130	0.2
Beryllium	15/20	0.001	0.005	0.002
Cadmium	2/20	0.004	0.006	0.004
Chromium	2/20	0.012	0.014	0.010
Manganese	18/20	0.017	0.091	0.034
Nitrate (as N)	19/20	0.0092	165 (33)*	6.4
Selenium	16/20	0.011	0.0036	0.008
Thallium	2/20	0.0025	0.0029	0.0024
Vanadium	4/20	0.008	0.027	0.011

* Maximum detected concentration for nitrate when second quarter data are censored.
ND – Not detected

RGs are concentrations defining allowable residual contamination levels that can remain at the site for individual COCs for specific medium and land use combinations. Risk-based RGs are concentrations developed using risk assessment based calculations to protect human health and the environment. Based on the results of the RRA, risk-based RGs are calculated for the future on-site worker, and the future construction worker, respectively, for comparison to the residual concentrations of contaminants in surface and subsurface soils at the site. Since the human health and ecological risks were not unacceptable for surface-water and sediment media, development of RGs, RAOs, applicable or relevant and appropriate requirements (ARARs), or alternatives addressing these media at the PSF are not warranted.

There are currently no potable water wells at the PSF site and Fort Riley's water supply wells are located approximately 1.8 miles upgradient from the site. The DEH yard and PSF site are served by the existing Fort Riley water distribution system, which is operating at about 42 percent capacity and is anticipated to meet the foreseeable future water supply needs. The current designated uses (storage area) are to be maintained in the future in the DEH yard including the PSF site. Risk estimates for a hypothetical future groundwater use were calculated in the RRA for information only; therefore, risk-based RGs are calculated for a potential groundwater use for information. The exposure variables used for calculating the RGs are consistent with the values used in the RRA.

For surface soil, RGs have been developed for future workers at the site. For subsurface soil, RGs have been developed for future construction workers at the site in a manner that is consistent with the Baseline and Residual Risk Assessments and incorporate the cumulative effects of exposure via dermal contact, ingestion, and inhalation. The soil RGs developed for this FS differ from those used during the removal action in the following ways:

- More realistic dermal absorption factors were used for pesticides identified as chemicals of concern in soil.
- Surface and subsurface soils are considered separately in developing the current RGs (the RGs used during the removal action were based on surface soil exposure only, and, therefore, were conservative).
- A target risk level of 10^{-5} was used to develop the current RGs (versus 10^{-6} during the removal action).

Sections of the NCP allow risk levels of between 10^{-4} and 10^{-6} to be considered for establishing remedial goals to be attained by alternatives which consider multiple contaminants and pathways of exposure at the site. The NCP also allows preliminary and final remedial goals, i.e, target risk levels to be developed, depending upon site-specific circumstances. Risk-based remedial goal concentrations calculated at the 10^{-5} risk level incorporate consideration of the presence of multiple contaminants and routes of exposure. The current and probable future use of the PSF site as a light industrial area, used by workers, makes it unlikely that sensitive subgroups of the population would be exposed to site contaminants. The receptors are likely to be healthy adults and not sensitive populations (such as children and the elderly). Adsorption factors derived from studies using pesticides mixed with soil prior to application were approximately 10 times less than the factors used in the calculated RGs (ATSDR, 1987-1993). These factors result in calculated RG concentrations which are conservative. From these considerations, the 10^{-5} risk level is appropriate for the PSF site. Risk-based RGs at the 10^{-5} risk level for hypothetical future residential groundwater use are also presented for comparison with on-site groundwater for information only.

Superfund remedial response actions must address the requirements of the environmental laws which are determined to be "applicable" or "relevant and appropriate." The identification of ARARs involves the comparison of a number of factors, including the type of hazardous substances present and the use or potential use of the affected resource (chemical-specific), the types of remedial actions considered (action-specific), and the physical nature of the site (location-specific), to the statutory or regulatory requirements of the relevant environmental laws.

MCLs are not applicable to the site because the PSF groundwater is not directly provided to a public water supply system. As stated previously, future use of the on-site aquifer was not considered a reasonable possibility considering the available water system, low yield, and future operations at Fort Riley. Therefore, MCLGs/MCLs are not relevant or appropriate at the site because there is no actual, planned, or potential use of groundwater as a potable water source. Promulgated requirements in accordance with the NCP were not identified by Kansas State statutes recognizing the on-site groundwater as a potential water source. Since Kansas has not promulgated regulations recognizing subsurface waters as potential potable water sources, MCLGs/MCLs are therefore not applicable to the site. Because MCLs were compared to detected groundwater constituents for information only, they are not considered TBCs at the site.

Currently, there are no federal regulations (ARARs) governing the levels of contaminants in soils. Risk-based RGs are considered TBCs at the PSF site. The KDHE Bureau of Environmental Remediation issued interim soil cleanup standards in August 1993 (KDHE, 1993a) meant to provide guidance for establishing soil cleanup standards. Constituents included in these standards did not include the pesticides which were COCs at the site, and were therefore not TBCs for soil. Location-specific ARARs and action-specific ARARs are evaluated in the report. Currently, there are no location-specific or action-specific TBC requirements under examination for this site.

At the PSF site, the following considerations were used to establish RGs:

- For inorganics in soil and groundwater, background concentration ranges which exceeded risk-based or regulatory levels were used to establish RGs.

- For soil media, risk-based RGs were calculated using a carcinogenic risk range of 1×10^{-5} to 1×10^{-6} and a noncarcinogenic HI of 1.0. The lowest of the calculated values for the carcinogenic risk level and HI at the 10^{-5} and 10^{-6} risk levels were used for the range.

- For hypothetical groundwater use, upgradient and Fort Riley background concentrations discussed in Section 3 and the MCLs were used for comparison to detected site concentrations. For vanadium, an MCL was not available, and a concentration level with a noncarcinogenic HI of 1.0 was used.

The 10^{-5} risk level is considered appropriate for this industrial area, as discussed in Section 5.1. Both the 10^{-5} and 10^{-6} point of departure levels are presented for information and comparison. The selection of risk level has a very minor impact on the evaluation and results.

Tables ES-3 and ES-4 present summaries of the current detections of COCs in surface soils and subsurface soils, respectively, and comparisons of the detected concentrations of these contaminants to the calculated RG concentrations to identify exceedances at the PSF. Table ES-5 provides a comparison of the detected concentrations of the COCs in groundwater identified in the risk assessment with background concentrations and the MCLs. The exposure point concentrations and maximum detected concentrations of constituents are compared in Table ES-5 to maximum detected background concentrations and the MCLs to identify exceedances for consideration in establishing groundwater RAOs.

As discussed in the report, detected soil concentrations following the removal, with two exceptions, and calculated exposure point concentrations of constituents in PSF soils were less than RGs at the 10^{-6} risk level. Therefore, further remedial actions addressing soils are not warranted. No exposure to on-site groundwater exists under the current site uses, and the future use of the PSF groundwater is considered unlikely. Except for nitrate, detections significantly above MCLs and/or background for metals have not been observed in the wells at the PSF, and the available data do not provide evidence of groundwater contamination or a contaminant plume. Nitrate was consistently detected and the 95 percent UCL concentration exceeds the MCL in downgradient wells. Collection of additional groundwater data at the PSF is not needed because available data from the PSF and other areas of Fort Riley show that except for nitrate, constituents in groundwater are likely naturally occurring background. Fort Riley is currently investigating the sewer lines in the vicinity of the PSF, and from the observations it is concluded that the sewer line is partially blocked and could be an intermittent source of nitrate in the groundwater during periods of high flow as exfiltration is possible.

The RAO to prevent ingestion of groundwater exceeding drinking water standards is identified for the site. This RAO is currently being implemented, as the groundwater is not being used.

TABLE ES-3

CONTAMINANTS OF CONCERN DETECTION SUMMARY - SURFACE SOILS AND COMPARISON TO RISK-BASED REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

Pesticide Constituent	Detection Frequency[a]	Maximum Detected Concentration (mg/kg)	Exposure Point Concentration (mg/kg)	10^{-5} Risk-Based Remediation Goal (mg/kg)	10^{-6} Risk-Based Remediation Goal (mg/kg)	10^{-5} Risk Exceedance Frequency[b]	10^{-6} Risk Exceedance Frequency
Chlordane	17/52	1.12	0.12	12.3	1.23	0/52	0/52
4,4'-DDD	7/18	0.454	0.45	24.0	2.4	0/18	0/18
4,4'-DDE	12/18	0.847	0.37	16.9	1.69	0/18	0/18
4,4'-DDT	35/52	1.29	1.29	16.9	1.69	0/52	0/52
Dieldrin	20/52	0.158	0.04	1.27	0.127	0/52	1/52
Heptachlor	2/52	0.0093	0.0022	3.56	0.356	0/52	0/52

a Number of times the analyte was detected/number of times the analyte was sampled.
b Number of times the analyte concentration exceeded the remediation goal concentration/number of times the analyte was sampled.

TABLE ES–4

CONTAMINANTS OF CONCERN DETECTION SUMMARY – SUBSURFACE SOILS AND COMPARISON TO GOVERNING RISK–BASED REMEDIATION GOALS

Pesticide Storage Facility
Fort Riley, Kansas

Constituent	Detection Frequency [a]	Maximum Detected Concentration (mg/kg)	Exposure Point Concentration (mg/kg)	10^{-5} Risk–Based Remediation Goals (mg/kg)	10^{-6} Risk–Based Remediation Goal (mg/kg)	10^{-5} Risk Exceedance Frequency [b]	10^{-6} Risk Exceedance Frequency
Pesticides:							
Chlordane	41/126	10.2	0.220	20.9	18.9 (d)	0/126	0/126
4,4'–DDD	16/100	0.925	0.017	669	66.9	0/100	0/100
4,4'–DDE	31/101	0.666	0.033	473	47.3	0/101	0/100
4,4'–DDT	42/126	1.95	0.150	114	47.3 (d)	0/126	0/126
Dieldrin	12/126	0.077	0.0048	16.4	1.64	0/126	0/126
Heptachlor	8/126	0.3	0.0029	54.6	5.46	0/126	0/126
Volatile Compounds:							
Benzene	2/29	0.0066	0.0023	3080	308	0/29	0/29
Methylene chloride	13/29	0.031	0.019	7610	1,190 (d)	0/29	0/29
Toluene	7/29	0.038	0.0067	25,400 (d)	25,400 (d)	0/29	0/29
Semi–Volatile Compounds:							
Benzo[a]anthracene	3/29	0.33	0.1	81.2	8.12	0/29	0/29
bis(2–Ethylhexyl)phthalate	3/29	1.2	0.33	2540	638 (d)	0/29	0/29
Chrysene	3/29	0.29	0.092	3080	308	0/29	0/29
Diethylphthalate	1/29	0.43	0.24	101,000	10,100	0/29	0/29
Fluoranthene	3/29	0.53	0.13	5,070	507	0/29	0/29
Pyrene	5/29	0.57	0.12	3,800	380	0/29	0/29
Metals:							
Arsenic	31/31	20	4.6	130	17.4 (d)	0/31	1/31
Barium	29/29	190	105	28,500	2,850	0/29	0/29
Chromium	29/29	20	8.4	2,160 (d)	2,160 (d)	0/29	0/29
Lead	25/29	770	99.5	1,000 (c)	1,000 (c)	0/29	0/29
Mercury	1/29	0.1	0.054	130 (d)	130 (d)	0/29	0/29
Silver	3/29	1.2	0.46	2,160 (d)	2,160 (d)	0/29	0/29

a – Number of times the analyte was detected / number of times the analyte was sampled.
b – Number of times the analyte concentration exceeded the remedial goal / number of times the analyte was sampled.
c – OSWER Directive #9355.4–02, Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites, September 1989.
d – Remediation goal based on hazard index of 1.0.

TABLE ES-5

GROUNDWATER CONSTITUENT DETECTION SUMMARY AND COMPARISON TO MAXIMUM CONTAMINANT LEVELS ESTABLISHING REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

Analyte	Maximum Detected Background Concentration (mg/L)[f]	Downgradient Detection Frequency[a]	Maximum Detected Concentration (mg/L)	Calculated 95% UCL Concentration[b] (mg/L)	Federal Maximum Contaminant Level (MCL)[c] (mg/L)	MCL Exceedance Frequency[d]
Arsenic	0.039	5/20	0.016	0.00797	0.05	0/20
Beryllium	0.002	15/20	0.005	0.0027	0.004	1/20
Manganese	0.52	18/20	0.091	0.059	0.05[S]	5/20
Thallium	0.0025	2/20	0.0029	0.0029	0.002	2/20
Nitrate (as N)	10.0	19/20	165	33.7/130.7[e]	10	17/20

a Number of times the analyte was detected/number of times the analyte was sampled.
b 95% Upper Confidence Limit concentration, not including the background well detections.
c Governing remediation goals are the Federal Maximum Contaminant Levels (MCLs).
d Number of times the analyte exceeded the MCL/number of times the analyte was sampled, not including the background well.
e The 95% UCL concentration (33 mg/L) is equal to the maximum detected concentration when the second round sample data are censored. The 130.7 mg/L concentration includes all data.
f Includes Well PSF92-01 and Building 354 wells TS029201 and TS029202.
ND Not detected
S Secondary MCL

Considering the RAO established for this site, the following alternatives were identified to provide a range of alternatives to address the site:

- Alternative 1 - No Action: As the name implies, this alternative does not involve any remedial action. Evaluation of the removal action results again RAOs for remedial action is accomplished by evaluating the No Action alternative.

- Alternative 2 - Institutional Action (Groundwater Restrictions): This alternative includes the implementation of institutional action to restrict the future use of site groundwater. To implement institutional controls involving land use restrictions, administrative actions would be taken to prohibit groundwater use in the vicinity of the PSF, including prohibitions on installation of wells for drinking water purposes at the PSF.

- Alternative 3 - Institutional Action and Groundwater Monitoring: This alternative includes the Institutional Action (Groundwater Restrictions) as described for Alternative 2, and also includes conducting additional groundwater monitoring for nitrate at the site. Groundwater monitoring should not be started for at least six months following the repair of the sewer to allow attenuation of contaminants.

Groundwater monitoring was included in Alternative 3 to provide a range of alternatives.

Detailed Analysis of Alternatives

The detailed analysis results in the presentation of the relevant information needed to allow decision makers to select a site remedy, rather than the decision-making process itself. During the detailed evaluation of remedial alternatives, each alternative will be assessed against the evaluation criteria listed and described below. The last two criteria are not directly evaluated in the FS report, and are evaluated during the proposed plan and Record of Decision phases of the project following the FS.

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- Regulatory agency acceptance
- Community acceptance

The alternatives are individually evaluated for these criteria in the report, and a comparative analysis is made to compare the alternatives to each other based on their ability to meet these evaluation criteria.

Overall Protection of Human Health and the Environment - Alternatives 1, 2, and 3 are currently protective of human health and the environment because groundwater at the site is not currently used for drinking water purposes and there is no unacceptable human exposure to the site. The No Action Alternative (Alternative 1) would not be protective of human health if the on-site groundwater at the PSF was used as a potable water source. For Alternatives 2 and 3, protection of human health would be achieved with administrative and available legal actions prohibiting the future use of site groundwater. Alternatives 2 and 3 are rated equal to each other and slightly higher than Alternative 1 for this criterion.

Compliance with ARARs - Based on current site use, Alternatives 1, 2, and 3 would be in compliance with ARARs because use of groundwater with concentrations above MCLs is not occurring and no soil exists at the site above individual constituent RGs. Because Alternatives 2 and 3 include controls prohibiting future groundwater use, these alternatives would prevent the hypothetical use of PSF groundwater. Alternative 1, however, would also be expected to comply with ARARs in the future, because groundwater use is not expected to occur at the PSF, considering that an existing water supply system with adequate capacity for current and expected future water demands already serves the PSF area. Alternative 3 includes on-site groundwater monitoring which could be conducted to meet ARARs. Alternatives 2 and 3 are rated equally for compliance with ARARs above Alternative 1.

Long-Term Effectiveness and Permanence - Long-term effectiveness and permanence was provided by the removal action which removed contaminated soil from the site. None of the identified alternatives would provide additional treatment. Therefore, long-term effectiveness and permanence is not applicable to any of the alternatives.

Reduction in Toxicity, Mobility, or Volume - Toxicity, mobility, and volume of contaminants have already been reduced by the removal action. Alternatives 1, 2, and 3 do not involve treatment and thus will not reduce the toxicity, mobility, or volume of constituents. Therefore, these alternatives are rated equally for this evaluation criterion.

Short-Term Effectiveness - Evaluation of Alternative 1 for short-term effectiveness is not applicable since this is a "no-action" alternative, and no activities are planned. Alternative 2 would not include any on-site activities and is therefore not applicable. Alternative 3 would involve only on-site activities associated with additional groundwater sampling from existing monitoring wells at the site and can be readily implemented.

Implementability - Alternative 1 is a "no-action" alternative, so implementability would not be applicable. The institutional controls and groundwater monitoring activities associated with Alternatives 2 and 3 may be readily implemented, and these alternatives are rated equally.

Cost - No cost has been identified with the No Action Alternative (Alternative 1). Total costs of implementing groundwater use restrictions in Alternative 2 were estimated at $20,000. Alternative 3, Institutional Action and Groundwater Monitoring, was estimated at $64,500, including present worth and operation and maintenance (O&M) costs for a two-year monitoring period. Alternative 1 is ranked first, followed by Alternative 2, with Alternative 3 ranked last.

1.0 INTRODUCTION AND BACKGROUND

The United States Army Corps of Engineers, Missouri River Division, Kansas City District (CEMRK) under Contract DACW41-92-D-9002, retained Law Engineering and Environmental Services, Inc., Government Services Division, (LAW) in support of the Fort Riley, Directorate of Environment and Safety, Installation Restoration Program to perform a Remedial Investigation/Feasibility Study (RI/FS) at the Pesticide Storage Facility (PSF) at Fort Riley, Kansas. Since the initiation of the PSF project, several organizational changes have been made at Fort Riley, including the conversion of the DEH to Public Works (PW) directorate and the creation of the Directorate of Environment and Safety in 1994. The previous designations are used throughout this report to maintain consistency with previous documents.

Pursuant to Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Fort Riley was proposed for inclusion on the National Priority List (NPL) on July 14, 1989. Two Operable Units (OUs) at Fort Riley, the PSF (OU001) and Southwest Funston Landfill (SFL) (OU002), were combined by the U.S. Environmental Protection Agency (USEPA) as one site. The USEPA reasoned that both contaminant sources potentially affect the same shallow aquifer and target populations. These two sites were finalized on the NPL on August 30, 1990, and were assigned a combined score of 33.79 on the Hazard Ranking System (HRS). An HRS of 28.5 is needed for inclusion on the NPL. The two sites are the subjects of separate RI/FS efforts.

The Department of the Army - Fort Riley, the U.S. Environmental Protection Agency (USEPA) Region VII, and the State of Kansas Department of Health and Environment (KDHE), negotiated a Federal Facility Agreement (FFA) for Fort Riley, Docket No. VII-90-F-0015 (FFA, 1991). This agreement, also referred to as the Interagency Agreement (IAG), was signed by the Army in August 1990 and by USEPA Region VII and KDHE in February 1991, and became effective on June 28, 1991.

1.1 PURPOSE AND ORGANIZATION OF REPORT

The PSF has been previously investigated on several different occasions. Two pesticide monitoring studies and a closure at the site were completed between 1974 and 1990. RI/FS planning activities were conducted from 1990 to 1992. An RI/FS was initiated in 1992, and while the RI/FS was under development in 1993, Fort Riley conducted an Engineering Evaluation/Cost Analysis (EE/CA) which considered a non-time-critical removal action at the PSF (DEH, 1993a). Subsequently, a Removal Action Memorandum was completed in December 1993 (DEH, 1993b). The RI report was completed in April 1994. Removal action activities which included the excavation and off-site disposal of pesticide-contaminated soils were completed in June 1994.

This report is prepared to complete the RI/FS reporting requirements at the PSF site and consists of both an RI Addendum and the Feasibility Study. Actual site conditions encountered during the removal action differed from the site conditions which were predicted in the RI Report based on available information from the RI field investigation. The removal action excavations and additional soil sampling revealed that the contaminated soil areas differed from those predicted from the RI field data. The RI Addendum presents a revised description of the soil contamination that existed at the PSF site using the RI field data and the additional data obtained from the removal action. Also included is a description of the current site conditions following the completion of the removal action. An additional groundwater sampling round has also been conducted since the RI Report was completed. Revisions to the previous RI Baseline Risk Assessment (BLRA) are presented in a residual risk assessment (RRA) which provides revised estimates of site risks considering the current conditions at the site, and the additional groundwater data. The FS identifies remedial action objectives (RAOs) and remedial alternatives, and evaluates alternatives considering the current risks at the site.

The organization of this report is in general accordance with the USEPA's Guidance on Conducting Remedial Investigations and Feasibility Studies Under CERCLA, OSWER Directive 9355.3-01, October 1988. The report is divided into seven sections. The remainder of Section 1 presents summaries of the previous studies prior to and including the RI site characterization activities (LAW, 1993a), and describes the removal action.

The RI Addendum includes Sections 2 through 4:

- Section 2 presents a description of the nature and extent of soil contamination that existed at the site prior to the removal action activities using both the RI data and the additional data obtained during the removal action.

- Section 3 presents a description of the current site conditions following the removal action; describes the September 1994 groundwater sampling results; and incorporates this groundwater data with the previous sampling results presented in the RI.

- Section 4 includes a residual risk assessment (RRA) to estimate the current site risks remaining following the removal action and includes the September 1994 groundwater data in the reevaluation of groundwater risks.

The FS is presented in Sections 5 and 6:

- Section 5 presents the development and description of remedial alternatives considering the current site conditions. This section includes calculations of revised risk-based remediation goals, identification of applicable or relevant and appropriate requirements (ARARs), development of remedial action objectives (RAOs), and development of alternatives.

- Section 6 provides the detailed analysis of the alternatives developed in Section 5, and includes a comparative analysis of alternatives.

References used in this document are listed in Section 7.

1.2 SITE DESCRIPTION

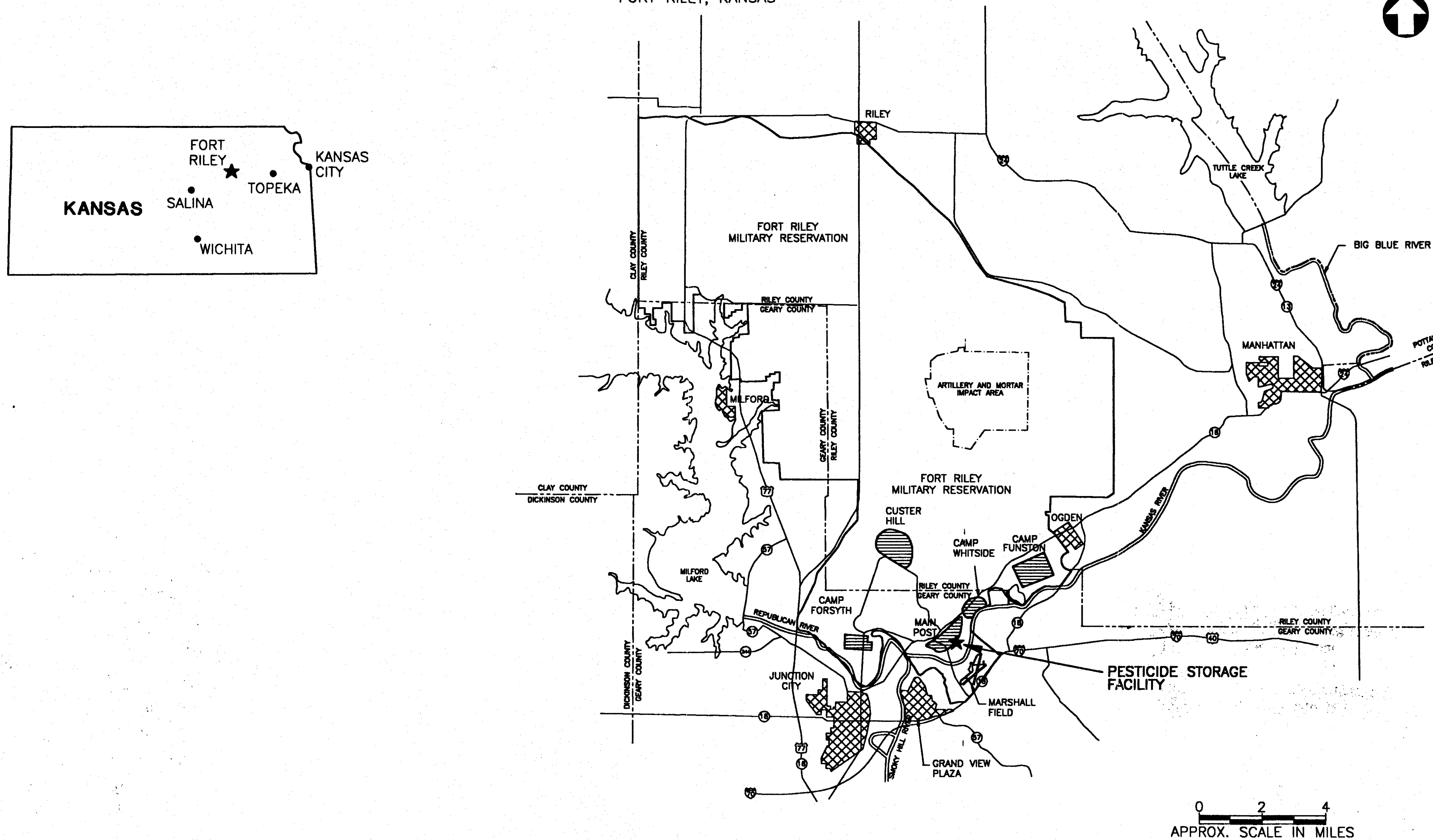
1.2.1 Installation History

The Fort Riley Military Installation was established in 1852 as an outpost near the confluence of the Smoky Hill and Republican Rivers in Geary and Riley Counties, Kansas (LAW, 1993a) as shown in Figure 1-1. The development and growth of Fort Riley proceeded in response to the evolution of the American military mission, in response to the Indian conflicts of the last half of the 1800s, the Spanish American War, World Wars I and II, the Korean and Vietnamese conflicts, and the Persian Gulf War.

Since its inception, Fort Riley has continuously served as a center of military education and readiness. Fort Riley has functioned as a small municipality and light industrial complex, at times having an installation population, including military and civilian residents, of over 20,000. Municipal activities on the installation include solid waste disposal (land filling), wastewater treatment, wastewater discharge and general infrastructure maintenance. Specific tasks associated with maintenance duties would include general construction activities, pesticide and herbicide application, fleet maintenance and general storage and repair services.

Fort Riley serves in a military capacity as a training, equipment supply, and military maintenance center and, therefore, has historically required management and disposal of wastes associated with these activities. Pesticides (including insecticides and rodenticides), herbicides, fungicides, insect repellents, and soil fumigants have been used at Fort Riley for a variety of applications, and are referred to herein collectively as "pesticides and herbicides" (LAW, 1993a). Historically, the types of pesticides and herbicides used at Fort Riley have also been generally available to the public at the time of use.

FIGURE 1-1
PESTICIDE STORAGE FACILITY LOCATION MAP
FORT RILEY, KANSAS



1.2.2 Site Description, History, and Operations at the PSF

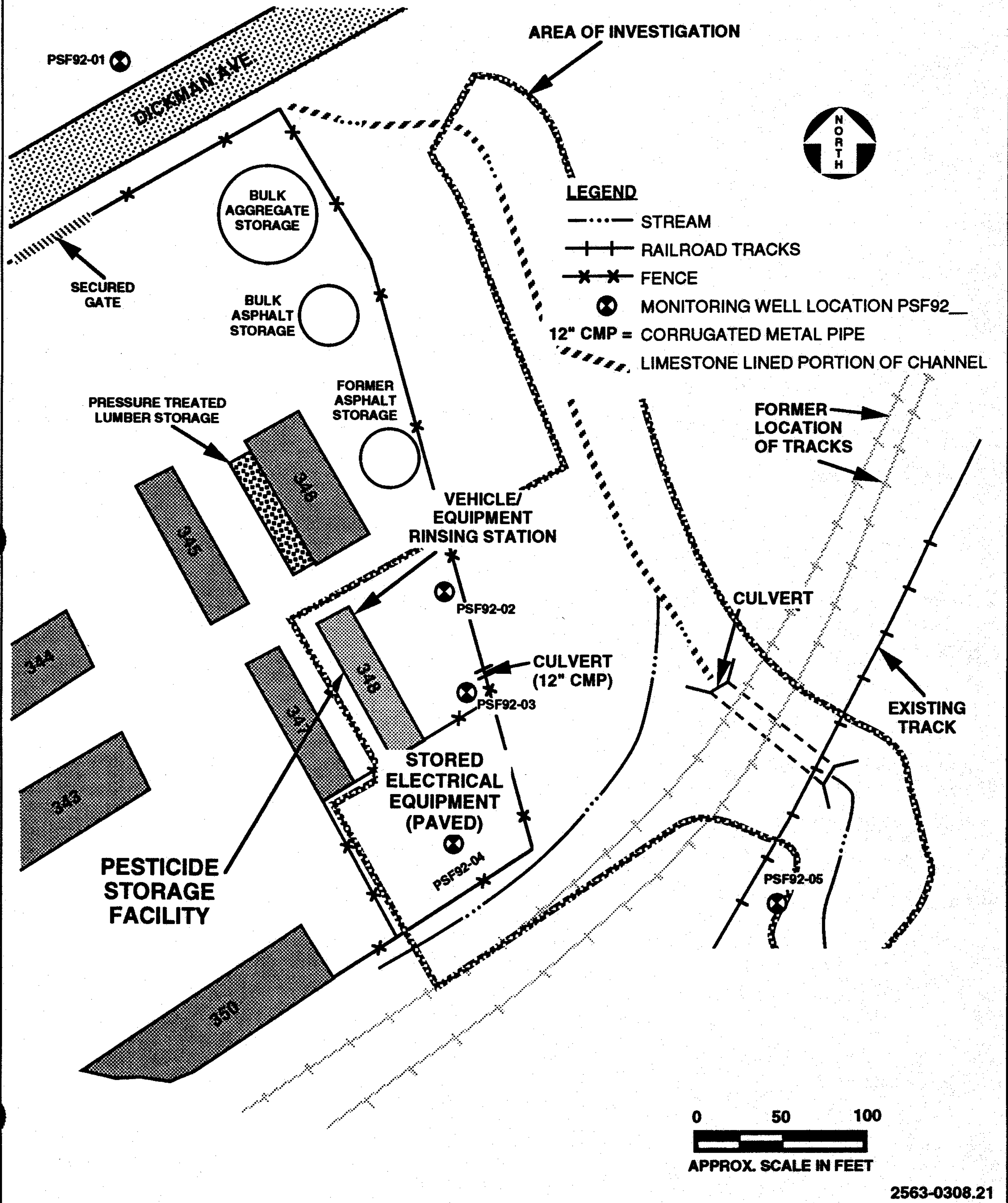
Figure 1-1 shows the location of the PSF at Fort Riley. Figure 1-2 shows the configuration of the Directorate of Engineering and Housing (DEH) yard within the vicinity of the PSF as it appeared in 1992, following the installation of the five monitoring wells which were part of the RI field work activities (LAW, 1993a). The DEH yard extends south of Dickman Avenue to the south-central edge of the Main Post cantonment area. Items stored within the DEH area include paint, pesticides/herbicides, pressure-treated lumber, electrical and plumbing materials, bulk asphalt, bulk aggregate, and fence materials. Vehicle maintenance and storage facilities are also located at the DEH yard. Stored items include heavy equipment, pick-up trucks, mowers, dump trucks, loaders, lift trucks and equipment, and tools used to perform maintenance activities.

The area of investigation is approximately two-thirds of an acre and consists of the southeast portion of the DEH yard which is a fenced, secured storage and maintenance area that supports services necessary to maintain the buildings, grounds, and utility systems at Fort Riley. Items and materials that have been stored in "outside warehouse areas" have been relocated over time.

The Pesticide Storage Facility Building No. 348 (formerly Building No. 292) was constructed in 1941 to serve as a general purpose warehouse. Fort Riley records do not state what was initially stored in Building 348. However, a personal interview with the Fort Riley Senior Pesticide and Herbicide Program Manager and the Exterior Works Branch Chief indicated that the building had been used for the storage of pesticides since at least 1973 (LAW, 1993a). Inventories of the chemicals commonly available (1971) to Fort Riley when formulation and mixing occurred at the PSF, and substances stored at the PSF after this practice was discontinued, (recorded in 1979 and 1983) are presented in the RI (LAW, 1993a). Chemicals previously stored at Building 348 included insecticides, herbicides, repellents, rodenticides, a fungicide, and a soil fumigant. The remainder of the building was used to store general improvement materials, equipment and paint. Information derived from DEH files (dated pre-1990) indicated that pressure-treated lumber was stored along the eastern fence. DEH records from the spring and summer of 1991 also show that pressure-treated lumber storage occurred adjacent to the eastern fence at the site. Pressure-treated lumber was removed to allow access to these site areas for the 1992 RI field investigation.

In the past, spray vehicles were filled with water on the eastern side of Building 348. During this time, overfilling of spray tanks occurred, with water containing pesticides spilling onto the ground. Vehicles used to transport and spray the pesticide mixes were also washed in this area. Pesticide and herbicide wastewaters, rinse water, and concentrated spills were allowed to run onto the ground. Due to the topography at the site, water generated by overfilling and washing would tend to flow toward the east, down the slope leading to the limestone-lined drainage channel. Since at least 1976, the majority of pesticide application has been performed by outside contractors to Fort Riley. Contractors were not allowed to use the PSF for formulation or mixing of pesticides.

FIGURE 1-2
PESTICIDE STORAGE FACILITY – 1992
FORT RILEY, KANSAS



Discussions with Army employees familiar with past operations at the PSF confirmed that grading and possibly trenching activities had been carried out across the site over the years. Grading activities included the use of fill material from other areas of Fort Riley to maintain suitable PSF topography. Additional inquiry into the site history performed after completion of the RI Report revealed that trenches were constructed and backfilled within the area of investigation (LAW, 1994a). Current and past DEH workers describe two trenches that were constructed during different time periods to the east of the chain link fence at the site. These trenches were reportedly constructed by excavating soil in the area, and were unlined and uncovered during the times they were operational. The reason for construction of these trenches was not known by the DEH workers interviewed. However, because the trenches impounded surface-water run-off, they probably served as accumulation points for contaminants.

The first trench was reportedly constructed between 1967 and 1974. Information about how the trench was constructed was not available. This excavation was oriented parallel to the fence, and is estimated to have measured approximately 6 feet in width and 18 feet in length. The depth of the excavation was unknown. The date that the excavation was filled in was also not known. The second trench excavated at the site is estimated to have been constructed between 1979 and 1982. This trench (called a "slit trench" by one DEH worker) was constructed using heavy earth-moving equipment. The width of this trench was reported to be approximately 6 feet, its depth approximately 4 feet, and its length reported to be the length of Building 348 (approximately 120 feet). The trench was reportedly backfilled with soil during the early to mid-1980s.

Interviews conducted with DEH employees indicated that a floor drain had been present inside Building 348 (LAW, 1994a). This floor drain reportedly emptied into the base sanitary sewer system. However, the available utility maps of the sewer system in the vicinity of the PSF site did not show laterals emanating from Building 348. Interviewees indicated that they did not witness pesticide spills in the interior of the building or the use of the drain for the disposal of pesticides or hazardous substances. The floor drain was eventually filled with concrete on an unknown date and is currently inactive. The sewer lateral from this drain was found during the removal action.

In 1982, general improvements were made to Building 348 consisting of the addition of insulation to the roof/ceiling spaces and installation of fire proofing to the vertical walls. In 1984, the interior portion of Building 348 was renovated to correct for deficiencies to meet federal standards for pesticide storage.

Aerial photographs and interviews indicated that several bins used for the collection of scrap metal had been located along the west side of the fence (i.e., inside the PSF site operational area). Items stored within the study area in 1992 at the time of the RI field investigation included paint, pesticides/herbicides, pressure treated lumber, electrical and plumbing materials, bulk asphalt, bulk aggregate, and fence materials. During the RI site visit, no visual evidence of surficial or below ground disposal of chemical wastes was detected. In August 1994, pesticide storage and handling operations were transferred to a new Pesticide Storage Building, located within the DEH yard area but outside the limits of this investigation. The southern portion of Building 348 is still used for material storage.

Another operational practice of note is the manner in which containers at the PSF site were disposed. Used pesticide containers were triple-rinsed and emptied into a spray tank; the containers were then punctured several times to prevent reuse. The containers were stored for short periods of time (approximately one to three days) inside of Building 348 prior to disposal in an off-site landfill (LAW, 1994a).

According to labeled photographs taken in December 1991 by DEH personnel, an underground water-line leak had occurred immediately east of Building 348, near the outdoor water faucet located at the northeast end of the building. Around December 1991, this piping was relocated to the west side of the building. The photographs showed moist water stains on the ground within the fenced area as a result of the water-line leak.

Also, in December 1991, a natural gas line leak developed in gas piping south of the railroad tracks (LAW, 1993a). Repairs of this leak occurred December 10, 1991, and resulted in the excavation of a portion of the gas line (to expose gas valving) east of Building 348. While the excavations were open, slide photographs were taken. Review of these slides reveal indications of several layers of gravel material being placed as surface cover. The excavated material was returned to the trench(es) when repairs were finished. Since that time, less than 1 foot of settlement had occurred where the excavations were developed as observed by field personnel during the field work (February 1992 through May 1993).

1.2.3 Surface Topography

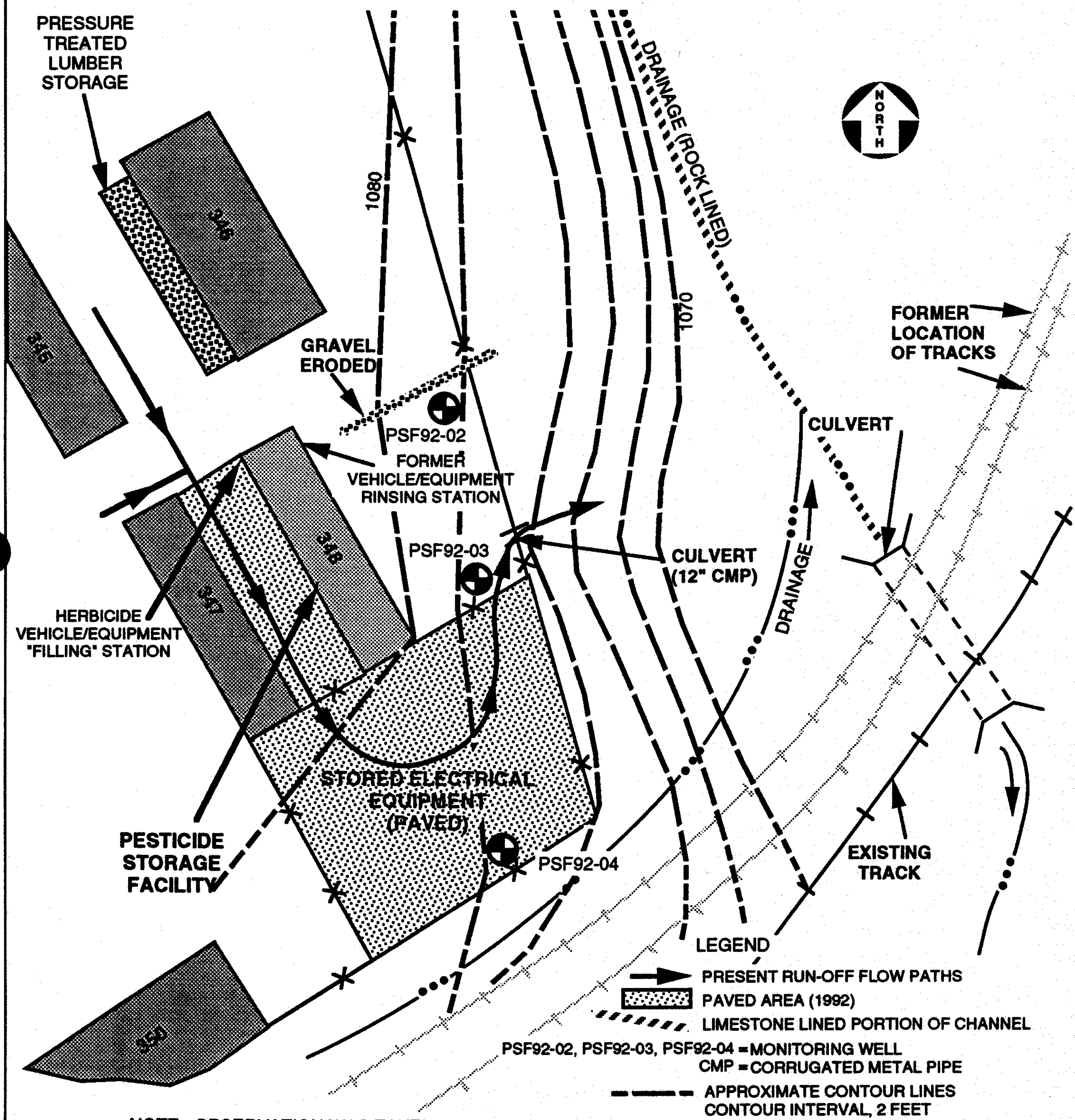
The PSF is situated on an escarpment on the north side of the Kansas River Valley approximately 2,000 feet west of the Kansas River, on the southeast edge of the Main Post containment area. Topographic elevations at the PSF are about 25 feet higher than the Kansas River (LAW, 1993a). The topographic survey performed as a part of RI field work confirmed the general observations of the site reconnaissance. The ground surface slopes downward towards the east-southeast with an average slope of approximately 1-foot fall for every 13 feet of run (1:13) or a grade of approximately 10 percent. There is an abrupt drop or slope change just east of the PSF fence line.

Surface run-off flows easterly, following the general topography of the site. Direct observation during a thunderstorm confirms that surface run-off follows the general topographic trends as seen in Figure 1-3 (IRP Manager, 1992). Surface run-off behaves as sheet flow in the unobstructed areas of the DEH yard. As the run-off follows the general slope it is, to a degree, interrupted by Buildings 345, 346, 347 and 348. Once the flow has "navigated" these obstacles,

FIGURE 1-3

OBSERVED PATH OF SURFACE WATER RUNOFF – 1992

PESTICIDE STORAGE FACILITY – 1992
FORT RILEY, KANSAS



NOTE: OBSERVATION WAS TAKEN AT PSF, 23 JULY 92, ~0900 HRS DURING HEAVY RAIN (IRP MANAGER 1992)

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it then enters a 12-inch corrugated metal pipe culvert discharging via overland into the rock-lined drainage channel east of the yard area. The lined drainage ditch runs from Dickman Avenue to the railroad tracks southeast of the site. The sides of the drainage ditch are constructed of cemented limestone blocks. This channel proceeds southward under the railroad tracks and then flows into an unnamed tributary leading to the Kansas River.

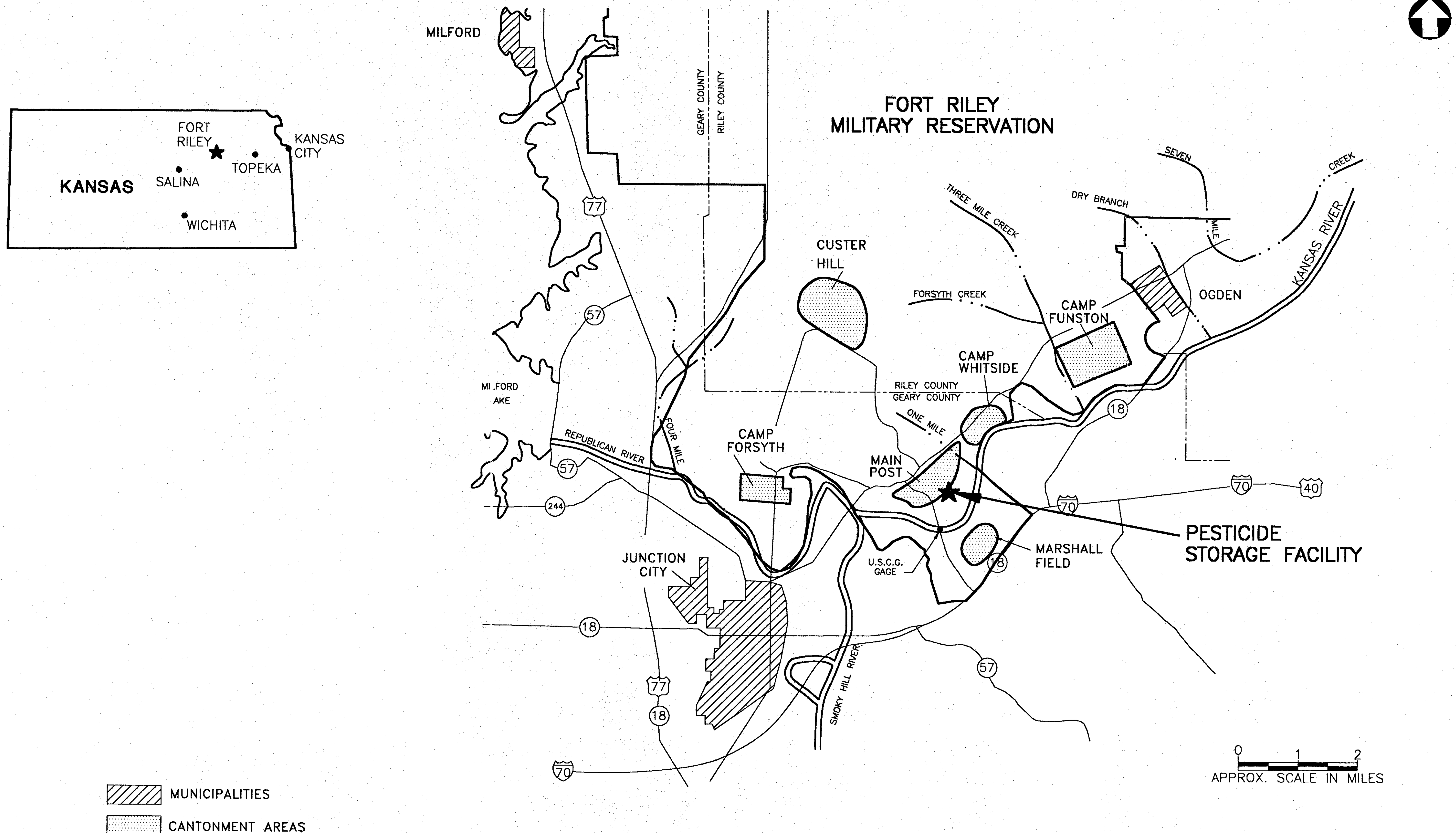
DEH personnel have indicated during personal interviews that numerous heavy thunderstorms occurred between 1981 and 1983 (Chief, Env. & Nat. Res. Div., DEH, 1992). The resulting storm-water run-off eroded sizeable channels, ruts, and "wash outs" in areas along and underneath the fence and to the east and south of the PSF fence lines. Some of these erosional features were large enough for a man to crawl through (Chief, Env. & Nat. Res. Div., DEH, 1992). Estimates indicate that between 3 and 5 feet of material was eroded from underneath the train tracks adjacent to the PSF at one time. In each case, new "fill" material was emplaced, returning the site to existing grade. The Chief of the Environmental & Natural Resources Division of the DEH also stated that, at the time of asphalt paving of the area south of the fence (August/September 1990), the blacktop area was built up anywhere from 1 to 1.5 feet, based on original fence height and surface of blacktop.

1.2.4 Surface-Water Hydrology

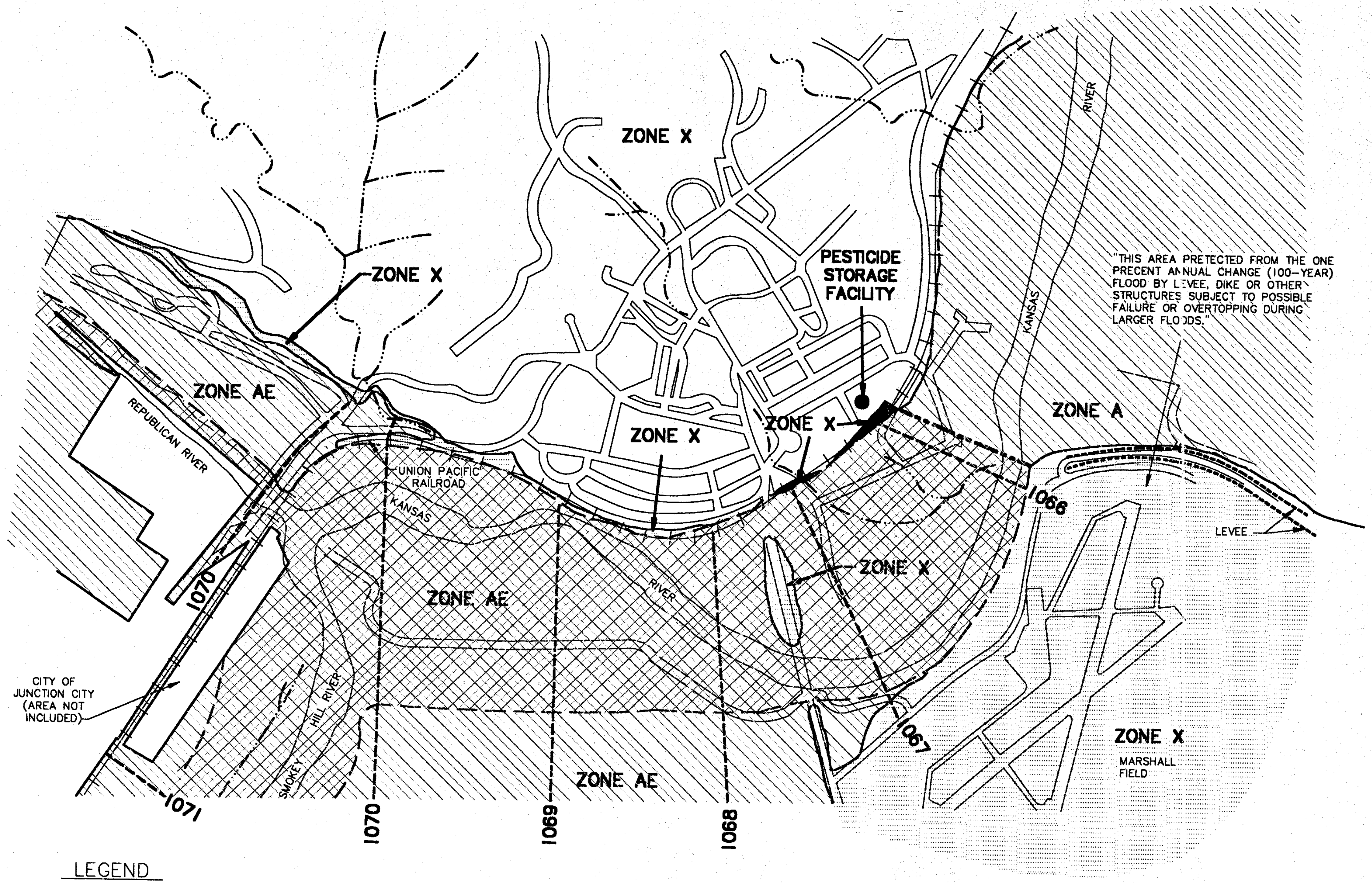
Surface-water features at Fort Riley can be characterized into three distinct categories: rivers, streams/drainages and impoundments (LAW, 1993a). Refer to Figure 1-4 for the locations of these features. The major rivers in the vicinity of the PSF are the Republican, Smoky Hill and Kansas Rivers. There is no levee between the PSF and the Kansas River (USGS, 1992). The Kansas River flows at a mean annual discharge rate of 2,750 cubic feet per second (cfs), calculated as the combined flow from the Republican and Smoky Hill Rivers (USGS, 1992) at the USGS gaging station on Henry Drive off Interstate 70. The Kansas River depth fluctuates between 1.5 and 12 feet. The Republican River flows at a mean annual discharge rate of 1,007 cfs. The lowest flow recorded was 50 cfs, and the highest flow recorded was 13,500 cfs (USGS, 1992). The Smoky Hill river discharges approximately 1760 cfs (USGS, 1992). General surface-water quality is considered moderate to poor especially during periods of lower flow (USGS, 1992). The waters are characterized as turbid, alkaline, moderately mineralized, buffered, with high dissolved oxygen content, low organic load, high nutrient levels, and high bacterial levels. However, the Kansas Department of Health and Environment has not issued restrictions on fish consumption and Class III recreation along the Kansas River near Fort Riley.

The report, Flood Insurance Study (FEMA, 1988), lists the following flood elevations above mean sea level (msl) for the Kansas River: 10 year equals 1,059 feet; 50 year equals 1,067 feet; 100 year equals 1,070.5 feet; and 500 year equals 1,078 feet. Therefore, based on these data and the ground surface (1,088 feet to 1,062 feet msl) for the PSF, the southern portion of the area of investigation lies within the 50-year floodplain. Figure 1-5 shows the area of flood hazard around the PSF. Previous Kansas River flood events are not documented to have reached or inundated the PSF. However, DEH personnel stated that floods of the early 1950s reached

FIGURE 1-4
MAJOR DRAINAGES AND SURFACE WATER FEATURES
FORT RILEY, KANSAS



filename: G:\FT-RILEY\FIG1-4.DWG



N

NOTES

THIS MAP IS FOR USE IN ADMINISTERING THE NATIONAL FLOOD INSURANCE PROGRAM; IT DOES NOT NECESSARILY IDENTIFY ALL AREAS SUBJECT TO FLOODING PARTICULAY FROM LOCAL DRAINAGE SOURCES OF SMALL SIZES, OR ALL PLANIMETRIC FEATURES OUTSIDE SPECIAL FLOOD HAZARD AREAS.

CERTAIN AREAS NOT IN SPECIAL FLOOD HAZARD AREAS MAY BE PROTECTED BY FLOOD CONTROL STRUCTURES

BOUNDARIES OF THE FLOODWAYS WERE COMPUTED AT CROSS SECTIONS AND INTERPOLATED BETWEEN CROSS SECTIONS. THE FLOODWAYS WERE BASED ON HYDRAULIC CONSIDERATIONS WITH REGARD TO REQUIREMENTS OF THE FEDERAL EMERGENCY MANAGEMENT AGENCY.

FLOODWAY WIDTHS IN SOME AREAS MAY BE TO NARROW TO SHOW TO SCALE. REFER TO FLOODWAY DATA TABLE WHERE FLOODWAY WIDTH IS SHOWN AT 1/20 INCH.

COASTAL BASE FLOOD ELEVATIONS APPLY ONLY LANDWARD OF THE SHORELINE

ELEVATION REFERENCE MARKS ARE DESCRIBED IN THE FLOOD INSURANCE STUDY REPORT.

CORPORATE LIMITS SHOWN ARE CURRENT AS OF THE DATE OF THIS MAP. THE USER SHOULD CONTACT APPROPRIATE COMMUNITY OFFICALS TO DETERMINE IF CORPORATE LIMITS HAVE CHANGED SUBSEQUENT TO THE ISSUANCE OF THIS MAP.

FOR ADJOINING PANELS, SEE SEPARATELY PRINTED MAP INDEX.

MAP REPOSITORY

COUNTY COURTHOUSE ANNEX, JUNCTION CITY, KANSAS (MAPS AVAILABLE FOR REFERENCE ONLY, NOT FOR DISTRIBUTION)

INITIAL IDENTIFICATION:
OCTOBER 18, 1977

FLOOD HAZARD BOUNDARY MAP REVISIONS:
FEBRUARY 20, 1979

FLOOD INSURANCE RATE MAP EFFECTIVE:
FEBRUARY 4, 1988

FLOOD INSURANCE RATE MAP REVISIONS:

SOURCE

FEDERAL EMERGENCY MANAGEMENT AGENCY
PANEL NUMBER 200579-0055C
FEB. 4, 1988.

0 1600 3200
SCALE IN FEET

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD
ZONE A NO BASE FLOOD ELEV. DETERMINED
ZONE AE BASE FLOOD ELEV. DETERMINED

FLOODWAY AREA IN ZONE AE

OTHER FLOOD AREAS
ZONE X AREAS OF 500-YEAR FLOOD; AREAS OF 100 YEAR FLOOD WITH AVERAGE DEPTHS OF LESS THAN 1 FOOT OR DRAINAGE AREA LESS THAN 1 SQUARE MILE; AND AREAS PROTECTED BY LEVEES FROM 100-YEAR FLOOD

OTHER AREAS
ZONE X
ZONE D

BOUNDARY DIVIDING SPECIAL FLOOD HAZARD ZONES, AND BOUNDARY DIVIDING AREA OF DIFFENRENT COASTAL BASE FLOOD ELEVATIONS WITHIN SPECIAL FLOOD HAZARD ZONES

---1067--- BASE FLOOD ELEVATION LINE; ELEVATION IN FEET*

* REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929

AREAS DETERMINED TO BE OUTSIDE 500-YEAR FLOOD PLAIN

AREAS IN WHICH FLOOD HAZARDS ARE UNDETERMINED

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

FLOOD HAZARD BOUNDARY MAP

PREPARED BY/DATE:	FIGURE NUMBER:	FILE DATE:	28.OCT.94
CHECKED BY/DATE:	1-5	PLOT DATE:	9.MAY.95
APPROVED BY/DATE:		FILE NAME:	fldmap.dwg

and inundated the DEH yard in general and the PSF specifically. High water stages in the Kansas River occur from the last part of February through the first part of June. The lowest river stages occur from late October through January (USGS, 1992). Before the construction of Milford Reservoir, major flooding occurred approximately every eight to 10 years, with a three- to five-day duration (USGS, 1992).

Surface-water impoundments at or near Fort Riley include a man-made reservoir, several oxbow lakes (crescent shaped lake formed in an abandoned river meander which has become separated from the main stream by a change in the course of the river), and several large and smaller ponds. Milford Reservoir is located west of Fort Riley and is fed by the Republican River. There are no surface-water impoundments within the PSF drainage basin or immediately downstream of the Kansas River.

1.2.5 Geology

This section presents a summary discussion of the regional and site-specific geology as related to the PSF investigation. Additional information is available in the RI Report. The primary reference for this section is the Kansas Geological Survey (KGS) Bulletin #189 - "The Stratigraphic Succession in Kansas," 1968 (KGS, 1968).

1.2.5.1 Regional Geology - Fort Riley is situated in three distinct geomorphic areas (Figure 1-6). The first is the uplands area, which is underlain by flat-lying and gently-dipping (northwesterly), interbedded limestone and shale units. The shallowest rocks beneath the uplands area consist of various shale units. The deeper limestone are typically exposed along the escarpments. Small streams have dissected these thick shale units and eroded much of the area into a rolling plateau. Local relief ranges from 164 to 240 feet in the uplands area. The second is steep to hilly country which extends from the uplands down to the alluvial bottomlands. This second geomorphic area is occasionally mantled by loess deposits. The third is the alluvial bottomlands of the Republican and Kansas Rivers. Relief in this area ranges from 25 to 60 feet.

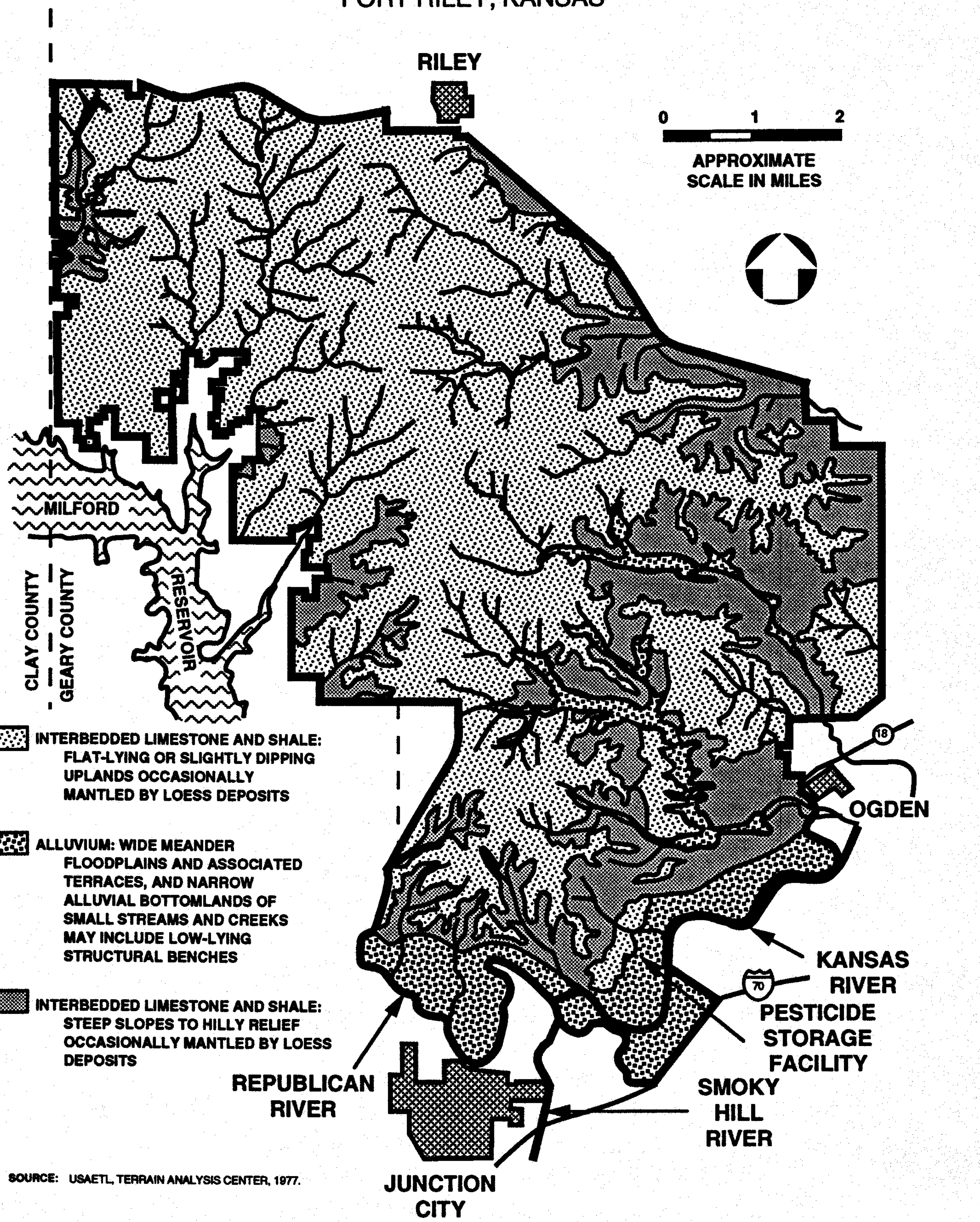
Stratigraphic units present at Fort Riley are Lower Permian in age and consist of alternating limestones and shales (Figure 1-7). The Chase Group and the Council Grove Group are the uppermost geologic units, with the Chase group being the uppermost of the two. Bedding planes dip gently to the northwest at approximately 15 feet per mile.

Geologic formations at Fort Riley within the Council Grove Group, include Stearns Shale, Bader Limestone, Easly Creek Shale, Crouse Limestone, Blue Rapids Shale, Funston Limestone, and Speiser Shale.

FIGURE 1-6

GEOLOGIC MAP OF FORT RILEY

FORT RILEY, KANSAS



SOURCE: USAETL, TERRAIN ANALYSIS CENTER, 1977.

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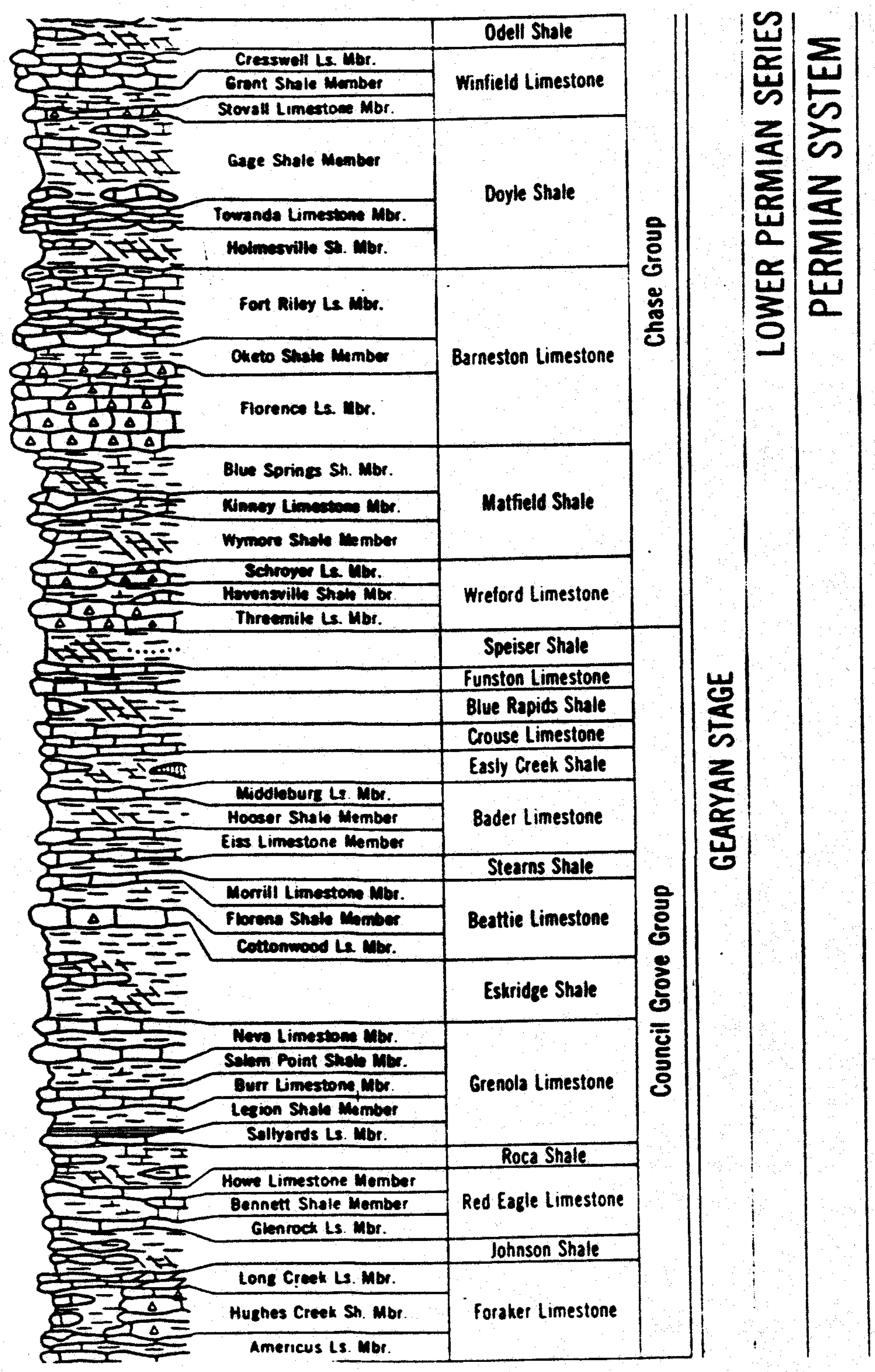
FIGURE 1-7

GENERAL STRATIGRAPHIC SEQUENCE-ROCK COLUMN

FORT RILEY, KANSAS



SOURCE: ZELLER, 1968

CP

1.2.5.2 Site-Specific Geology - This section presents a summary of site-specific geology as related to the PSF evaluation. The PSF is located in the Buck Creek Terrace deposits north of the Kansas River alluvium (LAW, 1993a). These terrace deposits are part of the valley-fill deposits of the Kansas River valley and contain water-bearing sand and gravel (KGS, 1974). They are described as grading upward from brownish-yellow sand, sandy silt and fine gravel in the lower part to reddish-brown and reddish-tan silt in the upper part. The soils formed in this material are described as reddish-brown or reddish-tan silt and clay.

In general, the relative positions of the alluvium and terrace areas are described as follows. Geologically recent alluvium extended from the Kansas River to the first distinguishable escarpment. Older alluvial deposits underlie the Newman terrace that extends from the first escarpment to the next escarpment (or change in soil texture) towards the valley wall. Finally, still older alluvium underlies the second Buck Creek terrace, which extends to the valley wall. The alluvium beneath these two terraces are referred to as terrace deposits.

Field investigations revealed the depth to the competent shale and limestone bedrock is approximately 28 feet below ground surface (bgs). This corresponds to an elevation of approximately 1,034 msl. The unconsolidated materials alternate between brown and black silt or clayey silt and brown to yellow-brown fine to coarse sand or clayey sand. In the monitoring well borings (PSF92-02, -03, -04), asphalt or gravel was present at the surface. The bedrock encountered beneath the alluvial and terrace deposits is Lower Permian in age and believed to be of the Council Grove Group, Gearyan Stage. Refer to Figures 1-8 and 1-9 for graphical representations of the site-specific geological conditions.

An area fill is interpreted to have been placed for site grading during the original site construction in 1941. Approximately 10 feet of fill was noted on the east side of Building 348 near PSF92-03. Schematic cross sections A-A' (Figures 1-8 and 1-9) illustrate approximate profiles north of and through Building 348. Substantially more fill was placed near Building 348, probably in an effort to extend the terrace surface southward. Fill at PSF92-02 and PSF92-04 is estimated to be at 7 and 3 feet, respectively.

1.2.6 Soils

Geotechnical analysis from the five borings completed during the RI has classified the soil as clayey sands (SC) and clayey silts (ML) under the Unified Soil Classification System (LAW, 1993b). Table 1-1 shows the classification of the soil at each boring together with parameters analyzed and the Unified Soil Classification System identification.

The Soil Survey of Riley County and Part of Geary County, Kansas by the United States Department of Agriculture Soil Conservation Service (USDASCS, 1975) has classified the soil at the PSF and its vicinity to be of the Kennesaw Series silt loam, with 6 to 10 percent slopes.

FIGURE 1-8

LOCATION OF GEOLOGIC CROSS SECTION

PESTICIDE STORAGE FACILITY – 1992
FORT RILEY, KANSAS

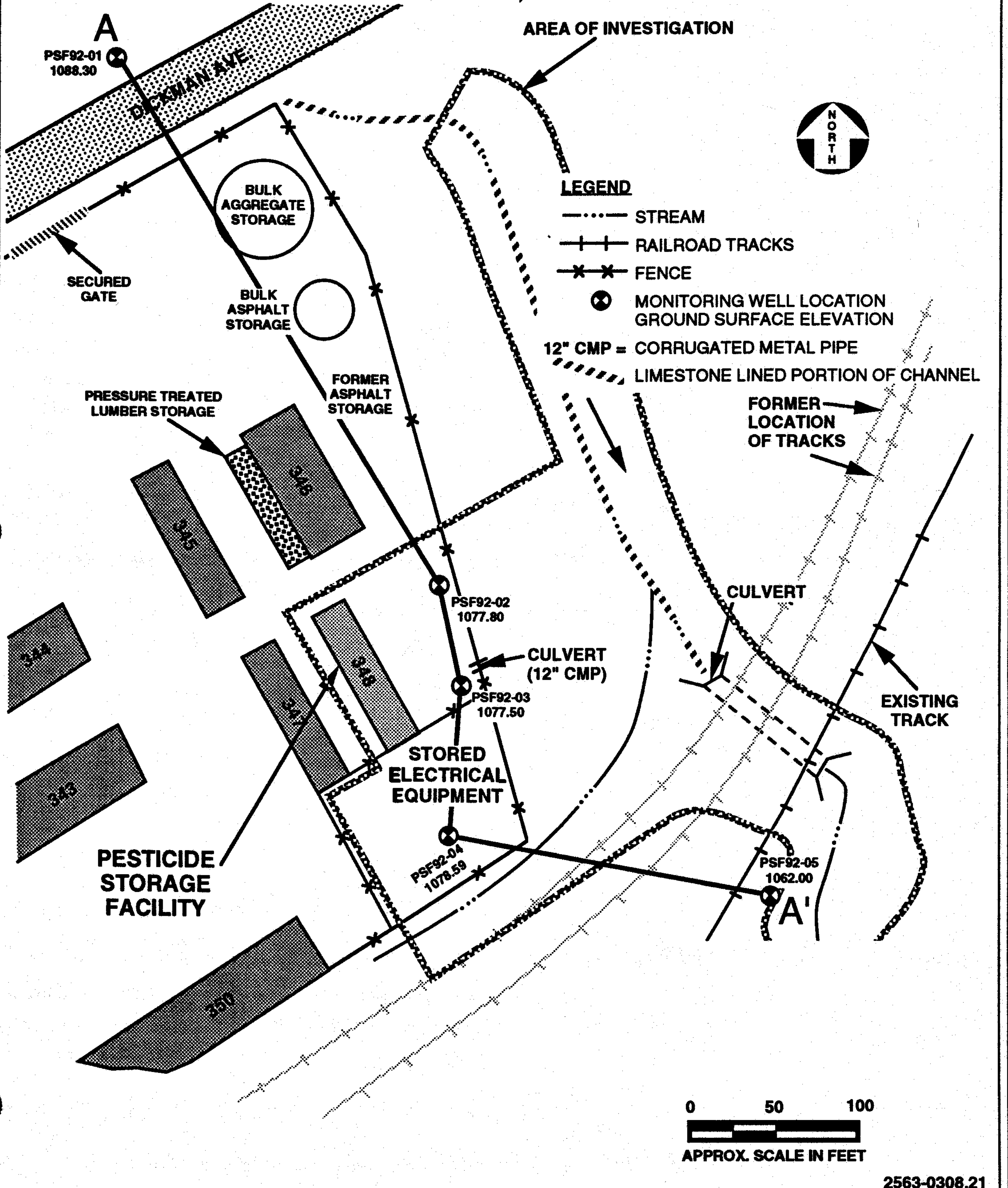


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FIGURE 1-9
GEOLOGIC CROSS SECTION A-A'
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

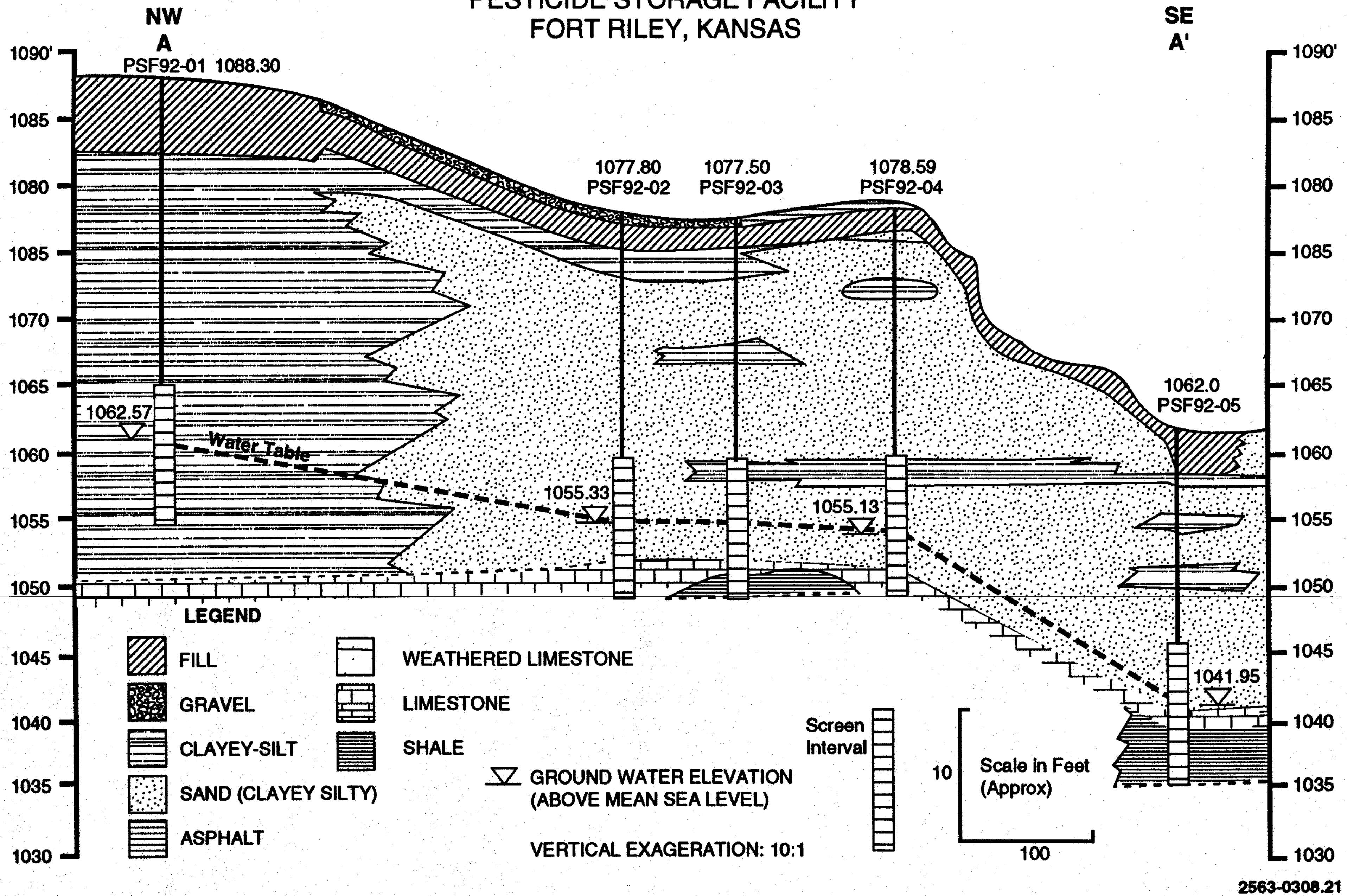


TABLE 1–1

ANALYTICAL RESULTS
GEOTECHNICAL SAMPLES
Pesticide Storage Facility
Fort Riley, Kansas

WELL NO/ SAMPLE DEPTH	% SAND	% SILT	% CLAY	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIFIED SOIL CLASSIFICATION
PSF92–01 GT/ 7' – 9'	46.0	46.0	8.0	26	18	8	CL
PSF92–01 GT/ 25' – 27'	27.0	62.0	11.0	27	18	9	CL
PSF92–02 GT/ 2' – 4'	19.5	60.0	20.5	19	19	N.P.	SC
PSF92–02 GT/ 22' – 24'	82.5	13.0	4.5	NR	NR	N.P.	SC
PSF92–03 GT/ 2' – 4'	12.5	67.5	20.0	35	22	13	CL
PSF92–03 GT/ 20' – 22'	17.0	69.5	13.5	24	18	6	CL
PSF92–04 GT/ 2' – 4'	69.5	25.0	5.5	15	15	N.P.	SC
PSF92–04 GT/ 22' – 24'	12.0	80.0	8.0	24	21	3	ML
PSF92–05 GT/ 3' – 5'	56.0	35.0	9.0	22	18	4	SC
PSF92–05 GT/ 17' – 19'	61.0	33.5	5.5	NR	NR	N.P.	SC

NOTES: CL = Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
SC = Clayey sands, sand–clay mixtures.
ML = Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts, with slight plasticity.
GT = Geotechnical
NP = Nonplastic
NR = Not reported

Source: Unified Soil Classification System

The surface layer is about 12 inches thick consisting of dark gray to dark grayish-brown silt loam. The subsoil which extends to 36 inches deep is made up of brown to light brown silt loam. The Kennesaw soils are well drained and moderately permeable. Surface run-off is medium to rapid in some cultivated areas, and erosion is a severe hazard.

1.2.7 Hydrogeology

This section presents a summary of the general and site-specific hydrogeology of the region taken from the RI Report (LAW, 1993a).

1.2.7.1 Regional Hydrogeology - The Fort Riley Military Installation covers a portion of the Republican and Kansas Rivers and Milford Reservoir watersheds (Figure 1-4). This area is characterized by poorly developed karst topography (KGS, 1968) and cyclothymic stratigraphic sequences of interbedded limestones and shales. The term "karst" refers to lithologic characteristics associated with dissolution of carbonate rock by groundwater movement through the rock column (LAW, 1993a). Karst is a type of topography that is characterized by sinkholes, caves, and underground drainage (Bates and Jackson, 1984).

The principal source of water for municipal, industrial and irrigation supplies is the combined river and valley fill deposits of the Kansas River Valley (KGS, 1974). Groundwater is also produced, to a lesser degree, from solution channels and joints in the Permian Age limestone bedrock aquifer which underlies the unconsolidated overburden (KGS, 1974).

The alluvium adjacent to the Kansas River and the Pleistocene Age Newman and Buck Creek terrace deposits are major geologic units in the Kansas River Valley (KGS, 1974). Within these deposits are zones of sands and gravels which are considered important water-bearing units.

Supplies adequate for local drinking water and moderate-scale agricultural activities can be derived from bedrock wells (KGS, 1974). Depth and presence of groundwater varies depending on local physiographic, geologic, and hydrologic conditions. The regional direction of groundwater flow is generally towards the Kansas River and is influenced by river stage.

1.2.7.2 Site-Specific Hydrogeology - This section summarizes the site-specific hydrogeologic conditions discussed in the RI (LAW, 1993a). The primary source of drinking water for Fort Riley, Junction City and Ogden is the valley fill alluvium (alluvial aquifer) of the Republican and Kansas Rivers (KGS, 1974). Junction City and Fort Riley water supply wells are within the Republican River floodplain. Wells completed in limestone at Fort Riley are producing from zones approximately 70 feet below the ground surface. The alluvial deposit are capable of yielding more than 14,000 gpm from a single well (KGS, 1974). This aquifer is recharged through direct infiltration of rain and seepage from limestone and shales. The Kansas and Republican Rivers are also primary sources of recharge to the alluvial aquifer. Water levels in the Fort Riley water supply wells generally range from 15 to 25 feet below land surface.

Five groundwater monitoring wells were installed in 1992 at the PSF. Analysis and reduction of the well slug test data resulted in calculated K values for the PSF wells ranging from 1.171 x 10^{-4} ft/min (5.9 x 10^{-5} cm/sec) to 1.03 x 10^{-3} ft/min (5.21 x 10^{-4} cm/sec) (LAW, 1993a).

The calculated direction of flow is east-southeast with an observed gradient of approximately 0.07 ft/ft toward the Kansas River and appears to follow the approximate dip of the bedrock surface and the general topographic trends. Figure 1-10 shows the groundwater potentiometric surface estimated in December 1992. Water levels recorded at the site are also presented on this figure, and the depth to groundwater was about 23 feet at the time. Based on the range of estimates for hydraulic conductivity and the estimated hydraulic gradient given above, and assuming an effective porosity value for the geologic media of 0.30, calculated groundwater flow velocities range from 2.7 x 10^{-5} ft/min to 2.4 x 10^{-4} ft/min (LAW, 1993a). The yield of the on-site aquifer was estimated to be 1 to 2 gallons per minute (gpm), based on monitoring well pumping and recharge rates observed during the sampling events (LAW, 1993a). Water levels in PSF wells were measured in September 1994, and the potentiometric surface at the PSF during this event and additional analysis to estimate a range of on-site aquifer yields are presented in Section 3.

1.2.8 Ecological Description

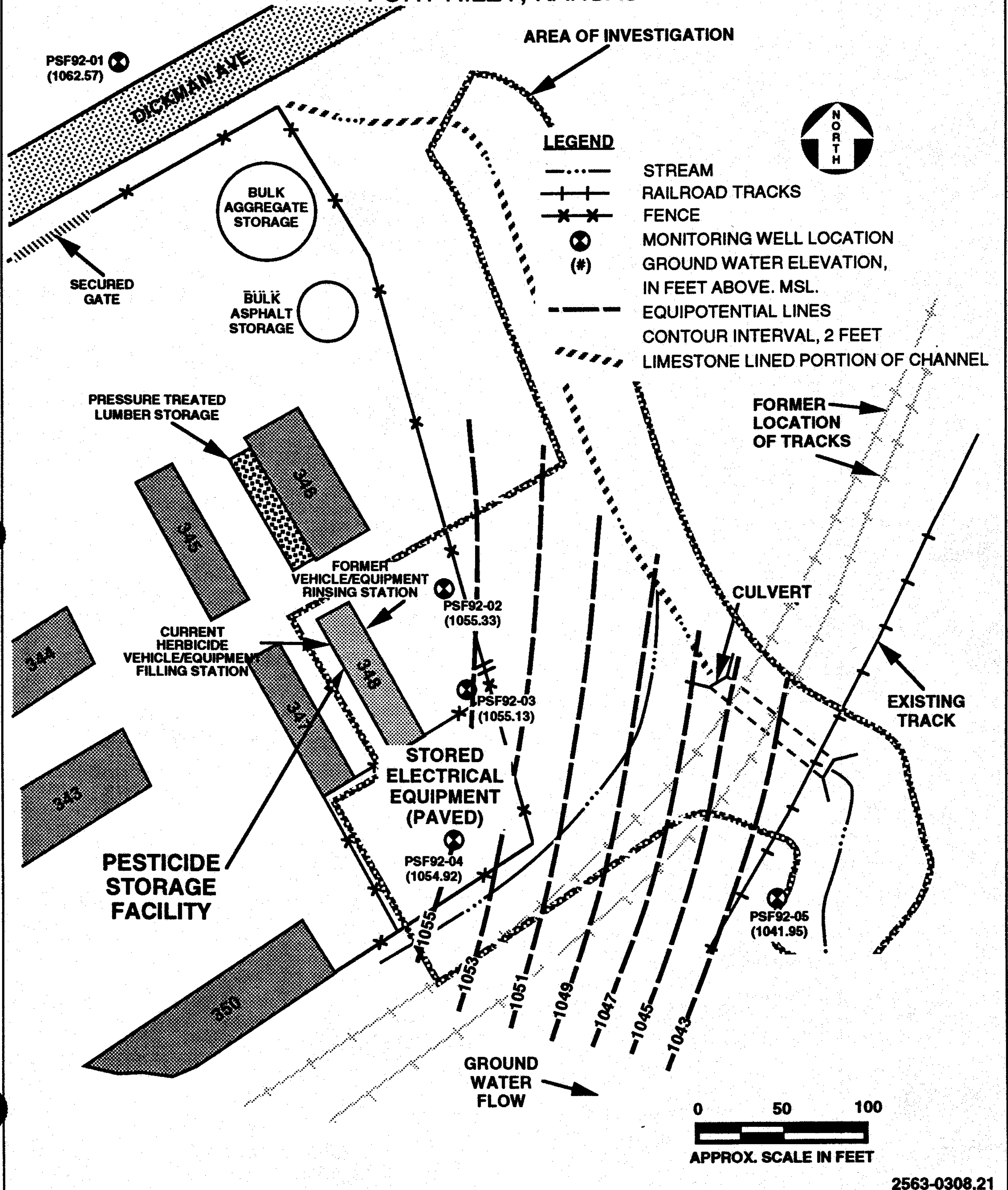
Land use in the undeveloped portions of Fort Riley consists primarily of grasslands or woodlands, with very little acreage devoted to crop production (LAW, 1993a). Cropland on the reservation is planted primarily as wildlife food plots or as a firebreak between private and federal lands. Grasslands may be comprised either of native prairie species, of cool-season tame grasses, or of naturally invaded grasses and forbs on old field or "go-back" acres where crops once grew (USFWS, 1992a).

A survey of threatened and endangered species on the Fort Riley Military Reservation was conducted by the U.S. Fish and Wildlife Service (USFWS, 1992a). The results of this survey indicate that eight federally-listed threatened and endangered species along with twelve federal category 2 candidate species could potentially occur on Fort Riley. Category 2 candidate species are those which the U.S. Fish and Wildlife Service is seeking additional information regarding their biological status, in order to determine if listing of these species is warranted. Although the eastern hognose snake was included in this survey, the status of this species has changed from "state-listed endangered" to a species "in need of conservation" (LAW, 1993a).

FIGURE 1-10

POTENTIOMETRIC SURFACE MAP, DEC. 1992

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



A PSF site survey was conducted by CEMRK contractor personnel accompanied by the Fish and Wildlife Administrator at Fort Riley on August 5, 1992. The purpose of this survey was to determine if PSF activities had impacted any habitats suitable for threatened and endangered species. Due to the close proximity of the PSF to the floodplain of the Kansas River, the wooded area to the east of the PSF can be categorized as a riparian woodland; however, there are no documented sightings of wintering bald eagles in this area. The Fish and Wildlife Administrator mentioned that the confluence of the drainage ditch to the east of the PSF and the Kansas River provides a suitable habitat for the sturgeon chub, which is a federal Category 2 species. Although the confluence of the drainage ditch to the east of the PSF and the Kansas River provides a suitable habitat for the sturgeon chub (USFWS, 1992b), the summary report on threatened and endangered species states that the occurrence of the sturgeon chub at Fort Riley is very unlikely (USFWS, 1992a).

Based on a wetlands delineation report completed on March 8, 1993 by the Corps of Engineers, Kansas City District (CEMRK, 1993) and Section 404 of the Clean Water Act (CWA), there are not wetlands within the immediate vicinity of the PSF that meet jurisdictional requirements. A review of the National Wetlands inventory conducted by the U.S. Fish & Wildlife Service did not identify wetlands within the immediate vicinity of the PSF. The Fort Riley Fish and Wildlife Administrator indicated that based on facultative plant types, soil types, and/or duration of inundation (annually) there could be nonjurisdictional wetlands. The Administrator further stated that these were likely associated with the drainages nearby. However, they would be small (less than 0.25 acre) and of low quality.

1.2.9 Climate

The Fort Riley area experiences four distinct seasons: summer, fall, winter, and spring. During the summer months (June, July, and August), the average daily high temperature is 89 degrees Fahrenheit while the average daily low temperature is 65 degrees Fahrenheit. The summer daily mean temperature is 77 degrees Fahrenheit.

During the winter months (December, January, and February), the average daily high and low temperatures are 47 degrees Fahrenheit and 27 degrees Fahrenheit, respectively. The winter daily mean temperature is 30 degrees Fahrenheit.

Extreme high and low summer temperatures are 110 degrees Fahrenheit and 42 degrees Fahrenheit, respectively, while the extreme high and low winter temperatures are 79 degrees Fahrenheit and -20 degrees Fahrenheit, respectively.

The average amount of precipitation for this area of Kansas is approximately 34 inches per year with 70 per cent of that occurring during the six month period between April and September. However, during the 1992 calendar year, when a majority of the field activities took place, the

Fort Riley Marshall Army Air Field Weather Station recorded nearly 45 inches of precipitation. Equally unusual is that approximately one-half, or 24 inches, occurred during the summer months, which for Kansas are typically the drier months of the year. Thirteen inches of rain fell in the month of July 1992 alone.

The data presented above are averages over a 30-year period (1962-1992) as recorded by the First Weather Group, Detachment 8, Fort Riley Marshall Air Field. Table 1-2 presents these data in tabular form.

1.2.10 Demographics and Groundwater Use Near the PSF

Locations of existing residences and groundwater wells supplying potable water to the area relative to the PSF site were identified so that the estimated impacts from potential or actual releases from the PSF site could be evaluated in the risk assessment. The Fort Riley Military Installation is situated along the north bank of the Kansas River in Riley and Geary counties in north central Kansas, near the cities of Manhattan, Odgen, Junction City, and Grandview Plaza, Kansas (Figure 1-1). Respective populations of these cities and Fort Riley are as follows:

COMMUNITY	POPULATION	SOURCE
Fort Riley	17,164	(1990 Economic Impact Survey)
Manhattan	37,712	(Assistant Director of Planning, Manhattan)
Ogden	1,500	(City Clerk of Ogden)
Junction City	21,000	(Deputy City Clerk, Junction City)
Grandview Plaza	1,266	(City Clerk, Grandview Plaza)

Troop housing and support facilities are also located in the southern portion of Fort Riley and consist of the Main Post, Camp Forsyth, Custer Hill, Camp Whitside, Camp Funston, and Marshall Army Air Field. The remainder of the installation consists of troop/family housing, numerous training areas, gunnery complexes, small arms firing ranges, drop zones, tank trails, and an impact area used for live fire artillery. The closest residential area on post, Housing Area No. 5, is located approximately 0.3 miles northwest of the site, along Lowe Place, Carpenter Avenue, and Carpenter Place (Figure 1-11). A more detailed discussion of demographics and land use is presented in the RI (LAW, 1993a).

The primary source of drinking water for Fort Riley, Junction City, and Ogden is the valley fill alluvium (alluvium aquifer) of the Republican and Kansas Rivers (KGS, 1974). These alluvial deposits are capable of yielding more than 1,400 gpm from a single well. Junction City's and Fort Riley's water supply wells are within the Republican River floodplain (Figure 1-12), about 1.8 miles upstream from the PSF. Ogden's water supply wells are located downstream, approximately 3 miles from the site.

TABLE 1–2

AVERAGED CLIMATOLOGICAL DATA – 1962 THROUGH 1992
FORT RILEY AREA
Pesticide Storage Facility
Fort Riley, Kansas

		Extreme Maximum Temperature	Mean Temperature	Extreme Minimum Temperature	Rainfall (inches)	Snowfall (inches)
	Jan	75°F	27°F	−26°F	0.90	5.00
Winter	Feb	86°F	32°F	−21°F	1.00	4.00
	Mar	90°F	42°F	−10°F	2.20	4.00
Spring	Apr	94°F	55°F	7°F	3.00	1.00
	May	100°F	65°F	27°F	4.60	0.00
	Jun	110°F	74°F	40°F	5.70	0.00
Summer	Jul	112°F	80°F	43°F	3.80	0.00
	Aug	109°F	78°F	45°F	3.40	0.00
	Sep	112°F	69°F	30°F	3.50	0.00
Fall	Oct	100°F	56°F	20°F	2.90	0.00
	Nov	84°F	43°F	−9°F	1.40	1.00
Winter	Dec	77°F	32°F	−14°F	1.20	4.00

Source: First Weather Group, Detachment 8, Fort Riley Marshall Air Field

FIGURE 1-11

RESIDENTIAL AREAS LOCATED NEAR THE PESTICIDE STORAGE FACILITY

PESTICIDE STORAGE FACILITY – FORT RILEY, KANSAS

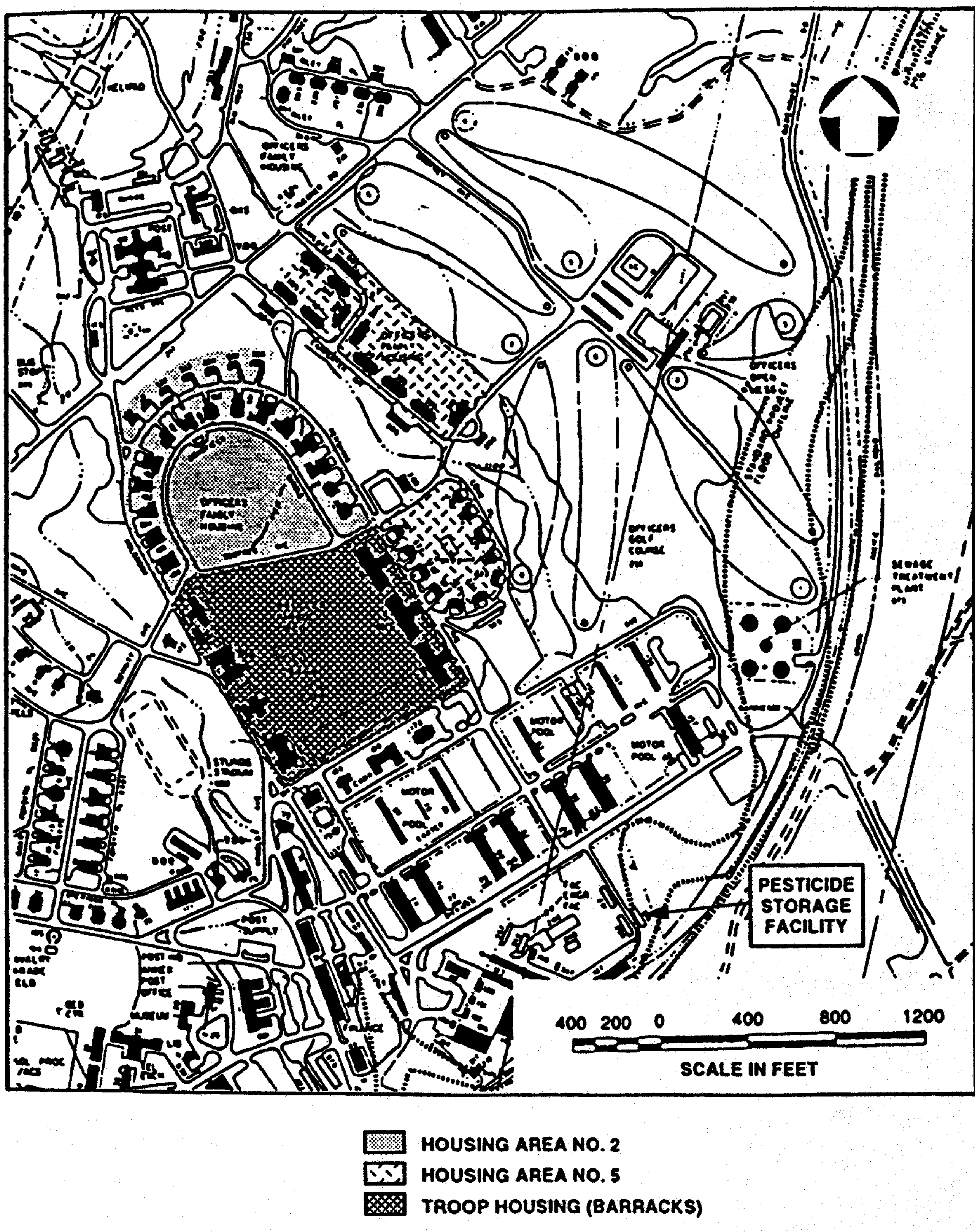


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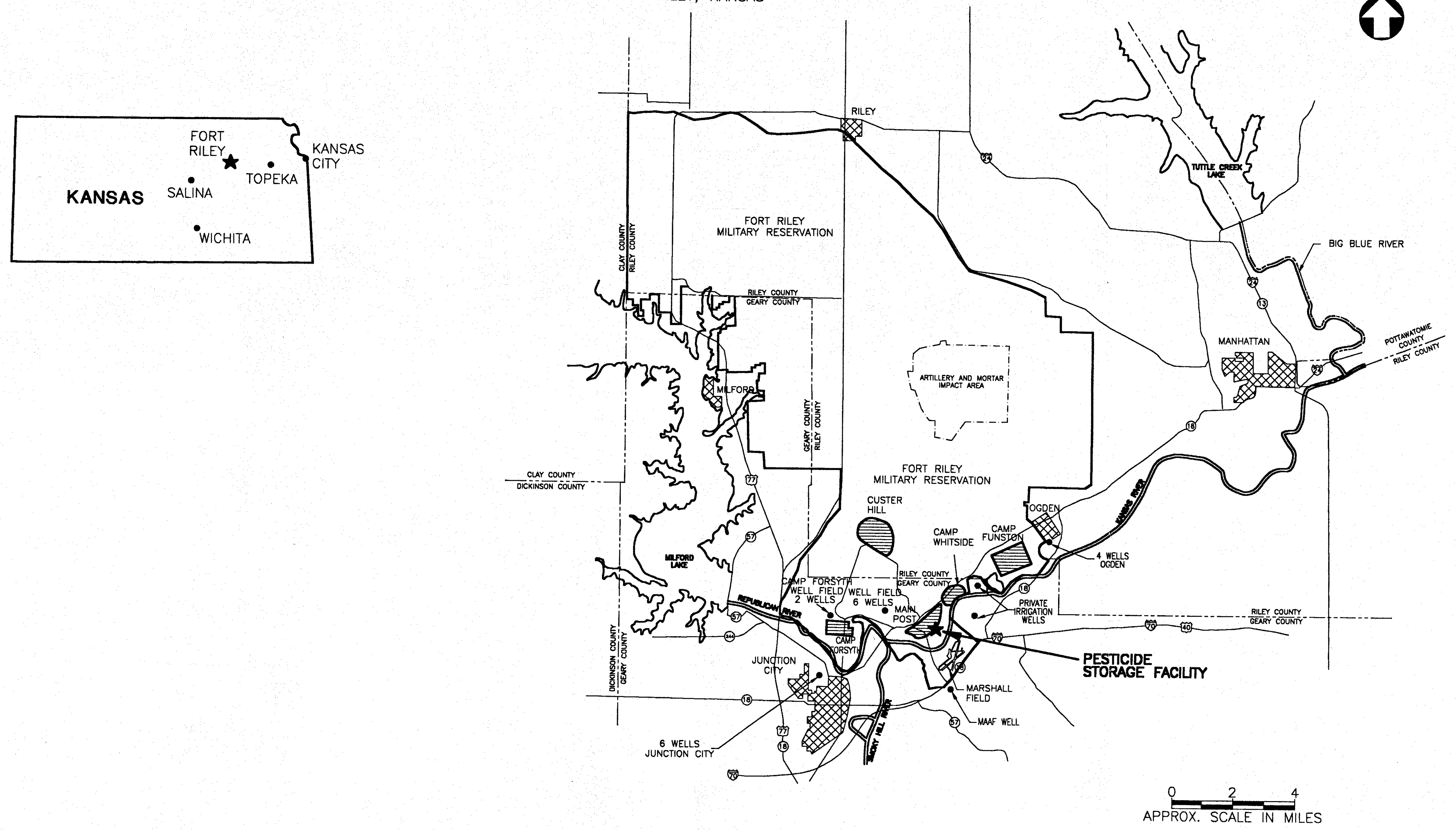
FIGURE 1-12

SUPPLY WELL LOCATIONS NEAR PESTICIDE STORAGE FACILITY

FORT RILEY, KANSAS



filename: G:\FT-RILEY\FIG3-6.DWG

1.2.11 Cultural and Historical Description

Interest in the antiquities within Fort Riley and the region have been documented to extend back to the late 19th century. Since the 1930s, several institutions and individuals have conducted archaeological research in the region, and, within the Fort Riley complex. The Main Post complex, comprising approximately 271 acres including the DEH yard area, was placed on the National Register of Historic Places in 1974 by the U.S. Department of Interior. These resources consist primarily of historic structures. Several archaeological resources are also contained within the historical district. The total Historic District encompasses an area of approximately 670 acres. Examination of recent cartography and records revealed that this part of Fort Riley has been an integral part of the main post at least since the early part of this century. Current cartography documents that parts of the study area have been urbanized.

The PSF study area lies within the boundaries of the Historical District; however, Building 348 was constructed in 1941 and is not designated to have historical significance. The study area has been extensively altered by filling, grading, and construction of the limestone-lined channel during the past 60 years. Considering these past activities, it is likely that any remaining historic or cultural resources present within the PSF site have been disturbed.

1.3 OVERVIEW OF PREVIOUS INVESTIGATIONS AND REMOVAL ACTION AT THE PSF

The PSF has been investigated on several different occasions, and a closure and removal action have been completed at the site. Previous investigations and actions at the PSF site are as follows:

- Pesticide Monitoring Study, 1974
- Pesticide Monitoring Study, 1986
- Closure Plan Wipe Samples, 1987
- Finalization on the NPL, August 30, 1990
- Closure of two CONEX containers, and a portion of Building 292 (now Building 348), finalized on December 3, 1990
- Fort Riley and U.S. Army Corps of Engineers RI/FS Planning Activities 1990 to 1992
- Development of Work Plan for the RI/FS 1991-1992

- Remedial Investigation 1992 to 1993
- Feasibility Study under development in 1993
- Engineering Evaluation/Cost Analysis 1993
- Removal Action Memorandum signed, December 1993
- Pesticide-contaminated soils were excavated and disposed off site by the removal action, March-June 1994
- Five rounds of groundwater samples have been collected from the PSF wells: July 1992, November 1992, February 1993, May 1993, and September 1994

Brief descriptions of these activities are presented in Sections 1.4 and 1.5. The RI activities resulted in a site characterization and interpretation of the nature and extent of contamination at the PSF site, based on the observed field investigation results. The RI investigation activities and the resulting site characterization are documented in the RI Report (LAW, 1993a).

While the RI, baseline risk assessment (BLRA), and an FS were under development, Fort Riley completed an EE/CA which considered a removal action at the site to address pesticide-contaminated soils. The public comment period for the EE/CA was August 17 to September 16, 1993, and a public meeting was held at Fort Riley on September 7, 1993. No public participants attended this meeting. Subsequently, the Removal Action Memorandum (DEH, 1993b) was signed in December 1993.

The Removal Action Memorandum specified excavation and off-site disposal of pesticide-contaminated soils, based on the extent of contamination interpreted from the RI field sampling results. Additional PSF soil sampling was then performed as a part of removal action planning activities to better define the extent of contamination and to establish the initial limits of excavation. These removal action sampling results identified a larger area of contamination at the PSF site than interpreted from the RI field sampling, and the initial limits of the removal action excavation were expanded, as discussed in Section 2.

During the removal action, site areas were excavated based on established soil contaminant concentrations (risk-based remediation goals) for pesticides with areas exceeding these contaminant levels removed, as discussed in Section 1.7.4.3. The excavations were backfilled with fill material obtained locally to approximately their original elevations, and the removal action activities were completed in June 1994 (OHM, 1994). The planning and completion of the removal action resulted in a revised understanding of the nature and extent of soil contamination at the PSF, as the observed conditions differed from those anticipated from the RI field investigation. Additional discussion is presented in Sections 2 and 3.

An additional round of groundwater samples was collected from the PSF monitoring wells in September 1994, and the sample analysis results are presented in a separate Quality Control Summary Report (QCSR) (LAW, 1994c). The FS, which was under development at the time of initiation of the EE/CA and removal action in May 1993, was not finalized at that time because the removal action was implemented.

1.4 SUMMARY OF PREVIOUS SITE STUDIES PRIOR TO THE RI/FS

The PSF has been investigated on several different occasions, and the purpose of this section is to summarize the previous investigations and evaluations which led to the removal action. The following sections provide a chronological summary of previous investigations and evaluations conducted at the PSF site. The removal action is discussed in Section 2.

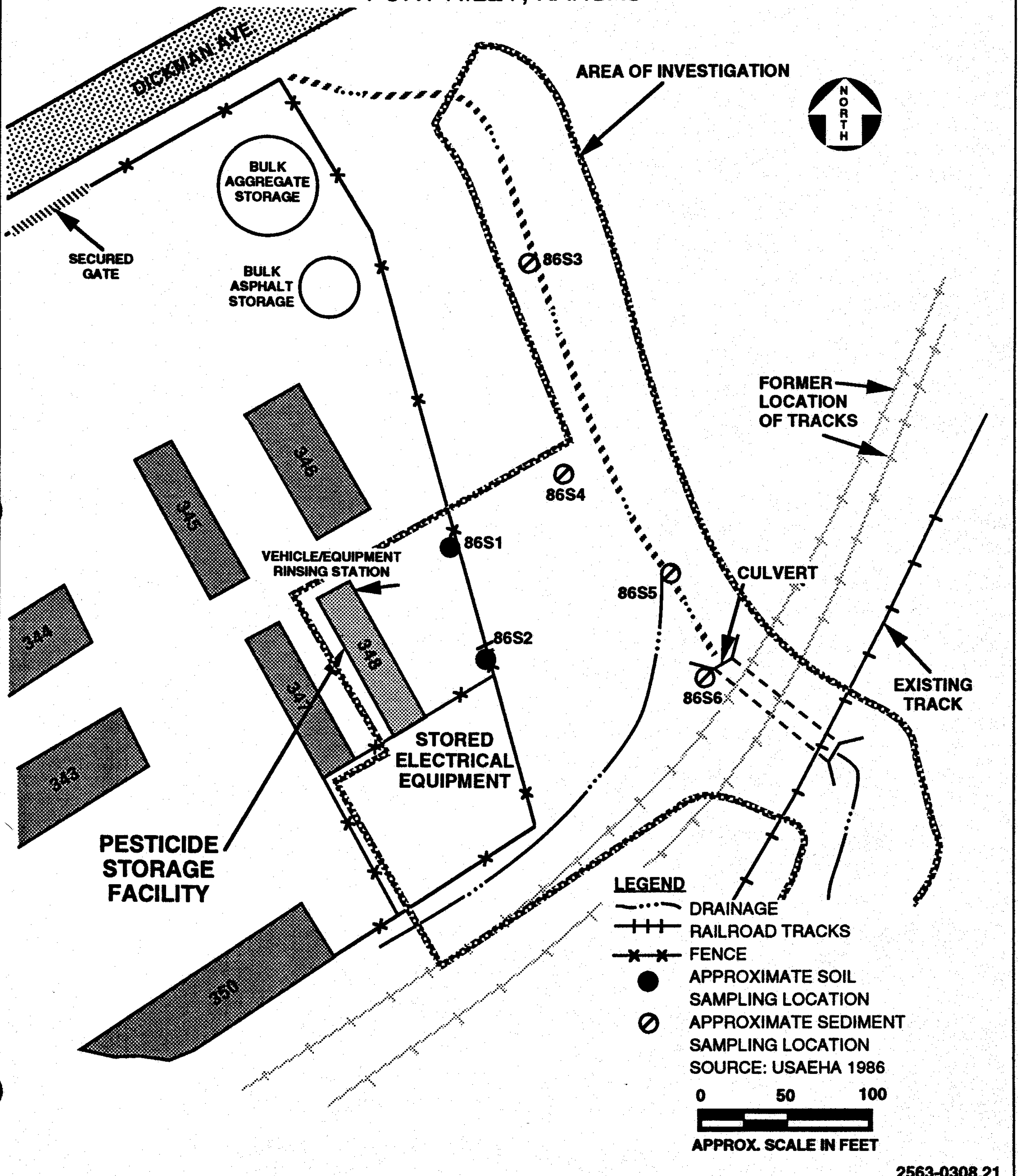
1.4.1 Pesticide Monitoring Study, 1974

The earliest site investigation of the PSF was conducted by the U.S. Army Environmental Hygiene Agency (USAEHA) in 1974, as part of the U.S. Army Pesticide Monitoring and Entomological Studies Program. A single soil sample was collected in July 1974, and four additional samples were taken in November 1974, in the immediate vicinity of the pesticide formulating and storage facility (Building 348, formerly Building 292), within the fenced area. Pesticide concentrations ranged from 0.41 parts per million (ppm) diazinon to 544.6 ppm chlordane (USAEHA, 1975). The fenced area was devoid of ground cover which was thought possibly due to the pesticide levels in the soils. Lower levels of pesticides were found in the soils of the wooded area, located east and downslope from the building, beyond the fence. Pesticide residues were also found in the sediments of unlined portions of the drainage ditch, located east and downstream from the Building 348 area. Water samples taken from the ditch contained no detectable concentrations of pesticides. Recommendations in the report included re-establishment of a grass cover or placement of an impermeable surface within the fenced area, and a revision of pesticide handling practices so as to minimized spillage. This study report has been included in the RI Report (LAW, 1993a). Contaminated soils within the fenced area were covered by a compacted gravel layer about 6 inches thick following the conclusions of the study.

1.4.2 Pesticide Monitoring Study, 1986

The purpose of the study was to confirm the presence or absence of pesticides in the soil in the vicinity of the PSF Building 348, and to develop an installation restoration plan to address the pesticides if present at significant levels. During May 1986, two soil and four sediment samples were collected at an approximate depth of 2 inches in the vicinity of the PSF (Figure 1-13). Two of the sediment samples (86S3, 86S5) contained no pesticides. Sediment sample 86S6

FIGURE 1-13
USAEHA APPROXIMATE SOIL/SEDIMENT SAMPLING LOCATIONS, MAY 1986
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



contained only low levels of DDT metabolites, chlordane and dieldrin. Two soil samples (86S1, 86S2) and the remaining sediments sample (86S4) contained a mixture of pesticides, including DDT metabolites, chlordane, dieldrin, and methoxychlor. Recommendations in the study included limiting access within the fenced area east of Building 348 (USAEHA, 1988) and continuing a pesticide monitoring program at the site.

1.4.3 Closure of a Portion of Building 348 and Two CONEX Containers, 1987 to 1990

A "Closure Plan for Hazardous Waste Storage Facilities, Building 292 and Two CONEXs" was written in 1987 (DEH, 1987) for a portion of the formerly designated Building 292 (now Building 348) and for two CONEX containers. A CONEX is a ribbed metal container used for shipping and temporary storage of goods and materials by the Army. These were considered hazardous waste storage facilities and closure was finalized under the provisions of 40 CFR 265 on December 3, 1990. The CONEXs were located next to Building 348, as shown in Figure 1-14.

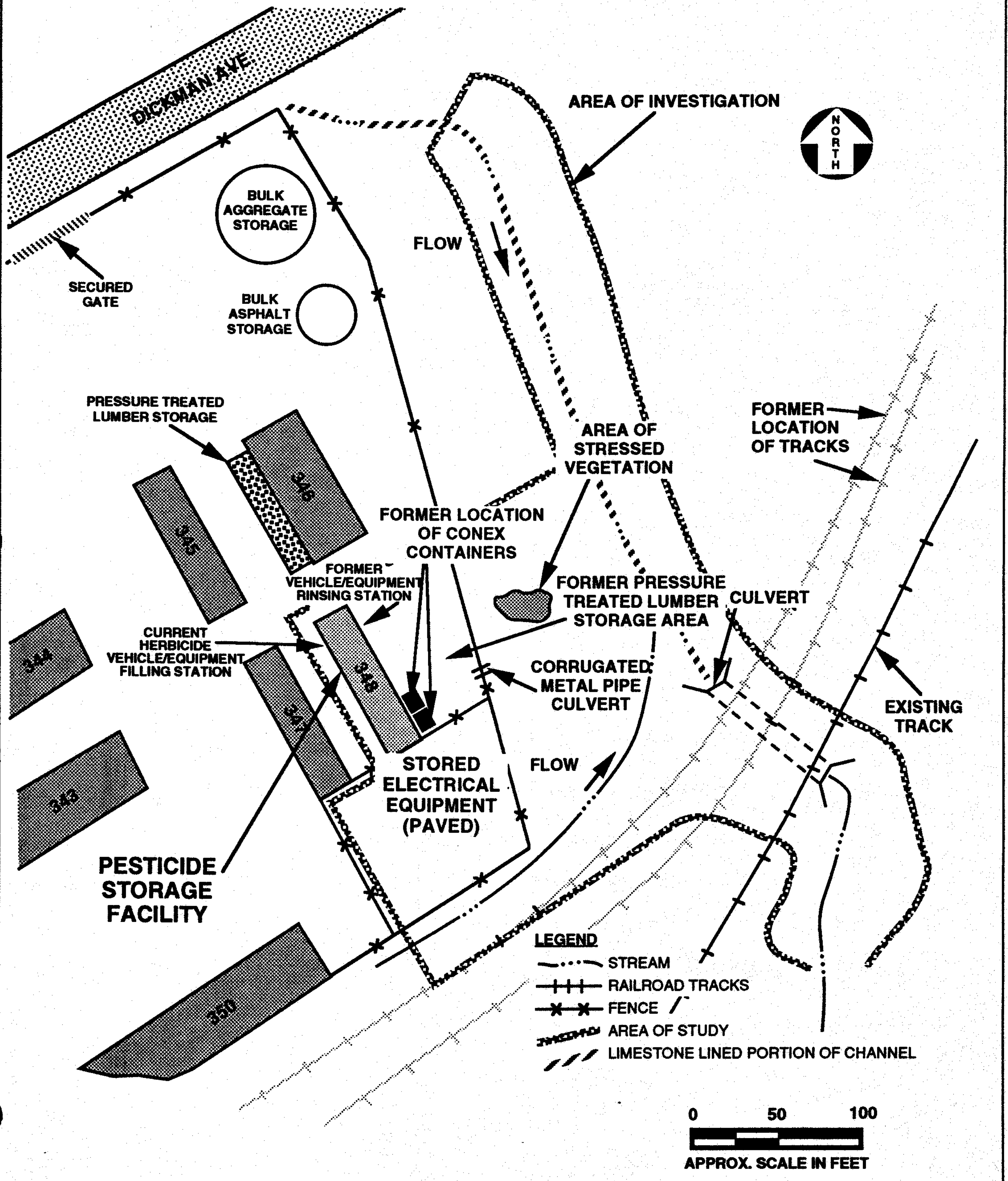
During 1988, according to the Polychlorinated Biphenyl (PCB) Program Manager, DEH, several PCB-containing electrical transformers were stored in these CONEX containers next to Building 348. In August 1990, wipe samples were collected from the inside of the CONEX containers located adjacent to the southeast corner of the PSF building. This sampling was conducted to comply with the procedures specified in the CONEX closure plan approved by the state of Kansas (KDHE, 1990). The final data report submitted by the contractor and verified by the Army showed the samples to be free of the pesticide and heavy metal contamination discussed above. After a review of the sampling results, the KDHE accepted the closure of Building 348 and CONEXs on December 3, 1990. The CONEX containers have since been removed by Fort Riley personnel (DEH, 1992b). Non-PCB transformers are no longer stored along the southeast side of Building 343 and the northeast side of Building 344.

1.5 REMEDIAL INVESTIGATION (RI), 1990 TO 1993

Fort Riley was finalized on the NPL on August 30, 1990. Fort Riley and the U.S. Army Corps of Engineers began planning the RI/FS in 1990, and Planning Documents were issued for the PSF. These planning documents identified the field sampling objectives, procedures, and sample locations for the RI field investigation activities. The Draft-Final Planning Documents submitted December, 1991 included the following:

- Volume I - Work Plan
- Volume II - Site Safety and Health Plan
- Volume III - Quality Assurance Project Plan
- Volume IV - Field Sampling Plan

FIGURE 1-14
PESTICIDE STORAGE FACILITY – 1992
FORT RILEY, KANSAS



2563-0308.21

Subsequent to this submittal, modified planning documents were prepared during 1992. A Draft Modified Work Plan was submitted for regulatory review in May 1992. Draft Final Modified Planning documents were issued in September 1992 as follows:

- Volume I - Draft Final Modified Work Plan
- Volume II - Draft Final Modified Quality Assurance Project Plan
- Volume III - Draft Final Modified Site-Specific Safety and Health Plan
- Volume IV - Draft Final Modified Basic Site Safety and Health Plan
- Volume V - Draft Final Modified Field Sampling Plan

Field sampling activities occurred concurrent with the preparation of the Modified Planning Documents and sampling activities were performed on the following dates:

- A pilot hole soil boring was performed on January 24, 1992.

- Surface water and sediment samples were collected from March 31 to April 2, 1992. Two additional sediment samples were collected on July 16, 1992.

- Soil samples at the site were collected April 4 to 8, 1992.

- Soil borings for monitoring well installations were drilled from April 28 to May 5, 1992. Monitoring wells were installed May 1 to 5, 1992.

- Four rounds of groundwater samples were collected at the site during the RI as follows:

July 14 to 23, 1992	Baseline Samples
November 5, 1992	First Quarter
February 3, 1993	Second Quarter
May 5 to 6, 1993	Third Quarter

During 1992 through 1993, a RI was conducted with the purpose of evaluating the nature and extent of contamination and developing information to support the evaluation of alternatives for remedial actions at the PSF (LAW, 1993a). Specific objectives of the RI were:

- To evaluate the nature and extent of constituent releases

- To determine the potential for contaminant migration

- To identify public health and environmental risks associated with the site in terms of regulatory environmental standards and advisories

- To provide information to serve as a basis for future response actions.

A brief summary of the RI field activities, analytical results, and conclusions is presented in this section. More detailed descriptions are documented in the RI Report (LAW, 1993a). The site description in this section presents the site conditions prior to the removal action as interpreted based on the RI field sampling results. A BLRA was completed in the RI based on these interpreted site conditions. A revised discussion of the PSF site conditions from the observations made during the removal action is presented in Section 3. A residual risk assessment (RRA) evaluating current site risks, based on site conditions after the completion of the non-time-critical removal action, is presented in Section 4.

1.5.1 Field Sampling Program

The RI field activities included sampling of the soils, groundwater, surface water, and sediments in the vicinity of the PSF. Surface soil samples were collected at four locations, ranging in depth from 0.25 to 1.5 feet. Shallow soil borings were collected at 20 locations, usually at depth intervals from 2.0 to 2.5 feet and 4.0 to 4.5 feet. Five monitoring wells were installed, and a total of 15 soil samples were collected from the monitoring well boreholes. Well PSF92-01, upgradient, and wells PSF92-02 through PSF92-05 downgradient, were installed at the approximate locations as shown on Figure 1-2. Six surface-water and 14 sediment samples were collected from seven locations along the lined drainage ditch east and southeast of the site. These soil, groundwater, surface water, and sediment samples are discussed below.

1.5.2 Analytical Results of Soil Samples Collected in 1992

The locations of surface and subsurface soil samples collected in 1992 at the PSF are shown on Figures 1-15 and 1-16. Surface soil sample PSFSS-01 and subsurface soil samples PSFSB-01A and PSFSB-01B were used to establish background concentrations for surface and subsurface soils, respectively. Several pesticides were detected in the soil samples including DDT and its metabolites (DDD and DDE), alpha- and gamma-chlordane, heptachlor, dieldrin, methoxychlor, endrin, Ronnel (Fenchlorphos) and malathion. Three distinct areas of pesticide contamination were indicated (Figure 1-17). This figure indicates the estimated extent of soil contamination at the PSF, as interpreted from RI soil sampling results, and not areas of contamination above any established action limit concentration (LAW, 1993a). The first area was around the north end of the PSF and extending east, and was attributed to rinse water from the washing of vehicles and pesticide spraying equipment running onto the ground and draining to the east. The second area occurred near the southeast corner of Building 348 and extended to the east, where the CONEX containers were formerly located. The third area of pesticide contamination was the location of stressed vegetation east of the PSF, near the drainage ditch to the east of Building 348. Acid herbicides were analyzed in surface soil sample PSFSS-04 collected from a 1- to 12-inch depth from this area, but were not detected in the sample. The source of the contamination

FIGURE 1-15
SURFACE SOIL SAMPLE LOCATIONS – APRIL 1992
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

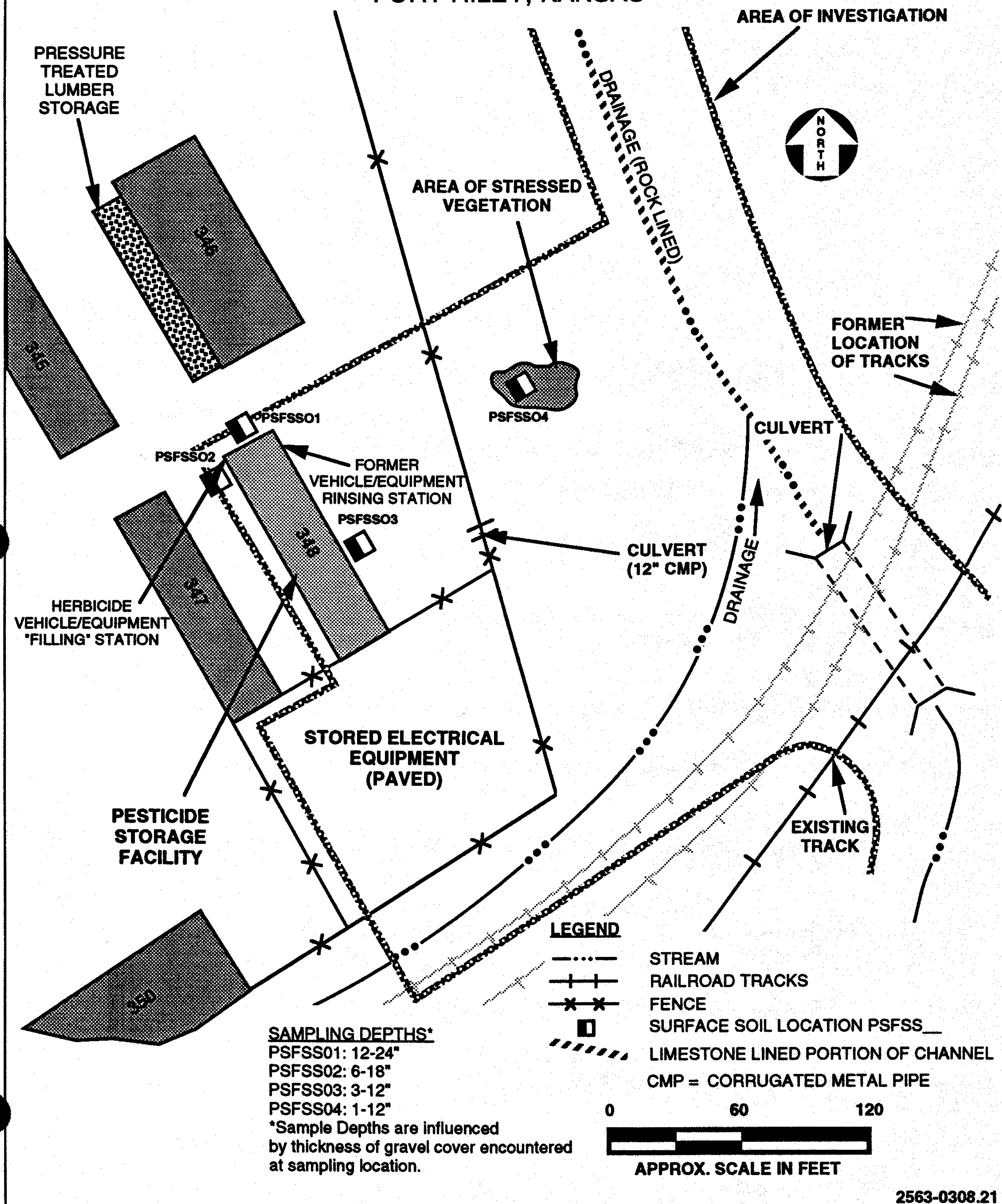
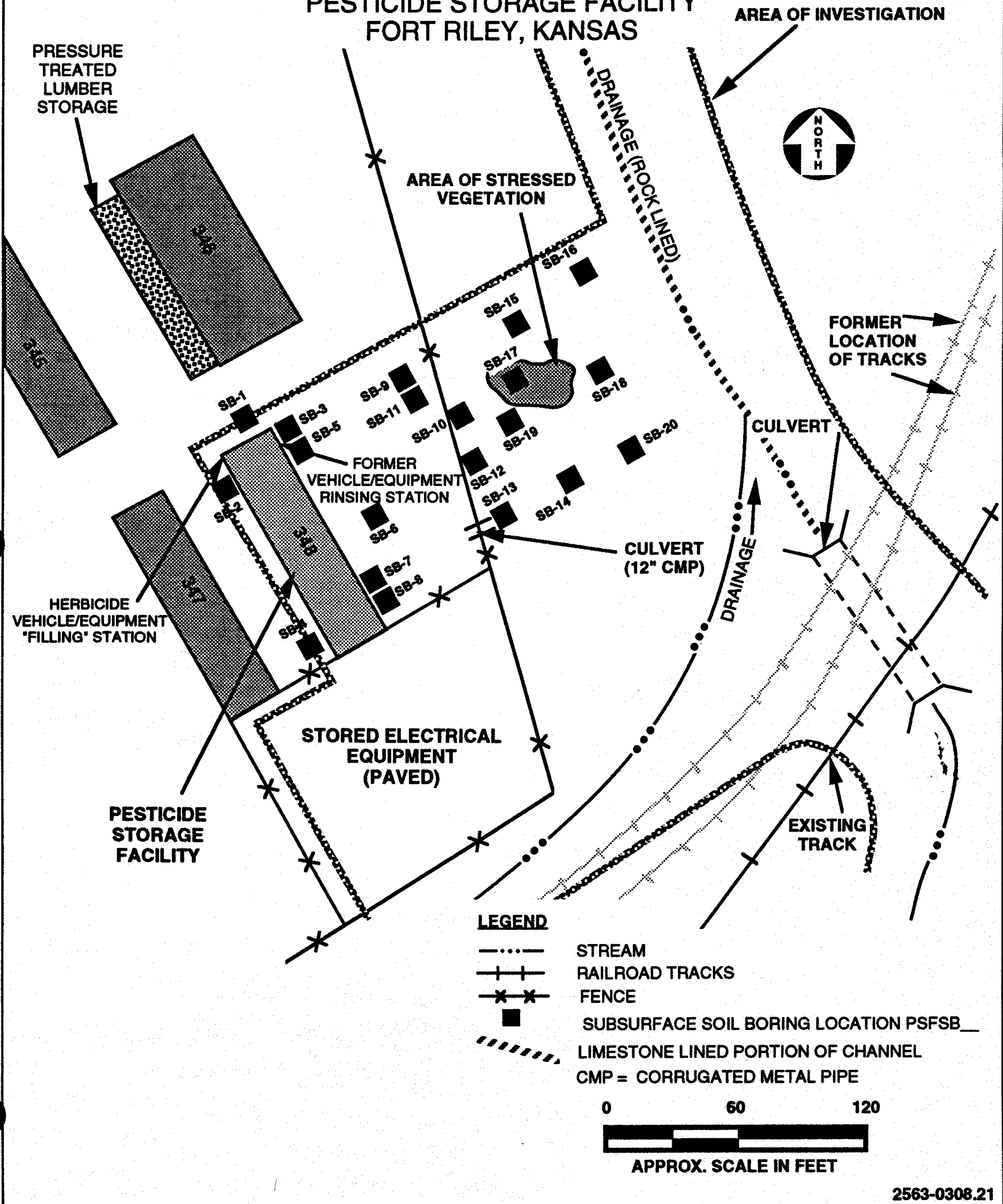
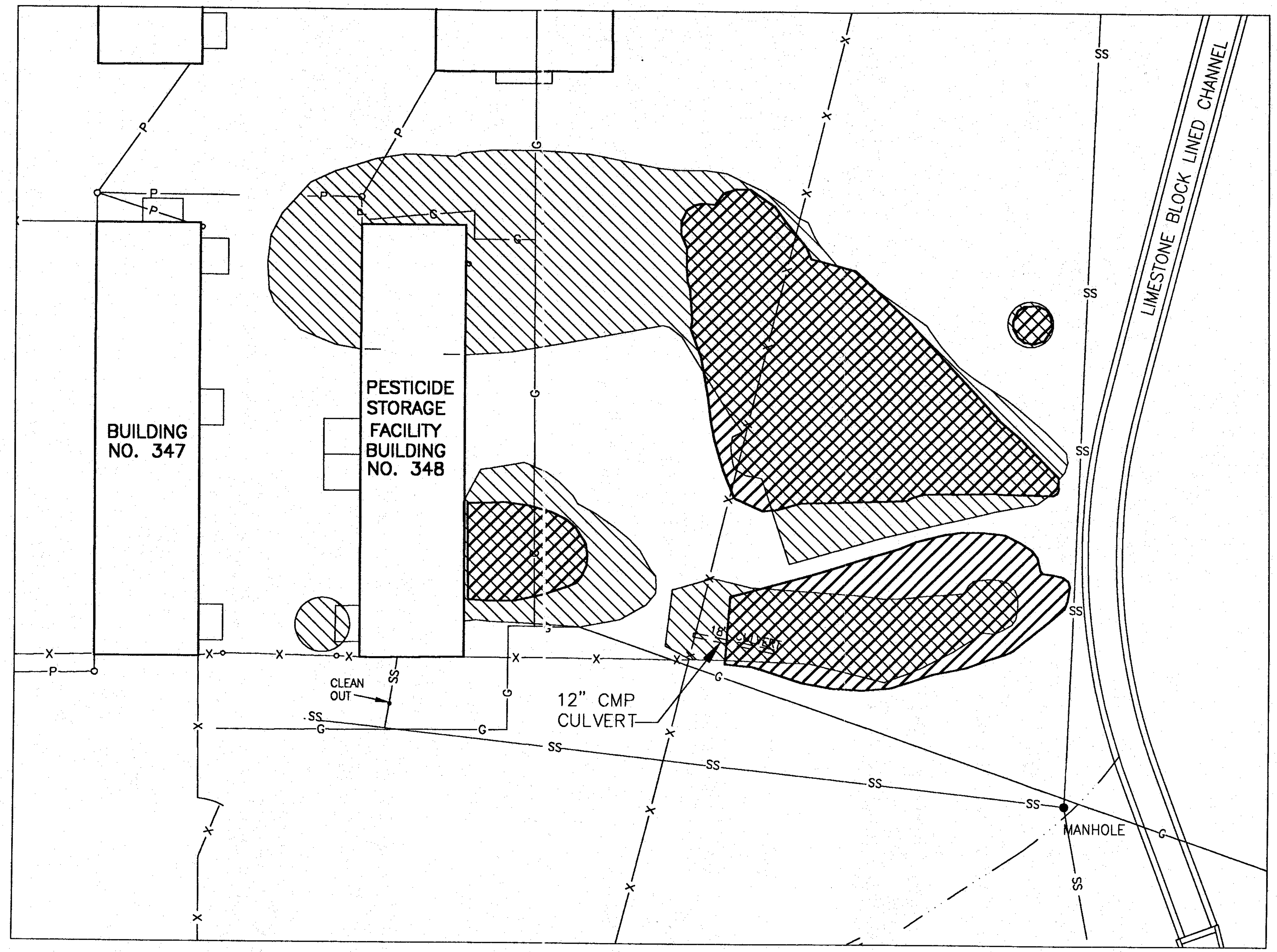


FIGURE 1-16
SUBSURFACE SOIL BORING SAMPLE LOCATIONS – APRIL 1992
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS





LEGEND:

- —X— FENCE
- —G— GAS UTILITY
- —SS— SANITARY SEWER
- CMP CORRUGATED METAL PIPE
- PAH CONCENTRATIONS
- PESTICIDES

0 30 60
SCALE IN FEET

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

SOIL CONTAMINATION AREAS INTERPRETED FROM 1992 RI SAMPLING

PREPARED BY/DATE: SEG/5–95	FIGURE NUMBER: 1–17	FILE DATE: 6.DECEMBER.94
CHECKED BY/DATE: EFW/5–95		PLOT DATE: 19.MAY.95
APPROVED BY/DATE: KAH/5–95		FILE NAME: PESTMAP.DWG

may have been attributed to either a spill, or the result of surface run-off from the Building 348 area being conveyed in an erosion pathway which terminated in this area. A small area near the southwest corner of Building 348, under existing pavement, was also identified from sampling results.

Of the metals analyzed, arsenic, barium, chromium and lead were routinely found in detectable concentrations in both background and PSF site samples. These metals are naturally occurring components of the earth's crust that are found in most soils and waters. Elevated concentrations of lead were detected in two samples: PSFSS-03 at 540 milligrams per kilogram (mg/kg) at the 0.25 to 1-foot depth and PSFSB-08A at 770 mg/kg at a 2 to 2.5-foot depth. Arsenic concentrations above the background concentrations were observed in two samples. Arsenic was detected at a maximum concentration of 120 mg/kg in a single sample (PSFSB-10C) at the 3.5 to 4.5-foot depth and at 20 mg/kg in sample PSFSB-02A at the 2 to 2.5-foot depth interval.

Several PAHs were detected in a single surface soil sample (PSFSS-O4) and several shallow soil samples. In sample PSFSS-04, five semi-volatile constituents were detected with fluoranthene (1.3 mg/kg), phenanthrene (0.78 mg/kg), and pyrene (1.0 mg/kg) at predominant concentration levels. In addition, several PAHs were detected in the soil at the 1- to 2-foot interval in the monitoring borehole sample MWSB-O2A. PAHs detected include acenaphthene, anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, and pyrene. In subsurface soils, maximum detected concentrations were pyrene (4.1 mg/kg), fluoranthene (3.4 mg/kg), phenanthrene (2.7 mg/kg), and 2,4-dichlorophenol (2.3 mg/kg). Six other PAHs were detected at maximum concentrations less than 2 mg/kg and eight PAHs at less than 1 mg/kg. The primary areas of PAH concentrations were soils along the fence due east of the PSF and extending east, and at the bottom of the culvert leading away from the southeastern corner of the fence. A third area of PAH concentration was located near the southeast corner of the PSF. The pattern of the PAH concentrations followed surface run-off patterns. Constituents of the asphalt paving activities conducted prior to collection of the soil samples, treated lumber, and asphalt stored in the DEH yard north and northwest of the PSF facility are potential sources. DEH records prior to 1990 and 1991 show what appears to be treated lumber stored adjacent to the eastern fence. This lumber was relocated to allow access for the RI field work. Potential sources of the PAHs at the PSF also could have included aromatic naphtha formulations used to dissolve pesticides, mixing, application, or spills; however, there were no reported or documented uses of PAHs to dissolve pesticides for past applications at the PSF. These areas of contamination are shown on Figure 1-17.

The volatile organic compound (VOC) toluene was detected in two surface soil samples near detection limits (at 0.006 mg/kg in PSFSS-02 and at 0.0073 mg/kg in PSFSS-04), and in several of the shallow soil samples, usually at the 4.0- to 4.5-foot depth interval. Benzene was detected in soils of two monitoring well boreholes at depth intervals of 15 to 17 feet (MWSB-01A) and 21 to 25 feet (MWSB-01B). The maximum detected benzene concentration was 0.0066 mg/kg. Toluene and benzene are constituents found in gasoline.

1.5.3 Analytical Results of Groundwater - Baseline through Third Quarter Samples

This section presents a summary of the groundwater sampling performed during the RI. The September 1994 samples are discussed in Section 3. Groundwater samples were collected from the five monitoring wells (Figure 1-18) in July 1992, in order to establish baseline data for groundwater quality at the site (LAW, 1992). PSF92-01 served as a background well, while the four other wells were placed in locations believed downgradient to detect groundwater contamination originating from the PSF site. Quarterly groundwater sampling events were then conducted in November 1992, February 1993, and May 1993 (LAW, 1993c, 1993d, 1993e). Table 1-3 shows the frequencies of detection, the frequencies of exceedance of the respective Maximum Contaminant Levels (MCLs), and the concentration ranges of the metal constituents over all four sampling events.

Analytical results of the samples collected to establish baseline data (July 1992) showed metals and inorganics as the main constituents of the groundwater around the PSF, with the alkali earth metals (calcium, magnesium, potassium and sodium) exhibiting the highest concentrations. Concentrations (total and dissolved) of four metals (barium, beryllium, chromium and selenium) were consistent with background conditions. Only the metals manganese (total and dissolved), total aluminum, total iron and total zinc occurred slightly above background concentrations. Manganese exceeded the secondary MCL of 0.05 mg/L in samples PSF92-02 and PSF92-03.

Concentrations (total and dissolved) of eight metals (barium, beryllium, calcium, iron, magnesium, manganese, selenium and zinc) detected in first, second and third quarter groundwater samples were consistent with the baseline concentrations. Arsenic was detected once in PSF92-06 (duplicate sample of PSF92-02 in the second quarter), and in PSF92-05 during all quarters. Arsenic did not exceed the MCL (0.050 mg/L). Total cadmium was only detected during the third quarter sampling event in PSF92-01 (background), PSF92-04, and PSF92-05 at 0.004 mg/L, 0.004 mg/L and 0.006 mg/L, respectively. The federal MCL for cadmium (0.005 mg/L) was exceeded once in the PSF92-05 sample. Total chromium was detected in two baseline samples: PSF92-01 at 0.010 mg/L, and PSF92-02 at 0.012 mg/L. It occurred again in PSF92-02 during the third quarter at 0.014 mg/L. The chromium MCL was never exceeded. Dissolved copper and total copper were detected in both background and downgradient wells at concentrations less than 0.012 mg/L. During the second and third quarters, dissolved and/or total copper were detected in each well. Total lead was detected in wells PSF92-03 (0.002 mg/L) and PSF92-04 (0.002 mg/L) only during the third quarter sampling event. In PSF92-05, both aluminum and iron increased during the first quarter and were detected at their maximum concentrations of 0.550 mg/L and 0.910 mg/L, respectively, then showed large decreases in the second quarter, and were below detection limits in the third quarter.

Thallium was analyzed for during all sampling events and was not detected during the baseline, first quarter, and second quarter sampling events. During these sampling events, USEPA Method 6010 (USEPA, 1986) was used in the analysis. After the second quarter event, the MCL for thallium was lowered to 0.002 mg/L, and Method 6010 no longer produced a detection

FIGURE 1-18
MONITORING WELL LOCATIONS
PESTICIDE STORAGE FACILITY – MAY 1992
FORT RILEY, KANSAS

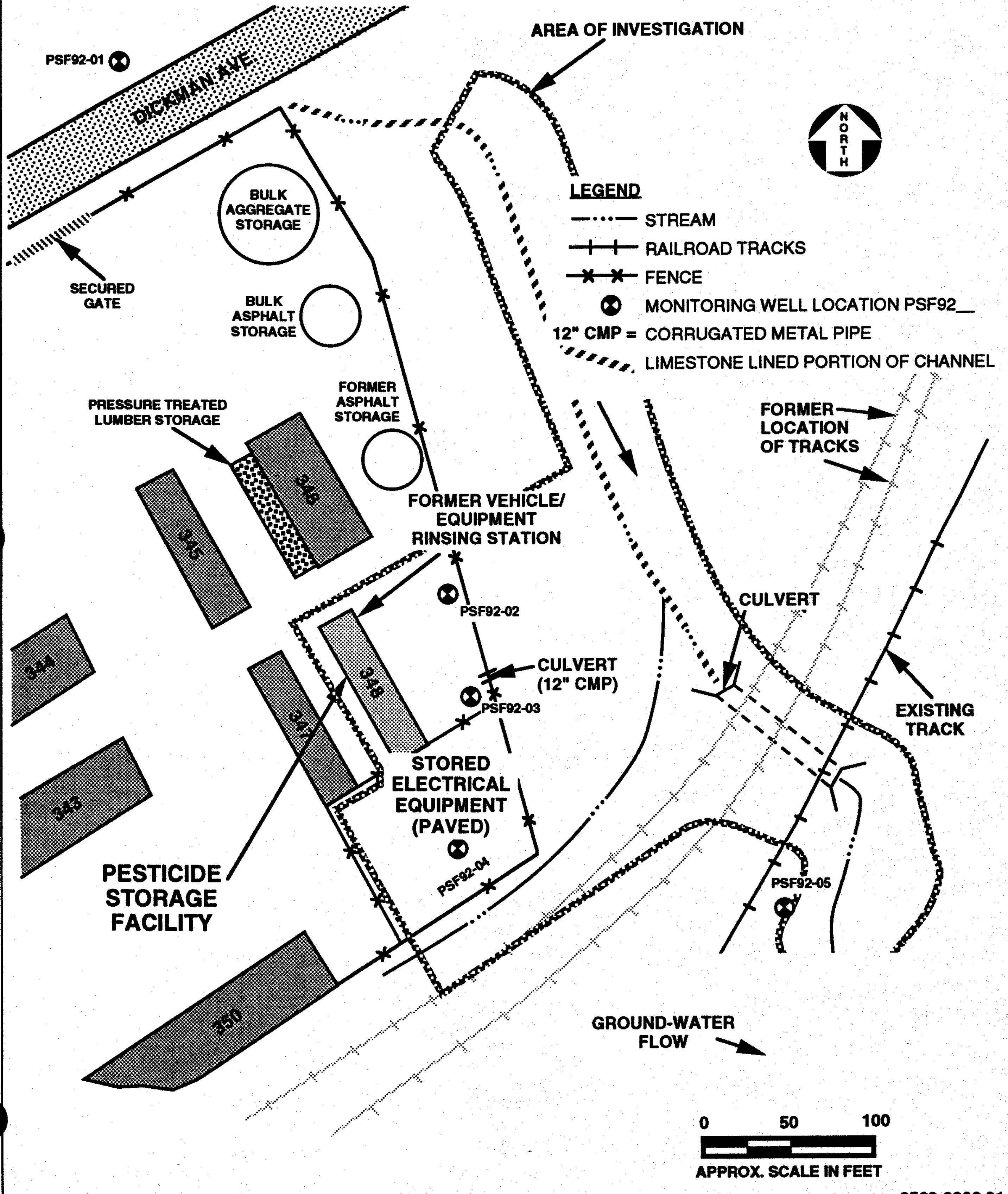


TABLE 1-3

CHEMICALS DETECTED IN GROUNDWATER SAMPLES
BASELINE THROUGH THIRD QUARTER
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	Maximum Concentration Detected in Background Sample	Frequency of Detection [a]	Method Detection Limit	Arithmetic Mean	Range of Detected Concentrations [b]	95% Upper Confidence Limit [c]
Volatile Organics:						
Methylene Chloride	9.3 T	3/4	0.005	0.0080	0.0018 – 0.021 T	0.051
Trichloroethene	ND	1/4	0.003	0.0019	< 0.003 – 0.003	0.0030
Dissolved Metals:						
Arsenic	ND	1/4	0.002	0.0045	< 0.002 – 0.015	0.54
Aluminum	ND	2/4	0.11	0.14	0.17 – 0.28	1.1
Barium	0.088	4/4	0.005	0.099	0.084 – 0.12	0.12
Beryllium	ND	4/4	0.001	0.0019	0.0015 – 0.003	0.0031
Calcium	8.8	4/4	0.093	210	140 – 340	380
Iron	ND	1/4	0.045	0.036	< 0.045 – 0.078	0.12
Magnesium	14	4/4	0.17	33	18 – 55	72
Manganese	0.024	4/4	0.001	0.052	0.031 – 0.083	0.10
Mercury	ND	1/4 d	0.0002	0.00018	< 0.0002 – 0.0004 d	0.00078
Potassium	3.3	4/4	0.22	8.7	3.8 – 19	39
Selenium	0.0011	4/4	0.001	0.0019	0.0012 – 0.0026	0.0033
Sodium	11	4/4	0.29	51	25 – 90	130
Vanadium	ND	1/4	0.007	0.0086	< 0.007 – 0.024	0.14
Zinc	0.0065 B_1	4/4 B_1	0.002	0.0066	0.0055 – 0.0075	0.0086
Total Metals:						
Antimony	0.022	1/16	0.031	0.017	<0.031 – 0.032	0.018
* Arsenic	ND	5/16	0.002	0.0026	< 0.002 – 0.016	0.0039
* Aluminum	ND	10/16	0.1	0.22	< 0.100 – 0.800	0.44
* Barium	0.2	16/16	0.005	0.13	0.060 – 0.13	0.10
* Beryllium	0.002	15/16	0.002	0.0022	< 0.0020 – 0.005	0.0028
Calcium	150	16/16	0.11	190	130 – 350	220
* Chromium	0.01	2/16	0.01	0.0060	< 0.01 – 0.014	0.0070
Cobalt	ND	1/16	0.01	0.0050	<0.01 – 0.009	0.0056
Copper	0.011	6/16	0.005	0.0046	<0.005 – 0.012	0.0064
Iron	0.071	12/16	0.050	0.32	0.050 – 1.5	1.3
Lead	ND	2/16	0.005 / 0.001	0.0011	<0.001 – 2.5	0.0016
Magnesium	26	16/16	0.17	30	18 – 56	36
* Manganese	0.034	16/16	0.015	0.046	0.023 – 0.091	0.057
Nickel	0.019	4/16	0.018	0.012	<0.018 – 0.024	0.014
Potassium	5.3	16/16	0.216	10	3.7 – 50	14
Selenium	0.003	16/16	0.001	0.0020	0.0011 – 0.0036	0.0024
Sodium	22	16/16	0.29	50	25 – 130	65
* Thallium	ND	2/16	0.001 – 100	0.0029	< 0.001 – 0.0029 e	NA
* Vanadium	0.011	4/16	0.007 – 0.010	0.0073	< 0.007 – 0.027	0.0097
Zinc	0.013	8/16	0.007	0.014	< 0.007 – 0.098	0.024
Wet Chemical Inorganics:						
Inorganic Chloride	147	16/16	0.2	110	39 – 399	180
* Nitrate	6.4	15/16	0.2	32	<0.2 – 165	250
Sulfate	85	16/16	0.2	180	108 – 386	230
Total Sulfide	ND	1/16	1.0	3.8	<1.0 – 52.5	3.4
Bicarbonate, as $CaCO_3$	249	12/16	1.0	270	<1.0 – 493	750000

Note: All concentrations are in mg/L (ppm). "Dissolved Metals" contains only baseline data.
ND = Not detected at concentrations greater than or equal to the Method Detection Limit.
NA = Not appropriate. (Due to the large number of NDs and large MDLs, calculation of a UCL for thallium was not performed).
* Selected as a potential chemical of concern
a Number of samples in which the chemical was positively detected divided by the number of samples available.
b Range does not include the concentration of chemicals detected in the background sample.
c The 95% Upper Confidence Limit is calculated using statistical procedures appropriate for characterizing lognormal populations (Gilbert, 1987). The UCL may be "artificially" elevated due to small sample size and large standard deviation of the data set.
d Total mercury was not detected in any sample. Since dissolved metals concentrations cannot exceed total metals concentrations, this result may be a false positive resulting from lab contamination.
e For thallium, the largest concentration actually detected was 0.0029 mg/L (see 9/10//93 letter in Appendix L). However, thallium was not detected using methods with MDLs as large as 0.110 mg/L.
T = Sample results are associated with the trip blank (indicates possible cross-contamination).
B_1 = Sample results are associated with the method blank (indicates possible lab contamination).

limit below the MCL. The third quarter samples were analyzed using USEPA Method 7841 with a detection limit of 0.001 mg/L. Thallium was observed in two wells during this quarter. The originally reported thallium concentrations for the PSF92-02 third quarter sample and duplicate were 0.0017 mg/L and nondetect, respectively. During reanalysis, it occurred in sample PSF92-02 at 0.0029 mg/L and at 0.0016 mg/L in the duplicate sample for this well. For well PSF92-03, the thallium concentration was originally reported at 0.0025 mg/L. Upon reanalysis, the concentration was reported as 0.0013 mg/L. Thallium was not detected in the background well. These results indicated thallium results reported above and below the federal MCL for thallium (0.002 mg/L). As discussed in Section 3.2.1, uncertainties in reported thallium levels were caused by the high levels of calcium, magnesium, and sodium that are present at Fort Riley.

Of the inorganic constituents analyzed, first quarter and third quarter concentrations of nitrate were consistent with the baseline concentrations. During the February 3, 1993, second quarter sampling event, nitrate showed an increase from two to five times in all samples with the exception of PSF92-01. During this sampling quarter, nitrate exceeded the MCL (10 mg/L as N) in all site wells with the exception of the background well (PSF92-01). Discrepancies for nitrate in one second quarter water sample were also noted in the Fort Riley PSF (2/93) Fort Riley, KS, Chemical Quality Assurance Report, 21 June 1993 (CEMRD, 1993), resulting in uncertainty pertaining to these elevated second quarter results.

A quality assurance sample was collected for analysis from well PSF92-03 during the February 3, 1993, sampling event. This sample was analyzed by the U.S. Army Corps of Engineers, Missouri River Division Laboratory in Omaha, Nebraska. The QA lab result reported nitrate at less than 0.01 mg/L, while the sample analysis result was reported at 50.6 mg/L. The QA Report stated: "The extremely large discrepancy for nitrate analysis seems anomalous." Both the PSF92-03 and PSF92-03 QA samples were analyzed by USEPA Method 300.0 for nitrate, chloride, and sulfate, and no discrepancies were noted for chloride and sulfate.

Volatile organic compounds were not detected in the groundwater samples, with the exception of 0.003 mg/L of trichloroethylene (TCE) in sample PSF92-05 detected once during the baseline sampling event. Pesticides and semi-volatile organics were analyzed for but not detected in the groundwater during these sampling events.

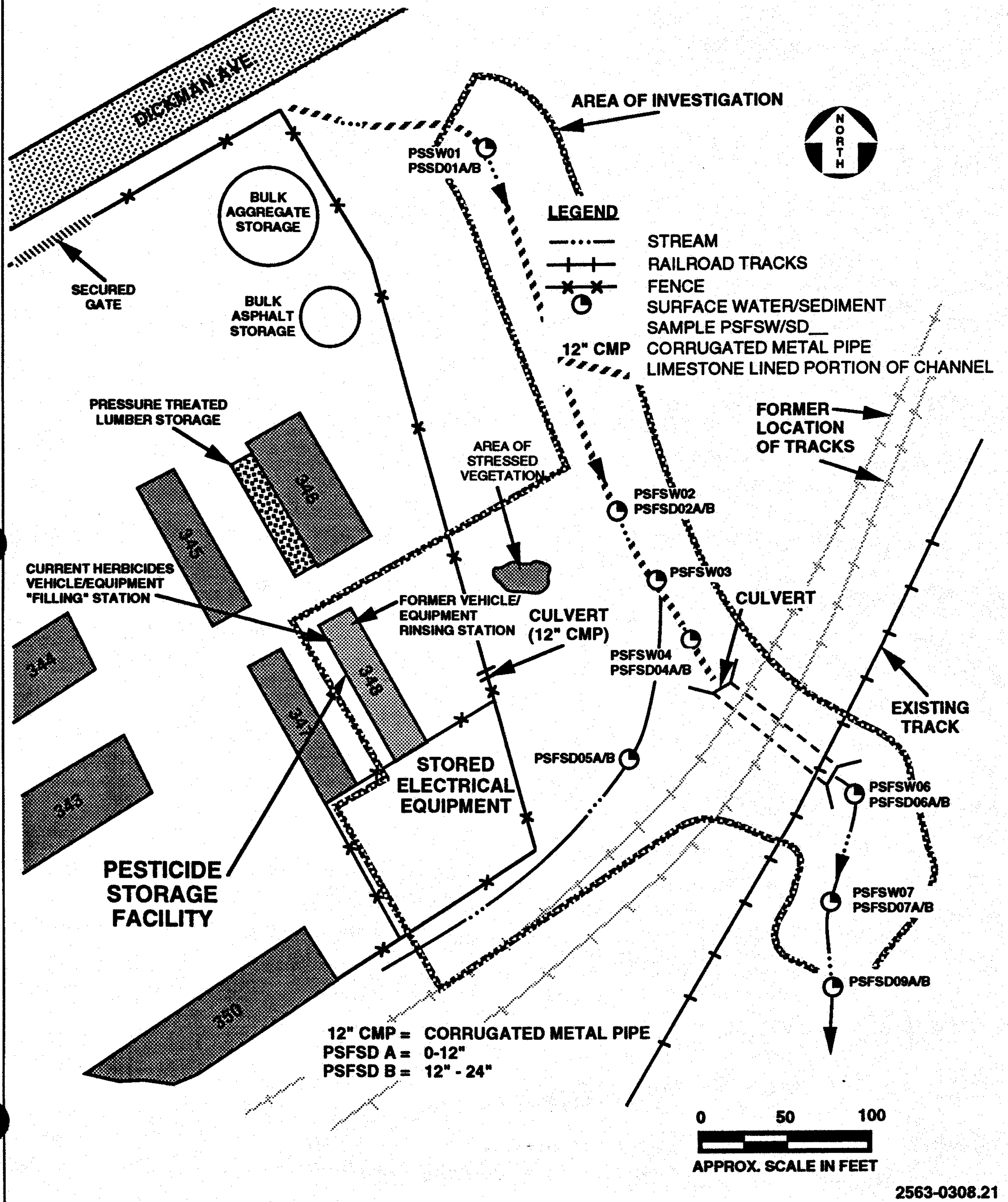
1.5.4 Analytical Results of Surface-Water Samples Collected in 1992

Analytical results of surface-water samples are presented in Appendix D. Only total metals and inorganic constituents naturally occurring in surface waters and soils were detected in the surface-water samples upstream and downstream from the PSF site (Figure 1-19). Total concentrations of aluminum, iron, and zinc increased immediately downstream of the PSF. Sulfates were observed to increase immediately downstream from the site.

FIGURE 1-19

SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS

PESTICIDE STORAGE FACILITY – MARCH-APRIL 1992
FORT RILEY, KANSAS



1.5.5 Analytical Results of Sediment Samples Collected in 1992

Analytical results of sediment samples are presented in Appendix D. Sediments samples collected in the lined drainage ditch east of the PSF contained pesticides, VOCs, PAHs and metals (Figure 1-19). Pesticide concentrations increased immediately downstream of the PSF facility, and then gradually decreased further downstream.

Sediment samples were composited from 0- to 1-foot and 1- to 2-foot depths. Several VOCs were detected in the sediments, including toluene, carbon disulfide, 1,2-dichloropropane and 1,1,2,2-tetrachloroethane. Carbon disulfide, 1,2-dichloropropane and 1,1,2,2-tetrachlorethane were only found in one sample each.

The metals arsenic, barium, cadmium, chromium and lead were found in the sediments both upstream and downstream. Of these, only lead showed an increase downstream from the PSF.

1.5.6 Summary of Conclusions of RI

The summary of conclusions derived from the evaluation of data collected during the PSF RI activities (1992 - 1993) is as follows:

- Of the constituents detected, pesticides, PAHs and metals were found with the greatest frequency. These metals were also detected in upgradient samples and are naturally occurring in this area.
- Pesticides were indicated in three distinct areas in PSF soils: around the north end of the PSF and extending to the east; near the southeast corner of the PSF and extending to the east; and in the area of stressed vegetation near the drainage ditch to the east of the PSF.
- Pesticides detected in greatest frequency in the surface soils were chlordane, DDT and metabolites, and dieldrin; in subsurface soils, chlordane and DDT and metabolites.
- PAHs were detected in the soils in three areas of the PSF: along the fence to the east of the PSF and extending to the east; at the bottom of the culvert leading to the east from the southeastern corner of the fence; and near the southeastern corner of the PSF.
- The metals analyses of soil samples revealed that arsenic, barium, chromium, and lead were found in detectable concentrations in downgradient and background samples. Arsenic, chromium, and lead

concentrations downgradient exceeded background levels in some samples; barium levels were consistent with background.

- Analytical results revealed that VOCs, pesticides, PAHs, and metals existed in the sediment within the drainage ditch to the east of the PSF. These metals were also detected in the upgradient sample and are naturally occurring in soils in the area.

- Analytical results revealed metals and inorganics in the groundwater samples collected from PSF wells and the background well, with metals generally detected at concentrations consistent with background concentrations; no pesticides and a single detection of a VOC were observed.

- Constituents detected in the surface water consisted of various metals and inorganics detected upgradient and downgradient which are naturally occurring in the area. Downgradient concentrations were consistent with the upgradient sample except that aluminum, iron, vanadium, zinc, and sulfate were slightly above background in some samples.

- Based on the conclusions derived from the analytical data and the resulting BLRA, the surface soils, subsurface soils, and sediment may present carcinogenic risks exceeding 10^{-6} and the threshold (Hazard Index 1.0) for noncarcinogenic effects to on-site workers and future residents. A summary of carcinogenic risk estimates from the BLRA exceeding 10^{-6} is presented in Table 1-4. Noncarcinogenic risk estimates from the BLRA for these same pathways are presented in Table 1-5.

As presented in the BLRA in the RI report, future groundwater use is unlikely at the site. As the groundwater use pathway is incomplete under current and probable future land uses at the site, risk estimates for a hypothetical future on-site groundwater use were calculated for information only in the BLRA. As shown in Tables 1-4 and 1-5, cancer risks and the hazard indices for this groundwater use pathway exceeded 10^{-6} and 1.0, respectively.

The ecological risk assessment concluded that negative impact to fauna and flora was not readily apparent. Any impacts would be minimized from selection by species of more favorable habitat locally available. Pesticides were not detected in downstream surface water (Kansas River) at the Southwest Funston Landfill site.

TABLE 1-4

SUMMARY OF CANCER RISKS
FROM THE BASELINE RISK ASSESSMENT
Pesticide Storage Facility
Fort Riley, Kansas

RECEPTOR	EXPOSURE ROUTE AND MEDIUM	CANCER RISK
SOIL MEDIA		
Current Site Worker	Incidental ingestion of surface soil	1E-06
Current Site Worker	Dermal contact with surface soil	8E-04
Future Site Worker	Incidental ingestion of surface soil	6E-06
Future Site Worker	Dermal contact with surface soil	4E-03
Future Site Worker	Inhalation of fugitive dust	1E-06
Future Site Worker	Dermal contact with sediments	2E-06
Current Utility Worker	Dermal contact with surface soil	4E-06
Current Utility Worker	Dermal contact with subsurface soil	2E-06
Future Utility Worker	Dermal contact with surface soil	2E-05
Future Utility Worker	Dermal contact with subsurface soil	8E-06
Current Landscaper	Dermal contact with surface soil	1E-06
Current Landscaper	Dermal contact with subsurface soil	2E-06
Future Landscaper	Dermal contact with surface soil	2E-05
Future Landscaper	Dermal contact with subsurface soil	7E-06
Future Construction Worker	Incidental ingestion of surface soil	1E-06
Future Construction Worker	Dermal contact with surface soil	7E-05
Future Construction Worker	Dermal contact with subsurface soil	4E-05
Current/Future Recreational Child	Dermal contact with surface soil	NA
SEDIMENT MEDIA		
Future Site Worker	Dermal contact	2E-06
GROUNDWATER MEDIA (For Information Only)		
Future Site Resident (Adult)	Ingestion of ground water	2E-04
Future Site Resident (Adult)	Dermal contact	4E-07
Future Site Resident (Child)	Ingestion of ground water	NA
Future Site Resident (Child)	Dermal contact	NA

NA - Not assessed because cancer risks are not estimated for children.

TABLE 1-5

SUMMARY OF HAZARD INDICES
FROM THE BASELINE RISK ASSESSMENT
Pesticide Storage Facility
Fort Riley, Kansas

RECEPTOR	EXPOSURE ROUTE AND MEDIUM	HAZARD INDEX
SOIL MEDIA		
Current Site Worker	Incidental Ingestion of surface soil	2E-02
Current Site Worker	Dermal contact with surface soil	9E+00
Future Site Worker	Incidental ingestion of surface soil	6E-02
Future Site Worker	Dermal contact with surface soil	3E+01
Future Site Worker	Inhalation of fugitive dust	4E-07
Future Site Worker	Dermal contact with sediments	2E-02
Current Utility Worker	Dermal contact with surface soil	4E-02
Current Utility Worker	Dermal contact with subsurface soil	2E-02
Future Utility Worker	Dermal contact with surface soil	1E-01
Future Utility Worker	Dermal contact with subsurface soil	7E-02
Current Landscaper	Dermal contact with surface soil	1E-02
Current Landscaper	Dermal contact with subsurface soil	2E-02
Future Landscaper	Dermal contact with surface soil	1E-01
Future Landscaper	Dermal contact with subsurface soil	1E-01
Future Construction Worker	Incidental ingestion of surface soil	3E-01
Future Construction Worker	Dermal contact with surface soil	2E+02
Future Construction Worker	Dermal contact with subsurface soil	7E+00
Current/Future Recreational Child	Dermal contact with surface soil	2E+00
SEDIMENT MEDIA		
Future Site Worker	Dermal contact	2E-02
GROUNDWATER MEDIA (For Information Only)		
Future Site Resident (Adult)	Ingestion of ground water	4.6E+00
Future Site Resident (Adult)	Dermal contact	9.0E-03
Future Site Resident (Child)	Ingestion of ground water	2.2E+01
Future Site Resident (Child)	Dermal contact	1.0E-02

1.6 FEASIBILITY STUDY DEVELOPMENT DURING 1993

A Draft FS was under development in February through May of 1993 based on the preliminary site characterization results under review during the preparation of the RI Report. The BLRA under review in the RI Report indicated unacceptable risks due to surface and subsurface soils, and Draft FS development focused on remedial actions addressing soil contaminants. Specific objectives identified for the Draft FS were: to identify appropriate remedial action objectives; to develop a range of site-specific remedial alternatives to address remedial action objectives; to evaluate and screen identified remedial alternatives; and to prepare initial cost estimates and a comparative analysis of identified alternatives.

The Draft FS included preliminary identification of applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) requirements. ARARs are the federal or state regulatory requirements which establish the criteria defining the cleanup goals for contaminants at the site. Remediation goals (RGs) were developed, which were based on identified ARARs and calculated risk-based contaminant levels when ARARs were not available to address the site contaminated media.

Remedial technologies were identified and initially screened utilizing the evaluation criteria of effectiveness, implementability and cost. Favorable technologies were combined to define remedial action alternatives which were subjected to a detailed analysis for their potential ability to achieve site remedial action objectives and meet identified ARARs. Alternatives identified included a No Action alternative, institutional controls to limit site exposures, grading and capping of contaminated areas, and an excavation and off-site disposal alternative.

In May 1993, Fort Riley, the USEPA, and KDHE agreed to suspend the completion of the FS, and investigate a removal action option at the PSF site. To pursue a removal action, an EE/CA was performed to document the development and evaluation of removal action alternatives.

1.7 COMPLETED REMOVAL ACTION DESCRIPTION

This section provides a summary of the removal action activities completed at the PSF site. The removal action process is discussed, followed by brief summaries of the EE/CA, Action Memorandum, and the construction activities accomplished at the PSF site in completing the removal action.

1.7.1 Removal Action Process

As discussed above, Fort Riley investigated a removal action option for the site. The authority for Fort Riley, as the lead agency, to proceed with a removal action is described in Section

(2)(e)(1) of Executive Order 12580 (USEPA, 1991a). The appropriateness of a removal action was evaluated considering such factors as potential exposure to human health and the environment and potential for migration of contaminants in soils at the site. Because the site posed no immediate threat to human health and the environment, it was determined that a non-time-critical removal action was appropriate. Fort Riley initiated a non-time-critical removal action, in accordance with NCP 300.415, to address the PSF site. By definition, as a non-time-critical removal action, at least six months lead time was available prior to initiation of any response actions. Because this six-month planning period was available, per NCP 300.415, Fort Riley conducted an engineering evaluation/cost analysis (EE/CA). Under this process, an EE/CA report is required to document the lead agency's (the Army in this case) desire to perform a removal action and to identify and evaluate removal action alternatives being considered. The preferred alternative is also identified.

Details of the EE/CA are provided in the following section.

1.7.2 Engineering Evaluation/Cost Analysis (EE/CA) for PSF - 1993

During May through September 1993, the Fort Riley DEH prepared an EE/CA for a Removal Action at the PSF (DEH, 1993a). The EE/CA addressed only soil contamination at the PSF. The Draft FS served as the basis for the EE/CA development. The purpose of the report was to assess the appropriateness of performing non-time-critical removal action activities at the PSF to address the risks due to arsenic and pesticides in the soils. The stated objectives of the EE/CA report were as follows:

- Determine if a removal action was appropriate to protect human health and the environment.

- Identify and evaluate alternative conceptual options, and recommend options for a removal action which were consistent with the needs for a removal action, which could be incorporated into the permanent solution to remediate the site, and could meet the time schedule for construction.

- Develop an alternative that met safety and health requirements and that allowed for the continuing use of the site.

Similar to a Feasibility Study, the EE/CA included information presented in the RI Report (LAW, 1993a), under review at the time of EE/CA preparation. An immediate threat to human health, necessitating an immediate removal action, was not identified. The RI revealed that the soil was contaminated with arsenic and primarily the pesticide DDT and its metabolites (DDE and DDD), chlordane, dieldrin, and heptachlor. These constituents were the primary contributors to risk, and, based on the presence of these constituents of concern, implementation of early action was evaluated by Fort Riley.

In addition to arsenic, the pesticides chlordane, 4,4'-DDT, heptachlor, and dieldrin in the soil were included as contaminants to be addressed in the EE/CA remedial alternatives evaluation. These compounds exceeded proposed RCRA Corrective Action Levels (CALs) (Federal Register, 1990), and were the primary contributors to carcinogenic risk. RCRA CALs were initially used as screening concentration levels to define the extent of contamination because calculation of risk-based RGs was under development.

The broad scope of the removal action was to prevent or minimize the actual or potential exposure of site receptors to hazardous contaminants at the PSF. Specific objectives of the removal action were identified in the EE/CA as follows:

- Minimize potential exposure to soils for site receptors
- Minimize potential for contamination migration through erosion and leaching
- Consistency with Final Remedy
- Attainment of ARARs to the extent practical

As was performed during the developing FS, the requirements of the environmental laws determined to be "applicable" or "relevant and appropriate" (ARARs) were identified. Based on the ARARs, general response actions were identified to categorize potential remedial actions for the PSF, considering the constituents of concern (arsenic, chlordane, 4,4-DDT, heptachlor and dieldrin). The general response actions included: (1) No-Action; (2) Institutional Controls; (3) Containment; (4) Treatment; and (5) Removal/Disposal. The various potential remedial technologies associated with the general response actions were identified and screened.

Based on the results of the technology screenings, six remedial action alternatives were developed and evaluated for their potential to achieve site remedial action objectives and the cleanup criteria.

Alternative 1 -	No Action
Alternative 2 -	Institutional Controls
Alternative 3 -	Institutional Controls/Grading
Alternative 4 -	Institutional Controls/Grading/Capping (Asphalt Cap)
Alternative 5 -	Institutional Controls/Grading/Capping (Asphalt/Concrete Cap)
Alternative 6 -	Removal and Disposal

The EE/CA completed in August 1993 resulted in Fort Riley recommending Alternative 5 as the preferred removal action. Upon completion of the EE/CA report by Fort Riley, the report was added to the Administrative Record for Fort Riley NPL sites. A 30-calendar-day public comment period was held from 17 August 1993 to 16 September 1993 in accordance with the Inter Agency Agreement (IAG) and the NCP. Fort Riley published a notice of the EE/CA report in local newspapers and scheduled a public meeting on 7 September 1993 to present the EE/CA report to the public and solicit comments. No members of the public attended the public meeting. Comments made on the EE/CA by the USEPA and KDHE resulted in further consideration of more cost-effective and permanent alternatives than Alternative 5. In the planning and development of the removal action activities, Fort Riley further evaluated cost estimates for off-site disposal alternatives.

1.7.3 Action Memorandum for Removal Action - December 1993

In December 1993, the Fort Riley DEH prepared an Action Memorandum for Removal Action at the PSF to document the Army's decision to take a removal action at the PSF (DEH, 1993b). The memorandum also served as a vehicle to obtain USEPA Region VII and KDHE concurrence with the selected removal action alternative. The removal action selected in the Action Memorandum consisted of the excavation of PSF site soils exceeding the following risk-based remediation goals (cleanup levels):

- Chlordane 0.17 mg/kg
- DDT 0.66 mg/kg
- Dieldrin 0.014 mg/kg
- Heptachlor 0.050 mg/kg
- Arsenic 0.12 mg/kg

These cleanup levels were based on the "Future Site Worker" surface soil exposure scenario as defined in the BLRA. These concentration levels were calculated using a target risk level of 1×10^{-6} for each constituent and this site worker scenario. Note that these cleanup criteria were later revised during the removal action as discussed in the next section.

During development of the Action Memorandum, contaminated soils at the PSF were determined not to be listed hazardous wastes as no records or knowledge of documented spills of pure products had been found. Excavated soils would have been classified as characteristic hazardous waste if they failed the Toxicity Characteristic Leaching Procedure (TCLP) tests (USEPA, 1993c). In the Action Memorandum, Fort Riley expressed their intent to dispose of the excavated soils at a RCRA Subtitle C permitted facility, if found to be hazardous wastes. Nonhazardous soils would be disposed in a RCRA Subtitle D permitted facility.

The Action Memorandum decision to excavate and dispose of contaminated soil, as opposed to the EE/CA recommendation to cap the PSF site, was based on comments received from USEPA Region VII and KDHE (USEPA, 1993b; KDHE, 1993). Unlike capping, excavation was seen as a permanent remedy which removed the source area (soil) and reduced the mobility, toxicity, and volume of contamination at the PSF. The USEPA had expressed a preference for a permanent, protective remedy for addressing site contaminants requiring no long-term maintenance at the PSF (USEPA, 1993c).

The removal action performed at the PSF site is briefly described in the following section.

1.7.4 Summary of Removal Action Activities

As explained in Section 1.7.3, the Action Memorandum documented the Army's decision to take a removal action at the PSF and was the vehicle by which Fort Riley obtained USEPA Region VII and KDHE concurrence with the removal action. Following this concurrence, Fort Riley utilized the USACE Omaha District "Rapid Response" contracting capabilities for execution of the removal action. A rapid response contractor was retained by the USACE to remove contaminated soils from the PSF site at Fort Riley, Kansas. Preliminary planning and discussions pertaining to the execution of the removal action took place in December 1993. The Final Work Plan for the removal action was issued January 28, 1994, and field work began in early February 1994.

In general, the tasks involved in the removal action were:

- Sampling, analytical testing, and site preparation prior to excavation
- Excavation of soil
- Confirmatory sampling and analysis and revised RGs
- Characterization, transportation, and disposal of excavated soil
- Site restoration

Details of these various activities and the consistency with the removal action objectives are summarized below.

1.7.4.1 Sampling and Analytical Testing Prior to Excavation - Initially, the areas to be excavated were defined based on studies performed during the RI activities (LAW, 1993a). The volume of soil to be removed from these areas was initially estimated at 850 cubic yards (1,100 tons), assuming a unit soil weight of approximately 96 pounds per cubic foot (OHM, 1994). During the Removal Action, the actual limits of excavation were further defined by a series of sampling, excavation, and confirmatory sampling events. During the removal action, the PSF site was sampled for pesticides (chlordane, DDT, dieldrin, and heptachlor) per USEPA Method 3050/8080 and for arsenic per USEPA Method 3050/6010. Samples were sent to an off-site laboratory for analysis. Details of the sampling and analysis plan and site sampling activities are provided in the "Draft Final Project Report for Rapid Response Removal of Contaminated Soils, Pesticide Storage Facility and Colyer Manor Sites, Fort Riley, Kansas" (OHM, 1994) (Rapid Response Report).

In an effort to evaluate background metal soil concentrations, a total of 22 background soil composite samples at various locations at Fort Riley on February 7 and 8, 1994. The samples were analyzed for arsenic, beryllium, thallium, nitrate, lead, and barium. Section 2.1 of this report summarizes the results of these background data samples.

1.7.4.2 Excavation of Soil - Excavation of soil was completed in phases with each phase followed by additional soil sampling. The soil sampling data were used to plan excavations for the subsequent phase to remove soil with concentrations above RGs.

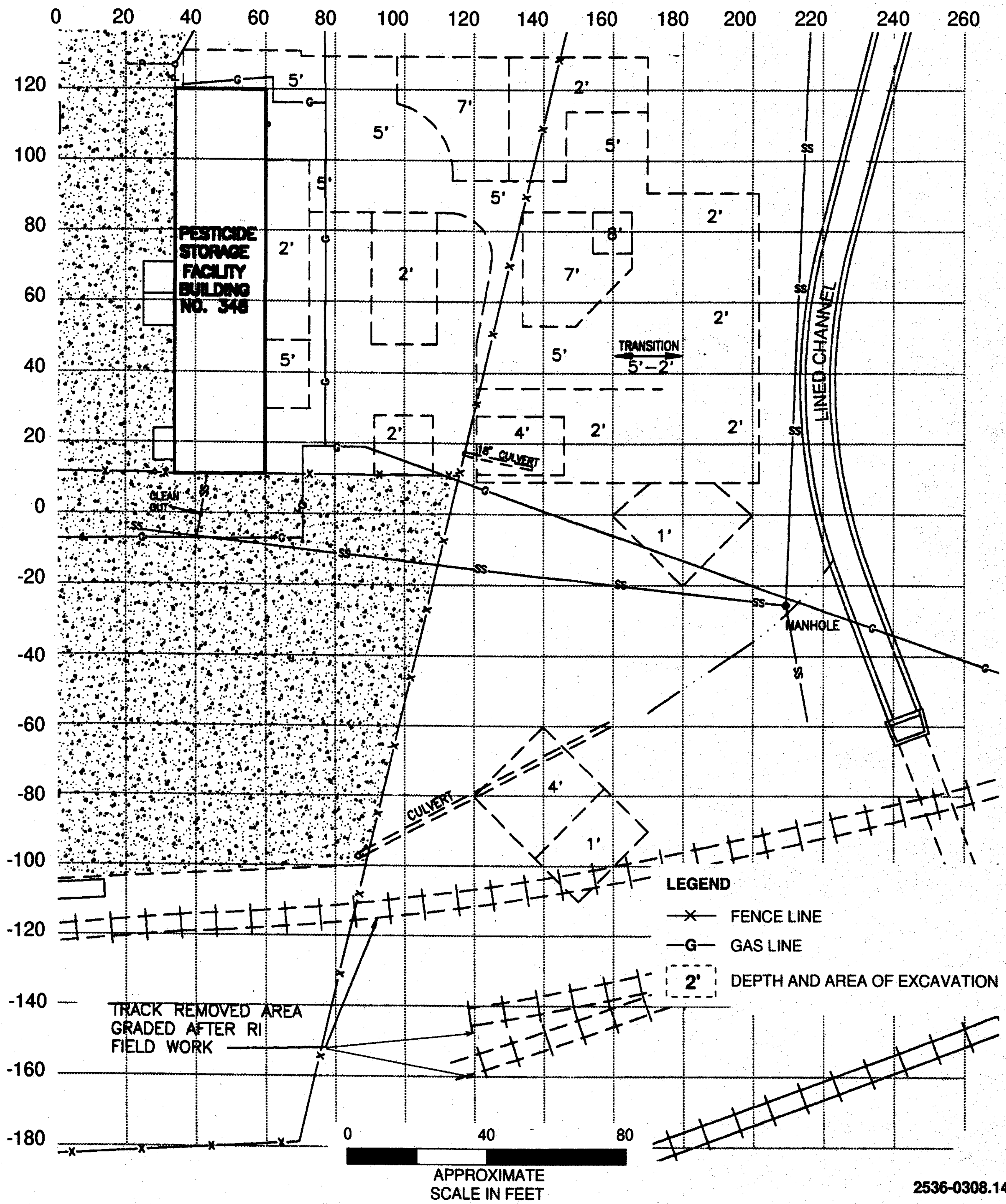
Based on the initial scope of work and on subsequent exploratory data that were generated, the contractor commenced excavation at the site on March 27, 1994. VOCs were not contaminants of concern at this site, and air monitoring was performed during initial excavation activities. Based on these results, monitoring requirements were downgraded for the work. The initial phase of excavation was completed on March 30, 1994. Based on the results of soil samples taken at the completion of initial excavation, Fort Riley initiated additional excavation at the site. Additional excavations commenced on May 17, 1994, and were completed on May 19, 1994. In order to remove contaminated soil to the established RGs but not excavate areas which were below levels of concern, the soils at the PSF were excavated to varying depths across the site. Figure 1-20 shows a plan view of the site and the depths to which different areas were excavated. Excavation primarily involved the area east of Building 348, out to approximately 20 feet west from the lined drainage ditch. An area was also excavated on the north side of the building from the building wall out directly north 10 feet. Section 3.1 provides additional descriptions of the site conditions following the removal action.

1.7.4.3 Confirmatory Sampling and Analysis and Revised RGs - The first round of sampling, begun February 4, 1994, was intended to define the limits of excavation and disposal characteristics. Additional sampling rounds were initiated on February 24, March 7, March 17, April 8, and May 19, 1994. The February sampling events were pre-excavation activities. In March, additional sampling was performed to further define the limits of excavation. After some excavation activities in late March, samples from within excavated areas were taken in April. Additionally, composite samples were taken along walls of the excavation, from parts of the floors of excavated areas, and from areas where limited excavation had occurred due to

FIGURE 1-20

FINAL REMOVAL ACTION EXCAVATIONS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



irregular and/or truncated dimensions. On May 19, the limits for final excavation were established based on a review of the analytical data from previous sampling events. Final sampling was conducted with the confirmatory samples being sent to an off-site laboratory for pesticide (USEPA Method 8080) analysis.

RGs for the removal action were initially calculated during development of the FS using the exposure scenarios presented in the BLRA of the Draft RI report for the future site worker. A 10^{-6} carcinogenic risk level was used in the calculation of RGs. Absorption factors utilized in the BLRA assumed a default of 100 percent dermal absorption of chemicals, meaning that 100 percent of a chemical exposure was absorbed into the skin. This 100 percent absorption rate was extremely conservative.

The RGs for the chemicals comprising most of the risk in the BLRA (i.e., chlordane, dieldrin, and DDT) were recalculated during the removal action based on revised absorption factors. A revised RG was not calculated for heptachlor because this chemical was not a "risk driver" in the BLRA. New absorption factors that represent the upper bound proportion of the pesticides that would be retained in the skin (ATSDR 1987-1993) were agreed upon for use by USEPA Region VII because they appeared to be supported by adequate data (LAW, 1994b). The revised RGs were also based on a carcinogenic target risk level of 10^{-6}, and are compared with the RGs presented in the Action Memorandum in Table 1-6.

Arsenic levels in RI background soil samples were from 1.2 to 2.4 mg/L, based on a single surface soil and two subsurface soil samples. These concentrations exceeded the previously calculated RG of 0.12 mg/kg, and showed that arsenic background levels should be considered to establish a revised RG for the removal action. A limited background sampling effort was performed during the removal action as discussed in Section 2.1 to collect background data for arsenic.

To confirm limits of excavation, the soil was analyzed for the constituents of concern and the concentrations were compared to the RGs established for the site. Surface RGs were utilized as the cleanup levels for both surface and subsurface soil. This approach is considered conservative because the potential for chronic exposure to surface soil is greater than that for subsurface soil. Confirmatory samples taken from the initially established excavations at the PSF site showed certain points remained above the action levels established in the action memorandum and revised during the removal action. Samples which exceeded the revised RGs and not excavated were, in general, at locations under asphalt adjacent to Building 348, areas adjacent to the building foundation where the excavation would have endangered the structural integrity of the building, or at sufficient depth that soils from this area would not be available for exposure considering surface soil exposure scenarios. Confirmation samples in these areas were not collected during the removal action. Details on the current site characterization, including an evaluation of soil remaining at the site, are provided in Section 3.

TABLE 1-6

COMPARISON OF REVISED REMEDIAL GOALS FOR SOILS USED FOR THE REMOVAL ACTION EXCAVATIONS WITH REMEDIAL GOALS FROM THE ACTION MEMORANDUM
Pesticide Storage Facility
Fort Riley, Kansas

CONSTITUENT	ACTION MEMORANDUM RGs		REVISED RGs	
	Absorption Factor	Remedial Goal (mg/kg)	Absorption Factor	Remedial Goal (mg/kg)
Chlordane	100%	0.17	10.9%	1.58
DDT	100%	0.66	37.8%	1.73
Dieldrin	100%	0.014	10.9%	0.127
Heptachlor	100%	0.050	100%	0.050
Arsenic	100%	0.12	NA	(1)

References for absorption factors per ATSDR, 1987-1993
NA Not applicable
(1) Remedial goal of background soil concentrations was established.

1.7.4.4 Characterization, Transportation, and Disposal of Excavated Soil - As stated in Section 1.7.3, contaminated soils were not considered listed hazardous wastes, but would be classified as characteristic hazardous waste if they failed the TCLP analysis. All soil removed from the site was characterized as nonhazardous because, based on the results of the sampling and analysis activities, the soil did not exhibit a characteristic of hazardous waste (OHM, 1994). The waste transportation and disposal included approximately 2,600 tons of nonhazardous, pesticide-contaminated soils from the PSF. The Rapid Response report includes transportation and disposal summary tables, photographs, and the manifests and waste profile packages for the PSF.

The pesticide-contaminated soils from the PSF were excavated and loaded for disposal on March 27 to March 30, 1994; April 7, 8, and 9, 1994; and May 17 and 18, 1994. Because several discrete samples showed elevated results for the pesticide, the USACE Omaha District decided to dispose of the soils by direct burial in a Subtitle C landfill. The soils were manifested and shipped using lined semi-trailer dump trucks supplied by Fort Transfer to Peoria Disposal Company's Landfill No. 1 in Peoria, Illinois. Drums of drill cuttings and related materials from the RI investigations at the PSF were delivered to the site by Fort Riley and were disposed of by inclusion with the soils. Illinois Hazardous Waste manifests were used for tracking the waste. These manifests and permit application laboratory analyses can be found in the Rapid Response report (OHM, 1994). No manifest discrepancies or exception reports were noted for this soil.

1.7.4.5 Site Restoration - At the completion of the final excavation, final samples were taken and the site was then immediately backfilled and graded to existing contours. The purpose of the final samples was to document site conditions upon completion of the removal action. The temporary fence was removed, and the permanent fence was reinstalled. With the permanent fence in place, the maintenance yard inside the fence was brought to final grade using stone from a local haul road (the haul road temporarily established for removal activities at the Colyer Manor Site, located in Camp Forsyth at Fort Riley).

The contractor mobilized on June 15, 1994, to remedy erosion problems created outside the permanent fence by heavy rains. Topsoil was placed in the area outside the fence, and the area was seeded, fertilized, and covered with fabric to protect the seed from erosion.

2.0 REVISED NATURE AND EXTENT OF SOIL CONTAMINATION FROM REMOVAL ACTION AND RI DATA

As discussed in Section 1.7, removal action activities were initially based on the nature and extent of soil contamination predicted in the RI report. Because a limited number of soil samples were collected during the RI, additional soil sampling for pesticides was performed during removal action planning activities to better define the soil concentrations and to establish the initial limits of the removal action excavation. The information collected from these activities was used in planning the initial excavations at the PSF. Once initial excavation was completed, additional samples were collected from within excavated areas to measure remaining constituent levels. Based on the results of these samples, additional excavation was performed in some areas. Final confirmatory sampling was then conducted. The additional information obtained from these removal action activities indicated that site conditions differed significantly from the interpretations presented previously in the RI report (LAW, 1993a). A limited background soil sampling effort was also conducted during the removal action to evaluate selected metals and nitrate background concentrations at Fort Riley.

Additional site information was also discovered after the RI was completed. This information identified two former trenches that were dug at the site, as discussed in Section 1.2.2. Grading activities were also carried out across the site over the years to maintain suitable topography and restore eroded areas. Also, surface soil grading was performed within the area of investigation in the summer of 1993 to extend the fenced area south of Building 348 in an area where railroad tracks were previously removed and to construct a gravel surface. Areas possibly impacted by the grading activities associated with this work were sampled for pesticides during the removal action.

This section presents the soil sampling results from the removal action activities, and revised interpretations of the nature and extent of soil contamination at the PSF that existed prior to the removal action. The interpretation is based on the sampling results obtained from both the RI and removal action.

2.1 RESULTS OF LIMITED BACKGROUND SOIL SAMPLING

A limited background sampling effort was completed during the removal action. Twenty-two soil samples were collected and analyzed for arsenic, barium, beryllium, lead, thallium, and nitrate (CEMRK, 1994).

These samples were collected from locations believed representative of three specific geologic and hydrogeologic regimes at Fort Riley. The three regimes were the river valley alluvium, the river valley terrace deposits and the upland areas (not affected by the current erosional processes of the river valley) which contribute sediments to the valley.

In the upland areas, five samples, were taken from the upper most soils (because surface soils are very near bedrock on these cliffs) and from the exposed shale units below but not into the terrace deposits. Five grab samples were taken in each location and composited into each analytical sample for analysis.

In the alluvium and terrace materials, samples were taken from each foot of the upper 5 feet in each location and composited into one sample. The upper 5 feet were selected as the target interval because most of the soil contamination found at the PSF site was encountered in this depth interval. A total of 11 samples from the valley alluvium were collected from three separate areas in an attempt to identify different background levels at Fort Riley. Alluvium samples were collected from areas representative of sedimentary deposits from the Republican River Valley, Smoky Hill River Valley and Kansas River Valley areas. Samples A1 through A4 were collected from the Republican River Sediments. Sample A6 was collected from the Smoky Hill River sediment. Sample A5, collected near the junction of the Smoky Hill and Republican Rivers, and samples A7 through A11 were collected to represent the sediments of the Kansas River Valley.

The six samples collected from the terrace deposits were taken at approximately the same terrace elevation as the PSF site. These samples were collected from various areas at Fort Riley believed to approximate the natural background levels in the local terrace deposits which may result from either river sediments or from erosion from the uplands.

Additional information pertaining to this limited background soil sampling effort can be found in Appendix H of the Removal Action Report (OHM, 1994). Analytical results are included in Appendix D.

During the RI field activities, arsenic, barium, and lead were detected in two soil samples, (MWSBO1A at depths of 15 to 17 feet, and MWSBO1B at depths of 21 to 25 feet), analyzed from the upgradient well PSF92-01 soil boring which were considered representative of background conditions. Table 2-1 presents a summary of the background concentration ranges from the RI and removal action. Section 3 provides comparisons between the ranges of background soil concentrations to the ranges detected in soils remaining at the PSF after removal action excavations.

2.2 REVISED NATURE AND EXTENT OF SOIL CONTAMINATION

This section considers the additional data from the removal action soil sampling activities in conjunction with previous RI data to develop a revised nature and extent of soil contamination.

TABLE 2-1

RANGES FOR BACKGROUND METALS
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER	BACKGROUND RANGE (mg/kg)	NUMBER OF BACKGROUND SAMPLES
Arsenic	1.2 - 7.1	25
Barium	31 - 200	25
Beryllium	<0.50-0.59	24
Chromium	6.7 - 9.3	3
Lead	4.3 - 46	25
Nitrate	<1.0 - 3.9	22
Thallium	<25	22

Sources: OHM, 1994 and LAW, 1993a

Samples collected during the removal action were generally obtained on a control grid system at 20-foot intervals. Soil samples were collected from multiple depths at several points along this grid system during the removal action activities. These samples and the RI site investigation soil samples were related to this common grid system by overlaying computer-generated drawing files. A survey conducted during the RI field work (LAW, 1993a) and the drawing files produced by the removal action contractor (OHM, 1994) were combined to relate the RI sampling locations to this control grid system established for the removal action using the Building 348 "footprint" as the common reference.

The PSF site soil samples collected during the removal action were analyzed for the pesticides chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, and heptachlor. The chlordane values were reported as the total of alpha- and gamma-chlordane analyses. DDT metabolites 4,4'-DDD and 4,4'-DDE were analyzed for but not reported separately in 33 of 129 removal action soil samples. Data are therefore presented as "DDT and metabolites" for mapping purposes, with the metabolite concentrations added together with the 4,4'-DDT concentrations. Arsenic in PSF soils was analyzed in two samples from location RA-39 at depths of 5 and 7 feet during the removal action, and PAHs were not analyzed in removal action soil samples.

Consistent with the previous BLRA in the RI report, surface soil is defined as soil less than 2 feet in depth, and subsurface soil is defined as soil at depths of 2 feet and greater. It should be noted that soil located under currently paved areas at depths less than 2 feet are considered subsurface because the paved surface is a barrier to direct contact with these soils. Surface and subsurface soils are evaluated separately in the following sections.

2.2.1 Surface Soil Evaluation

Table 2-2 presents analytical results for chlorinated pesticides obtained during the RI and removal action sampling activities for surface soil samples (depth less than 2 feet) collected at the site, the dates, and depths at which the samples were collected. RI samples were composited from soil collected at depths below the thickness of asphalt and/or gravel cover at the sampled locations as indicated in Table 2-2. Removal action samples were collected as grab samples at a discrete depth. Figure 2-1 shows the locations of these surface soil samples and also indicates the depths of the samples collected at each location. As indicated on this table and figure, three surface soil samples were collected during the RI, and 73 surface soil samples were collected during the removal action. Figures 2-2 through 2-4 summarize the pre-removal action distributions of chlordane, DDT and metabolites, and dieldrin in surface soil interpreted from the sampling results. Sample locations from Figure 2-1 are also shown on these figures. The distributions shown on Figures 2-2 through 2-4 were generally based on linear interpolations of the detected concentrations. Areas of contamination indicated are influenced by the relative locations of samples to each other. Additional maps showing the sampled locations and detected concentrations that were reviewed to generate these figures are included in Appendix D for information.

TABLE 2-2

SURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and Metabolites* (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-01	180	160	03/07/94	1	<0.017	0.222	<0.003	<0.003
RA-02	60	140	02/04/94	1	<0.05	0.220	<0.005	<0.005
RA-03	80	140	02/04/94	1	0.057	<0.05	<0.005	<0.005
RA-04	100	140	02/04/94	1	<0.05	<0.05	<0.005	<0.005
RA-05	120	140	02/04/94	1	<0.05	<0.05	<0.005	<0.005
RA-06	140	140	02/24/94	1	0.024	0.022	<0.002	<0.001
RA-07	160	140	03/07/94	1	0.158	0.170	<0.003	<0.003
RA-08	180	140	03/07/94	1	<0.017	<0.003	<0.003	<0.003
RA-09	200	140	03/07/94	1	<0.033	0.040	<0.003	<0.003
RA-10	40	120	02/04/94	1	0.720	0.150	1.40	0.026
RA-13	140	120	02/04/94	1	0.083	0.380	0.032	<0.005
RA-14	160	120	02/24/94	1	1.60	0.810	<0.020	<0.010
RA-15	180	120	03/07/94	1	0.033	0.429	<0.003	<0.003
RA-17	80	100	03/08/94	1	1.25	<0.033	<0.033	0.026
RA-20.5	160	100	02/04/94	1	0.083	0.006	<0.005	<0.005
RA-21	180	100	03/07/94	1	<0.033	0.028	<0.003	<0.003
RA-22	215	100	03/07/94	1	<0.033	<0.003	<0.003	<0.003
RA-24	80	80	02/04/94	1	<0.05	<0.05	<0.005	<0.005
RA-27	140	80	03/07/94	1	2.80	0.194	<0.003	0.011
RA-27.5	160	80	03/07/94	1	0.721	0.223	0.030	<0.003
RA-28	180	80	02/04/94	1	1.80	0.570	<0.005	<0.005
RA-28.5	200	80	02/24/94	1	0.034	0.011	0.007	0.001
RA-29	60	60	02/04/94	1	0.670	<0.050	<0.005	0.009
RA-30	80	60	03/30/94	1	<0.028	DDD 0.024 DDT 0.054 DDE 0.039	<0.003	<0.0009
RA-31	100	60	02/04/94	1	<0.050	<0.050	<0.005	<0.005
	100	60	03/30/94	1	3.50	DDD <0.003 DDT 1.71 DDE <0.009	0.407	0.031
RA-32	140	60	03/07/94	1	<0.330	2.63	<0.066	<0.066
RA-33	160	60	03/07/94	1	<0.831	1.26	<0.166	<0.166
RA-34	180	60	02/04/94	1	2.90	1.90	0.023	0.012
RA-34.5	200	60	02/04/94	1	0.200	0.150	<0.005	<0.005
RA-35	212	60	02/24/94	1	0.740	<0.120	<0.040	ND[1]
RA-37	80	40	03/30/94	1	0.034	DDE 0.046 DDD <0.002 DDT <0.003	<0.003	<0.0009

TABLE 2-2

SURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and Metabolites* (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-38	100	40	03/30/94	1	1.12	DDT 0.730 DDD <0.003 DDE <0.009	<0.003	0.009
RA-38.5	120	40	02/04/94	1	<0.050	<0.050	0.041	<0.005
RA-40	140	40	02/04/94	1	1.20	0.480	0.027	<0.005
RA-40.5	160	40	02/04/94	1	0.370	0.096	<0.005	<0.005
RA-41	180	40	02/24/94	1	1.50	0.400	0.030	<0.010
RA-41.5	200	40	02/24/94	1	0.300	0.064	0.014	0.010
RA-42	240	40	03/07/94	0	<0.033	0.012	<0.003	<0.003
RA-43	80	20	03/30/94	1	0.418	DDE 0.346 DDD 0.454 DDT 0.273	0.030	<0.009
RA-44	100	20	3/30/94	1	3.84	DDE 0.096 DDD 0.275 DDT 0.482	<0.003	0.017
RA-45	120	20	02/24/94	1	<0.020	0.013	0.015	<0.001
RA-46	140	20	02/24/94	1	1.50	0.790	0.038	<0.010
RA-47	160	20	02/24/94	1	0.250	0.062	0.015	<0.010
RA-48	180	20	02/24/94	1	1.50	0.240	0.032	<0.010
RA-49	215	20	03/07/94	1	<0.033	<0.003	<0.003	<0.003
RA-50	140	0	03/07/94	1	<0.017	0.026	<0.003	<0.003
RA-51	180	0	03/30/94	1	3.44	DDT 0.592 DDD 0.316 DDE 0.593	0.072	ND(1)
	180	0	03/07/94	0	<0.410	0.644	0.142	<0.082
RA-52	215	0	03/07/94	1	<0.033	0.044	0.009	<0.003
RA-53	240	0	03/07/94	0	<0.033	0.012	<0.003	<0.003
RA-54	210	-18	03/08/94	0	0.221	0.095	0.036	<0.003
RA-55	120	-20	03/30/94	0	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
			03/07/94	1	<0.083	0.218	0.026	<0.017
RA-56	156	-20	03/07/94	1	0.309	0.605	<0.003	<0.003
RA-57	200	-20	03/07/94	1	0.260	0.369	0.051	<0.004
RA-58	229	-20	03/07/94	1	<0.017	<0.003	<0.003	<0.003
RA-59	120	-60	03/30/94	0	<0.034	DDE 0.126 DDD 0.107 DDT 0.167	0.074	<0.001
	120	-60	03/08/94	1	0.358	0.434	0.121	<0.003

TABLE 2-2

SURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

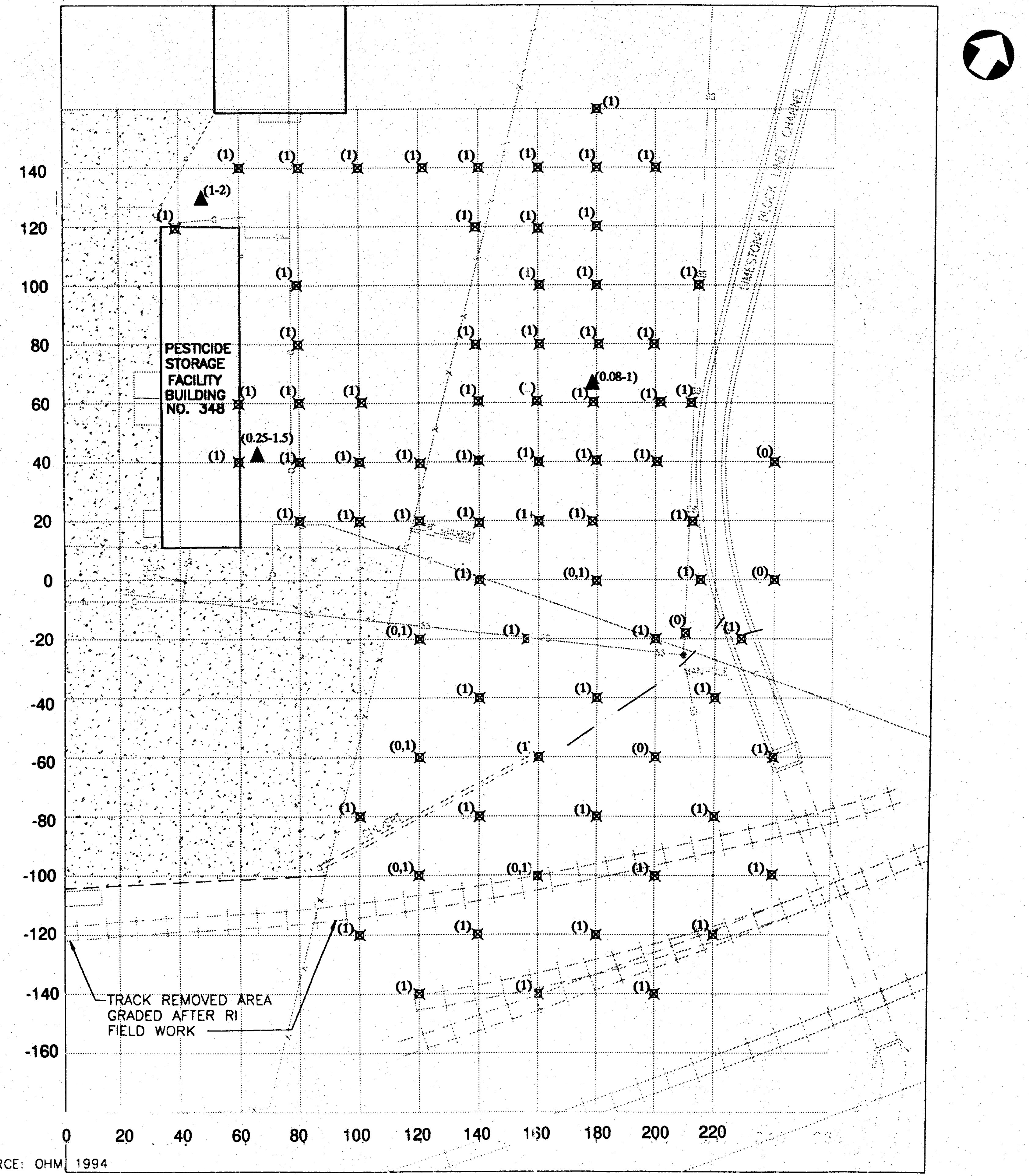
Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and Metabolites* (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-60	140	−40	03/07/94	1	<0.033	0.050	0.007	<0.007
RA-61	180	−40	03/07/94	1	<0.017	0.112	0.024	<0.003
RA-62	220	−40	03/07/94	1	0.072	0.288	0.022	<0.003
RA-63	60	40	02/04/94	1	<0.050	<0.050	<0.005	<0.005
RA-64	160	−60	03/08/94	1	0.140	<0.003	0.014	<0.003
RA-65	200	−60	05/19/94	0	0.021	DDE 0.847 DDD 0.335 DDT 1.29	0.158	<0.001
RA-66	240	−60	03/08/94	1	<0.033	0.172	0.017	<0.003
RA-67	100	−80	03/08/94	1	0.151	0.143	0.032	<0.003
RA-68	140	−80	03/08/94	1	0.218	0.047	0.013	<0.003
RA-69	180	−80	03/08/94	1	<0.033	0.091	0.017	<0.003
RA-70	220	−80	03/08/94	1	0.439	0.667	0.109	0.004
RA-71	120	−100	03/30/94	0	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.011
	120	−100	03/30/94	1	<0.034	DDT 0.378 DDE 0.188 DDD <0.003	0.082	<0.001
RA-72	160	−100	03/30/94	0	<0.034	DDT 1.21 DDD 0.659 DDE 0.852	0.238	<0.001
	160	−100	03/30/94	1	<0.034	DDE 0.232 DDD 0.071 DDT 0.213	0.064	<0.001
RA-73	200	−100	03/30/94	1	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-74	240	−100	03/30/94	1	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-75	100	−120	03/30/94	1	<0.034	DDD 0.164 DDE 0.111 DDT 0.327	0.054	<0.001
RA-76	140	−120	03/30/94	1	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001

TABLE 2–2

SURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and Metabolites* (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA–77	180	–120	03/30/94	1	<0.034	DDE 0.040 DDT 0.079 DDD <0.002	<0.004	<0.001
RA–78	220	–120	03/30/94	1	<0.034	DDE 0.061 DDT <0.002 DDD <0.003	<0.004	<0.001
RA–79	120	–140	03/30/94	1	<0.034	DDT 0.379 DDD 0.163 DDE 0.254	0.107	<0.001
RA–80	160	–140	03/30/94	1	<0.034	DDE 0.036 DDT 0.075 DDD <0.003	<0.004	<0.001
RA–81	200	–140	03/30/94	1	<0.034	DDE 0.203 DDT 0.175 DDD 0.100	<0.004	<0.001
SB–1	47.9	129.8	04/08/92	1–2	0.750	DDT 0.670 DDD <0.071 DDE 0.180	0.094	<0.035
SB–7	67.4	39.8	04/05/92	0.25–1.5	0.059	DDT 0.450 DDD <0.008 DDE 0.094	<0.008	<0.004
SB–17	178.7	66.5	04/06/92	0.08–1	1.300	DDT <0.074 DDD <0.074 DDE 1.80	<0.074	<0.037

RA – Prefix samples from Removal Action (OHM, 1994).
SB – Prefix samples from RI (LAW, 1993a).
ND – Not detected.
* DDT metabolites (DDD and DDE) only reported for select samples.
Results for metabolites presented if analyzed.
(1) Detection limit not reported by laboratory.



LEGEND:

▲ SURFACE SOIL SAMPLE LOCATION (1992 RI)

⊠ SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)

ASPHALT

RAILROAD

GAS LINES

FENCE

SANITARY SEWER

OVERHEAD POWERLINE

(0,1) DEPTHS SAMPLED (DEPTHS BELOW GROUND SURFACE)

0 40 80

SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

SURFACE SOIL LOCATIONS SAMPLED DURING THE RI AND REMOVAL ACTION

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	FILE DATE: 21.OCTOBER.94
CHECKED BY/DATE: EFW/5-95	2-1	PLOT DATE: 5-9-95
APPROVED BY/DATE: KAH/5-95		FILE NAME: fr01.DWG

FIGURE 2-2

PRE-REMOVAL ACTION DISTRIBUTION OF CHLORDANE IN SURFACE SOIL

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

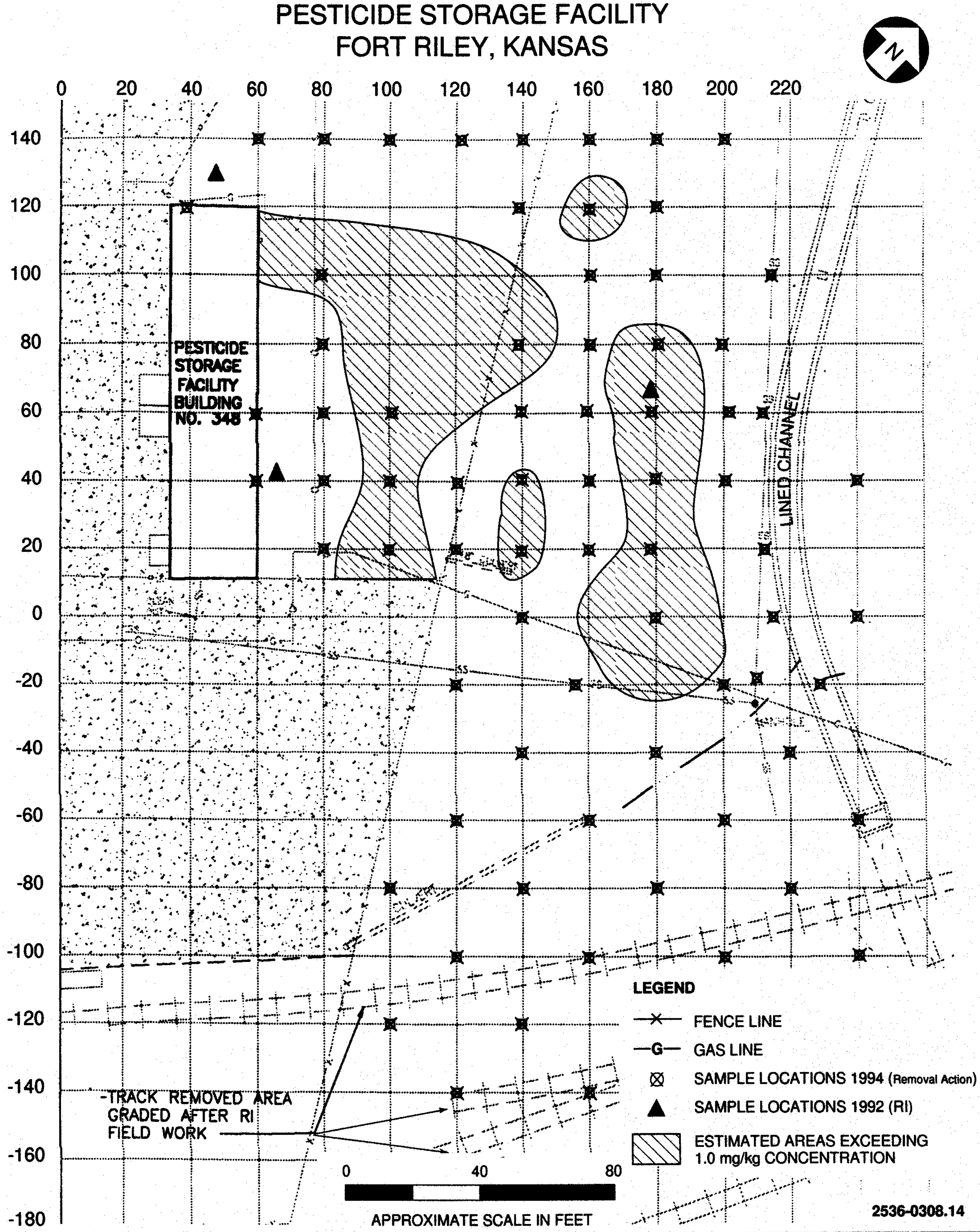


FIGURE 2-3

PRE-REMOVAL ACTION DISTRIBUTION OF DDT & METABOLITES IN SURFACE SOIL

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

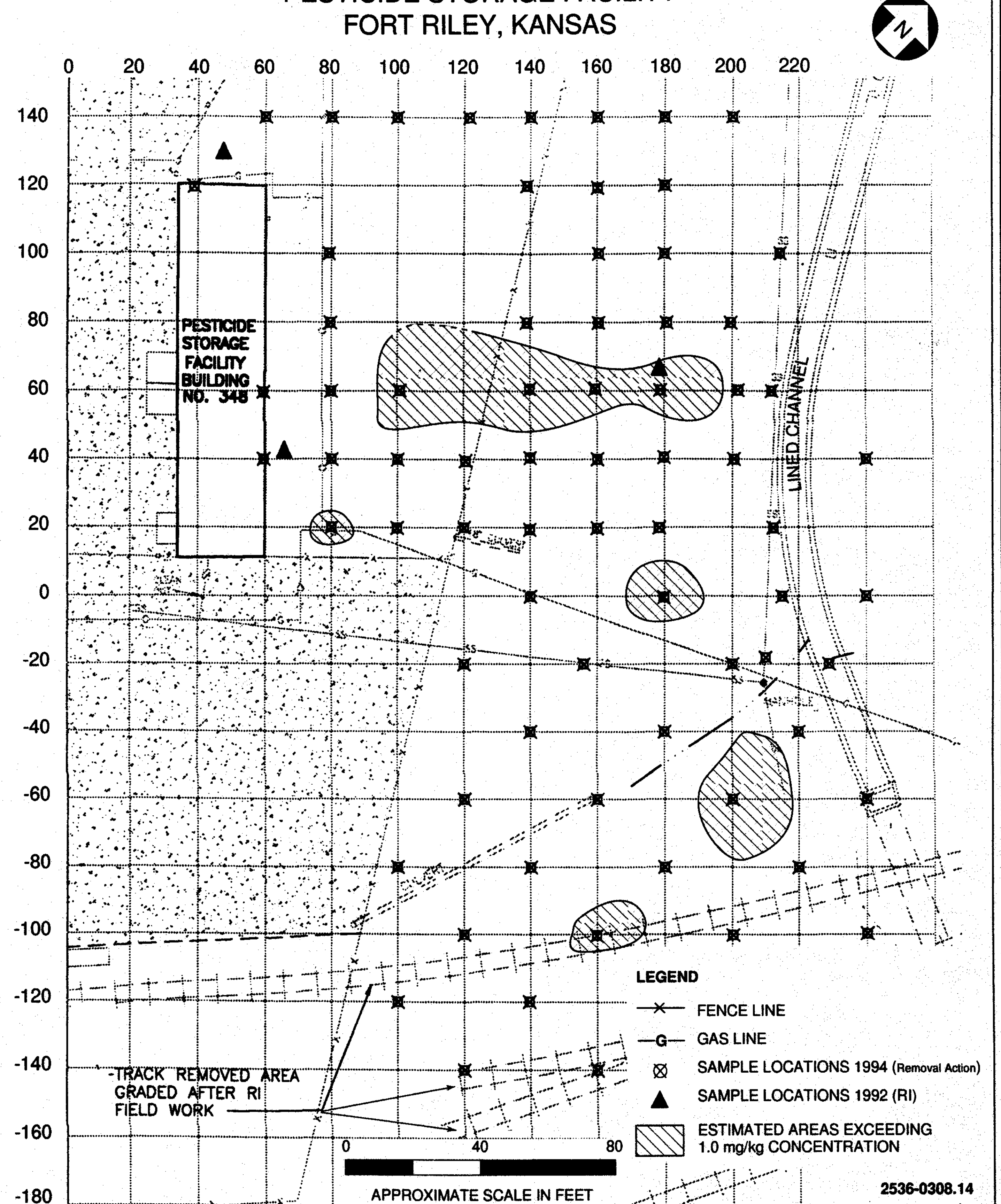
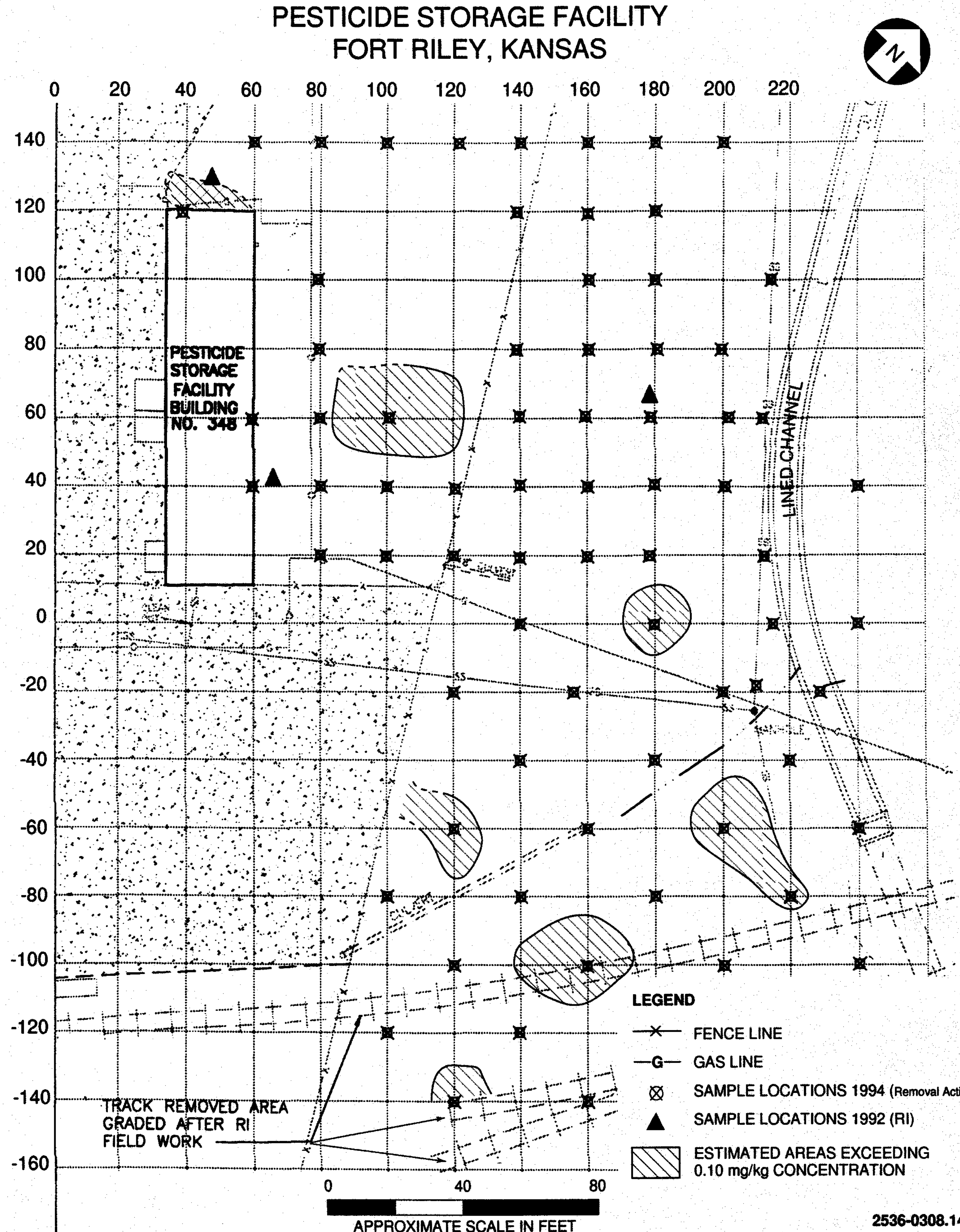


FIGURE 2-4

PRE-REMOVAL ACTION DISTRIBUTION OF DIELDRIN IN SURFACE SOIL

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



Chlordane

The revised removal action RG was 1.58 mg/kg for chlordane and seven samples exceeded this concentration. Areas of chlordane concentrations above 1.0 mg/kg are shown on Figure 2-2 which shows that four distinct areas of chlordane at concentrations exceeding 1.0 mg/kg were indicated from the sampling results. The maximum detected concentration of chlordane in surface soils was 3.84 mg/kg (sample RA-44) which occurred approximately 40 feet east of the southeast corner of Building 348 within the gravel area inside the fence. Chlordane was also detected at similar concentrations at sample RA-31 (3.50 mg/kg), about 40 feet north of sample RA-44 also in the gravel area inside the fence. These samples were collected within the largest area of contamination just east of Building 348. Samples collected at RA-28 (1.80 mg/kg), RA-34 (2.90 mg/kg), and RA-51 (3.44 mg/kg) defined the other large area of contamination located about 65 feet downgradient from the gravel area. Two small areas of contamination were also identified. The isolated area about 80 feet east of the southern end of Building 348 was defined by sample RA-40 (1.20 mg/kg) and RA-46 (1.50 mg/kg). The small area about 100 feet east of the northern end of Building 348 was defined by sample RA-14 at 1.60 mg/kg. RI and removal action sampling results indicated diffuse areas of contamination at low levels probably due to the erosion of contaminated soils during rainstorms and the mixing of soils during grading activities carried out over the years at the site. Concentrations were also likely reduced by degradation over time as discussed in the RI report, which showed that higher contaminant concentrations existed at the site prior to the RI sampling. At the northern, southern, and eastern boundaries of sampling, chlordane was only detected infrequently at low levels below 1.0 mg/kg. Sampling results from the soils in the area disturbed by the grading associated with extending the fenced area southward did not indicate contamination at levels above 1.0 mg/kg.

DDT and Metabolites

Areas of DDT and metabolites at concentrations exceeding 1.0 mg/kg are shown on Figure 2-3 which indicates five distinct areas of contamination. The revised removal action RG was 1.73 mg/kg and four samples exceeded this concentration level. The largest area shown east of the building was identified by samples RA-32 (2.63 mg/kg) and RA-34 (1.90 mg/kg). The isolated areas near the removed tracks were also identified by samples RA-65 (2.472 mg/kg) and RA-72 (2.721 mg/kg). Samples collected nearest to RA-65 and RA-72 did not exceed 1.0 mg/kg, and these areas were estimated using a linear interpolation of detected concentrations between the samples. This method resulted in estimated areas of contamination influenced by the relative locations of adjacent samples. Two small areas of contamination were identified upstream and downstream from a 12-inch culvert that existed east of the building. These were defined by sample RA-43 at 1.073 mg/kg nearest the building and RA-51 at 1.501 mg/kg further east and downstream. These three areas identified nearest Building 348 were likely the result of past erosion and deposition processes. The largest area also followed surface run-off patterns to the east. The historical source responsible for the two other areas nearest the railroad tracks is not apparent as surface run-off from around the building does not contact these areas. Site grading activities at the PSF and degradation processes are believed to have resulted in the low levels of DDT below 1.0 mg/kg observed in many samples at the site, indicating a diffuse area of contamination existed. These results also indicated that the soils in the area disturbed by the grading to extend the fenced area were not contaminated at levels above 1.0 mg/kg.

Dieldrin

The revised removal action RG was 0.127 mg/kg for dieldrin and four samples exceeded this concentration level. Figure 2-4 shows that the locations of previously contaminated surface soils above 0.10 mg/kg generally followed patterns similar to the DDT contamination discussed in the previous paragraph. An exception was that the highest detected concentration (1.40 mg/kg) was located at sample RA-10 near the northwest corner of Building 348. Limited samples were collected in this area which is near the existing asphalt paving; however, this sample appeared to represent an isolated area of contamination. Low levels of dieldrin were detected within the gravel area inside the fence and in areas outside the fence to the east and south of the PSF building. The area of contamination shown within the gravel area east of the building was based only from sample RA-31, at 0.407 mg/kg. The detections outside the fenced area (samples RA-51, RA-59, RA-65, RA-70, RA-72, RA-79) were primarily along or at the bottom of the hillside slope and in areas likely to have been impacted by erosion and deposition from surface run-off. Observed concentrations in these samples varied from 0.109 mg/kg (RA-70) to 0.238 mg/kg (RA-72) which were also likely the result from past grading activities at the PSF and degradation over time. These results indicated that the soils in the area disturbed by the grading to extend the fenced area were not contaminated at levels above 0.10 mg/kg.

Heptachlor

Heptachlor was detected infrequently in surface soils at levels at or below 0.031 mg/kg, which was below the removal action RG for this constituent (0.05 mg/kg). Because the heptachlor RG was not exceeded in surface soil samples collected during the removal action, heptachlor was not mapped.

2.2.2 Subsurface Soil Evaluation

Table 2-3 presents analytical results for chlorinated pesticides obtained during the RI and removal action sampling activities for subsurface soil samples (2-foot depths and greater) collected at the PSF site. As indicated in Table 2-2, 55 subsurface soil samples were collected during the RI and 129 subsurface soil samples were collected during the removal action. Figure 2-5 shows the locations of the subsurface samples and the various depths at these locations where soil samples were collected for analysis. Removal action samples were collected as discrete grab samples at specific depth, while the previous RI soil samples were collected by compositing soil from a 1-foot depth interval. Figures 2-6 through 2-9 summarize the extent of chlordane, DDT and metabolites, dieldrin, and heptachlor in subsurface soils. These maps also

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[1] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-01	180	160	03/08/94	3	<0.017	<0.003	<0.003	<0.003
RA-07	160	140	03/08/94	3	<0.017	<0.003	<0.003	<0.003
RA-08	180	140	03/08/94	3	<0.017	<0.003	<0.003	<0.003
RA-09	200	140	03/08/94	3	<0.016	<0.003	<0.003	<0.003
RA-10	40	120	02/04/94	5	<0.050	<0.050	<0.005	<0.005
RA-11	80	120	03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	80	120	03/30/94	7	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-12	100	120	03/30/94	5	0.563	DDT 0.447 DDD 0.149 DDE 0.130	<0.003	<0.0009
	100	120	03/30/94	7	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-12.5	120	120	03/30/94	5	0.280	DDT 0.280 DDD ND[1] DDE 0.050	ND[1]	ND[1]
	120	120	03/30/94	7	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-13	140	120	03/30/94	2	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	140	120	03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[1] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-14	160	120	03/30/94	2	<0.028	DDT 0.036 DDD 0.023 DDE 0.020	<0.003	<0.0009
	160	120	03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	160	120	04/08/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
	160	120	04/08/94	7	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-15	180	120	03/08/94	3	<0.017	<0.003	<0.003	<0.003
RA-16	60	100	04/08/94	2	2.67	DDT 0.509 DDD 0.218 DDE 0.132	0.020	0.129
RA-17	80	100	03/08/94	3	<0.017	<0.003	<0.003	<0.003
	80	100	03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	80	100	03/30/94	7	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-18	100	100	03/30/94	5	<0.05	<0.05	<0.005	<0.005
	100	100	03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	100	100	03/30/94	7	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-19	120	100	03/30/94	5	0.175	DDT 0.097 DDD <0.003 DDE 0.060	<0.003	<0.0009
	120	100	03/30/94	7	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[1] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-20	140	100	03/30/94	2	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	140	100	03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-20.5	160	100	03/30/94	2	5.67	DDT 0.970 DDD 0.304 DDE 0.389	<0.003	0.014
	160	100	03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-21	180	100	03/08/94	3	<0.016	<0.003	<0.003	<0.003
RA-22	215	100	03/07/94	3	<0.033	<0.003	<0.003	<0.003
RA-23	60	80	04/08/94	2	3.36	DDT 1.95 DDD 0.925 DDE 0.332	<0.004	<0.001
	60	80	02/04/94	5	<0.05	<0.05	<0.005	<0.005
RA-25	100	80	05/19/94	2	0.048	DDT 0.051 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-26	120	80	02/04/94	5	<0.05	<0.05	<0.005	<0.005
RA-27	140	80	03/08/94	3	<0.033	0.050	0.006	<0.003
	140	80	03/30/94	5	2.19	DDT 2.29 DDD 0.296 DDE 0.449	<0.003	<0.0009
	140	80	04/08/94	5	0.683	DDT 0.493 DDD 0.124 DDE 0.144	<0.004	0.003
	140	80	03/30/94	7	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	140	80	04/08/94	7	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[1] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-27.5	160	80	03/30/94	5	1.53	DDT 2.53 DDD 0.913 DDE 0.344	<0.003	0.004
	160	80	03/30/94	7	1.34	DDT 3.36 DDD 1.34 DDE 0.488	<0.003	0.005
	160	80	05/19/94	8	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-28	180	80	03/30/94	2	0.298	DDT 0.035 DDD 0.029 DDE 0.033	<0.003	<0.0009
	180	80	03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-29	60	60	04/08/94	2	5.35	DDT <0.002 DDD <0.003 DDE 0.034	<0.004	0.038
RA-30	80	60	03/30/94	3	0.049	DDT <0.002 DDD <0.003 DDE 0.018	<0.003	<0.0009
	80	60	03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-31	100	60	03/30/94	3	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	100	60	03/30/94	5	<0.028	DDT 0.186 DDD 0.017 DDE 0.041	<0.003	<0.0009
RA-32	140	60	03/08/94	3	2.32	0.225	<0.016	<0.016
	140	60	03/30/94	5	4.87	DDT 1.69 DDD 0.128 DDE 0.292	<0.003	<0.027
	140	60	04/08/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
	140	60	03/30/94	7	0.167	DDT 0.034 DDD <0.003 DDE 0.012	<0.003	<0.0009
	140	60	04/08/94	7	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[1] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-33	160	60	03/07/94	3	0.409	0.264	0.004	<0.003
	160	60	02/04/94	5	<0.050	<0.050	<0.005	<0.005
	160	60	03/30/94	5	0.272	DDT 0.105 DDD <0.0005 DDE 0.027	<0.0006	0.001
	160	60	03/30/94	7	ND[1]	ND[1]	ND[1]	ND[1]
RA-34	180	60	03/30/94	2	2.98	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	0.008
	180	60	03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-36	65	40	04/08/94	5	0.201	DDT 0.112 DDD 0.084 DDE 0.049	<0.004	<0.001
	65	40	04/08/94	5	0.042	DDT <0.002 DDD 0.019 DDE <0.011	<0.004	<0.001
	65	40	04/08/94	5	0.266	DDT 0.768 DDD 0.271 DDE 0.254	<0.004	<0.001
RA-37	80	40	03/30/94	3	<0.028	DDT 0.017 DDD 0.011 DDE 0.022	<0.003	<0.0009
	80	40	03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE 0.010	<0.003	<0.0009
RA-38	100	40	03/30/94	3	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	100	40	03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-39	130	40	03/30/94	5	<0.028	DDT <0.002 DDD 0.001 DDE <0.009	<0.003	<0.0009

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[(1)] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-40	140	40	03/30/94	2	4.09	DDT 0.829 DDD 0.531 DDE 1.00	<0.003	0.011
	140	40	03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	140	40	03/30/94	5	0.332	DDT 0.068 DDD 0.023 DDE 0.066	<0.003	<0.0009
	140	40	04/08/94	5	0.623	DDT 0.221 DDD 0.081 DDE <0.011	<0.004	<0.001
	140	40	04/08/94	7	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-40.5	160	40	03/30/94	2	3.51	DDT 0.959 DDD 0.570 DDE 1.16	<0.003	0.013
	160	40	03/30/94	4	0.826	DDT 0.077 DDD 0.034 DDE 0.013	<0.0032	<0.0009
RA-41	180	40	03/30/94	2	0.302	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	180	40	03/30/94	4	10.2	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-43	80	20	03/30/94	3	0.087	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	80	20	03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
RA-44	100	20	03/30/94	3	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
	100	20	03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[(1)] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-46	140	20	03/30/94	2	0.172	DDT 0.013 DDD 0.018 DDE 0.043	<0.003	<0.0009
	140	20	03/30/94	4	3.54	DDT 0.472 DDD 0.586 DDE 0.794	<0.003	0.008
	140	20	04/08/94	4	8.71	DDT 0.917 DDD 0.513 DDE <0.011	<0.004	<0.001
	140	20	05/19/94	4	0.059	DDT 0.016 DDD <0.003 DDE 0.036	<0.003	<0.0009
RA-47	160	20	03/30/94	2	5.89	DDT 0.715 DDD 0.365 DDE 0.666	<0.003	0.023
RA-48	180	20	03/30/94	2	0.325	DDT 0.039 DDD <0.003 DDE 0.043	<0.003	<0.0009
	180	20	03/07/94	3	<0.033	<0.003	<0.003	<0.003
	180	20	03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.009
RA-49	215	20	03/07/94	3	<0.033	<0.003	<0.003	<0.003
RA-50	140	0	03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-51	180	0	03/07/94	3	0.329	0.553	0.034	<0.003
	180	0	03/30/94	5	0.562	DDT 0.144 DDD <0.003 DDE 0.126	<0.004	<0.001
RA-52	215	0	03/07/94	3	<0.033	<0.003	<0.003	<0.003
RA-55	120	-20	03/08/94	3	<0.016	0.026	<0.003	<0.003
	120	-20	03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[1] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-56	156	-20	03/08/94	3	<0.033	0.143	0.007	<0.003
RA-57	200	-20	03/08/94	3	<0.033	0.012	<0.003	<0.003
RA-58	229	-20	03/08/94	4	<0.017	<0.003	<0.003	<0.003
RA-59	120	-60	03/08/94	3	0.140	<0.003	<0.003	<0.003
	120	-60	03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE 0.060	<0.004	<0.001
RA-60	140	-40	03/08/94	3	<0.017	<0.003	<0.003	<0.003
RA-61	180	-40	03/08/94	3	0.070	0.053	0.011	<0.003
RA-64	160	-60	03/08/94	3	<0.016	0.011	<0.003	<0.003
RA-67	100	-80	03/08/94	3	<0.017	<0.003	<0.003	<0.003
	100	-80	03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-68	140	-80	03/08/94	3	2.39	0.055	<0.003	<0.003
	140	-80	05/19/94	4	0.026	DDT 0.184 DDD 0.072 DDE 0.501	<0.003	<0.0009
	140	-80	03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-69	180	-80	03/08/94	3	0.080	0.109	0.022	<0.003
	180	-80	03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-70	220	-80	03/08/94	3	0.081	0.044	0.009	<0.003
RA-71	120	-100	03/30/94	3	<0.034	DDT 0.153 DDD 0.044 DDE 0.251	0.066	<0.001
	120	-100	03/30/94	5	<0.034	DDT 0.198 DDD 0.079 DDE 0.378	0.042	<0.001

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[(1)] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
RA-72	160	-100	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
	160	-100	03/30/94	5	<0.034	DDT 0.098 DDD <0.003 DDE 0.053	0.023	<0.001
RA-73	200	-100	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
	200	-100	03/30/94	5	<0.034	DDT 0.036 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-74	240	-100	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-75	100	-120	03/30/94	3	<0.034	DDT 0.154 DDD 0.051 DDE 0.076	<0.004	<0.001
RA-76	140	-120	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-77	180	-120	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-78	220	-120	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-79	120	-140	03/30/94	3	<0.034	DDT 0.070 DDD 0.044 DDE 0.089	<0.004	<0.001
RA-80	160	-140	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
RA-81	200	-140	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[1] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
SB-1	47.9	129.8	04/08/92	2.0-2.5	0.046	DDT 0.016 DDD <0.008 DDE <0.008	<0.008	<0.004
	47.9	129.8	04/08/92	4.0-4.5	0.166	DDT 0.087 DDD <0.008 DDE 0.024	0.027	<0.004
SB-2	26.8	111.9	04/07/92	0.5-1.5*	3.200	DDT 1.000 DDD <0.062 DDE 0.270	0.077	0.300
	26.8	111.9	04/07/92	2.0-2.5	0.420	DDT 0.042 DDD <0.039 DDE <0.039	<0.039	0.045
	26.8	111.9	04/07/92	4.0-4.5	0.320	DDT <0.370 DDD <0.370 DDE <0.370	<0.037	0.028
SB-3	69.7	117.6	04/05/92	2.0-2.5	0.210	DDT 7.70 DDD <0.390 DDE <0.390	<0.390	<0.200
	69.7	117.6	04/05/92	4.0-4.5	<0.180	DDT 4.50 DDD <0.370 DDE <0.370	<0.370	<0.180
	69.7	117.6	04/05/92	4.0-4.5	3.10	DDT 33.0 DDD <1.50 DDE <1.50	<1.50	<0.740
SB-4	24.8	19.1	04/07/92	2.0-2.5	0.181	DDT 0.140 DDD <0.016 DDE 0.031	<0.016	<0.008
	24.8	19.1	04/07/92	4.0-4.5	0.125	DDT 0.096 DDD <0.016 DDE 0.021	<0.016	<0.008
SB-5	71.4	109.5	04/05/92	2.0-2.5	1.580	DDT 0.850 DDD <0.039 DDE 0.110	0.200	0.230
	71.4	109.5	04/05/92	3.5-4.5	0.142	DDT 0.053 DDD <0.008 DDE 0.008	0.010	0.017
SB-6	89.3	55.9	04/07/92	2.0-2.5	<0.004	DDT <0.007 DDD <0.007 DDE <0.007	<0.007	<0.004
	89.3	55.9	04/07/92	4.0-4.5	0.008	DDT 0.014 DDD <0.007 DDE <0.007	<0.007	<0.004

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[1] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
SB-7	67.4	39.8	04/07/92	2.5-3.0	0.123	DDT 0.750 DDD <0.070 DDE 0.160	<0.070	<0.035
	67.4	39.8	04/07/92	4.0-4.5	0.194	DDT 2.800 DDD <0.150 DDE <0.240	<0.150	<0.077
SB-8	66.8	29.1	04/07/92	2.0-2.5	0.070	DDT 0.440 DDD <0.043 DDE 0.110	<0.043	<0.021
	66.8	29.1	04/07/92	4.0-4.5	0.012	DDT 0.150 DDD <0.008 DDE 0.020	<0.008	<0.004
SB-9	120.4	114.9	04/07/92	1.5-2.5	0.780	DDT 5.700 DDD <0.380 DDE 0.870	<0.380	<0.190
	120.4	114.9	04/07/92	4.0-4.5	0.410	DDT 2.600 DDD <0.370 DDE 0.420	<0.370	<0.190
SB-10	140.6	83.4	04/04/92	1.5-2.5	0.890	DDT <0.071 DDD 0.360 DDE 0.180	<0.071	<0.035
	140.6	83.4	04/04/92	3.5-4.5	0.122	DDT 0.057 DDD <0.009 DDE 0.036	<0.009	<0.004
	140.6	83.4	04/04/92	3.5-4.5	0.148	DDT 0.083 DDD 0.025 DDE 0.052	<0.016	<0.008
SB-11	118.4	105.6	04/07/92	2.0-2.5	0.122	DDT 0.032 DDD <0.008 DDE 0.026	<0.008	0.005
	118.4	105.6	04/07/92	4.0-4.5	0.430	DDT 0.150 DDD <0.067 DDE 0.110	<0.067	<0.034
SB-12	134.7	66.3	04/08/92	2.0-2.5	0.76	DDT 0.150 DDD 0.430 DDE 0.190	<0.039	<0.020
	134.7	66.3	04/08/92	4.0-4.5	1.700	DDT 0.100 DDD <0.069 DDE 0.170	<0.069	<0.034

TABLE 2–3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[1] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
SB–13	132.4	19.4	04/06/92	1.5–2.5	0.096	DDT 0.049 DDD 0.052 DDE <0.009	<0.009	<0.004
	132.4	19.4	04/06/92	1.5–2.5	0.340	DDT 0.190 DDD <0.042 DDE 0.150	<0.042	<0.021
	132.4	19.4	04/06/92	4.0–4.5	0.020	DDT 0.012 DDD <0.010 DDE <0.010	<0.010	<0.005
SB–14	150.9	13.9	04/04/92	2.0–2.5	0.135	DDT 0.130 DDD <0.009 DDE 0.053	<0.009	<0.005
	150.9	13.9	04/04/92	4.0–4.5	0.010	DDT 0.012 DDD <0.008 DDE <0.008	<0.008	<0.004
SB–15	184.8	86.1	04/04/92	2.0–2.5	0.009	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
	184.8	86.1	04/04/92	4.0–4.5	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
SB–16	200.9	95.6	04/04/92	1.5–2.5	0.138	DDT 0.310 DDD <0.037 DDE <0.037	<0.037	<0.019
	200.9	95.6	04/04/92	3.5–4.5	0.013	DDT 0.025 DDD <0.008 DDE <0.008	<0.008	<0.004
SB–17	178.7	66.5	04/06/92	1.5–2.5	0.560	DDT 0.610 DDD <0.041 DDE 0.370	<0.041	<0.020
	178.7	66.5	04/06/92	1.5–2.5	0.940	DDT 1.30 DDD 0.040 DDE 0.750	<0.040	<0.020
	178.7	66.5	04/06/92	4.0–4.5	0.016	DDT 0.025 DDD <0.007 DDE <0.007	<0.007	<0.004

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

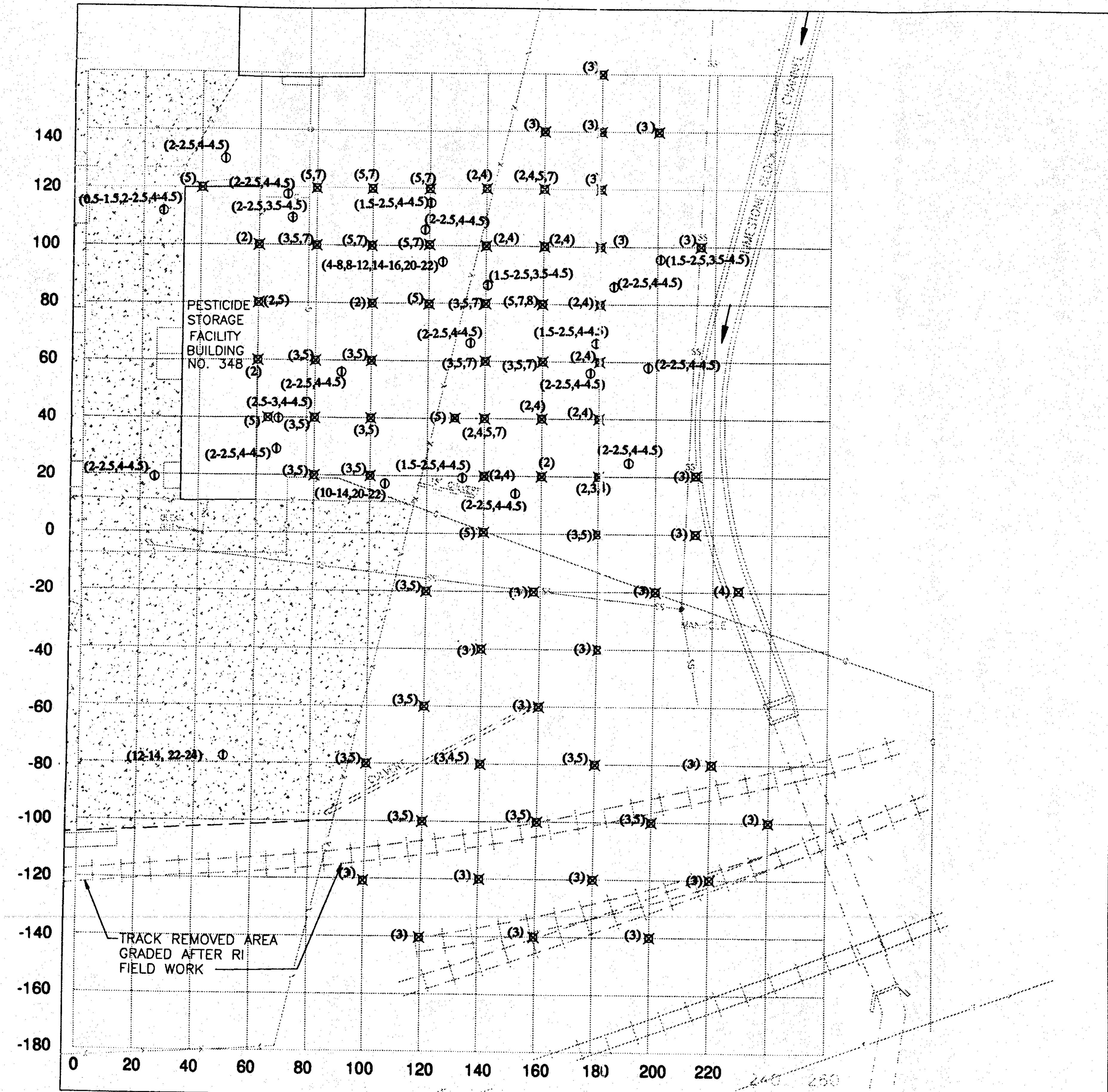
Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[(1)] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
SB-18	197.0	58.0	04/05/92	2.0-2.5	0.078	DDT 0.170 DDD <0.008 DDE 0.110	<0.008	<0.004
	197.0	58.0	04/05/92	4.0-4.5	0.036	DDT 0.082 DDD <0.008 DDE 0.022	<0.008	<0.004
SB-19	176.8	56.0	04/04/92	2.0-2.5	0.031	DDT 0.050 DDD <0.008 DDE 0.026	<0.008	<0.004
	176.8	56.0	04/04/92	4.0-4.5	0.025	DDT 0.036 DDD <0.008 DDE 0.022	<0.008	<0.004
SB-20	190.6	24.7	04/08/92	2.0-2.5	0.011	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
	190.6	24.7	04/08/92	4.0-4.5	0.026	DDT 0.025 DDD <0.008 DDE 0.011	<0.008	<0.004
PSF92-01	81.2	318.4	04/28/92	15-17	<0.004	DDT <0.007 DDD <0.007 DDE <0.007	<0.007	<0.004
	81.2	318.4	04/28/92	21-25	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
PSF92-02	124.1	94.7	05/05/92	4-8	<0.004	DDT <0.007 DDD <0.007 DDE <0.007	<0.007	<0.004
	124.1	94.7	05/05/92	8-12	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
	124.1	94.7	05/05/92	14-16	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
	124.1	94.7	05/05/92	20-22	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004

TABLE 2-3

SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

Sample Location I.D.	Coordinates X	Coordinates Y	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and[(1)] Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
PSF92-03	105.8	18.5	05/02/92	10-14	0.005	DDT <0.008 DDD <0.008 DDE <0.008	0.009	<0.004
	105.8	18.5	05/02/92	20-22	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
PSF92-04	49.8	-77.9	05/04/92	12-14	0.033	DDT <0.007 DDD <0.007 DDE 0.012	0.013	<0.004
	49.8	-77.9	05/04/92	22-24	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
PSF92-05	179.6	-233.4	04/29/92	9-11	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
	179.6	-233.4	04/29/92	17-19	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004

RA - Prefix samples from Removal Action (OHM, 1994)
SB and PSF92 - Prefix samples from RI (LAW, 1993a)
ND - Not detected
* Currently under asphalt, considered subsurface.
** DDT metabolites (DDD and DDE) only reported for select samples.
Results for metabolites presented if analyzed.
(1) Detection limit not reported by laboratory.



MAP SOURCE: OHM, 1994

LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE
- (3,5,7) DEPTHS SAMPLED **(DEPTHS BELOW GROUND SURFACE)**

0 40 80

SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

SUBSURFACE SOIL LOCATIONS SAMPLED DURING THE RI AND REMOVAL ACTION

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	2-5	PLOT DATE:	5-1-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	fr02.DWG

FIGURE 2-6

PRE-REMOVAL ACTION DISTRIBUTION OF CHLORDANE IN SUBSURFACE SOIL

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

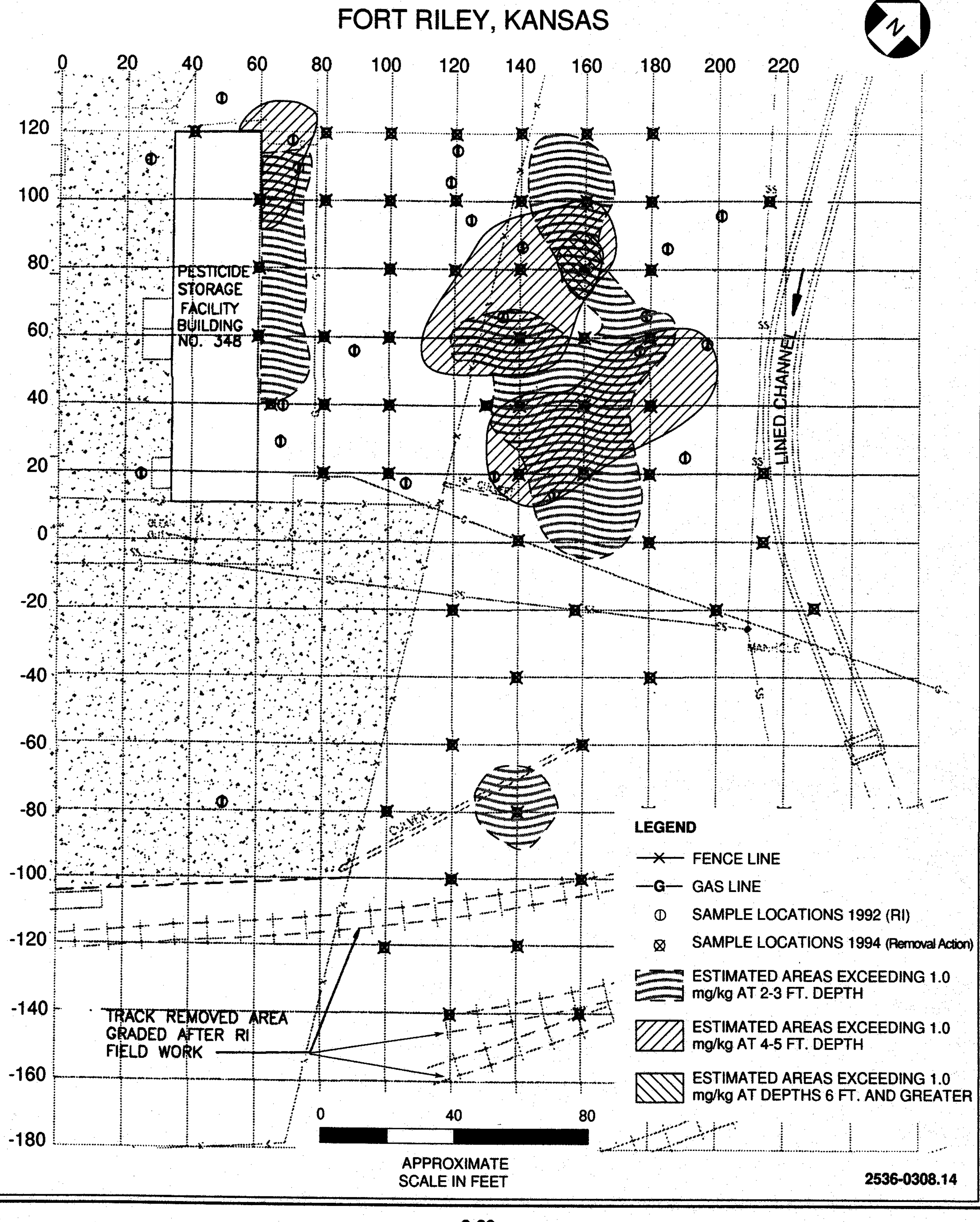


FIGURE 2-7

PRE-REMOVAL ACTION DISTRIBUTION OF DDT & METABOLITES IN SUBSURFACE SOIL

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

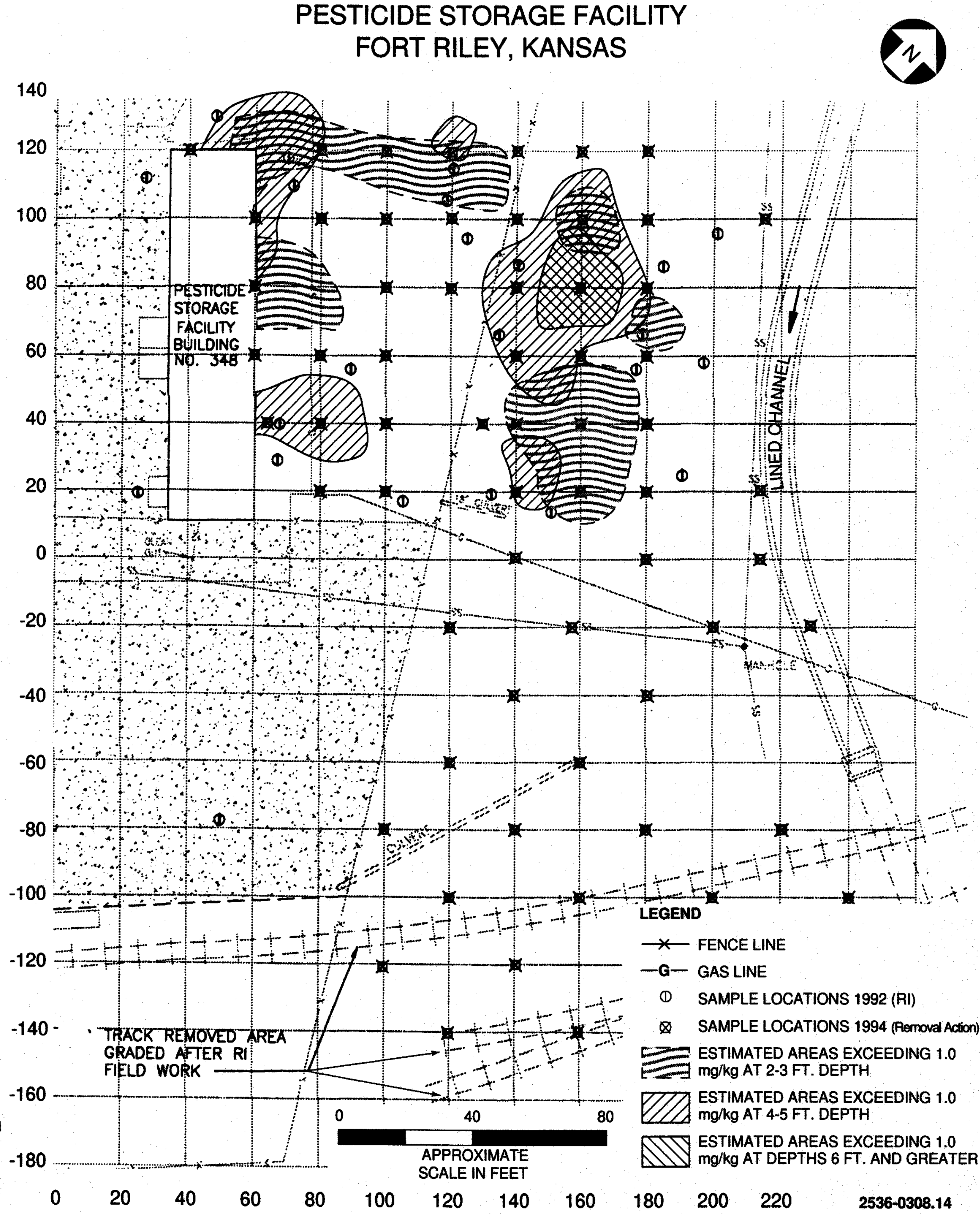


FIGURE 2-8

PRE-REMOVAL ACTION DISTRIBUTION OF DIELDRIN IN SUBSURFACE SOIL

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

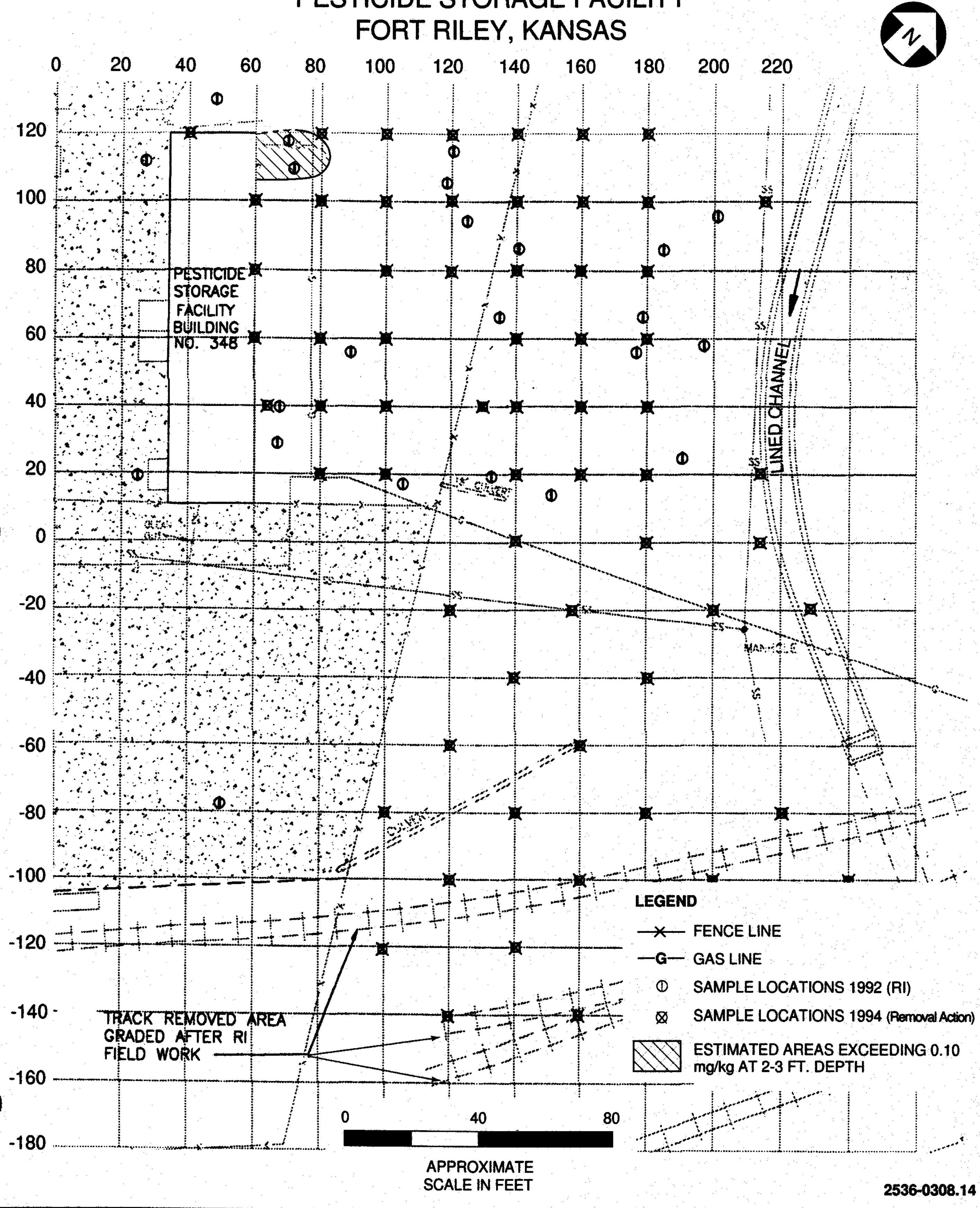
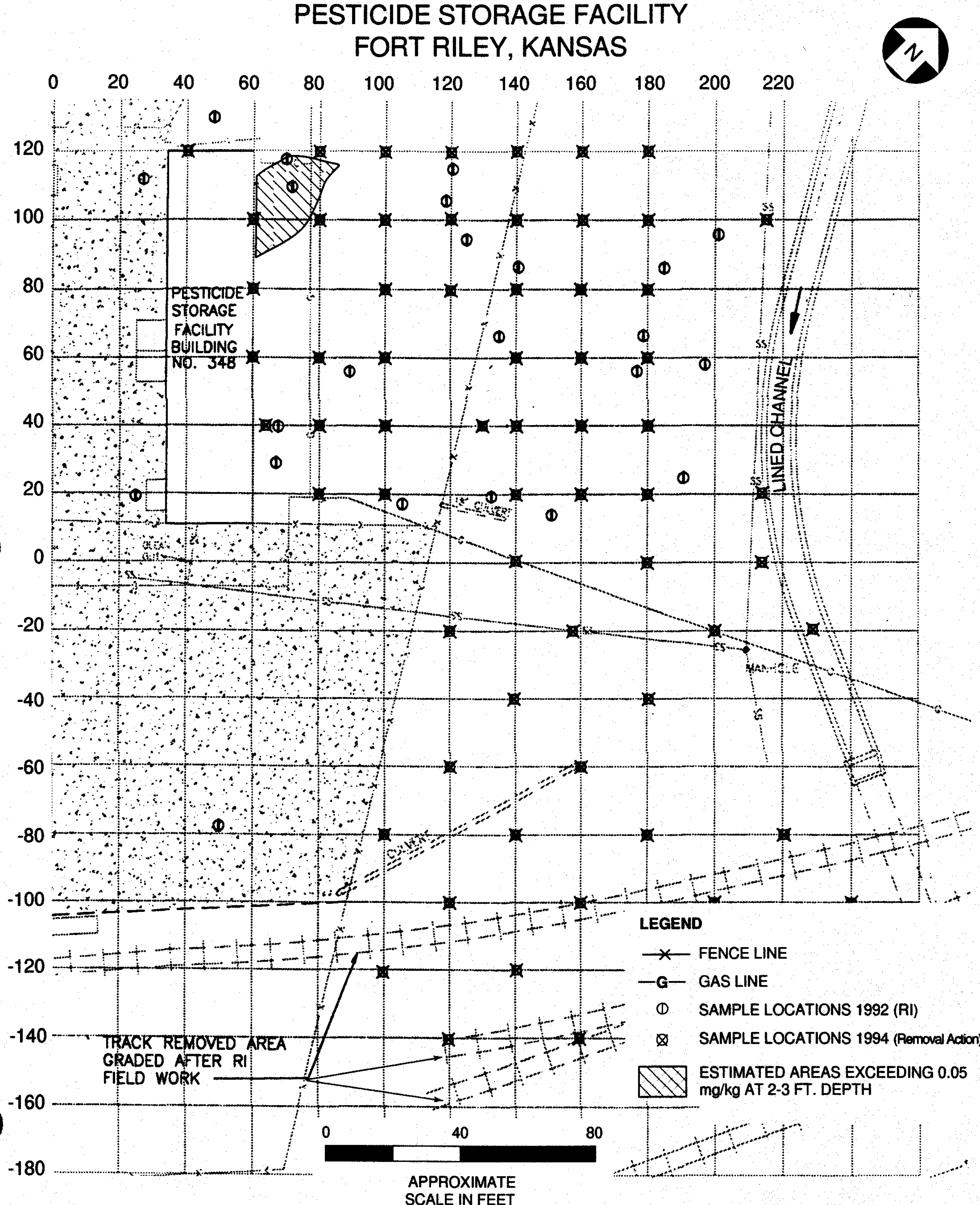


FIGURE 2-9

PRE-REMOVAL ACTION DISTRIBUTION OF HEPTACHLOR IN SUBSURFACE SOIL

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



2536-0308.14

show the sampled locations from Figure 2-5. Additional maps showing the sampled locations and detected concentrations that were reviewed to generate these figures are included in Appendix D. RI samples collected as composites from 1.5- to 2.5-foot depths were included with the removal action samples from the 2- and 3-foot depths. RI samples collected from a composite at the 3.5- to 4.5-foot depth were included with removal action samples from 4- to 5-foot depths for mapping. Although removal action samples were collected at discrete depths, the removal action and RI samples collected from within each 1-foot depth increment were combined for mapping purposes. This was done to provide more data at each depth increment mapped to limit the interpolations needed between data points and allowed contaminated areas to be identified in 1-foot depth increments consistent with removal action excavations.

Chlordane

As seen in Figure 2-6, areas of chlordane concentrations exceeded 1.0 mg/kg were identified at depths of 2 to 3 feet, 4 to 5 feet, and 6 to 7 feet. At the 2- to 3-foot depth, 10 samples exceeded the RG concentration (1.58 mg/kg). At depths of 4 to 5 feet, 6 samples, and at depths of 6 feet and greater no samples exceeded the RG. An area of chlordane contamination adjacent to the east side and extending around the northeast corner of Building 348 was defined by samples RA-29 at 5.35 mg/kg, RA-23 at 3.36 mg/kg, RA-16 at 2.67 mg/kg, and SB-5 at 1.58 mg/kg at the 2- to 3-foot depth. At the 4- to 5-foot depth, sample SB-3 at 3.10 mg/kg was the only sample collected along the building which exceeded the 1.0 mg/kg concentration. This sample was used to estimate the contaminated area extending around the northeast corner of the building. Contamination in this area is likely the result of previous operating practices as discussed in the RI Report (LAW, 1993a).

A prevalent second area of contamination approximately parallel to and about 30 feet east of the fence at the site, running about the length of Building 348 was defined by samples RA-20.5, SB-12, RA-32, RA-34, RA-40, RA-40.5, and RA-47, at the 2- to 3-foot depth. This area may identify the location of the former trenches excavated at the site which were discussed in Section 1.2.2. The maximum chlordane concentration detected at the 2- to 3-foot depth was 5.89 mg/kg, detected at RA-47. In this area east of the fence (samples RA-46 and RA-41), chlordane concentrations of 8.71 and 10.2 mg/kg, respectively, were detected at the 4- to 5-foot depth which exceeded the maximum concentrations detected at the 2- to 3-foot depth. Contamination in this area may have extended northward under the contaminated area identified by the samples at the 2- to 3-foot depth. These sampling results show that contaminant concentrations can vary and may increase with depth at the site. These conditions are the believed result of the site grading and trenching activities conducted over the years which had caused an irregular distribution of contaminated soils at the site. One of these trenches was reported to be approximately 4 feet deep, 6 feet wide and running the length of Building 348. The areal distribution and depths of detected contamination was similar to this historical information. Chlordane was detected once at a concentration exceeding 1.0 mg/kg at depths greater than 5 feet, at sample RA-27.5 (1.34 mg/kg) at a depth of 7 feet. Chlordane was not detected at the 8-foot depth in this location, which was within this trench area.

The third area of contamination at a depth of 3 feet south of the PSF working area (RA-68 at 2.39 mg/kg). This area is centered at grid coordinates 140 and -80, southeast of Building 348. Sediment deposits as the source of this contamination is not apparent as surface run-off from around the Building area drained eastward in an area farther north. Contamination may be related to site grading activities. Lower levels of contamination were also detected in the vicinity surrounding these three areas. Sampling data indicated that contamination was confined within the study area as chlordane was not detected in the most northern and southern samples at the site.

DDT and Metabolites

The revised removal action RG for DDT and metabolites was 1.73 mg/kg. Areas of DDT and metabolite concentrations exceeding 1.0 mg/kg are indicated in Figure 2-7. Exceedances above the RG concentration were as follows: at depths of 2 to 3 feet -7 samples; at depths of 4 to 5 feet -7 samples; at a depth of 7 feet -1 sample; and, at depths exceeding 8 feet no samples exceeded the RG. As seen in this figure contamination was also identified in the well-defined area approximately 30 feet east of the fence that may to be the location of the former trenches discussed previously. As with the chlordane contamination in the area identified near the northeast corner of Building 348, the maximum detected DDT concentration (33.0 mg/kg at SB-3) was higher at the 4- to 5-foot depth than at the 2- to 3-foot depth (7.70 mg/kg at SB-3). Two other areas of DDT contamination were also observed within the gravel area just east of Building 348, in similar locations as the chlordane contamination, being identified by samples RA-23 at 3.207 mg/kg at the 2- to 3-foot depth and SB-7 at 2.80 mg/kg at the 4- to 5-foot depth. At the 2- to 3-foot and 4- to 5-foot depths, lower levels of contamination (less than 1.0 mg/kg) were detected in the vicinity surrounding the area that may indicate the former trench, extending approximately 100 feet to the south and 30 feet to the north of these trenches.

DDT contamination was also detected above 1.0 mg/kg at a depth of 7 feet within the area that may have been former trenches. A single sample (RA-27.5) detected at 5.188 mg/kg indicated a localized area of contamination existed directly below the contamination detected at the 4- to 5-foot depth increment (3.79 mg/kg). These results indicated an increase in the contaminant concentration with increased soil depth in this area, further confirming the irregular pattern of contamination that existed at the PSF site. DDT was not detected at the 8-foot depth in this area or in the areas sampled east of Building 348 inside the fence during removal action sampling. Because DDT was not detected in samples at the 8-foot depth, soil samples were not obtained during the removal action at depths exceeding 8 feet. RI samples collected previously below this depth did not have DDT concentrations exceeding 1.0 mg/kg.

Dieldrin

Dieldrin concentrations detected in subsurface soils during the RI and removal action sampling events are presented in Figure 2-8. Figure 2-8 indicates a single area of contamination at the 2- to 3-foot depth, defined by sample SB-5 which exceeded the revised removal action RG of

0.127 mg/kg at 0.200 mg/kg. Sample SB-5 was collected as a composite sample from depths of 2 to 2.5 feet. Dieldrin was only detected in four samples at the 4- to 5-foot depth. The maximum detected concentration at the 4- to 5-foot depth range was 0.042 mg/kg, at RA-71. Dieldrin was detected in only two soil samples collected at depths exceeding 5 feet (0.009 mg/kg in PSF92-03 at 10 to 14 feet, and 0.013 mg/kg in PSF92-04 at 12 to 14 feet).

Heptachlor

As shown in Figure 2-9, an area of heptachlor contamination exceeding the revised removal action RG of 0.05 mg/kg was located near the northeast corner of Building 348. Three samples collected at depths of 2 to 3 feet exceeded the RG concentration. The maximum detected concentration in this area at the 2- to 2.5-foot depth was 0.230 mg/kg, detected in sample SB-5 which defined this area. Heptachlor was infrequently detected in other areas of the site, and these detections at concentrations below 0.05 mg/kg were within the former trench area discussed previously. The maximum site concentration of heptachlor was detected at 0.300 mg/kg in sample SB-2 under the existing pavement near the northwest corner of Building 348 and was therefore not mapped. At depths of 4 to 5 feet, heptachlor was only detected in six samples, and the maximum concentration detected was 0.028 mg/kg, at the SB-2 sample location near the northwest corner of Building 348. Heptachlor was detected in only one sample at depths exceeding 5 feet (0.005 mg/kg in sample RA-27.5 at 7 feet).

Arsenic was analyzed in 2 subsurface soil samples during the removal action (RA-39 at depths of 5 and 7 feet), and 26 soil samples during the RI. In subsurface soils, arsenic exceeded the Fort Riley background concentration range in samples at four locations in separate areas of the site (SB-10, SB-13, SB-02, and RA-39). Concentrations in only two samples were significantly above the background range, which were SB-10 (120 mg/kg) at a 3.5- to 4.5-foot depth, and SB-02 (20 mg/kg) at a 2- to 2.5-foot depth which is under existing pavement west of the PSF building. Therefore, arsenic concentrations were not mapped.

2.3 COMPARISON OF REMOVAL ACTION EXCAVATIONS WITH DISTRIBUTIONS OF PESTICIDES IN SOILS

A summary of the removal action activities was presented in Section 1.7.4. In this section, the distributions of contamination estimated from the RI data are compared with the revised projections using RI and removal action data. The removal action excavations are also compared with these revised distributions of contaminants.

The extent of surface soil contamination was not mapped in the RI Report (LAW, 1993a) because only three surface soil samples were collected, and a comparison cannot be made with the projections of surface soil contamination. Area estimates of pesticide contaminated subsurface soil were made in the RI Report, based on the limited data that were available.

Samples obtained during the RI would not be expected to characterize the contamination nearly as well as exploratory samples obtained when the soils were actually being excavated.

Figures 2-10 through 2-13 provide graphical comparisons of the subsurface distributions of chlordane, DDT and metabolites, dieldrin, and heptachlor from the RI Report with the revised projections using RI and removal action data. The comparisons are made considering depths at or below 2 feet. Individual comparisons at the various depth increments were not attempted, because the data have indicated that the contaminants in the soil are not evenly dispersed and varied greatly in concentrations between samples laterally and vertically. The contamination areas indicated on Figures 2-10 through 2-13 are intended to show general areas of contamination interpreted from the soil samples and not absolute limits of contamination above the stated concentrations. The areas shown were linearly interpolated from the sample results. Interpolations from the samples are influenced significantly by the relative locations of samples to each other.

As seen on Figures 2-10 and 2-11, additional areas of chlordane and DDT and metabolites above 1.0 mg/kg were identified from the additional data collected during the removal action. In Figure 2-10 the chlordane distribution near the northeast corner of the building was predicted in the RI based on the limited sample spacing in this area. Removal action samples were collected frequently in this area on the established 20-foot grid and a better definition of the contamination resulted in a reduced areal distribution. Similarly, in other areas, the distributions of DDT and metabolites near Building 348 were better defined from removal action data, and resulted in expanded areas being identified. Areas east of the fence were also defined by the removal action data for chlordane and DDT and metabolites which were not predicted in the RI. Dieldrin and heptachlor were both detected in an area east of and near the northeast corner of Building 348. Dieldrin was only detected during the RI at a concentration exceeding 0.10 mg/kg and was not detected in any removal action soil samples above this concentration. The areas of dieldrin and heptachlor contamination predicted in the RI Report were generally confirmed during the removal action. As seen on Figures 2-12 and 2-13, these areas were further defined by the additional samples. During the removal action excavations, a sanitary sewer lateral was discovered in an area approximately 30 feet south of the northeast corner of Building 348, being about 20 feet east of the building. The depth of this line in the vicinity of the building was 3 to 4 feet. Pesticide-contaminated soils at levels of concern were not detected at a depth exceeding 4 feet in the vicinity of this sewer, and the sewer was not identified as a historical source of contaminants.

Estimated distributions of pesticides in surface soils and subsurface soils at depths below 2 feet exceeding the removal action RGs are compared with the removal action excavation in Figures 2-14 and 2-15, respectively. The area centered at RA-65 (grid location 200, -60) was defined by a single surface soil sample with DDT and metabolites detected at 2.472 mg/L and dieldrin at 0.158 mg/kg. The area shown was influenced by the relative positions of the adjacent samples which had detected concentrations less than the removal action RGs. Contaminant distributions presented on Figure 2-15 were developed by compositing the subsurface

FIGURE 2-10

ESTIMATED SUBSURFACE SOIL CHLORDANE DISTRIBUTIONS FROM RI VERSUS RI AND REMOVAL ACTION DATA

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

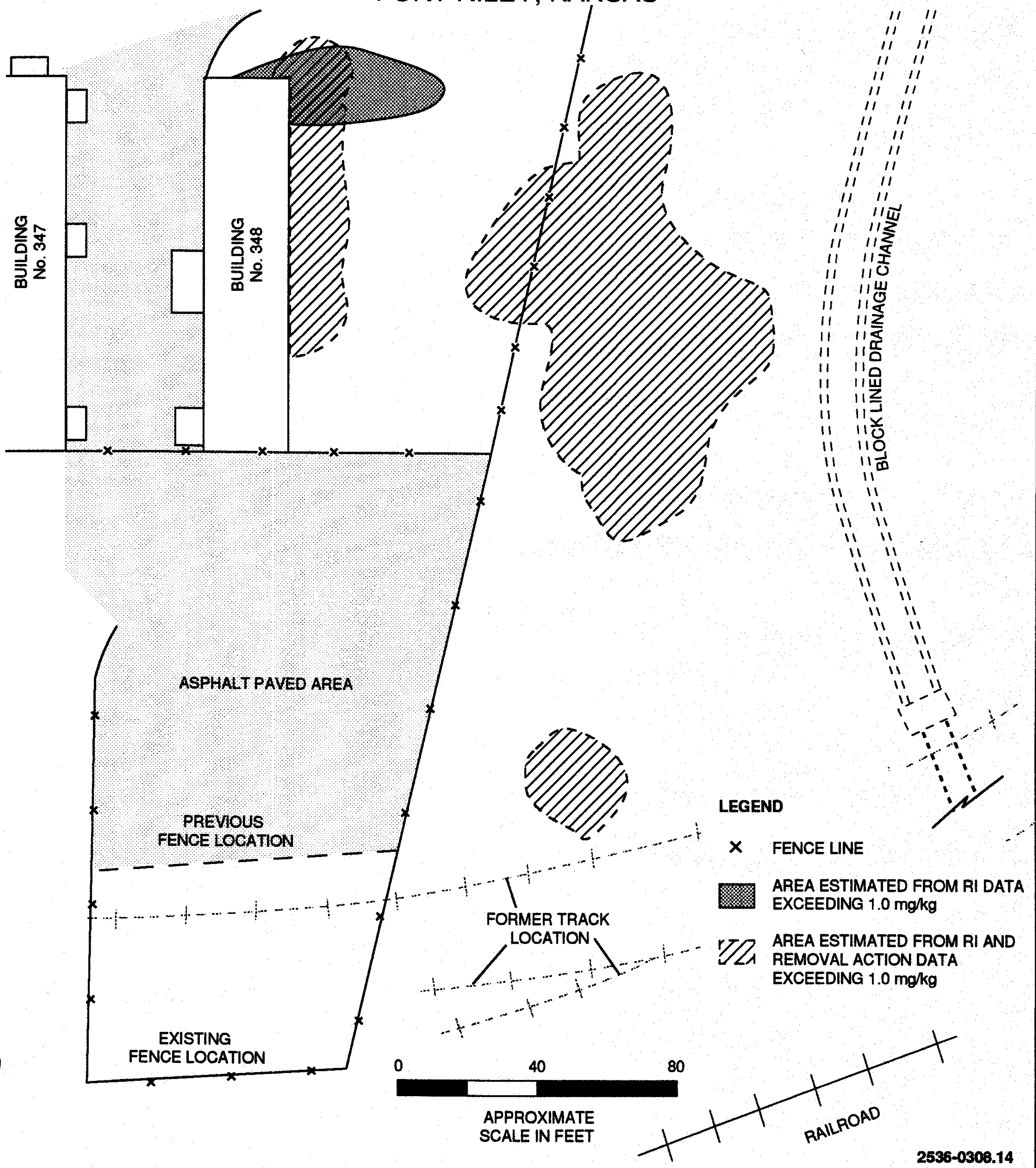


FIGURE 2-11

ESTIMATED SUBSURFACE SOIL DDT & METABOLITES DISTRIBUTIONS FROM RI VERSUS RI AND REMOVAL ACTION DATA

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

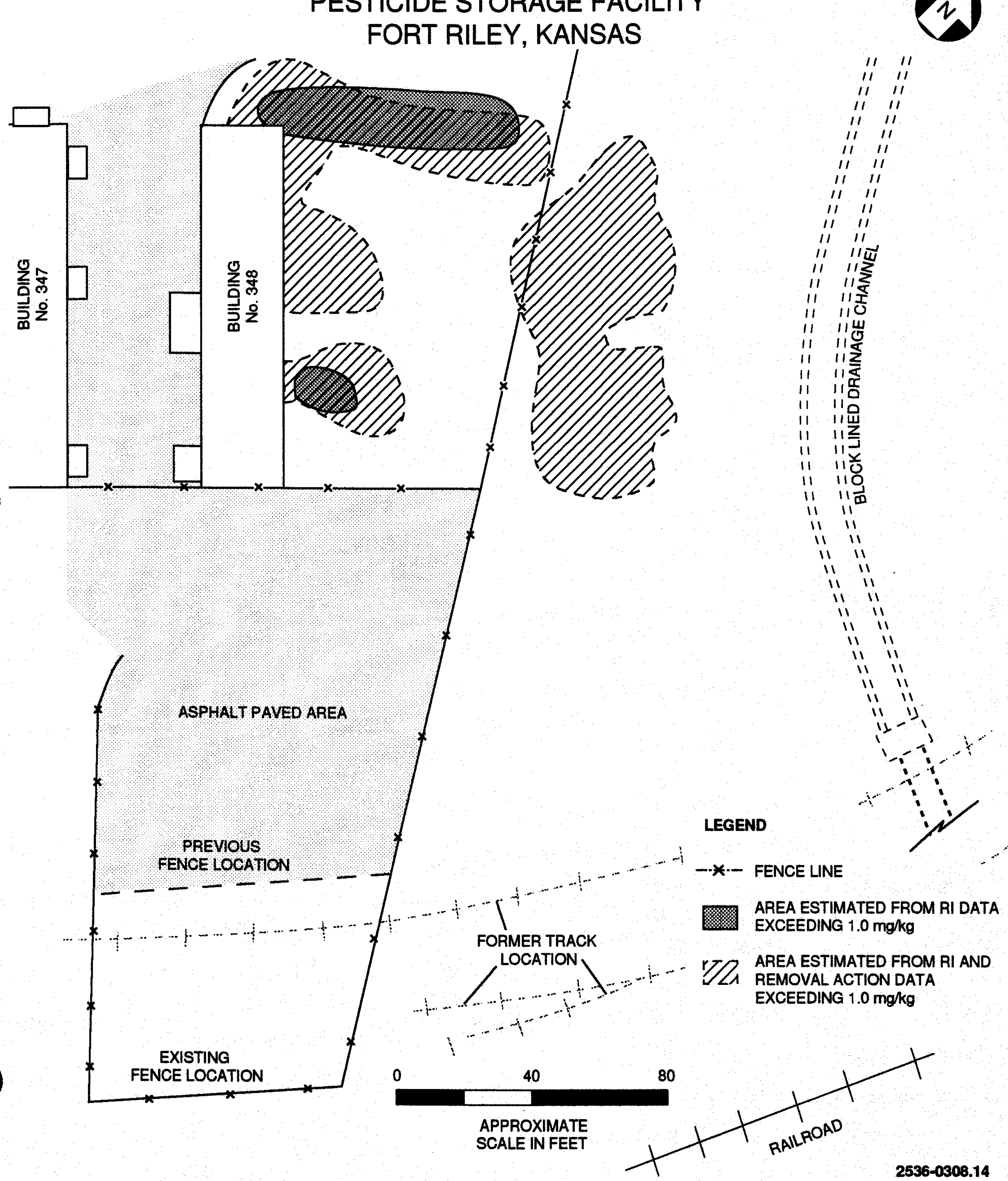


FIGURE 2-12

ESTIMATED SUBSURFACE SOIL DIELDRIN DISTRIBUTIONS FROM RI DATA VERSUS RI AND REMOVAL ACTION DATA

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

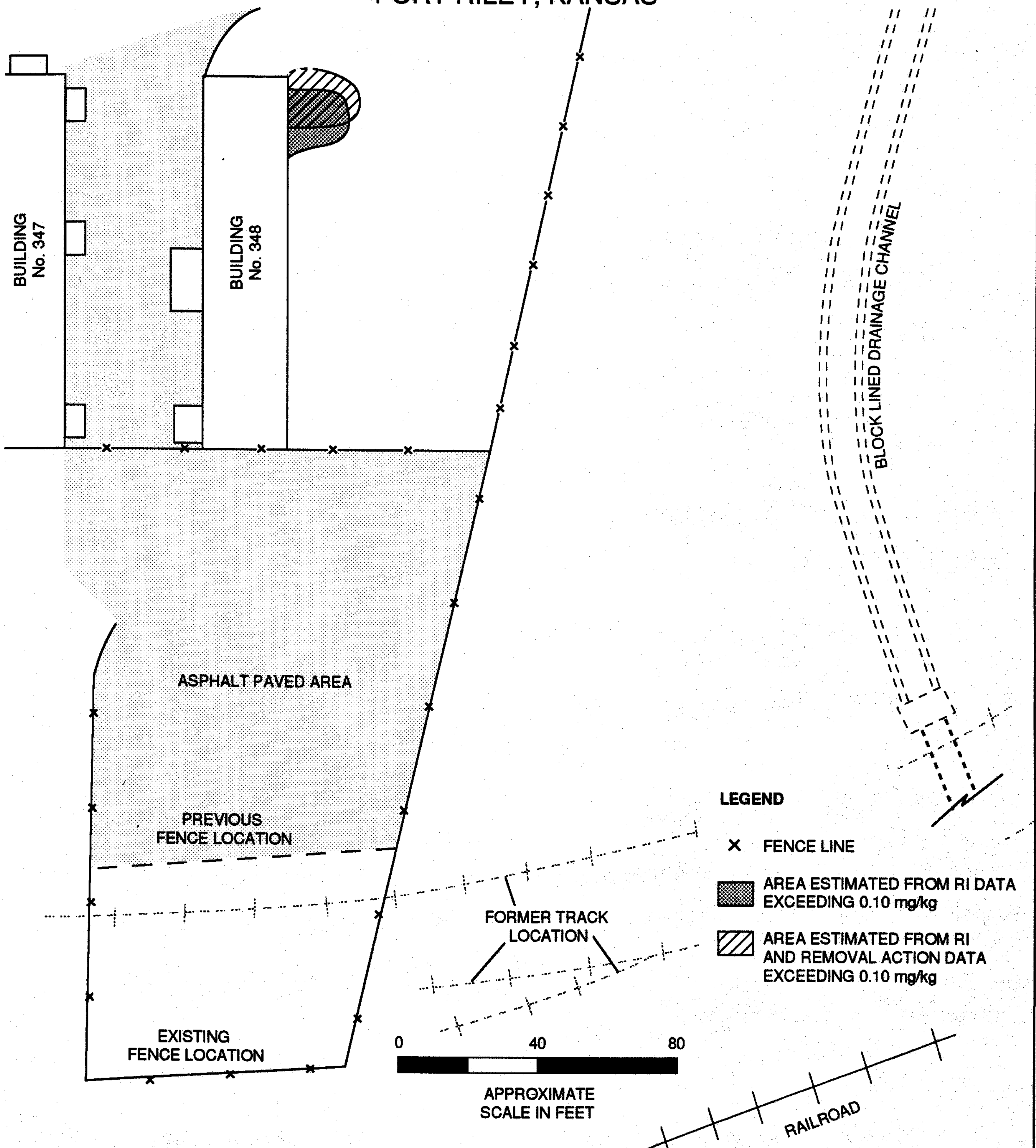


FIGURE 2-13

ESTIMATED SUBSURFACE SOIL HEPTACHLOR DISTRIBUTIONS FROM RI VERSUS RI AND REMOVAL ACTION DATA

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

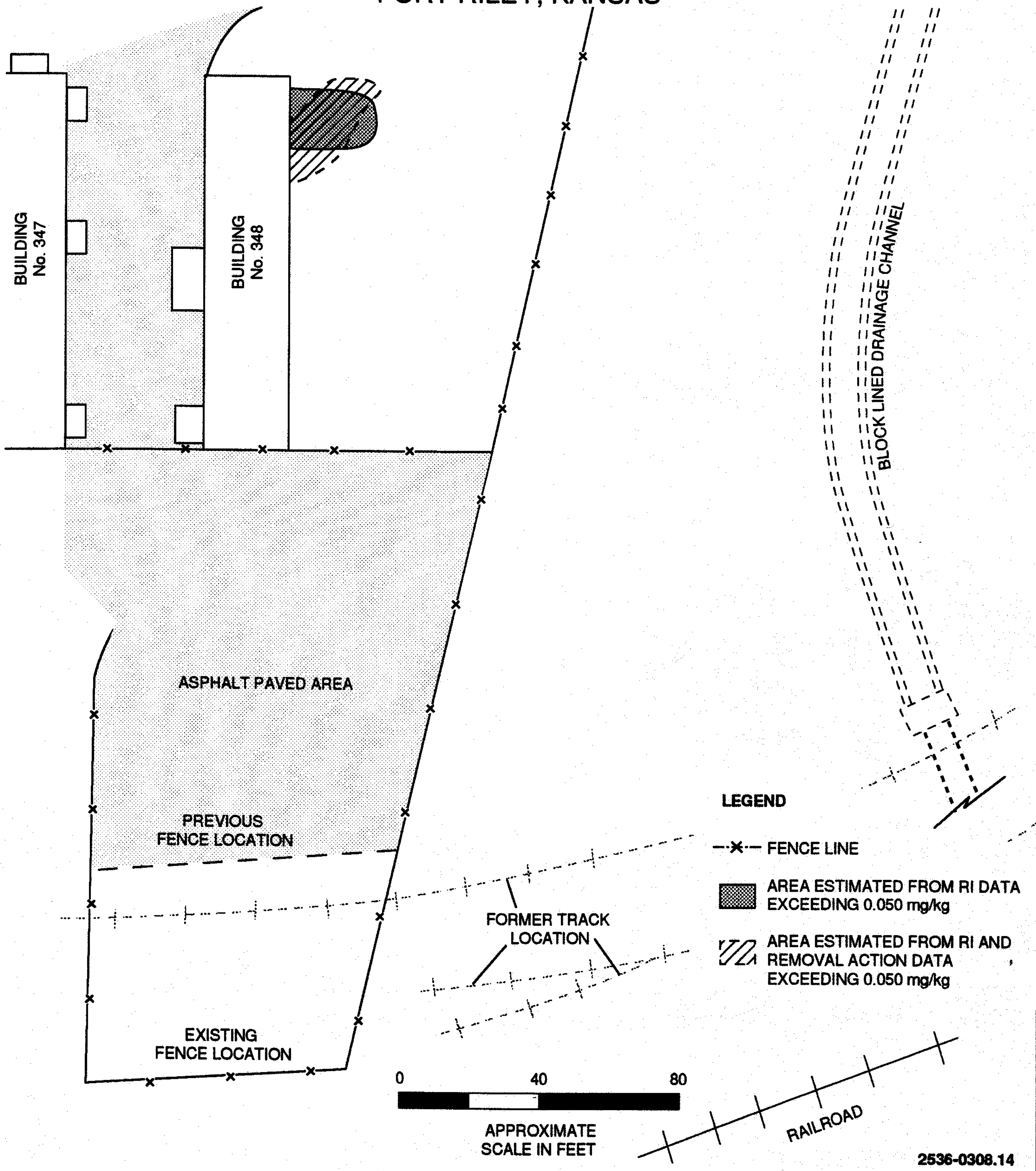


FIGURE 2-14

REMOVAL ACTION EXCAVATIONS COMPARED WITH SURFACE SOIL DISTRIBUTION OF PESTICIDES

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS

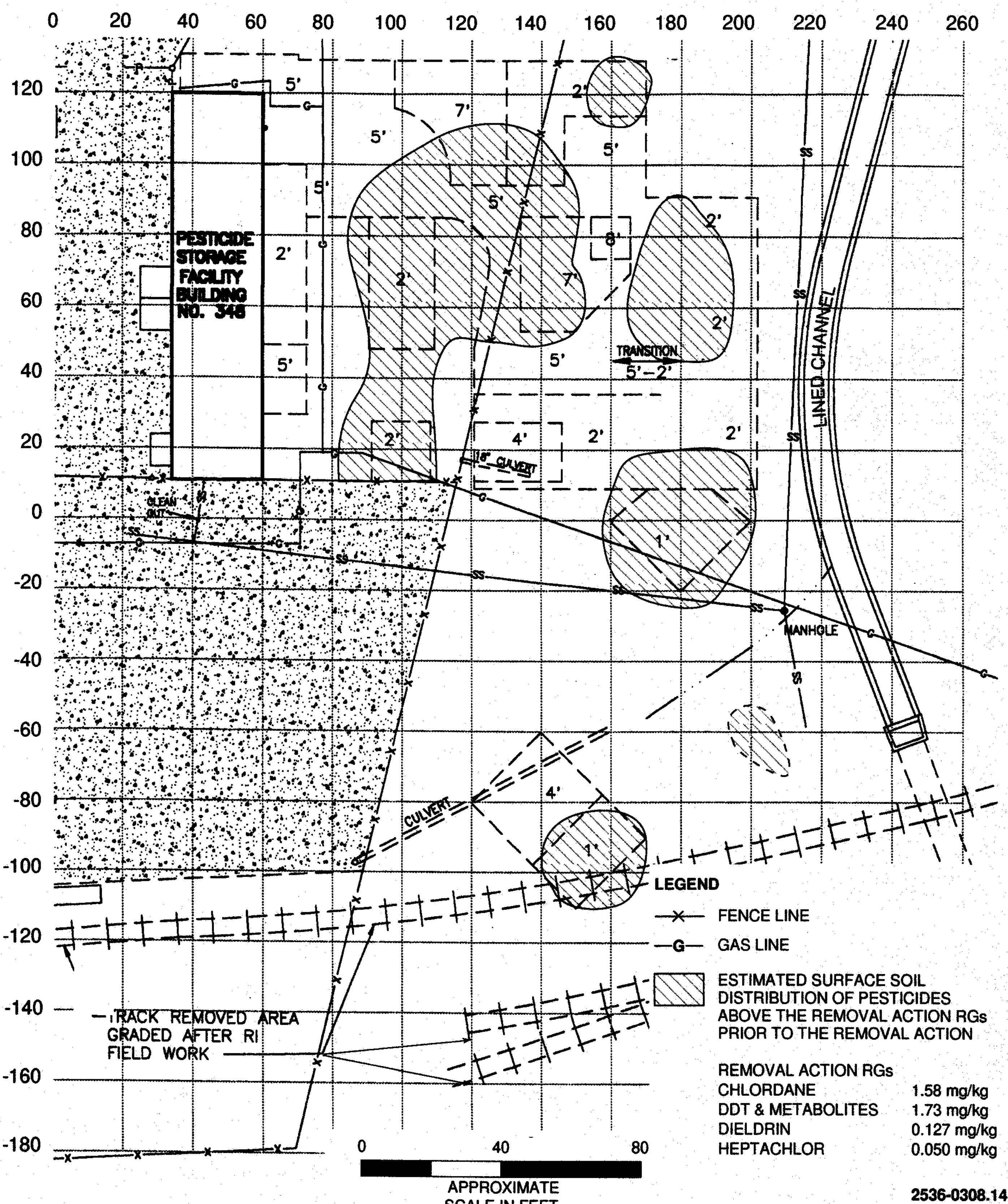
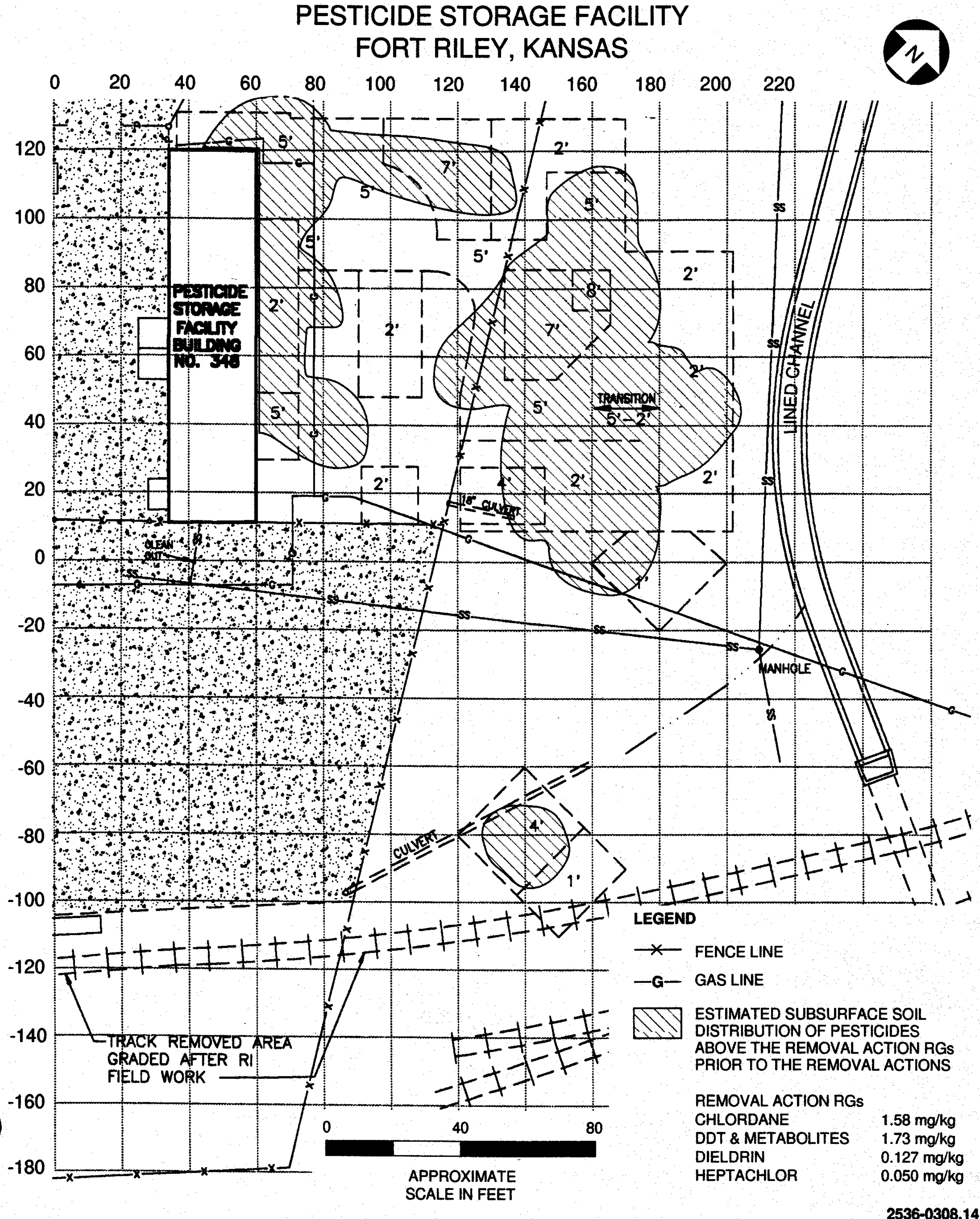


FIGURE 2-15

REMOVAL ACTION EXCAVATIONS COMPARED WITH SUBSURFACE SOIL DISTRIBUTION OF PESTICIDES

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



distributions at depths below 2 feet. As seen in these figures, the identified distributions of pesticides were substantially within the excavated areas. Section 3 presents a description of the current site conditions following the removal action excavations.

3.0 CURRENT SITE CHARACTERIZATION

The site characterization presented in Section 1.5.2 included a summary of the analytical data from soil samples collected at the PSF site as part of the RI field work during March through May 1992 (LAW, 1993a). Section 2 discussed soil sampling during removal action activities and summarized site conditions based on samples obtained during both the removal action and the RI. Section 3.1 summarizes the current site conditions using sampling results from soils remaining at the PSF site following removal action excavations. This section also includes a comparison of background concentrations (as discussed in Section 2.1) to concentrations remaining in the PSF soils.

Only soils were addressed by the removal action. Therefore, surface-water and sediment site characterizations presented in the RI Report (LAW, 1993a) are still relevant. Surface-water and sediment characterization data are fully described in the RI Report are not repeated in this section. The most recent groundwater sampling round (September 1994) was completed following the finalization of the RI and is discussed in Section 3.2. For completeness, Section 3.2 also discusses previous groundwater sampling results from the RI Report. Section 3.3 discusses site-specific hydrology based on the most recent groundwater sampling data; Section 3.4 provides contaminant fate and transport information; and Section 3.5 summarizes current site conditions based on visual observations.

3.1 SUMMARY OF CURRENT SOIL DATA EVALUATION

As part of the RI activities, surface and subsurface soils were sampled at the PSF site (LAW, 1993a). Locations of these samples were shown on Figures 1-15 and 1-16. Soil samples were also taken from the monitoring well borings during the RI. Extensive sampling of the PSF soils was performed by the rapid response contractor to further define the areas of pesticide contamination for the removal action described in Sections 1.7 and 2.

For purposes of evaluation of the soil data and performing the residual risk assessment (RRA) presented in Section 4 consistent with the BLRA, the site soil samples were partitioned between surface soils (depths less than 2 feet), and subsurface soils (2 feet and greater). The following subsections discuss separately analytical results for the surface and subsurface soils currently present at the site.

3.1.1 Evaluation of Surface Soil Pesticides Analytical Results

Table 3-1 presents analytical results for surface soil sample locations (not removed during the removal action) along with dates and depths at which the samples were collected. As discussed

TABLE 3-1

REMAINING SURFACE SOIL ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES FOLLOWING THE REMOVAL ACTION
Pesticide Storage Facility
Fort Riley, Kansas

Coordinates X	Coordinates Y	Sample Location I.D.	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and Metabolites* (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
180	160	RA-01	03/07/94	1	<0.017	0.222	<0.003	<0.003
60	140	RA-02	02/04/94	1	<0.05	0.220	<0.005	<0.005
80	140	RA-03	02/04/94	1	0.057	<0.05	<0.005	<0.005
100	140	RA-04	02/04/94	1	<0.05	<0.05	<0.005	<0.005
120	140	RA-05	02/04/94	1	<0.05	<0.05	<0.005	<0.005
140	140	RA-06	02/24/94	1	0.024	0.022	<0.002	<0.001
160	140	RA-07	03/07/94	1	0.158	0.170	<0.003	<0.003
180	140	RA-08	03/07/94	1	<0.017	<0.003	<0.003	<0.003
200	140	RA-09	03/07/94	1	<0.033	0.040	<0.003	<0.003
180	120	RA-15	03/07/94	1	0.033	0.429	<0.003	<0.003
180	100	RA-21	03/07/94	1	<0.033	0.028	<0.003	<0.003
215	100	RA-22	03/07/94	1	<0.033	<0.003	<0.003	<0.003
80	80	RA-24	02/04/94	1	<0.05	<0.05	<0.005	<0.005
80	60	RA-30	03/30/94	1	<0.028	DDD 0.024 DDT 0.054 DDE 0.039	<0.003	<0.0009
212	60	RA-35	02/24/94	1	0.740	<0.120	<0.040	ND(1)
80	40	RA-37	03/30/94	1	0.034	DDE 0.046 DDD <0.002 DDT <0.003	<0.003	<0.0009
100	40	RA-38	03/30/94	1	1.12	DDT 0.730 DDD <0.003 DDE <0.009	<0.003	0.009
240	40	RA-42	03/07/94	0	<0.033	0.012	<0.003	<0.003
80	20	RA-43	03/30/94	1	0.418	DDE 0.346 DDD 0.454 DDT 0.273	0.030	<0.009
120	20	RA-45	02/24/94	1	<0.020	0.013	0.015	<0.001
215	20	RA-49	03/07/94	1	<0.033	<0.003	<0.003	<0.003
140	0	RA-50	03/07/94	1	<0.017	0.026	<0.003	<0.003
215	0	RA-52	03/07/94	1	<0.033	0.044	0.009	<0.003
240	0	RA-53	03/07/94	0	<0.033	0.012	<0.003	<0.003
210	-18	RA-54	03/08/94	0	0.221	0.095	0.036	<0.003
120	-20	RA-55	03/30/94	0	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
		RA-55	03/07/94	1	<0.083	0.218	0.026	<0.017
156	-20	RA-56	03/07/94	1	0.309	0.605	<0.003	<0.003
200	-20	RA-57	03/07/94	1	0.260	0.369	0.051	<0.004
229	-20	RA-58	03/07/94	1	<0.017	<0.003	<0.003	<0.003
120	-60	RA-59	03/30/94	0	<0.034	DDE 0.126 DDD 0.107 DDT 0.167	0.074	<0.001
		RA-59	03/08/94	1	0.358	0.434	0.121	<0.003

TABLE 3-1

REMAINING SURFACE SOIL ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES FOLLOWING THE REMOVAL ACTION
Pesticide Storage Facility
Fort Riley, Kansas

Coordinates X	Coordinates Y	Sample Location I.D.	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and Metabolites* (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
140	-40	RA-60	03/07/94	1	<0.033	0.050	0.007	<0.007
180	-40	RA-61	03/07/94	1	<0.017	0.112	0.024	<0.003
220	-40	RA-62	03/07/94	1	0.072	0.288	0.022	<0.003
160	-60	RA-64	03/08/94	1	0.140	<0.003	0.014	<0.003
200	-60	RA-65	05/19/94	0	0.021	DDE 0.847 DDD 0.335 DDT 1.29	0.158	<0.001
240	-60	RA-66	03/08/94	1	<0.033	0.172	0.017	<0.003
100	-80	RA-67	03/08/94	1	0.151	0.143	0.032	<0.003
180	-80	RA-69	03/08/94	1	<0.033	0.091	0.017	<0.003
220	-80	RA-70	03/08/94	1	0.439	0.667	0.109	0.004
120	-100	RA-71	03/30/94	0	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.011
120	-100	RA-71	03/30/94	1	<0.034	DDT 0.378 DDE 0.188 DDD <0.003	0.082	<0.001
200	-100	RA-73	03/30/94	1	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
240	-100	RA-74	03/30/94	1	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
100	-120	RA-75	03/30/94	1	<0.034	DDD 0.164 DDE 0.111 DDT 0.327	0.054	<0.001
140	-120	RA-76	03/30/94	1	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
180	-120	RA-77	03/30/94	1	<0.034	DDE 0.040 DDT 0.079 DDD <0.002	<0.004	<0.001
220	-120	RA-78	03/30/94	1	<0.034	DDE 0.061 DDT <0.002 DDD <0.003	<0.004	<0.001
120	-140	RA-79	03/30/94	1	<0.034	DDT 0.379 DDD 0.163 DDE 0.254	0.107	<0.001
160	-140	RA-80	03/30/94	1	<0.034	DDE 0.036 DDT 0.075 DDD <0.003	<0.004	<0.001
200	-140	RA-81	03/30/94	1	<0.034	DDE 0.203 DDT 0.175 DDD 0.100	<0.004	<0.001

RA - Prefix samples from Removal Action (OHM, 1994).
* DDT metabolites (DDD and DDE) only reported for select samples.
Results for metabolites presented if analyzed.
(1) Detection limit not reported by laboratory.

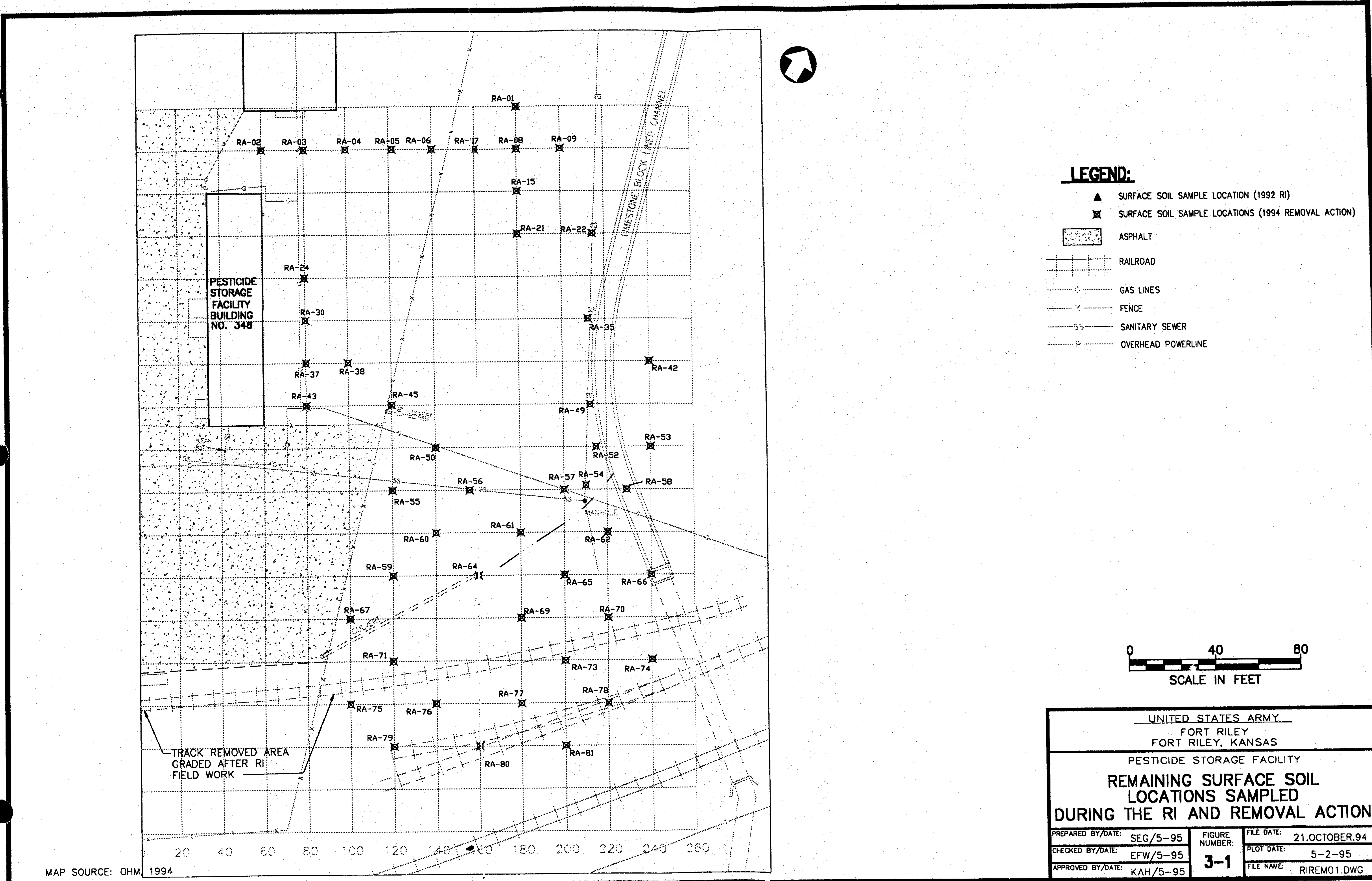
in Section 2, analysis of these soils included the pesticides chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, and heptachlor. The DDT metabolites 4,4'-DDD and 4,4'-DDE were only analyzed for select soil samples. Table 3-1 presents results for the metabolites if analyzed. Figure 3-1 shows locations of surface soil samples for soil still remaining at the site. The only soils remaining represented by surface samples are those where no excavation took place. Detections of the pesticides were distributed throughout the site where surface soils remain. However, these occurrences were at relatively low concentrations. Figure D-16 identifies the locations of remaining surface soil samples, and Figures D-17 through D-20 in Appendix D show the analyses results for pesticides analyzed and plotted at their respective locations. Table 3-2 presents the minimum and maximum concentrations encountered for these pesticides in surface soils, along with detection frequencies and removal action RG exceedance frequencies. Figure 3-2 shows the location of remaining surface soil samples exceeding removal action RGs. The compound DDT and its metabolite, DDE, had the highest frequencies of occurrence, being detected in 67 percent of the surface soil samples. As mentioned above, DDT and its metabolites were evaluated separately. Heptachlor was detected in only 4 percent of the surface samples. Chlordane, DDD and dieldrin showed similar frequencies of occurrence at 32 percent, 39 percent, and 38 percent, respectively. Surface soil results for each pesticide are discussed below.

The removal action RG for chlordane was 1.58 mg/kg. As shown in Table 3-2, the maximum detected concentration of chlordane was 1.12 mg/kg (sample RA-38, located approximately 40 feet east of Building 348). The RG exceedance was 0 percent, indicating that soils with chlordane levels above the RG were removed from the site during the removal action excavation.

The removal action RG for DDT and metabolites was 1.73 mg/kg. In Figure 3-2, results for DDT and metabolites are added together, but on Table 3-1 and for risk purposes (Section 4), DDT and metabolites are evaluated separately. The highest concentrations of DDE and DDT were 0.847 mg/kg and 1.29 mg/kg, respectively, at the surface (sample RA-65, located approximately 100 feet east of the fence line). The highest concentration of DDD was 0.454 mg/kg at 1 foot (sample RA-43, located approximately 20 feet east of Building 348). As shown in Table 3-2, the RG exceedance for DDT, DDD, and DDE, individually, was 0 percent. As shown on Figure 3-2, when added together, DDT and metabolites only exceed the removal action RG in one sample, RA-65, at a concentration of 2.472 mg/kg.

The removal action RG for dieldrin was 0.127 mg/kg. The highest concentration of dieldrin was 0.158 mg/kg, found in a surface sample located at RA-65 (located approximately 100 feet east of the fence line). The location of this sample is shown on Figure 3-2. This concentration exceeds the removal action RG.

The removal action RG for heptachlor was 0.05 mg/kg, which was not exceeded in surface soil samples collected prior to the removal action. The highest concentration of heptachlor in existing soil was 0.009 mg/kg found in a 1-foot sample (sample RA-38). As shown in Table 3-2, heptachlor was only detected in two remaining surface soil samples.


RA-01
RA-02
RA-03
RA-04
RA-05
RA-06
RA-17
RA-08
RA-09
RA-15
RA-21
RA-22
RA-24
RA-30
RA-35
RA-37
RA-38
RA-42
RA-43
RA-45
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RA-65
RA-66
RA-67
RA-69
RA-70
RA-71
RA-73
RA-74
RA-75
RA-76
RA-77
RA-78
RA-79
RA-80
RA-81
PESTICIDE STORAGE FACILITY BUILDING NO. 348
LIMESTONE BLOCK LINED CHANNEL
MANHOLE
TRACK REMOVED AREA GRADED AFTER RI FIELD WORK
20 40 60 80 100 120 140 160 180 200 220 240 260
MAP SOURCE: OHM 1994
LEGEND:
SURFACE SOIL SAMPLE LOCATION (1992 RI)
SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)
ASPHALT
RAILROAD
GAS LINES
FENCE
SANITARY SEWER
OVERHEAD POWERLINE
0 40 80
SCALE IN FEET
UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS
PESTICIDE STORAGE FACILITY
REMAINING SURFACE SOIL LOCATIONS SAMPLED DURING THE RI AND REMOVAL ACTION
PREPARED BY/DATE: SEG/5-95
CHECKED BY/DATE: EFW/5-95
APPROVED BY/DATE: KAH/5-95
FIGURE NUMBER: 3-1
FILE DATE: 21.OCTOBER.94
PLOT DATE: 5-2-95
FILE NAME: RIREMO1.DWG

TABLE 3-2

COMPARISON OF POSITIVE ANALYTICAL RESULTS FOR EXISTING SURFACE SOILS WITH REMEDIAL GOALS ESTABLISHED FOR THE REMOVAL ACTION

Pesticide Storage Facility
Fort Riley, Kansas

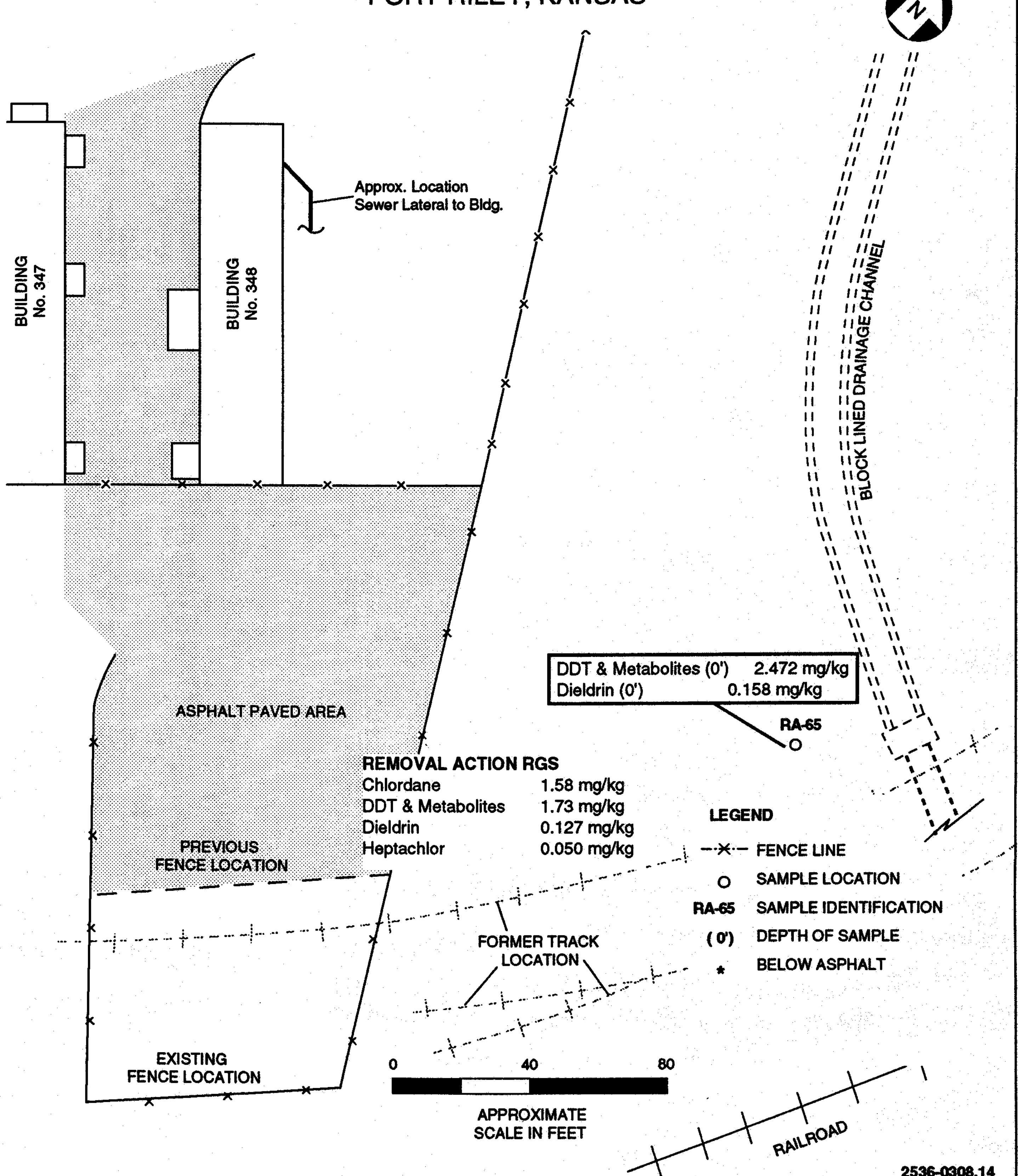
Parameter	Frequency of Detection	Percent Frequency of Detection	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Removal Action Remedial Goal (mg/kg)	Remedial Goal Exceedance Frequency
SURFACE SOIL SAMPLES:						
Chlordane	17/52	32%	0.0207	1.12	1.58	0/52
DDD	7/18	39%	0.0237	0.454	1.73[1]	0/18
DDE	12/18	67%	0.0356	0.847	1.73[1]	0/18
DDT	35/52	67%	0.012	1.29	1.73[1]	0/52
Dieldrin	20/52	38%	0.007	0.158	0.127	1/52
Heptachlor	2/52	4%	0.004	0.0093	0.050	0/52

[1] Removal Action RG established for DDT and metabolites

FIGURE 3-2

REMAINING SURFACE SOIL SAMPLES EXCEEDING REMOVAL ACTION REMEDIAL GOAL CONCENTRATIONS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



3.1.2 Evaluation of Subsurface Soil Analytical Results

Table 3-3 presents results of subsurface soil samples for soils remaining at the PSF site and includes analyses for the pesticides chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin and heptachlor. As discussed in Section 3.1.1, DDT metabolites were only reported for select samples, and Table 3-3 presents results for these metabolites if analyzed. It should be noted that samples located under currently paved areas are considered subsurface. Figure 3-3 shows the locations of subsurface soil samples for soil still remaining at the site. Figures D-21 through D-30 show the results of the analysis for these samples at various depth intervals. As in Section 2, samples collected from 1-foot depth increments were combined on each figure because the removal action excavations were carried out in 1-foot increments. Again, as observed for the surface samples, detectable levels of the pesticides are distributed throughout the PSF site. Generally, concentrations of the pesticides remaining in soils were relatively low. Table 3-4 presents minimum and maximum concentrations encountered for these pesticides in remaining soil, along with detection frequencies and removal action RG exceedance frequencies. Figure 3-4 shows the location of remaining subsurface soil samples exceeding removal action RGs. During the removal action, the RGs for surface soil exposure were used to guide subsurface soil excavation. Thus, it should be noted that comparisons of existing subsurface soil concentrations to removal action RGs are actually comparisons to surface soil RGs. Subsurface sample results for each pesticide are discussed below.

The highest concentrations of chlordane at the 2- to 3-foot depth interval were 5.35 mg/kg at 2 feet (sample RA-29, located against Building 348) and 5.89 mg/kg in a 2-foot sample (sample RA-47, located approximately 100 feet east of Building 348). At the 4- to 5-foot depth interval, the highest concentrations of chlordane were 8.71 mg/kg at 4 feet (sample RA-46, located 20 feet east of the fence line) and 10.2 mg/kg at 4 feet (sample RA-41, located approximately 55 feet east of the fence line). Thus, chlordane exists in soils at the PSF at concentrations greater than the removal action RG of 1.58 mg/kg. The highest concentration of depths of 6 feet and greater was 0.167 mg/kg. As shown in Table 3-4 and on Figure 3-4, 9 samples at 8 locations had concentrations of chlordane above the removal action RG.

The maximum concentration of DDT and its metabolites (added together) was 3.207 mg/kg in RA-23 (located adjacent to the east side of Building 348) at 2 feet which exceeds the removal action RG of 1.73 mg/kg for DDT and metabolites. At the 4- to 5-foot interval, the highest concentration was at RA-46 (located approximately 80 feet east of the southeast portion of Building 348) with 1.852 mg/kg at 4 feet. At 6 feet or deeper, the highest concentration of DDT and metabolites was detected in RA-32 at 0.046 mg/kg at 7 feet. As shown in Table 3-4, individually, only DDT exceeded the removal action RG once. As shown on Figure 3-4, when added together, DDT and metabolites exceeded the removal action RG in three samples.

As shown on Table 3-4, dieldrin was detected infrequently in subsurface soils which still exist at the site, and was not detected above the removal action RG of 0.127 mg/kg in soils remaining at the site.

TABLE 3-3

REMAINING SUBSURFACE SOIL ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES FOLLOWING THE REMOVAL ACTION
Pesticide Storage Facility
Fort Riley, Kansas

Coordinates X	Coordinates Y	Sample Location I.D.	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and(1) Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
180	160	RA-01	03/08/94	3	<0.017	<0.003	<0.003	<0.003
160	140	RA-07	03/08/94	3	<0.017	<0.003	<0.003	<0.003
180	140	RA-08	03/08/94	3	<0.017	<0.003	<0.003	<0.003
200	140	RA-09	03/08/94	3	<0.016	<0.003	<0.003	<0.003
40	120	RA-10	02/04/94	5	<0.050	<0.050	<0.005	<0.005
80	120	RA-11	03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
80	120		03/30/94	7	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
140	120	RA-13	03/30/94	2	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
140	120		03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
160	120	RA-14	03/30/94	2	<0.028	DDT 0.036 DDD 0.023 DDE 0.020	<0.003	<0.0009
160	120		03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
160	120		04/08/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
160	120		04/08/94	7	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
180	120	RA-15	03/08/94	3	<0.017	<0.003	<0.003	<0.003
60	100	RA-16	04/08/94	2	2.67	DDT 0.509 DDD 0.218 DDE 0.132	0.020	0.129
80	100	RA-17	03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
80	100		03/30/94	7	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009

TABLE 3-3

REMAINING SUBSURFACE SOIL ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES FOLLOWING THE REMOVAL ACTION
Pesticide Storage Facility
Fort Riley, Kansas

Coordinates X	Coordinates Y	Sample Location I.D.	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and(1) Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
100	100	RA-18	03/30/94	5	<0.05	<0.05	<0.005	<0.005
100	100		03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
100	100		03/30/94	7	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
140	100	RA-20	03/30/94	2	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
140	100		03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
180	100	RA-21	03/08/94	3	<0.016	<0.003	<0.003	<0.003
215	100	RA-22	03/07/94	3	<0.033	<0.003	<0.003	<0.003
60	80	RA-23	04/08/94	2	3.36	DDT 1.95 DDD 0.925 DDE 0.332	<0.004	<0.001
60	80		02/04/94	5	<0.05	<0.05	<0.005	<0.005
100	80	RA-25	05/19/94	2	0.048	DDT 0.051 DDD <0.003 DDE <0.009	<0.003	<0.0009
120	80	RA-26	02/04/94	5	<0.05	<0.05	<0.005	<0.005
140	80	RA-27	03/30/94	7	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
140	80		04/08/94	7	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
160	80	RA-27.5	05/19/94	8	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
180	80	RA-28	03/30/94	2	0.298	DDT 0.035 DDD 0.029 DDE 0.033	<0.003	<0.0009
180	80		03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
60	60	RA-29	04/08/94	2	5.35	DDT <0.002 DDD <0.003 DDE 0.034	<0.004	0.038

TABLE 3-3

REMAINING SUBSURFACE SOIL ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
FOLLOWING THE REMOVAL ACTION
Pesticide Storage Facility
Fort Riley, Kansas

Coordinates X	Coordinates Y	Sample Location I.D.	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and(1) Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
80	60	RA-30	03/30/94	3	0.049	DDT <0.002 DDD <0.003 DDE 0.018	<0.003	<0.0009
80	60		03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
100	60	RA-31	03/30/94	3	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
100	60		03/30/94	5	<0.028	DDT 0.186 DDD 0.017 DDE 0.041	<0.003	<0.0009
140	60	RA-32	03/30/94	7	0.167	DDT 0.034 DDD <0.003 DDE 0.012	<0.003	<0.0009
140	60		04/08/94	7	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
160	60	RA-33	02/04/94	5	<0.050	<0.050	<0.005	<0.005
160	60		03/30/94	5	0.272	DDT 0.105 DDD <0.0005 DDE 0.027	<0.0006	0.001
160	60		03/30/94	7	ND(1)	ND(1)	ND(1)	ND(1)
180	60	RA-34	03/30/94	2	2.98	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	0.008
180	60		03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
65	40	RA-36	04/08/94	5	0.201	DDT 0.112 DDD 0.084 DDE 0.049	<0.004	<0.001
65	40		04/08/94	5	0.042	DDT <0.002 DDD 0.019 DDE <0.011	<0.004	<0.001
65	40		04/08/94	5	0.266	DDT 0.768 DDD 0.271 DDE 0.254	<0.004	<0.001
80	40	RA-37	03/30/94	3	<0.028	DDT 0.017 DDD 0.011 DDE 0.022	<0.003	<0.0009
80	40		03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE 0.010	<0.003	<0.0009

TABLE 3-3

REMAINING SUBSURFACE SOIL ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
FOLLOWING THE REMOVAL ACTION
Pesticide Storage Facility
Fort Riley, Kansas

Coordinates X	Coordinates Y	Sample Location I.D.	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and(1) Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
100	40	RA-38	03/30/94	3	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
100	40		03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
130	40	RA-39	03/30/94	5	<0.028	DDT <0.002 DDD 0.001 DDE <0.009	<0.003	<0.0009
140	40	RA-40	03/30/94	5	0.332	DDT 0.068 DDD 0.023 DDE 0.066	<0.003	<0.0009
140	40		04/08/94	5	0.623	DDT 0.221 DDD 0.081 DDE <0.011	<0.004	<0.001
140	40		04/08/94	7	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
180	40	RA-41	03/30/94	2	0.302	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
180	40		03/30/94	4	10.2	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
80	20	RA-43	03/30/94	3	0.087	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
80	20		03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
100	20	RA-44	03/30/94	3	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
100	20		03/30/94	5	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.0009
140	20	RA-46	03/30/94	4	3.54	DDT 0.472 DDD 0.586 DDE 0.794	<0.003	0.008
140	20		04/08/94	4	8.71	DDT 0.917 DDD 0.513 DDE <0.011	<0.004	<0.001
140	20		05/19/94	4	0.059	DDT 0.016 DDD <0.003 DDE 0.036	<0.003	<0.0009

TABLE 3-3

REMAINING SUBSURFACE SOIL ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
FOLLOWING THE REMOVAL ACTION
Pesticide Storage Facility
Fort Riley, Kansas

Coordinates X	Coordinates Y	Sample Location I.D.	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and(1) Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
160	20	RA-47	03/30/94	2	5.89	DDT 0.715 DDD 0.365 DDE 0.666	<0.003	0.023
180	20	RA-48	03/30/94	2	0.325	DDT 0.039 DDD <0.003 DDE 0.043	<0.003	<0.0009
180	20		03/07/94	3	<0.033	<0.003	<0.003	<0.003
180	20		03/30/94	4	<0.028	DDT <0.002 DDD <0.003 DDE <0.009	<0.003	<0.009
215	20	RA-49	03/07/94	3	<0.033	<0.003	<0.003	<0.003
140	0	RA-50	03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
180	0	RA-51	03/07/94	3	0.329	0.553	0.034	<0.003
180	0		03/30/94	5	0.562	DDT 0.144 DDD <0.003 DDE 0.126	<0.004	<0.001
215	0	RA-52	03/07/94	3	<0.033	<0.003	<0.003	<0.003
120	-20	RA-55	03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
156	-20	RA-56	03/08/94	3	<0.033	0.143	0.007	<0.003
200	-20	RA-57	03/08/94	3	<0.033	0.012	<0.003	<0.003
229	-20	RA-58	03/08/94	4	<0.017	<0.003	<0.003	<0.003
120	-60	RA-59	03/08/94	3	0.140	<0.003	<0.003	<0.003
120	-60		03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE 0.060	<0.004	<0.001
140	-40	RA-60	03/08/94	3	<0.017	<0.003	<0.003	<0.003
180	-40	RA-61	03/08/94	3	0.070	0.053	0.011	<0.003
160	-60	RA-64	03/08/94	3	<0.016	0.011	<0.003	<0.003
100	-80	RA-67	03/08/94	3	<0.017	<0.003	<0.003	<0.003
100	-80		03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001

TABLE 3-3

REMAINING SUBSURFACE SOIL ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
FOLLOWING THE REMOVAL ACTION
Pesticide Storage Facility
Fort Riley, Kansas

Coordinates X	Coordinates Y	Sample Location I.D.	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and(1) Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
140	-80	RA-68	05/19/94	4	0.026	DDT 0.184 DDD 0.072 DDE 0.501	<0.003	<0.0009
140	-80		03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
180	-80	RA-69	03/08/94	3	0.080	0.109	0.022	<0.003
180	-80		03/30/94	5	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
220	-80	RA-70	03/08/94	3	0.081	0.044	0.009	<0.003
120	-100	RA-71	03/30/94	3	<0.034	DDT 0.153 DDD 0.044 DDE 0.251	0.066	<0.001
120	-100		03/30/94	5	<0.034	DDT 0.198 DDD 0.079 DDE 0.378	0.042	<0.001
160	-100	RA-72	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
160	-100		03/30/94	5	<0.034	DDT 0.098 DDD <0.003 DDE 0.053	0.023	<0.001
200	-100	RA-73	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
200	-100		03/30/94	5	<0.034	DDT 0.036 DDD <0.003 DDE <0.011	<0.004	<0.001
240	-100	RA-74	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
100	-120	RA-75	03/30/94	3	<0.034	DDT 0.154 DDD 0.051 DDE 0.076	<0.004	<0.001
140	-120	RA-76	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
180	-120	RA-77	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
220	-120	RA-78	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001

TABLE 3-3

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Pesticide Storage Facility
Fort Riley, Kansas

Coordinates X	Coordinates Y	Sample Location I.D.	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and(1) Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
120	-140	RA-79	03/30/94	3	<0.034	DDT 0.070 DDD 0.044 DDE 0.089	<0.004	<0.001
160	-140	RA-80	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
200	-140	RA-81	03/30/94	3	<0.034	DDT <0.002 DDD <0.003 DDE <0.011	<0.004	<0.001
26.8	111.9	SB-2	04/07/92	0.5-1.5*	3.200	DDT 1.000 DDD <0.062 DDE 0.270	0.077	0.300
26.8	111.9		04/07/92	2.0-2.5	0.420	DDT 0.042 DDD <0.039 DDE <0.039	<0.039	0.045
26.8	111.9		04/07/92	4.0-4.5	0.320	DDT <0.370 DDD <0.370 DDE <0.370	<0.037	0.028
24.8	19.1	SB-4	04/07/92	2.0-2.5	0.181	DDT 0.140 DDD <0.016 DDE 0.031	<0.016	<0.008
24.8	19.1		04/07/92	4.0-4.5	0.125	DDT 0.096 DDD <0.016 DDE 0.021	<0.016	<0.008
89.3	55.9	SB-6	04/07/92	2.0-2.5	<0.004	DDT <0.007 DDD <0.007 DDE <0.007	<0.007	<0.004
89.3	55.9		04/07/92	4.0-4.5	0.008	DDT 0.014 DDD <0.007 DDE <0.007	<0.007	<0.004
66.8	29.1	SB-8	04/07/92	2.0-2.5	0.070	DDT 0.440 DDD <0.043 DDE 0.110	<0.043	<0.021
66.8	29.1		04/07/92	4.0-4.5	0.012	DDT 0.150 DDD <0.008 DDE 0.020	<0.008	<0.004
150.9	13.9	SB-14	04/04/92	4.0-4.5	0.010	DDT 0.012 DDD <0.008 DDE <0.008	<0.008	<0.004
184.8	86.1	SB-15	04/04/92	4.0-4.5	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004

TABLE 3-3

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Pesticide Storage Facility
Fort Riley, Kansas

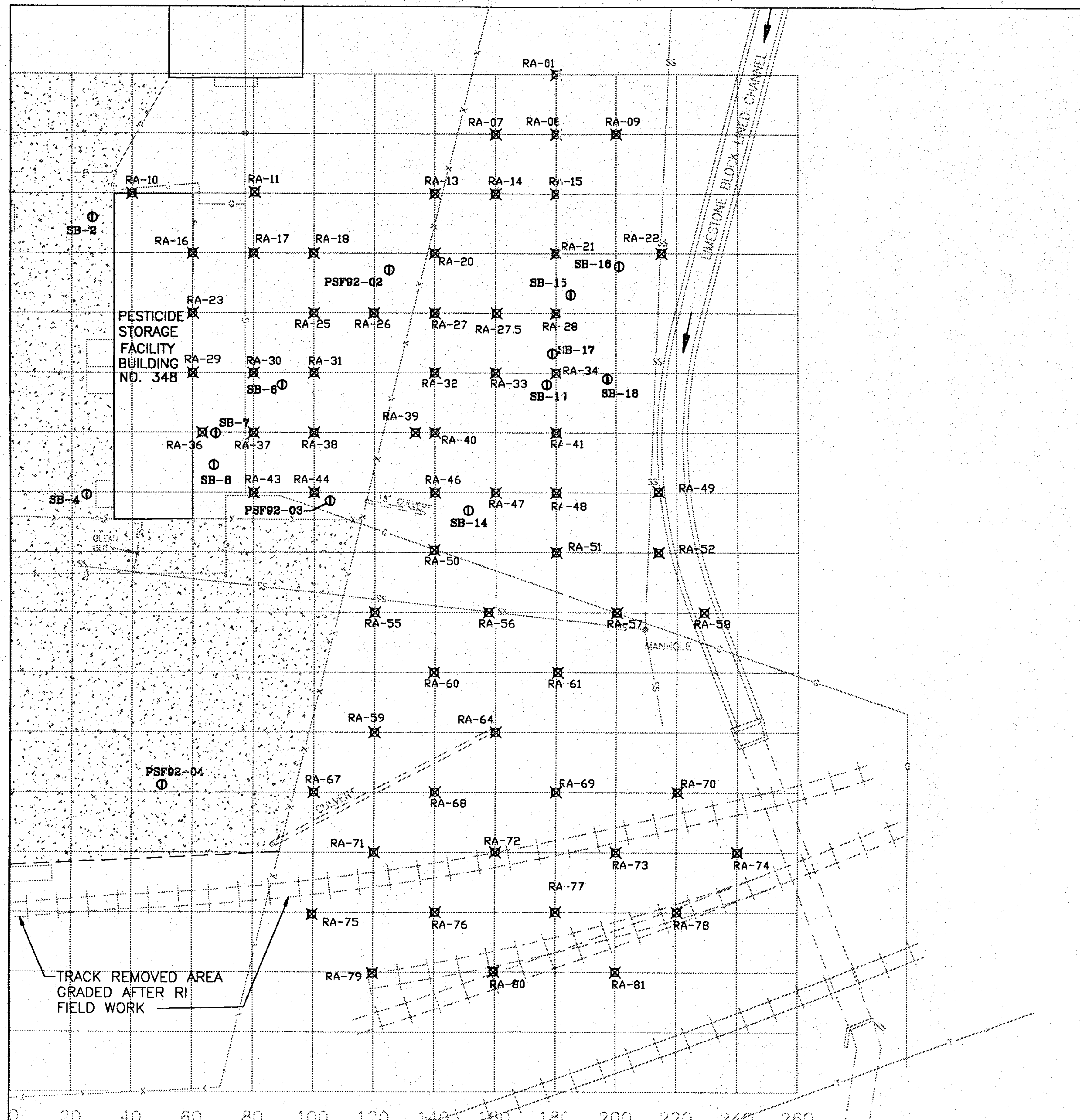
Coordinates X	Coordinates Y	Sample Location I.D.	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and(1) Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
200.9	95.6	SB-16	04/04/92	1.5-2.5	0.138	DDT 0.310 DDD <0.037 DDE <0.037	<0.037	<0.019
200.9	95.6		04/04/92	3.5-4.5	0.013	DDT 0.025 DDD <0.008 DDE <0.008	<0.008	<0.004
178.7	66.5	SB-17	04/06/92	4.0-4.5	0.016	DDT 0.025 DDD <0.007 DDE <0.007	<0.007	<0.004
197.0	58.0	SB-18	04/05/92	4.0-4.5	0.036	DDT 0.082 DDD <0.008 DDE 0.022	<0.008	<0.004
176.8	56.0	SB-19	04/04/92	4.0-4.5	0.025	DDT 0.036 DDD <0.008 DDE 0.022	<0.008	<0.004
190.6	24.7	SB-20	04/08/92	4.0-4.5	0.026	DDT 0.025 DDD <0.008 DDE 0.011	<0.008	<0.004
81.2	318.4	PSF92-01	04/28/92	15-17	<0.004	DDT <0.007 DDD <0.007 DDE <0.007	<0.007	<0.004
81.2	318.4		04/28/92	21-25	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
124.1	94.7	PSF92-02	05/05/92	4-8	<0.004	DDT <0.007 DDD <0.007 DDE <0.007	<0.007	<0.004
124.1	94.7		05/05/92	8-12	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
124.1	94.7		05/05/92	14-16	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
124.1	94.7		05/05/92	20-22	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
105.8	18.5	PSF92-03	05/02/92	10-14	0.005	DDT <0.008 DDD <0.008 DDE <0.008	0.009	<0.004
105.8	18.5		05/02/92	20-22	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004

TABLE 3-3

REMAINING SUBSURFACE SOIL ANALYTICAL RESULTS FOR CHLORINATED PESTICIDES
FOLLOWING THE REMOVAL ACTION
Pesticide Storage Facility
Fort Riley, Kansas

Coordinates X	Coordinates Y	Sample Location I.D.	Sample Date	Sample Depth (feet)	Chlordane (mg/kg)	DDT and(1) Metabolites** (mg/kg)	Dieldrin (mg/kg)	Heptachlor (mg/kg)
49.8	-77.9	PSF92-04	05/04/92	12-14	0.033	DDT <0.007 DDD <0.007 DDE 0.012	0.013	<0.004
49.8	-77.9		05/04/92	22-24	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
179.6	-233.4	PSF92-05	04/29/92	9-11	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004
179.6	-233.4		04/29/92	17-19	<0.004	DDT <0.008 DDD <0.008 DDE <0.008	<0.008	<0.004

RA - Prefix samples from Removal Action (OHM, 1994)
SB and PSF92 - Prefix samples from RI (LAW, 1993a)
ND - Not detected
* Currently under asphalt, considered subsurface.
** DDT metabolites (DDD and DDE) only reported for select samples.
Results for metabolites presented if analyzed.
(1) Detection limit not reported by laboratory.



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80

SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

SUBSURFACE SOIL LOCATIONS SAMPLED DURING THE RI AND REMOVAL ACTION

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	3-3	PLOT DATE:	5-3-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	FR03.DWG

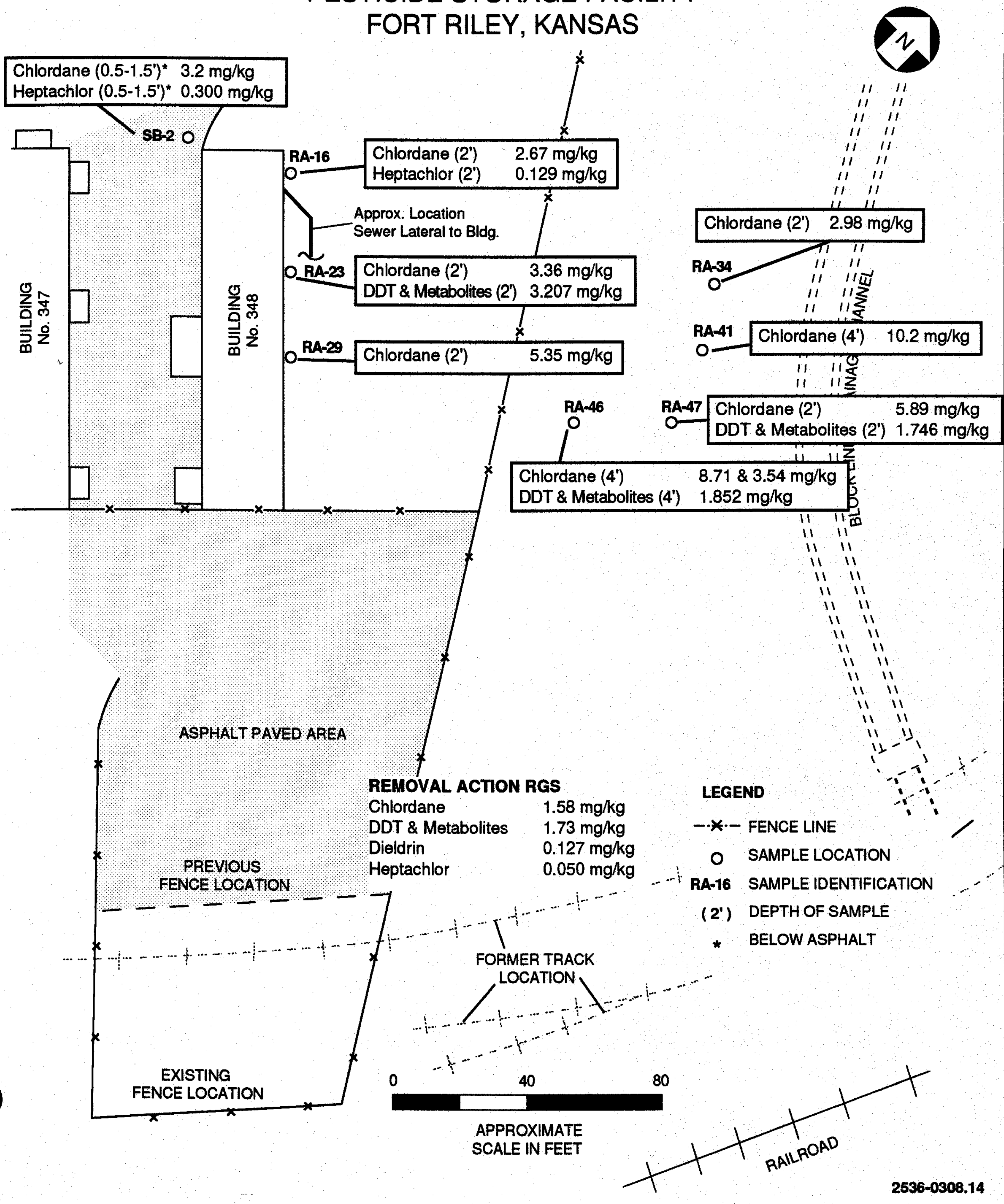
TABLE 3–4

COMPARISON OF POSITIVE ANALYTICAL RESULTS FOR EXISTING SUBSURFACE SOILS WITH REMEDIAL GOALS ESTABLISHED FOR THE REMOVAL ACTION
Pesticide Storage Facility
Fort Riley, Kansas

Sample ID	Frequency of Detection	Percent Frequency of of Detection	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Removal Action Remedial Goal (mg/kg)(1)	Remedial Goal Exceedance Frequency
SUBSURFACE SOIL SAMPLES:						
Chlordane	46/133	35	0.0051	10.2	1.58	9/133
DDD	20/106	19	0.0013	0.925	1.73(2)	0/106
DDE	35/106	33	0.0104	0.794	1.73(2)	0/106
DDT	47/133	35	0.011	1.95	1.73(2)	1/133
Dieldrin	12/133	9	0.007	0.077	0.127	0/133
Heptachlor	9/133	7	0.0012	0.3	0.050	2/133

(1) Removal Action RG for surface soil
(2) Removal Action RG established for DDT and metabolites

FIGURE 3-4
REMAINING SUBSURFACE SOIL SAMPLES EXCEEDING REMOVAL ACTION REMEDIAL GOAL CONCENTRATIONS
PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



The highest concentration of heptachlor at the site was detected at 0.300 mg/kg in sample SB-2 under the existing pavement near the northwest corner of Building 348. Heptachlor was detected in RA-16 (located adjacent to the east side of Building 348) at a concentration of 0.129 mg/kg at 2 feet, above the removal action surface soil RG of 0.050 mg/kg. At the 4- to 5-foot depth interval, the maximum concentration of heptachlor was found in SB-2 at a concentration of 0.028 mg/kg. Heptachlor was not detected at the PSF site in samples taken at 6 feet deep or below. Figure 3-4 shows the location of the two samples which exceeded the removal action RG for heptachlor.

Table 3-5 presents the "positive hits" results of soil samples collected during the RI field investigation for soils remaining at the site, and includes results for analyses of semi-volatile organic compounds (SVOCs), VOCs, and total metals. Table 3-6 presents the frequencies of occurrence, and the minimum and maximum concentrations encountered for detected nonpesticide contaminants in the subsurface soils remaining at the PSF.

Six metals were detected in the subsurface samples which remain at the site (Table 3-5). Lead exhibited elevated concentrations at sample locations SB-8 (770 mg/kg at 2.0 to 2.5 feet and 130 mg/kg at 4.0 to 4.5 feet), SB-14 (100 mg/kg at 4.0 to 4.5 feet), and SB-15 (130 mg/kg at 4.0 to 4.5 feet). The metal arsenic, one of the target compounds for the removal action, exhibited a concentration range of 0.4 to 20 mg/kg, with the highest concentration occurring at sample location SB-2 at the 2.0- to 2.5-foot depth interval. Arsenic, barium and chromium were found in all the samples, while lead occurred in 80 percent of the samples (Table 3-5).

Table 3-7 presents a comparison between the ranges of background soil concentrations for arsenic, barium, beryllium, chromium, and lead to the ranges of these constituents detected in the soils of the PSF site during the RI investigation for those soils remaining following the removal action. Two samples taken from location RA-39 at depths of 1 foot and 5 feet were analyzed for arsenic during the removal action,which are included in the data set. Although beryllium and nitrate were included in the analyses of background constituent concentrations during the removal action (OHM, 1994), these constituents were not analyzed for the soils at the PSF. Three metals were detected above the high-end background concentration in the PSF soils. Arsenic was found to exceed the background concentration in three samples; both chromium and lead were found to exceed the background concentration in five samples. However, none of these metals individually were found to cause excessive risk in the Residual Risk Assessment (Section 4 of this report) performed for the PSF site soils. Barium was not found to exceed the high-end background concentrations, and beryllium was not analyzed in any on-site samples.

The VOC toluene was detected only at low concentrations, occurring in 7 of 29 samples (Table 3-6). It was usually found at depths greater than 3.5 feet (Table 3-5), with the exception of sample locations SB-02 (at 0.5 to 1.5 feet) and SB-16 (at 1.5 to 2.5 feet). Benzene was only found in the deeper samples, with its shallowest occurrence from the background monitoring well location (PSF92-01) at the 15- to 17-foot interval. The presence of methylene chloride was

TABLE 3-5

POSITIVE ANALYTICAL RESULTS
REMAINING SUBSURFACE SOIL SAMPLES OTHER THAN PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	SB-02 (6-18") 04/07/92	SB-02 (2-2.5') 04/07/92	SB-02 (4-4.5') 04/07/92	SB-04 (2-2.5') 04/07/92	SB-04 (4-4.5') 04/07/92	SB-06 (2-2.5') 04/07/92	SB-06 (4-4.5') 04/07/92	SB-08 (2-2.5') 04/07/92	SB-08 (4-4.5') 04/07/92	SB-14 (4-4.5') 04/04/92	SB-15 (4-4.5') 04/04/92
SEMI-VOLATILE ORGANICS											
Benzo(a)anthracene, µg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	330	ND
Chrysene, µg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	290	ND
Diethylphthalate, µg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene, µg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	530	ND
Phenanthrene, µg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	250	ND
Pyrene, µg/kg	ND	ND	ND	ND	ND	ND	ND	170 (I2)	ND	570	ND
bis(2-ethylhexyl)phthalate, µg/kg	ND	ND	ND	ND	ND	ND	1200	ND	ND	410	ND
VOLATILE ORGANICS											
Benzene, µg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride, µg/kg	24	19 (B2)	10 (B2)	19 (B2)	22	18 (B2)	17	9.5 (B2)	13 (B2)	38 (B2)	35 (B2)
Toluene, µg/kg	6.0 (I2)	ND	ND	ND	9.5	ND	ND	ND	ND	ND	38 (I2)
TOTAL ICP METALS											
Barium, mg/kg	35	97	82	100	98	77	39	160	130	100	130
Chromium, mg/kg	6.9	6.5	8.3	11	6.3	5.3	4.6	4.8	6.5	8.3	5.5
Lead, mg/kg	32	13	11	12	9.9	4.7	4.7	770	270	140	7.6
Silver, mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL FURNACE METALS											
Arsenic, mg/kg	16	20	4.3	6.2	1.9	1.6	1.1	3.3	2.5	3.0	1.6
TOTAL MERCURY											
Mercury, mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND Not detected
NA Not analyzed
* Removal Action data located at RA-39
NAV Not available

B2 Sample results are less than 10 times the amount detected in the method blank. Result is estimated.
I2 Low internal standard response and high surrogate recovery. Result is biased high.

TABLE 3-5

POSITIVE ANALYTICAL RESULTS
REMAINING SUBSURFACE SOIL SAMPLES OTHER THAN PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	SB-16 (1.5-2.5') 04/04/92	SB-16 (3.5-4.5') 04/04/92	SB-17 (4-4.5') 04/06/92	SB-18 (4-4.5') 04/05/92	SB-19 (4-4.5') 04/04/92	SB-20 (4-4.5') 04/08/92	PSF92-01 (15-17') 04/28/92	PSF92-01 (21-25') 04/28/92	PSF92-02 (4-8') 05/05/92	PSF92-02 (8-12') 05/05/92	PSF92-02 (14-16') 05/05/92
SEMI-VOLATILE ORGANICS											
Benzo(a)anthracene, µg/kg	ND	ND	ND	ND	ND	160	ND	ND	ND	ND	ND
Chrysene, µg/kg	ND	ND	ND	ND	ND	200	ND	ND	ND	ND	ND
Diethylphthalate, µg/kg	ND	ND	ND	ND	ND	430	ND	ND	ND	ND	ND
Fluoranthene, µg/kg	ND	ND	ND	ND	ND	310	ND	ND	ND	ND	ND
Phenanthrene, µg/kg	ND	ND	ND	ND	ND	230	ND	ND	ND	ND	ND
Pyrene, µg/kg	110	ND	ND	ND	ND	310	ND	ND	ND	ND	ND
bis(2-ethylhexyl)phthalate, µg/kg	960	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VOLATILE ORGANICS											
Benzene, µg/kg	ND	ND	ND	ND	ND	ND	6.6	5.9	ND	ND	ND
Methylene chloride, µg/kg	28 (B2)	34 (B2)	29	31	31 (B2)	15 (B2)	62 (B2)	46 (B2)	18	19	17
Toluene, µg/kg	8.9	18	5.9	9.8	ND	ND	ND	ND	ND	ND	ND
TOTAL ICP METALS											
Barium, mg/kg	47	120	71	110	100	88	61	120	60	83	100
Chromium, mg/kg	4.7	8.7	5.7	6.8	6.9	6.9	6.8	8.7	11	4.8	6.4
Lead, mg/kg	18	12	8.0	15	12	89	5.1	10	4.7	ND	ND
Silver, mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	0.9	ND	1.1
TOTAL FURNACE METALS											
Arsenic, mg/kg	1.9	1.6	0.9	1.6	1.4	1.9	1.0	2.5	1.7	1.7	2.4
TOTAL MERCURY											
Mercury, mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND Not detected
NA Not analyzed
* Removal Action data located at RA-39
NAV Not available

B2 Sample results are less than 10 times the amount detected in the method blank. Result is estimated.
I2 Low internal standard response and high surrogate recovery. Result is biased high.

TABLE 3-5

POSITIVE ANALYTICAL RESULTS
REMAINING SUBSURFACE SOIL SAMPLES OTHER THAN PESTICIDES
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSF92-02 (20-22') 05/05/92	PSF92-03 (10-14') 05/02/92	PSF92-03 (20-22') 05/02/92	PSF92-04 (12-14') 05/04/92	PSF92-04 (22-24') 05/04/92	PSF92-05 (9-11') 04/28/92	PSF92-05 (17-19') 04/28/92	SP-10-B* (5') 04/08/94	SP-10-C* (7') 04/08/94
SEMI-VOLATILE ORGANICS									
Benzo(a)anthracene, µg/kg	ND	ND	ND	ND	ND	110	ND	NA	NA
Chrysene, µg/kg	ND	ND	ND	ND	ND	110	ND	NA	NA
Diethylphthalate, µg/kg	ND	ND	ND	ND	ND	ND	ND	NA	NA
Fluoranthene, µg/kg	ND	ND	ND	ND	ND	180	ND	NA	NA
Phenanthrene, µg/kg	ND	ND	ND	ND	ND	ND	ND	NA	NA
Pyrene, µg/kg	ND	ND	ND	ND	ND	180	ND	NA	NA
bis(2-ethylhexyl)phthalate, µg/kg	ND	ND	ND	ND	ND	ND	ND	NA	NA
VOLATILE ORGANICS									
Benzene, µg/kg	ND	ND	ND	ND	ND	ND	ND	NA	NA
Methylene chloride, µg/kg	11	19	22	21	20	70 (B2)	38 (B2)	NA	NA
Toluene, µg/kg	ND	ND	ND	ND	ND	ND	ND	NA	NA
TOTAL ICP METALS									
Barium, mg/kg	72	190	68	60	70	96	44	NA	NA
Chromium, mg/kg	7.1	11	6.1	20	6.0	10	6.6	NA	NA
Lead, mg/kg	ND	8.5	5.9	58	ND	30	5.9	NA	NA
Silver, mg/kg	1.2	ND	ND	ND	ND	ND	ND	NA	NA
TOTAL FURNACE METALS									
Arsenic, mg/kg	1.4	2.0	0.5	3.1	0.4	2.9	0.6	9.4	2.2
TOTAL MERCURY									
Mercury, mg/kg	ND	ND	ND	ND	ND	0.1	ND	NA	NA

ND Not detected
NA Not analyzed
* Removal Action data located at RA-39
NAV Not available

B2 Sample results are less than 10 times the amount detected in the method blank. Result is estimated.
I2 Low internal standard response and high surrogate recovery. Result is biased high.

TABLE 3-6

SUMMARY OF POSITIVE ANALYTICAL RESULTS - CONSTITUENTS OTHER THAN PESTICIDES FOR REMAINING SUBSURFACE SOIL SAMPLES
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	Frequency of Detection	Percent Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration
SUBSURFACE SOIL SAMPLES:				
Metals (mg/kg):				
Arsenic	31/31	100	0.4	20
Barium	29/29	100	35	190
Chromium	29/29	100	4.6	20
Lead	25/29	80	4.7	770
Mercury	1/29	3	0.1*	0.1
Silver	3/29	10	0.9	1.2
Volatile Organics (mg/kg):				
Benzene	2/29	7	0.0059	0.0066
Methylene Chloride	13/29	45	0.011	0.031
Toluene	7/29	24	0.0059	0.038
Semi-volatile Organics (mg/kg):				
Benzo(a)anthracene	3/29	10	0.11	0.33
bis(2-Ethylhexyl)phthalate	3/29	10	0.41	1.2
Chrysene	3/29	10	0.11	0.29
Diethylphthalate	1/29	3	0.43*	0.43
Fluoranthene	3/29	10	0.18	0.53
Phenanthrene	2/29	7	0.23	0.25
Pyrene	5/29	17	0.11	0.57

* = Only one detection of this constituent, thus reported concentration is minimum and maximum detected concentration.

TABLE 3-7

COMPARISON OF RANGES FOR BACKGROUND METALS TO PSF SOIL CONCENTRATIONS
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER	BACKGROUND RANGE (mg/kg)	NUMBER OF BACKGROUND SAMPLES	PSF RANGE (mg/kg)	EXCEEDANCE FREQUENCY ABOVE MAXIMUM BACKGROUND CONCENTRATION(1)
Arsenic	1.2 - 7.1	25	0.4 - 20	3/31
Barium	31 - 200	25	35 - 190	0/29
Beryllium	<0.50-0.59	24	NAL	NA
Chromium	6.7 - 9.3	3	4.6 - 20	5/29
Lead	4.3 - 46	25	4.7 - 770	5/29
Nitrate	<1.0 - 3.9	22	NAL	NA
Thallium	<25	22	NAL	NA

NA Not applicable
NAL Not analyzed
(1) Number of samples exceeding the maximum background concentration/number of samples analyzed.

Sources: OHM, 1994 and LAW, 1993a

attributed to the laboratory analytical methods used. The QCSR (LAW, 1992) provides supporting QC data which attributes methylene chloride detections to laboratory contamination.

The SVOCs detected were primarily PAHs and were found infrequently. Pyrene showed the highest frequency of detection, occurring in 5 of 29 subsurface samples for which it was analyzed. Soil sample locations SB-14 and SB-20 showed the largest number of detected PAHs at the depth interval of 4.0 to 4.5 feet, and generally the highest concentrations of these compounds.

3.1.3 Summary of Evaluation of Soil Analytical Results for Soils Remaining On Site

This section presents a summary of the nature and extent of contamination in surface and subsurface soils remaining at the site based on data collected during the RI field activities and removal action sampling. As discussed in Section 2.2, subsurface soils were evaluated considering all depths at or below 2 feet, and not individual comparisons at each depth. Figures 3-2 through 3-4 presented location and analytical results for pesticides remaining in surface soil and subsurface soil, respectively, above removal action RGs. Tables 3-2 and 3-4 evaluated pesticide concentrations in surface and subsurface soils, respectively, and provided the number of RG exceedances for each pesticide. Using information obtained from these figures and tables, a summary of nature and extent of pesticide contamination at the site is provided below. Additionally, summary results for metals, VOCs, and PAHs will be provided.

The pesticides chlordane, DDT, DDD, DDE and dieldrin were distributed through the PSF site, at depths down to at least 4.5 feet at relatively low concentrations. The presence of heptachlor was also detected, but on a much less frequent basis. In surface soil remaining at the site, only one sample remains with a pesticide concentration above the removal action RG (RA-65, located approximately 100 feet east of the fence lines) with a dieldrin concentration of 0.158 mg/kg and a DDT and metabolite concentration of 2.472 mg/kg. This is shown on Figure 3-2. As noted in Section 3.1.2, removal action RGs for surface soil were used to guide subsurface soil excavation. However, as will be discussed in Section 4, these surface soil RGs were very conservative estimates. As shown in Table 3-4, 12 exceedances of the surface soil RGs were identified in subsurface soil (nine for chlordane, one for DDT, and two for heptachlor). Figure 3-4 shows the locations of the subsurface samples remaining at the site which exceeded the removal action RGs. Section 4 presents a Residual Risk Assessment based on existing soils data and utilizing more appropriate subsurface RGs to evaluate the nature and extent of contamination remaining at the site.

Of the metals, lead was found to occur in subsurface samples at elevated concentrations at two locations. For each subsurface soil sample analyzed for metals, arsenic was detected, typically at low concentrations. Arsenic, chromium, and lead were found to exceed the high-end Fort Riley background soil concentrations in some PSF soil samples. However, none of these metals were found individually to cause excessive risk as determined by the Residual Risk Assessment discussed in Section 4. As discussed in Section 2.1, background soil samples for arsenic at Fort Riley were detected in the range of 1.2 to 7.1 mg/kg. Arsenic detected in surface soils at the PSF did not exceed 4.6 mg/kg which was within the range of Fort Riley background concentrations. Because levels of arsenic were not detected in the surface soils elevated above the range of background concentrations, arsenic sampling results were not mapped. The only VOCs detected in the soil samples were toluene and benzene. Toluene was more frequently found at the shallower subsurface depths, while benzene was limited to deeper soils.

PAHs were detected in a small number of subsurface samples. The greatest number and highest concentrations of these compounds were found in two subsurface soil samples. The PAHs detected in subsurface soils during the RI field investigation occurred mostly in the areas where soil has been removed and replaced by clean fill during the removal action.

3.2 GROUNDWATER DATA EVALUATION

As part of the RI activities, four rounds of groundwater samples were collected from the five PSF site wells (LAW, 1993a). A fifth round of samples was collected in September 1994. The following subsections evaluate site groundwater quality based on these five previous rounds of sampling and discuss site-specific hydrogeology using groundwater elevations data obtained during the September 1994 sampling event.

3.2.1 Evaluation of Constituent Concentrations in Groundwater for Selected Inorganics

The RI Report (LAW, 1993a) was conditionally approved in April 1994 by the KDHE (KDHE, 1994). General comments included in the approval letter indicated KDHE concerns pertaining to detected concentrations of arsenic, beryllium, nitrate, and thallium in some PSF groundwater samples. USEPA Region VII review comments addressing the RI report recommended additional sampling for thallium and nitrates. Except for nitrate, these constituents were detected infrequently at concentrations of concern during PSF sampling events, and available data presented in the RI Report (LAW, 1993a) relating the detected range of PSF concentrations to local Fort Riley background concentrations were inconclusive. A summary of the results obtained from the baseline (July 1992) through third quarter (May 1993) sampling events was presented in Table 1-3. The results from the baseline and first three rounds were presented in the RI and are summarized in Section 4 of this report. Additional groundwater sampling and analyses of the wells (one background and four downgradient) at the PSF was performed in September 1994. The complete sampling results were included in the Quality Control Summary Report, September 1994 Ground-Water Sampling Event, dated November 1994 (LAW, 1994d). Appendix D of this report provides a positive analytical results summary for the baseline and four subsequent rounds of sampling at the five PSF site wells. Results of the September 1994 sampling round and a comparison to previous results for these constituents of concern are discussed below.

Table 3-8 identifies the potential constituents of concern per the BLRA of the RI report and provides analytical results (total and dissolved) for these constituents from the September 1994 sampling event. Total and dissolved metals were analyzed for comparison. Dissolved metals are more representative of a filtered drinking water, and are expected to have concentrations not exceeding total levels, which are affected by the turbidity in the sample. Total and dissolved concentrations were comparable, except that, in some instances at concentration levels near the detection limit, dissolved metals were detected when total metals were not. It is not uncommon to observe positive detections for dissolved metals near the method detection limit when total metals were not detected when using the graphite furnace method of analysis (e.g., USEPA Method 7841 for thallium). This uncertainty also can result in reported concentrations for dissolved metals at concentrations slightly higher than the total metal results. Normal uncertainties and variations inherent in the analysis method result in allowed variations of plus or minus 10 percent at concentration levels greater than five times the method detection limit. As the metal concentration approaches the method detection limit, however, the uncertainty associated with each measurement increases. In general, a variation of two times the method detection limit can be expected and is considered within acceptable tolerances of current methods. Professional judgment, however, must also be considered, especially when additional constituents are present in the sample at concentrations known to cause interferences and possibly bias the analysis results.

Specific to the potential chemicals of concern during the September 1994 sampling event, total or dissolved antimony, arsenic, beryllium, cadmium, chromium, and vanadium were not detected at the five site wells. Total barium was detected in each well at concentrations ranging from 0.040 mg/L (PSF92-02) to 0.14 mg/L (PSF92-01). Dissolved concentrations of barium were consistent with the observed total concentration levels. Total manganese was detected in wells PSF92-03 and PSF92-05 at concentrations of 0.021 and 0.017 mg/L, respectively, and dissolved concentrations detected in these wells were comparable with total concentrations. Nitrate (as N) was detected in each well at concentrations ranging from 5.9 mg/L (PSF92-01) to 12 mg/L (PSF92-04). Pesticides were not detected above the laboratory detection limit (0.00005 mg/L) in any samples. During previous sampling events, the laboratory reporting limit was also established at 0.00005 mg/L and no pesticide detections were reported. Inorganic chloride was detected in each well at concentrations ranging from 31 mg/L (PSF92-01) to 62 mg/L (PSF92-05). Sulfate was detected in each well at concentrations ranging from 100 mg/L (PSF92-04 and PSF92-05) to 240 mg/L (PSF92-02).

Thallium was analyzed using USEPA Method 7841 with a detection limit of 0.001 mg/L. Thallium was detected in the background well PSF92-01 at a total concentration of 0.0024 mg/L. Dissolved thallium was not detected in the background well during the September 1994 sampling

TABLE 3-8

ANALYTICAL DATA SUMMARY TABLE
POTENTIAL CONSTITUENTS OF CONCERN IN GROUNDWATER
SEPTEMBER 1994
Pesticide Storage Facility
Fort Riley, Kansas

TEST METHOD/PARAMETER	METHOD PQL	PSF92-01 27-SEP-94	PSF92-02 26-SEP-94 SAMPLE	PSF92-02 26-SEP-94 DUPLICATE	PSF92-03 27-SEP-94	PSF92-04 27-SEP-94	PSF92-05 27-SEP-94
E300							
Nitrate as N	5.0	5.9	9.2 JL	9.1 JL	11	12	9.4
Inorganic Chloride	5.0	31	44	44	47	49	62
Sulfate	25.0	160	240	230	160	100	100
SW6010/SW3005 (Dissolved)/(Total)							
Barium	0.013/0.013	0.13/0.14	0.042/0.040	0.041/0.042	0.058/0.059	0.086/0.093	0.12/0.12
Beryllium	0.005/0.005	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050
Cadmium	0.005/0.005	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050
Chromium	0.001/0.0032	<0.0032/<0.0032	<0.0032/<0.0032	<0.0032/<0.0032	<0.0032/<0.0032	<0.0032/<0.0032	<0.0032/<0.0032
Manganese	0.015/0.015	<0.015/<0.015	<0.015/<0.015	<0.015/<0.015	0.021/0.021	<0.015/<0.015	<0.015/0.017
Vanadium	0.05/0.05	<0.050/<0.050	<0.050/<0.050	<0.050/<0.050	<0.050/<0.050	<0.050/<0.050	<0.050/<0.050
SW7041/SW3020 (Dissolved)/(Total)							
Antimony	0.0050/0.0050	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050	<0.0050/<0.0050
SW7060/SW3020 (Dissolved)/(Total)							
Arsenic	0.010/0.010	<0.010/0.010	<0.010/<0.010	<0.010/<0.010	<0.010/<0.010	<0.010/<0.010	<0.010/<0.010
SW7841/SW3020 (Dissolved)/(Total)							
Thallium	0.0010/0.0010	<0.0010/0.0024	<0.0010/<0.0010	<0.0010/<0.0010	<0.0010/<0.0010	<0.0010/<0.0010	0.0011/<0.0010

All units in mg/L.

DATA QUALIFICATION FLAGS

JL = Estimated quantitation; possibly biased low or a false negative based on QC data event. Total thallium was not detected in the four downgradient wells; however, dissolved thallium was reported at 0.0011 mg/L in well PSF92-05, just above the laboratory reporting limit (0.001 mg/L).

Analysis for thallium is complicated by several additional factors including spectral and chemical interferences, as noted in Winge, et al. Thallium is typically analyzed at 276.79 nm. At this wavelength, there are spectral interferences from iron (276.75 nm) and magnesium (276.85 nm). These interferences are very common components of soil and water and known to be prevalent in the Fort Riley area. The presence of these interferences may cause thallium results to be positively biased at these concentrations near the detection limit. High levels of calcium, magnesium, and sodium may also indicate the presence of chloride which is a chemical interferant for thallium. Chloride may cause "smoke" during the analysis or other surface effects which could also produce positive bias for thallium results. At Fort Riley, these interferences caused by high background levels of calcium (180 to 300 mg/L), magnesium, (28 to 50 mg/L) and sodium (52 to 130 mg/L) were noted in the May 5-6 1993 (third quarter) samples from wells PSF92-02 and PSF92-03. As stated in the September 10, 1993 case narrative letter provided in Appendix L of the RI Report (LAW, 1993a), the well PSF92-02 and duplicate (PSF92-06) samples from this well were reported at 0.0029 and 0.0016 mg/L, respectively during reanalysis of these samples. The original analyses of these samples were reported at 0.0017 mg/L and nondetect, respectively. Results from well PSF92-03 were reported at 0.0013 mg/L during reanalysis, and 0.0025 mg/L from the original analysis as discussed in the case narrative letter.

The best technology currently available for reduction of these interferences is the use of Zeeman background correction and innovative use of matrix modifiers. The classical modifier for thallium is sulfuric acid, but it does not yield the best results. In recent years, palladium or nickel nitrate have been found to guarantee better results. In 1993, the PSF samples were analyzed using sulfuric acid as the modifier. Samples were analyzed from September using a mixture of palladium and magnesium nitrate as a modifier for thallium. Therefore, the 1994 sampling results are likely to have less uncertainty than the 1993 analyses, due to better control of interferences. Interferences as discussed, however still result in uncertainty and the results reported may be positively biased at levels near the detection limit.

Table 3-9 summarizes the analytical results for potential constituents of concern detected in the background well PSF92-01 over the first four sampling rounds and includes sampling results from well PSF92-01 and the two wells at Building 354 from September 1994. Inorganic chloride and sulfate concentrations are also reported in the table. Table 3-10 presents for comparison the maximum concentration of these constituents detected in these background wells, the frequency of constituents detected in the downgradient wells, the range of detected concentrations observed during the five sampling periods and the MCLs. A discussion of these results with the September 1994 results for the constituents of concern is provided below.

TABLE 3-9

ANALYTICAL DATA SUMMARY TABLES
BACKGROUND GROUNDWATER CONCENTRATIONS (WELL PSF92-01)
Pesticide Storage Facility
Fort Riley, Kansas

Chemical of Concern	Baseline	First Quarter	Second Quarter	Third Quarter	September 1994(1)
Total Metals					
Antimony	<0.031	<0.022	0.022	<0.0022	<0.005
Arsenic	<0.002	<0.002	<0.002	ND	<0.010-0.039
Barium	0.1	0.12	0.16	0.2	0.14-1.1
Beryllium	0.0014	0.002	0.002	0.002	<0.005
Cadmium	<0.005	<0.005	<0.005	0.004	<0.005
Chromium	0.01	<0.010	<0.010	ND	<0.0032
Manganese	0.026	0.024	0.022	0.034	<0.015-0.52
Thallium	<0.100	<0.063	<0.063	<0.001	0.0024-0.0025
Vanadium	0.0083	0.011	0.006	ND	<0.050
Wet Chemical Inorganics					
Nitrate (as N)	4.5	3.8	6.4	2.2	5.9-10.0
Inorganic Chloride	10.3	63.5	129	147	31-100
Sulfate	84.7	70.8	52.2	52.9	130-160

Note: All units in mg/L.
(1) Range includes samples from Well PSF92-01 and the two wells sampled at Building 354 (TS029201 and TS029202).

TABLE 3–10

CHEMICALS OF POTENTIAL CONCERN DETECTED IN GROUNDWATER SAMPLES
BASELINE THROUGH SEPTEMBER 1994 SAMPLES
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	Maximum Concentration Detected in Background Wells (1)	Frequency of Detection (a)	Method Detection Limit	Range of Detected Concentrations			MCL Concentration
Total Metals (mg/L):							
Antimony	0.022	1/20	0.005–0.031	<0.031	–	0.032	0.006
Arsenic	0.039	5/20	0.002–0.010	< 0.002	–	0.016	0.050
Barium	1.1	20/20	0.005	0.042	–	0.13	2.0
Beryllium	0.002	15/20	0.002–0.005	< 0.0020	–	0.005	0.004
Cadmium	0.004	2/20	0.004–0.005	<0.004	–	0.006	0.005
Chromium	0.01	2/20	0.01	< 0.01	–	0.014	0.10
Manganese	0.52	18/20	0.015	<0.015	–	0.091	0.05 (s)
Thallium	0.0025	2/20	0.001 – 0.100	< 0.001	–	0.0029	0.002
Vanadium	0.011	4/20	0.007 – 0.050	< 0.007	–	0.027	NE
Wet Chemical Inorganics (mg/L):							
Nitrate (as N)	10.0	19/20	0.2	<0.2	–	165	10.0
Inorganic Chloride	147	20/20	0.2 – 5	38.5	–	399	250 (s)
Sulfate	160	20/20	0.2 – 25	100	–	386	250 (s)

ND = Not detected at concentrations greater than or equal to the Method Detection Limit.
NE = MCL not established for this constituent.
(a) Frequency does not include the detections in the background well. Number of samples in which the chemical was positively detected divided by the number of samples available.
(s) Secondary MCL.
(1) Includes concentrations detected in Well PSF92–01 during the five sampling rounds at the PSF and the Building 354 Wells TS029201 and TS029202 sampled September 1994.

Total antimony was detected twice during the first four sampling rounds, once in the background well PSF92-01 at a concentration of 0.022 mg/L (2/3/93) and once in PSF92-05 at a concentration of 0.032 mg/L (2/3/93). Total antimony was not detected from any PSF site well during the September 1994 sampling event. It should be noted that total antimony was analyzed utilizing USEPA Method 6010 for the first four sampling rounds. This method had a detection limit of 0.031 mg/L during the baseline event (July 1992) and a detection limit of 0.022 mg/L during the first through third quarter (November 1992 - May 1993). During the September 1994 sampling event, USEPA Method 6010 was specified for the analysis, but the laboratory used USEPA Method 7041, which had a lower detection limit of 0.005 mg/L.

Total arsenic concentrations detected in the site wells have decreased consistently since the baseline sampling event. The September 1994 data continues this decline, with all wells analyzing at nondetect.

Total barium has been detected in the background and all downgradient wells during all five sampling rounds. Concentrations of total barium remain consistent with background conditions and baseline concentrations.

Total beryllium has been detected in 15 of the 20 samples at concentrations ranging from 0.001 to 0.005 mg/L. Total beryllium was not detected in any PSF wells during the September 1994 sampling round. Concentrations of beryllium remained consistent with background conditions and baseline concentrations.

Total cadmium was only detected during the third quarter sampling event in wells PSF92-01 (background), PSF92-04, and PSF92-05 at concentrations of 0.004 mg/L, 0.004 mg/L, and 0.006 mg/L, respectively. Total cadmium was not detected during the September 1994 sampling round.

Inorganic chloride exceeded the maximum detected background concentrations of 147 mg/L in three of the five samples collected from well PSF92-02 during the five sampling rounds. The maximum detected background concentration for inorganic chloride was not exceeded by samples collected from wells PSF92-03, PSF92-04, and PSF92-05 during the five sampling rounds.

Total chromium was detected once in the background well and twice in downgradient wells during the first four sampling rounds. Total chromium was not detected during the September 1994 sampling round. Concentrations of total chromium remained consistent with background conditions and baseline concentrations.

As discussed in Section 1.5.3, baseline concentrations of total manganese were slightly above background concentrations, but concentrations of total manganese in subsequent sampling events were consistent with baseline concentrations. Total manganese was detected in the September 1994 sampling event at concentrations consistent with baseline concentrations and the background conditions.

First quarter, third quarter, and September 1994 nitrate concentrations were consistent with baseline concentrations. During the second quarter, nitrate showed an increase from two and one-half to five times in all samples except PSF92-01. However, as discussed in Section 1.5.3, discrepancies were noted for nitrate in one water sample, and the second quarter nitrate results were not confirmed by the Corps of Engineers - Missouri River Division (CEMRD) QA lab (CEMRD, 1993). Thus, uncertainty pertaining to these elevated second quarter results exists. The September 1994 results for nitrate confirmed that the high levels of nitrates observed during the second quarter (February 1993) are not consistently present in the PSF aquifer.

The maximum detected background concentration for sulfate was 160 mg/L collected from PSF92-01 during the September 1994 sampling round. This background concentration was not exceeded by samples collected from PSF92-04 or PSF92-05 during the five sampling rounds. The maximum detected background concentration for sulfate was exceeded by five of five samples from PSF92-02 and four of five samples from PSF92-03.

Thallium was analyzed utilizing USEPA Method 7060, with a detection limit from 0.063 to 0.100 mg/L, during the first three sampling rounds (baseline and first two quarters) and was not detected. After the second quarter samples were collected, the MCL for thallium was lowered to 0.002 mg/L, and the method of analysis for the third quarter and September 1994 sampling rounds was changed to USEPA Method 7841, with a detection limit of 0.001 mg/L. At this lower detection limit, total thallium was observed in two downgradient wells during the third quarter sampling event (PSF92-02 at 0.0029 mg/L and PSF92-03 at 0.0025 mg/L). Total thallium was detected in only the upgradient well at a concentration of 0.0024 mg/L during the September 1994 sampling event. These results indicated that thallium was detected at similar concentrations and frequencies in the upgradient and downgradient wells at the site.

Total vanadium has been detected at concentrations ranging from non-detect to 0.027 mg/L in downgradient wells. Concentrations of total vanadium remained consistent with background conditions.

Pesticides were analyzed but not detected above the detection limits during any sampling rounds.

Further evaluation of current groundwater data is presented in Section 4, the Residual Risk Assessment. Current groundwater data are evaluated in conjunction with available groundwater data from all sampling rounds.

3.2.2 Summary of Constituents Detected in Groundwater

This section summarizes the groundwater sampling results discussed in the previous section. Groundwater concentrations detected at the PSF are also compared to the MCLs and to upgradient background concentrations.

Four rounds of groundwater sampling from the five PSF wells were conducted during RI activities, and a fifth sampling round was conducted in September 1994. Groundwater analytical results indicated that metals, nitrate, inorganic chloride, and sulfate were the main constituents detected during these sampling events. As discussed in the previous section, ten constituents of potential concern were identified in the BLRA. These constituents were antimony, arsenic, barium, beryllium, cadmium, chromium, manganese, nitrate, thallium, and vanadium. In general, in comparing the September 1994 analytical results to the previous results, the results were consistent with the low concentrations and frequencies of detections for these constituents of concern previously detected. In downgradient wells, arsenic, barium, and chromium did not exceed the MCL in any samples, and vanadium did not exceed its RG in any sample. Antimony, beryllium, and cadmium exceeded the respective MCLs on one occasion over the five sampling rounds; thallium exceeded its MCL two times; manganese exceeded the secondary MCL five times out of the 20 samples obtained during the five sampling events; and nitrate exceeded the MCL on 17 out of 20 occasions.

Beryllium was detected in 15 out of 20 samples collected, and the exposure point concentration (0.0027 mg/L) is less than the MCL (0.004 mg/L). Beryllium exceeded the MCL in one sample (0.005 mg/L) collected from well PSF92-02 during the second round sampling event (February 3, 1993). Beryllium concentrations from well PSF92-02 were consistently detected at concentration levels of 0.002 to 0.003 mg/L during the other four sampling events. During the September 1994 sampling event, beryllium was not detected in the background well and not detected in any downgradient PSF wells. The background well PSF92-01 had beryllium detections which varied from 0.0014 to 0.002 mg/L, with 0.002 mg/L being recorded in three of the five samples. These concentration levels detected in the background well were consistently comparable with the other detections observed from the on-site wells. Considering the narrow range of detected concentrations (small standard deviation), the single exceedance of the MCL with an exposure point concentration less than the MCL, and that beryllium was not detected in any wells in September 1994, beryllium can be attributed to natural background conditions.

During September 1994 manganese was detected at concentrations of 0.52 mg/L and 0.079 mg/L in wells TS029202 and TS029201, respectively, at Building 354. These wells and the upgradient well PSF92-01 provided upgradient background data for comparison with the on-site wells. Manganese was only detected in downgradient wells PSF92-03 (at 0.029 mg/L) and PSF92-05 (0.017 mg/L) during the September 1994 sampling event, and was not detected in well PSF92-01. Data available from the five sampling rounds conducted at the PSF shows that manganese levels in downgradient wells were detected at concentrations less than 0.52 mg/L in 20 out of 20 samples, and only the baseline (July 16, 1992) sample from well PSF92-03, at 0.091 mg/L exceeded the 0.079 mg/L concentration. This data indicates that manganese levels observed at the PSF can be attributed to natural background levels.

Uncertainty exists pertaining to elevated levels of nitrate detected in the second quarter. Nitrate levels were detected at concentrations from 2.5 to 5 times the ranges detected during the other sampling rounds. A laboratory QA sample from this second quarter for nitrate was also reported at a concentration of less than 0.01 mg/L when the sample result was reported at 50.6 mg/L. During the two subsequent sampling events (May 1993 and September 1994), nitrate levels returned to concentrations consistent with baseline concentrations. The second quarter nitrate results are an anomaly not consistent with typical site conditions.

Total thallium was detected in the background well during the September 1994 sampling event, at a concentration similar to the previous downgradient concentrations, thus indicating that thallium levels above MCLs may be naturally occurring background conditions at the PSF. Additional evidence of these background concentrations in Fort Riley groundwater was observed in groundwater sampling conducted at other areas of Fort Riley. Thallium was detected at comparable levels in three wells representing background conditions in the Southwest Funston Landfill area. These were at well SFL92-102 sampled October 28, 1994, with a dissolved thallium level of 0.0011 mg/L; well SFL92-303, sampled May 6, 1993, with a total thallium concentration of 0.0017 mg/L, and well AEHA-MW5, at 0.001 mg/L dissolved thallium, sampled on September 14, 1993. Thallium was also detected in the Building 354 wells on September 28, 1994; well TS029201 at 0.0025 mg/L when sampled for both dissolved and total thallium, and well TS029202 at 0.0026 mg/L dissolved thallium. These results further confirm that the thallium levels observed at the PSF area represent background conditions occurring at Fort Riley.

Pesticides were not detected in PSF groundwater above the laboratory reporting limit during any of the sampling rounds including the September 1994 sampling event.

3.3 SITE-SPECIFIC HYDROGEOLOGY

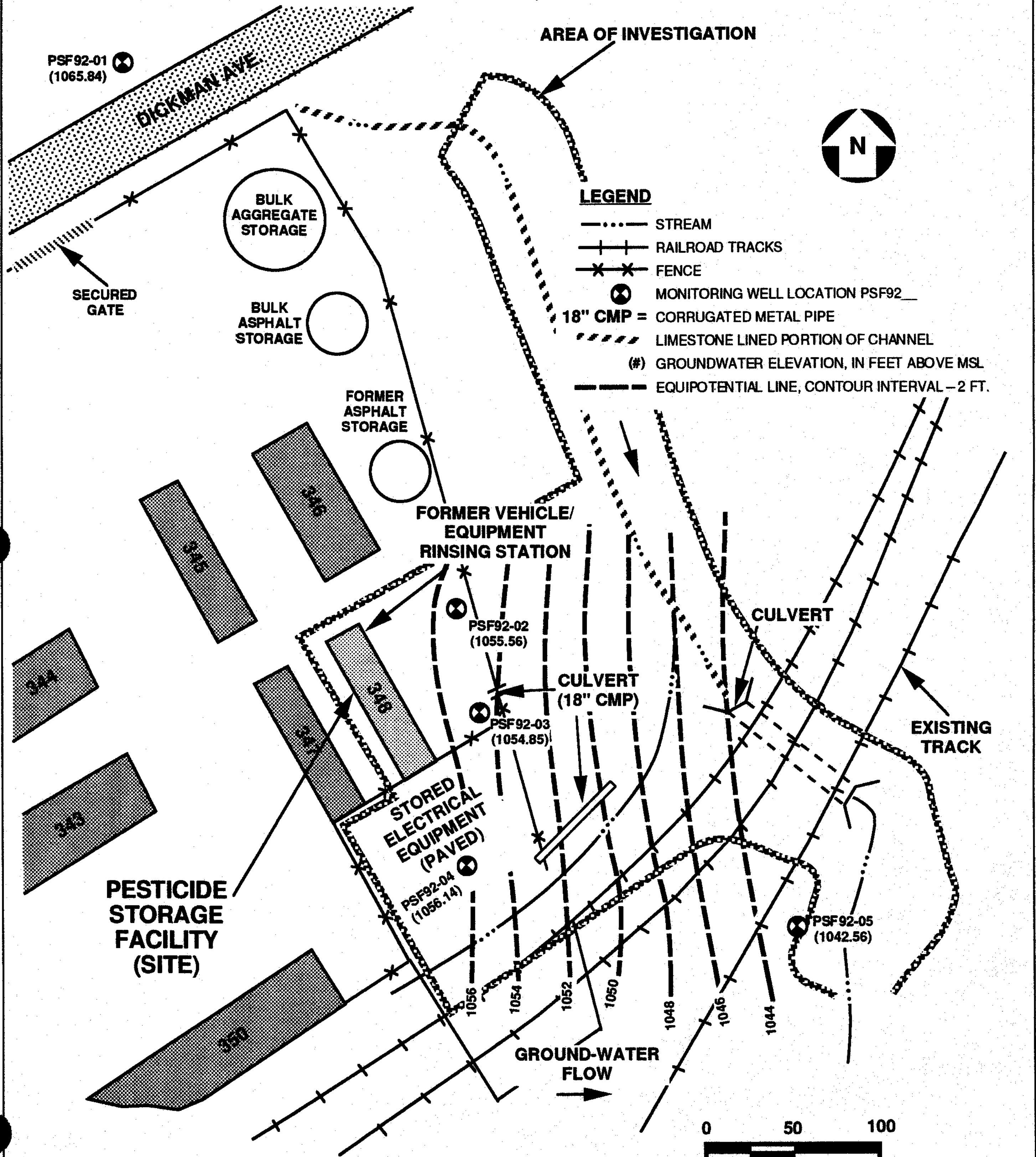
Site-specific hydrogeology based on groundwater data from December 1992 and presented in the RI Report was discussed in Section 1.2.7.2. In September 1994, groundwater levels were measured, and based on the groundwater elevations in the five site wells, the calculated direction of flow was determined to be east-southeast with a gradient of approximately 0.07 ft/ft which is consistent with the baseline conditions. The direction of flow was derived by performing three point calculations on grouped wells PSF92-02, PSF92-04, and PSF92-05. This is toward the Kansas River and appears to follow the approximate dip of the bedrock surface and the general topographic trends. Groundwater elevations for the five site wells and gradient contours are presented on Figure 3-5.

A summary of the monitoring well water levels observed during the sampling events completed at the PSF is presented in Table 3-11 to show the water level variations recorded at the site. As seen in this table, differences in the water levels varied from a maximum 5.81 feet in well PSF92-05 to a minimum 1.62 feet in well PSF92-04. As seen from the data recorded water levels consistently decreased in the direction toward the Kansas River which is east-southeast from the site.

FIGURE 3-5

POTENTIOMETRIC SURFACE MAP – SEPT. 1994

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



2536-0308.14

TABLE 3-11

GROUNDWATER LEVELS MEASURED IN MONITORING WELLS
Pesticide Storage Facility
Fort Riley, Kansas

Well Identification	Groundwater Elevations				
	Baseline July 14-23, 1992	First Quarter November 5, 1992	Second Quarter February 3, 1993	Third Quarter May 5-6, 1993	September 1994 September 26-27, 1994
PSF92-01	1062.57	NA	1064.12	1065.57	1065.84
PSF92-02	1055.33	NA	1056.51	1058.64	1055.56
PSF92-03	1055.13	NA	1055.51	1057.29	1054.85
PSF92-04	1054.92	NA	1055.43	1056.54	1056.14
PSF92-05	1041.95	NA	1043.39	1047.76	1042.56

NA - Data not available

A range of estimated well yields in the uppermost aquifer at the PSF was also calculated using methods given in Driscoll, 1986. In addition to this range, the average estimated yield was calculated, using the average of the estimated hydraulic conductivity and assumed average aquifer thickness. The uppermost aquifer is the alluvial material overlying the limestone and shales encountered at the site. The information used in the calculation of estimated well yield was derived from the data gathered during the installation of the five groundwater monitoring wells at the PSF in 1992, and from well slug test data collected from the wells and interpreted during RI field activities. A pump test which is the proper method for determining the yield was not performed at the site. Therefore, the yield estimates were calculated by making assumptions and using the available data from the RI, as described below.

The depth to rock in the five PSF monitoring wells ranged from an estimated 38 feet in PSF92-01 to approximately 28 feet in wells PSF92-02, PSF92-03, and PSF92-05. The saturated thickness of the alluvial material encountered in the well borings ranged from approximately 12.27 feet at PSF92-01 to 5.53 feet at PSF92-02. The calculated hydraulic conductivities derived from the slug test data interpretations presented in the RI ranged from 1.17×10^{-4} ft/min to 1.03×10^{-3} ft/min.

A range of estimated transmissivity of the alluvial material at the PSF was obtained by multiplying the range of observed saturated thickness (aquifer thickness) by the calculated hydraulic conductivities given above. The resulting transmissivities ranged from 0.93 ft^2/day to 18.2 ft^2/day. These values were used in conjunction with the observed aquifer thicknesses at the PSF to determine an estimated yield for a well installed in the PSF area. Well yield is the volume of water per unit of time discharged from a well, either by pumping or free flow (Driscoll, 1986). Assumptions made during the analysis included:

- Depth of water in well during pumping was 1 foot (conservative estimate; assumes almost total drawdown in well).

- Radius of well was assumed to be 0.25 feet (assumes a well diameter of 6 inches).

- The radius of the cone of depression at the pumping well was assumed to be 500 feet (this is a conservative estimate developed through the use of a sensitivity analysis of the effect of this value on well yield).

- Time of pumping was assumed to be 1 year of continuous pumping (conservative estimate, as most water wells are not pumped constantly).

- The uppermost alluvium was assumed to be unconfined; in accordance with Driscoll (1986), a storativity of 7.5×10^{-2} was used.

The range of well yield at the Fort Riley PSF site in gallons per minute (gpm) derived from the analyses was from approximately 0.12 to 5.2 gpm. These calculated yields are based on conservative assumptions, and may therefore be higher than would be observed if an aquifer test were performed in the uppermost alluvial deposits at the PSF.

To provide an estimate of the "average" well yield at the PSF site, using the available data, calculations were repeated using the average of hydraulic conductivities and aquifer thicknesses observed from the data. The "average" estimate of well yield calculated for the uppermost aquifer at the PSF site was 0.9 gpm, based on an estimated average hydraulic conductivity of 5.7×10^{-4} ft/min and an assumed average aquifer thickness of 7 feet. Well yields of 1 to 2 gpm were reported previously in the RI Report. These values are within the range predicted by this more rigorous analysis.

3.4 CONTAMINANT FATE AND TRANSPORT

Physical and chemical information concerning the transport and fate of contaminants is used to identify the potential migration routes for the environmental contamination. The fate and transport of constituents detected in site media is discussed in Section 5 of the RI Report (LAW, 1993a). This fate and transport information is summarized in the following paragraphs and in Tables 3-12 and 3-13.

The primary environmental migration routes for chemicals at the site are dependent upon the physical characteristics of the chemicals. In general, the pesticides and PAHs detected in site soils have low water solubilities and high K_{oc} values, indicating that these constituents have a high affinity for binding to soil particles, and a low potential for transfer to groundwater or surface water (ATSDR, 1987-1993; Howard, 1991). Almost without exception, the pesticides detected at the site bind strongly to soils, and resist displacement from the soil particle even under prolonged leaching tests. This binding process appears to occur regardless of soil type (i.e., organic content of soil) and pH (ATSDR, 1987-1991; Howard, 1991). Similarly, the high K_{OC} values and low water solubilities of the PAHs detected at the site indicate that these constituents would also remain bound to soil.

The assumption that these compounds are immobile in soil is substantiated by the fact that no pesticides or PAHs were detected in the groundwater and surface-water samples collected from the site during the RI investigation. Pesticides in groundwater have not been confirmed at the PSF, including the September 1994 groundwater samples. Detectable pesticide concentrations have been present in the PSF site's soil for at least 20 years; the 1974 study performed by USAEHA confirmed the presence of pesticides within site soils. If leaching to groundwater was a significant transport pathway for these compounds, pesticides would have been detected in the site's groundwater samples.

TABLE 3-12

ORGANIC CONTAMINANT FATE AND TRANSPORT DATA
Pesticide Storage Facility
Fort Riley, Kansas

CONSTITUENT	MOLECULAR WEIGHT (g/mole)	SOLUBILITY IN WATER (mg/L) (25 +/- 5° C)	ref.	VAPOR PRESSURE (atm) (25 +/- 5° C)	ref.	SPECIFIC GRAVITY (25 +/- 5° C)	ref.	HENRY'S LAW CONSTANT (atm-m^3/mole) (25 +/- 5° C)	ref.	LOG K_{oc}	ref.	LOG K_{ow}	ref.
VOLATILES:													
Benzene	78.11	1.80E+03	1	1.25E-01	1	0.87	1	5.48E-03	1	1.92	1	1.95	1
Carbon Disulfide	76.13	1.70E+03	1	4.74E-01	1	1.26	1	2.12E-02	1	2.47	1	1.84	1
1,2-Dichloropropane	112.99	2.70E+03	1	6.58E-02	1	1.56	1	2.94E-03	1	1.71	1	2.28	1
Methylene Chloride	84.93	1.67E+04	1	5.99E-01	1	1.33	1	2.18E-03	1	0.94	1	1.25	1
1,1,2,2-Tetrachloroethane	167.85	2.97E+03	1	1.05E-02	1	1.59	1	4.56E-04	1	2.56	1	2.56	1
Toluene	92.14	5.24E+02	1	2.89E-02	1	0.86	1	6.74E-03	1	2.06	1	2.50	1
Trichloroethene	131.39	1.10E+03	1	9.55E-02	1	1.46	1	9.10E-03	1	2.03	1	2.60	1
SEMI-VOLATILES:													
Acenaphthene	154.21	3.47E+00	1	2.04E-06	1	1.02(a)	1	7.92E-05	1	1.25	1	3.92	1
Alpha-chlordane	409.78	5.10E-02	1	3.00E-06	3	ND		ND		5.57	1	5.93	1
Anthracene	178.24	7.30E-02	1	2.24E-08	1	1.29	1	1.77E-05	1	4.27	1	4.45	1
Benzo(a)anthracene	228.30	9.40E-03	1	1.45E-10	1	1.27	1	2.29E-08	1	6.14	1	5.90	1
Benzo(b)fluoroanthene	252.32	1.20E-03	1	6.58E-10	1	ND		1.20E-05	1	5.74	1	6.57	1
Benzo(k)fluoroanthene	252.32	5.50E-04	1	1.26E-13	1	ND		1.04E-03	1	6.64	1	6.85	1
Benzo(g,h,i)perylene	276.34	2.60E-04	1	1.33E-13	1	ND		1.40E-07	1	6.89	1	7.10	1
Benzo(a)pyrene	252.32	3.80E-03	1	7.22E-12	1	1.35	1	2.40E-06	1	5.95	1	5.81	1
Bis(2-ethylhexyl)phthalate	390.00	4.00E-01	1	8.16E-11	1	0.99	1	1.10E-05	1	5.00	1	4.20	1
Chrysene	228.30	2.00E-03	1	8.29E-12	1	1.27	1	7.26E-20	1	5.39	1	5.61	1
4,4'-DDD	320.05	9.00E-02	1	1.34E-09	1	1.48	1	2.16E-05	1	4.64	1	5.99	1
4,4'-DDE	319.03	1.20E-02	1	8.54E-09	1	ND		2.34E-05	1	5.34	1	5.77	1
4,4'-DDT	354.49	3.10E-03	1	1.32E-10	1	1.56(b)	1	5.20E-05	1	5.38	1	5.98	1
Dibenzofuran	168.20	1.00E+01	1	ND		1.09(c)	1	ND		4.00	1	4.17	1
2,4-Dichlorophenol	163.00	4.50E+03	1	1.17E-04	1	1.38(b)	1	3.23E-06	1	2.94	1	3.15	1
Dieldrin	380.91	2.00E-01	1	2.37E-10	1	1.75	1	3.18E-05	1	4.08	1	4.66	1
Diethylphthalate	222.24	1.08E+03	1	2.18E-06	1	1.12	1	8.46E-07	1	1.84	1	2.47	1

TABLE 3-12

ORGANIC CONTAMINANT FATE AND TRANSPORT DATA
Pesticide Storage Facility
Fort Riley, Kansas

CONSTITUENT	MOLECULAR WEIGHT (g/mole)	SOLUBILITY IN WATER (mg/L) (25 +/- 5^{o} C)	ref.	VAPOR PRESSURE (atm) (25 +/- 5^{o} C)	ref.	SPECIFIC GRAVITY (25 +/- 5^{o} C)	ref.	HENRY'S LAW CONSTANT (atm-m^3/mole) (25 +/- 5^{o} C)	ref.	LOG K_{oc}	ref.	LOG K_{ow}	ref.
<u>SEMI-VOLATILES: (cont'd)</u>													
Endrin Aldehyde	380.92	2.60E-01	1	2.63E-10	1	ND		3.86E-07	1	4.43	1	5.60	1
Fluoranthene	202.26	2.36E-01	1	6.58E-09	1	1.25(d)	1	1.69E-02	1	4.62	1	5.22	1
Fluorene	166.22	1.69E+00	1	1.36E-06	1	1.20(d)	1	2.10E-04	1	3.70	1	4.18	1
Gamma-chlordane	409.78	1.85E+00	3	3.90E-06	3	ND		ND	1	5.48	1	8.69	1
Heptachlor	373.32	5.60E-02	1	5.26E-07	1	1.66	1	2.30E-03	1	4.34	1	4.40	1
Heptachlor Epoxide	389.32	2.70E-01	1	3.42E-09	1	ND		3.20E-05	1	4.32	1	3.65	1
Indeno(1,2,3-cd)pyrene	276.34	6.20E-02	1	1.32E-13	1	ND		2.96E-20	1	7.49	1	5.97	1
Malathion	330.36	1.45E+02	2	5.26E-08	2	ND		1.20E-07	2	3.26	4	2.89	2
Methoxychlor	345.66	4.50E-02	1	ND		1.41	1	ND		4.90	1	4.40	1
2-Methylnaphthalene	142.20	2.46E+01	1	ND		1.01	1	ND		3.87	1	3.86	1
Phenanthrene	178.24	1.18E+00	1	8.95E-07	1	1.18	1	2.56E-05	1	4.36	1	4.46	1
Pyrene	202.26	1.32E-01	1	3.29E-09	1	1.27	1	1.09E-05	1	4.80	1	5.09	1
2,4,6-Trichlorophenol	197.45	1.20E+03	1	2.89E-05	1	1.68	1	1.76E-07	1	2.85	1	3.85	1

1. Montgomery and Welkom (1990).
2. Superfund Public Health Evaluation Manual (1986).
3. ATSDR, Toxicology Profiles (1988-91).
4. Rao and Hornsby (1989).
a. Data obtained at 90 +/- 4^{o} C.
b. Data obtained at 15 +/- 4^{o} C.
c. Data obtained at 99 +/- 4^{o} C.
d. Data obtained at 0 +/- 4^{o} C.
ND - No data

TABLE 3-13

METAL CONTAMINANT FATE AND TRANSPORT DATA
Pesticide Storage Facility
Fort Riley, Kansas

CONSTITUENT	MOLECULAR WEIGHT (g/mole)	AQUATIC BIOCONCENTRATION FACTOR (BCF)	ref.
Aluminum	26.98	ND	
Arsenic	79.92	4.40E+01	1
Barium	137.33	ND	
Beryllium	9.01	1.90E+01	1
Cadmium	112.40	8.10E+01	1
Calcium	40.08	ND	
Chromium	51.99	1.60E+00	1
Copper	63.55	2.00E+02	1
Iron	55.85	ND	
Lead	207.20	4.90E+01	1
Magnesium	24.31	ND	
Manganese	54.94	ND	
Mercury	200.59	5.50E+03	1
Nitrate	62	ND	
Potassium	39.10	ND	
Selenium	78.96	1.60E+01	1
Silver	107.87	3.08E+03	1
Sodium	22.99	ND	
Thallium	204	ND	
Vanadium	50.94	ND	
Zinc	65.37	4.70E+01	1

1. Superfund Public Health Evaluation Manual (1986)
ND – No data

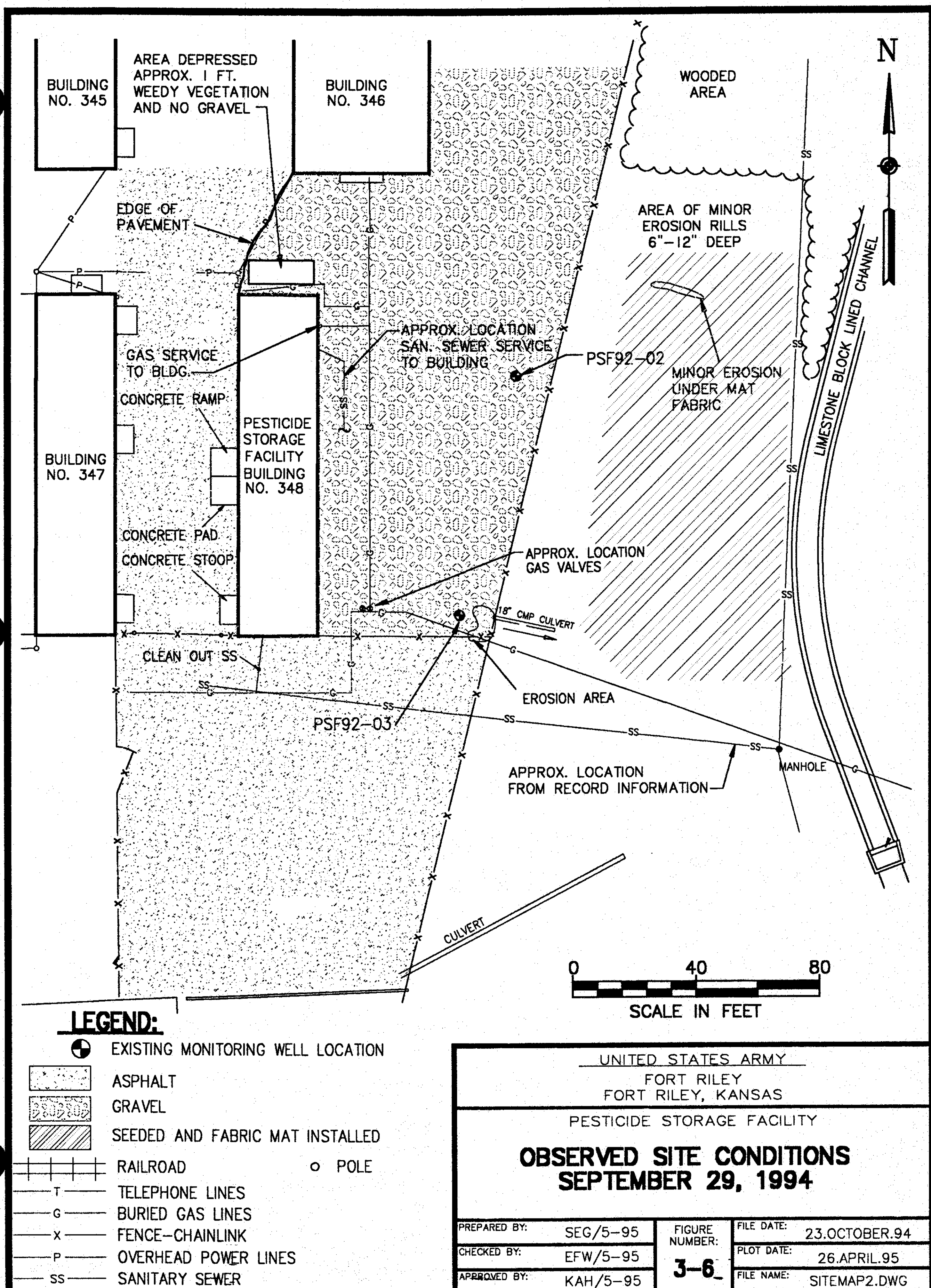
Because pesticides and PAHs are likely to remain bound to soil particles, secondary transport pathways include the transportation of adsorbed contaminants on soil particles by storm or surface-water run-off to sediments, and the subsequent transportation of these sediments to points downstream. Soil particles containing sorbed contaminants may also be dispersed as airborne particulates.

The VOCs detected in site soils are slightly water soluble. Therefore, they may leach into the groundwater or, if present in the upper surface soils, volatilize into the atmosphere. The low levels of VOCs detected in site soils are unlikely to affect the groundwater column to a great extent; modelling of the low VOC concentrations to groundwater is also considered unnecessary for the site.

For metals, the primary and secondary transport pathways in site soils are similar to the pathways discussed above, with the addition of water soluble species leaching to ground and surface water.

3.5 CURRENT SITE CONDITIONS

On September 29, 1994, the site was visited to observe current conditions. The following site description was based on visual observations made during the visit. Land surfaces had been regraded to generally follow the land surfaces existing prior to the removal action. In some areas slope transitions appeared to be modified to provide a more uniform slope. The land surfaces immediately around Building 348 consisted of graveled areas north and east of the building, and asphalted areas west and south of the building (Figure 3-6). Immediately north of the building was a 7-foot wide area depressed about 1 foot, with weeds and no gravel. At the time of the site visit, this area had not been backfilled after completion of the removal action in anticipation of possible repairs to be made to the portion of the gas line in the vicinity of this depressed area. This portion of the gas line had been damaged during the removal action. A small area of erosion (approximately 25 square feet) was observed at the 18-inch corrugated metal pipe (CMP) culvert inlet near the southeast corner of the fenced area. Drainage from the paved area south of the PSF site would flow northward to this culvert. Gas valves were observed near the southeast corner of the building. Erosion rills, approximately 6 to 12 inches deep, were observed along the northern boundary of the clearing limits east of the fence location. During storms, drainage from between Buildings 346 and 348 would be collected and flow through this area toward the east. Grass was observed growing in the area on which the removal action contractor had placed fabric and seeded. Some minor erosion was observed in a few areas under the fabric near its northern limits. Although not observed in the site visit, the approximate location of a sanitary sewer discovered during removal action excavations is shown on Figure 3-6. As previously stated in Section 2.3, potential soil contamination from the sewer was not observed.



BUILDING NO. 345
AREA DEPRESSED APPROX. 1 FT. WEEDY VEGETATION AND NO GRAVEL
BUILDING NO. 346
WOODED AREA
N
EDGE OF PAVEMENT
AREA OF MINOR EROSION RILLS 6"-12" DEEP
GAS SERVICE TO BLDG.
APPROX. LOCATION SAN. SEWER SERVICE TO BUILDING
PSF92-02
MINOR EROSION UNDER MAT FABRIC
LIMESTONE BLOCK LINED CHANNEL
CONCRETE RAMP
BUILDING NO. 347
PESTICIDE STORAGE FACILITY BUILDING NO. 348
CONCRETE PAD
CONCRETE STOOP
APPROX. LOCATION GAS VALVES
18" CMP CULVERT
CLEAN OUT SS
EROSION AREA
PSF92-03
MANHOLE
APPROX. LOCATION FROM RECORD INFORMATION
CULVERT
0 40 80
SCALE IN FEET
LEGEND:
EXISTING MONITORING WELL LOCATION
ASPHALT
GRAVEL
SEEDED AND FABRIC MAT INSTALLED
RAILROAD
POLE
TELEPHONE LINES
BURIED GAS LINES
FENCE-CHAINLINK
OVERHEAD POWER LINES
SANITARY SEWER
UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS
PESTICIDE STORAGE FACILITY
OBSERVED SITE CONDITIONS
SEPTEMBER 29, 1994
PREPARED BY: SEG/5-95
CHECKED BY: EFW/5-95
APPROVED BY: KAH/5-95
FIGURE NUMBER: 3-6
FILE DATE: 23.OCTOBER.94
PLOT DATE: 26.APRIL.95
FILE NAME: SITEMAP2.DWG

4.0 RESIDUAL RISK ASSESSMENT

This section presents the results of the residual risk assessment for the PSF at Fort Riley, Kansas. The risk assessment addresses the risk that remains at the site after completion of the Removal Action, and is an addendum to the RI Report (LAW, 1993a). This residual risk assessment includes a human health risk assessment and consideration of ecological risks due to potential exposures at the PSF site.

Because an extensive risk assessment has already been conducted for this site (LAW, 1993a), and in an effort to present only the risk information necessary to make informed decisions about the site, this residual risk assessment was conducted as a "streamlined" version of a baseline risk assessment. To this end, information that has not changed from the RI Report (LAW, 1993a) has been presented in summary form only in this residual risk assessment. For example, information presented in summary form only includes the fate and transport (Section 3) and toxicity assessment sections of the risk assessment. In addition, residual risks to human health have been calculated only for pathways for which risks were estimated to be equal to or greater than 1×10^{-6} (for carcinogens) or 1 (for noncarcinogens) in the RI (LAW, 1993a). Because exposure point concentrations decreased as a result of the Rapid Response Removal Action (with a couple of minor exceptions), this approach is still considered to be conservative. (Based on the screening "points of departure," and the risks estimated in the BLRA, the pathways assessed in this current risk assessment represent approximately 90 to 99 percent of the risks at the site.) The residual risk assessment has been streamlined in this manner so that the assessment can be focused on the pathways with the greatest potential to result in adverse health effects.

The groundwater exposure scenarios and associated risks are presented in Section 4.2 for information purposes only. Potential risks to human health due to hypothetical use of the uppermost aquifer beneath the site as a source of potable water are considered. This is because an adequate existing water supply currently serves the area, the aquifer is not currently used as a water supply, and its low yield make the uppermost aquifer an unlikely source of potable water in the future.

4.1 HUMAN HEALTH RISK ASSESSMENT - SOIL AND SEDIMENT

4.1.1 Introduction

The objective of this residual human health risk assessment is to examine the effects on exposed and potentially exposed populations following the soil removal action. The risk assessment approach used to evaluate potential impacts to human health as a result of soil and sediment contamination remaining at the PSF is consistent with the BLRA and with the approach presented in the USEPA "Risk Assessment Guidance for Superfund" document (USEPA, 1989a). The results of this residual human health risk assessment will be used to decide whether further remedial action is necessary at the PSF site.

The human health risk assessment consists of four steps, listed below. These four elements of the risk assessment are conducted in the following sections.

1. Identification of Chemicals of Concern
2. Exposure Assessment
3. Toxicity Assessment
4. Risk Characterization

4.1.2 Identification of Chemicals of Concern

For the purpose of this residual risk assessment, the chemicals remaining in the soil and sediment at the site have been retained as chemicals of concern (COCs) (Table 4-1). The results of the most recent soil sampling efforts were presented in Section 3. The soil and sediment data are from samples obtained during the removal action (OHM, 1994) and from site characterization activities performed as part of the RI Report (LAW, 1993a). Areas that were excavated to a depth of 2 feet or more during the Rapid Response removal action, and then backfilled, have been considered subsurface soil in the residual risk assessment. Other areas (i.e., not excavated or excavated to a depth of less than 2 feet) are considered to be surface soil unless covered by pavement or concrete.

The soil and sediment data used have been evaluated, as follows, and are considered to be adequate for risk assessment purposes and to present a picture of current site conditions. The RI field data were subjected to a data quality evaluation as discussed in the RI report. Removal action soil data were analyzed using USEPA Method 8080 for pesticides, and reported detection limits were found to be less than the removal action RG concentrations. Quality assurance samples during confirmation sampling conducted after excavations were completed during the removal action were evaluated by the Corps of Engineers, Missouri River Division Laboratory for compliance with Corps data quality standards (CEMRD, 1994). The QA samples met the Corps' HTW reporting requirements, and the information provided supported the quality of the data.

4.1.3 Exposure Assessment

An exposure assessment consists of the characterization of the exposure setting, identification of potential exposure pathways, and quantification of potential exposures to site-related contaminants of concern. As mentioned previously, only the exposure pathways for which risks were greater than or equal to 1×10^{-6} (for carcinogens) or 1 (for noncarcinogens) in the RI

TABLE 4-1

CHEMICALS DETECTED IN SOIL SAMPLES
DETECTION FREQUENCIES AND CONCENTRATION RANGES
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER	Frequency of Detection	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)
SURFACE SOIL SAMPLES:			
Chlorinated Pesticides:			
Chlordane	17/52	0.0207	1.12
DDD	7/18	0.0237	0.454
DDE	12/18	0.0356	0.847
DDT	35/52	0.012	1.29
Dieldrin	20/52	0.007	0.158
Heptachlor	2/52	0.004	0.0093
SUBSURFACE SOIL SAMPLES:			
Metals:			
Arsenic	31/31	0.4	20
Barium	29/29	35	190
Chromium	29/29	4.6	20
Lead	25/29	4.7	770
Mercury	1/29	--	0.1
Silver	3/29	0.9	1.2
Chlorinated Pesticides:			
Chlordane	41/126	0.0051	10.2
DDD	16/100	0.0013	0.925
DDE	31/101	0.0104	0.666
DDT	42/126	0.011	1.95
Dieldrin	12/126	0.007	0.077
Heptachlor	8/126	0.0012	0.3
Volatile Organics:			
Benzene	2/29	0.0059	0.0066
Methylene chloride	13/29	0.011	0.031
Toluene	7/29	0.0059	0.038
Semi-Volatile Organics:			
Benzo(a)anthracene	3/29	0.11	0.33
bis(2-Ethylhexyl)phthalate	3/29	0.41	1.2
Chrysene	3/29	0.11	0.29
Diethylphthalate	1/29	--	0.43
Fluoranthene	3/29	0.18	0.53
Phenanthrene	2/29	0.23	0.25
Pyrene	5/29	0.11	0.57

Note: Information presented is based on site conditions following the removal action. Values reported are for total chlordane which includes the sum of alpha-chlordane and gamma-chlordane.

(LAW, 1993a) were addressed in this residual risk assessment. However, a brief discussion of potentially exposed receptors is presented below.

Potentially Exposed Populations

The PSF site is located within the DEH yard. It is situated on an escarpment on the north side of the Kansas River Valley, approximately 2,000 feet west of the Kansas River, on the southeast edge of the Main Post cantonment area. The area immediately surrounding and including the PSF is moderately industrial/commercial in nature. The DEH yard includes areas used to perform vehicle and heavy equipment maintenance, and is also used for the storage of vehicles, equipment, and supplies. The DEH yard is enclosed by a fence and a gate that is locked after normal work hours.

Currently, the PSF site is inactive. Pesticides and related materials are now stored in the new pesticide building located approximately 1,500 feet from the site. Future land use is expected to be very similar to the current and historical uses. The portion of the Building 348 structure used for pesticide and herbicide storage will be examined and "closed" as appropriate. This action may or may not involve demolition of the structure and/or its floor slab and foundation. While not planned or expected at this time, the demolition of Building 348 (with and without reconstruction) is also a future possibility.

On the basis of established land use patterns at the site, (an active military installation), residential land use of the site is extremely unlikely. Also, the site is elevated only 10 to 15 feet above the Kansas River flood plain and is not protected by a levee. Finally, Fort Riley's master plan does not include residential development of the PSF site or the surrounding area (DEH, 1993c). Therefore, an on-site residential scenario was not developed for the residual risk assessment.

The human populations that are potentially exposed to the residual contamination at the site are those persons who may come into contact with the soil or sediment at the site. Due to the industrialized nature of the PSF site, and the fact that the DEH yard is restricted (i.e., fenced and secured), utility workers, landscaping crews, or on-site workers are the most likely human receptors for exposure to the soils at the PSF site. Site workers or landscapers may also contact contaminated sediments while performing maintenance or landscaping activities in the lined channel located east of the site. Construction workers would be potentially exposed to subsurface soil during future activities related to the possible demolition of Building 348.

Base residential housing areas exist within 0.5 miles of the PSF site. However, it is unlikely that on-post residents would come in contact with site media during recreational activities (i.e., running or jogging) due to the restricted nature of the DEH yard and the overgrowth present in the contaminated areas outside the fence.

Similarly, children living in the nearby housing areas are unlikely to be exposed to site contamination during play or exploration activities because playgrounds are provided for the children's recreational use. The equipment present on these playgrounds include swing sets, a set of rings, see-saws, a slide, a tennis court, a basketball hoop, plus two activity centers. Therefore, it is unlikely that children would travel to the PSF site to play on a regular basis. Also, children have not been observed playing near the DEH yard. However, in order to conservatively estimate exposures at the site, a children's recreational scenario has been included for evaluation.

Risks for the receptors discussed above have been quantified for the appropriate media (i.e., soil or sediment). The exposure pathways for which residual risks will be estimated for each of the receptors and media are shown on Table 4-2. As described previously, these exposure scenarios are those for which risks were estimated to be equal to or greater than 1 x 10^{-6} or 1 in the RI Report.

Quantification of Exposure

Quantifying potential exposures requires estimating the magnitude, frequency, and duration of exposure for the populations and exposure pathways selected for quantitative evaluation. This step is typically conducted in two stages: first, exposure point concentrations are estimated; second, pathway-specific intakes are estimated. The exposure point concentrations and intake variable values are selected so that the combination of variables results in an estimate of reasonable maximum exposure (RME) for each pathway. An RME is the maximum exposure that is reasonably expected to occur at a site. The RME approach is designed to present exposure estimates that are "protective and reasonable," but not the worst possible case (USEPA, 1989a).

The exposure point concentrations used to estimate risks are the 95th percent upper confidence limit (UCL) on the arithmetic mean of the concentrations detected. If the UCL is greater than the maximum detected concentration, then the maximum detected concentration is used as the exposure point concentration (USEPA, 1989a).

For scenarios involving potential exposure to surface soil, the exposure point concentrations were calculated using data from samples obtained from a depth of less than 2 feet below original ground surface. Similarly, data from samples obtained from 2 feet or more below original ground surface were used to calculate exposure point concentrations for potential exposures to subsurface soils. The only exception to this is that the sample obtained from below the asphalt at the southwest corner of Building 348 (SB-02) was included in the subsurface soil data set even though it was obtained at a depth of less than 2 feet. This is because the soil at this location is not readily accessible, and it is reasonable to assume that exposure at this location would be associated with construction activities. The concentrations used to calculate potential risks due to exposure to surface soil, subsurface soil, and sediment are presented on Table 4-3.

Pathway-specific intakes were estimated by identifying a series of variables that describe the exposed population. These variables typically include contact rate (e.g., soil ingestion rate), exposure frequency, exposure duration, and body weight. The specific calculation procedures and variables used in this residual risk assessment to estimate pathway-specific intakes are the

TABLE 4–2

EXPOSURE PATHWAYS
Pesticide Storage Facility
Fort Riley, Kansas

Medium	Receptor	Exposure Route
Surface Soil	Current Landscaper	Dermal Contact
	Current Site Worker	Dermal Contact, Incidental Ingestion
	Current Utility Worker	Dermal Contact
	Future Construction Worker	Dermal Contact, Incidental Ingestion
	Future Landscaper	Dermal Contact
	Future Recreational Child	Dermal Contact
	Future Site Worker	Dermal Contact, Inhalation of Fugitive Dust, Incidental Ingestion
	Future Utility Worker	Dermal Contact
Subsurface Soil	Current Landscaper	Dermal Contact
	Current Utility Worker	Dermal Contact
	Future Construction Worker	Dermal Contact
	Future Landscaper	Dermal Contact
	Future Utility Worker	Dermal Contact
Sediment	Future Site Worker	Dermal Contact

TABLE 4–3

ESTIMATED EXPOSURE POINT CONCENTRATIONS
Pesticide Storage Facility
Fort Riley, Kansas

Medium	Exposure Pathway	Parameter	Exposure Concentration	Comments
Surface Soils	Incidental Ingestion, Inhalation of Fugitive Dust, Dermal Contact	Chlordane	0.12 mg/kg	From removal action surface soil analytical results (see UCL Tables in Appendix A)
		4,4'–DDD	0.45 mg/kg* (1)	
		4,4'–DDE	0.37 mg/kg	
		4,4'–DDT	1.3 mg/kg* (2)	
		Dieldrin	0.040 mg/kg	*When the 95% UCL exceeded the maximum detected concentration, the maximum concentration was used as the exposure point concentration.
		Heptachlor	0.0022 mg/kg	(1) Value is from Sample I.D. 18801–060. (2) Value is from Sample I.D. 19084–005.
Subsurface Soils	Dermal Contact	Chlordane	0.22 mg/kg	From removal action and RI subsurface soil analytical results (see UCL Tables in Appendix A.)
		4,4'–DDD	0.017 mg/kg	
		4,4'–DDE	0.033 mg/kg	
		4,4'–DDT	0.15 mg/kg	
		Dieldrin	0.0048 mg/kg	
		Heptachlor	0.0029 mg/kg	
		Benzene	0.0023 mg/kg	
		Methylene Chloride	0.019 mg/kg	
		Toluene	0.0067 mg/kg	
		Benzo[a]anthracene	0.11 mg/kg	
		bis(2–Ethylhexyl)phthalate	0.33 mg/kg	
		Chrysene	0.092 mg/kg	
		Diethylphthalate	0.24 mg/kg	
		Fluoranthene	0.13 mg/kg	
		Phenanthrene	0.11 mg/kg	
		Pyrene	0.12 mg/kg	
		Arsenic	4.6 mg/kg	
		Barium	110 mg/kg	
		Chromium	8.4 mg/kg	
		Lead	100 mg/kg	
		Mercury	0.054 mg/kg	
		Silver	0.46 mg/kg	

TABLE 4–3

ESTIMATED EXPOSURE POINT CONCENTRATIONS
Pesticide Storage Facility
Fort Riley, Kansas

Medium	Exposure Pathway	Parameter	Exposure Concentration	Comments
Sediments				
	Dermal Contact	Chlordane	0.086 mg/kg	From RI sediment analytical results (see UCL Tables in Appendix A.)
		4,4'–DDD	0.059 mg/kg	
		4,4'–DDE	0.055 mg/kg	
		4,4'–DDT	0.096 mg/kg	
		Dieldrin	0.013 mg/kg	
		Benzo[a]anthracene	0.15 mg/kg	(Note: Samples SD1A and SD1B were not included in the statistical analysis for metals; these are background samples for inorganics.)
		Chrysene	0.18 mg/kg	
		Phenanthrene	0.21 mg/kg	
		Arsenic	2.8 mg/kg	
		Barium	120 mg/kg	
		Cadmium	1.8 mg/kg	
		Chromium	17 mg/kg	
		Lead	150 mg/kg	
		Mercury	0.24 mg/kg	

Note: Exposure point concentration calculations are presented in Appendix A.

same as those in the RI Report (LAW, 1993a). The variable values used to estimate intakes in the RI Report for future exposure scenarios were reevaluated for this residual risk assessment. Because these variable values are based on an estimation of a reasonable worst-case scenario, and because the future use of the site is not certain, they have been judged to still be representative of the potential magnitude of future exposures. Because the site is currently inactive, the variable values used to estimate intakes for the "current" scenarios (retained in this residual risk assessment for consistency with the RI Report) represent an overestimation of actual current exposures.

The absorption factors used in this Residual Risk Assessment for pesticides detected in the soil differ from those used in the RI (LAW, 1993a), in which 100 percent was used. These new absorption factors represent the upper bound proportion of the pesticides that would be retained in the skin (ATSDR, 1987-1993), and were approved for use in this residual risk assessment by USEPA Region VII (LAW, 1994b). The absorption rates used for the chemicals of concern in the soil are:

- Inorganics (0.01, or 1 percent) - USEPA 1992b
- Volatile and semi-volatile organic compounds (1, or 100 percent)
- Chlordane and heptachlor (0.109, or 10.9 percent) - ATSDR 1989 and 1991, respectively
- DDD, DDE, and DDT (0.378, or 37.8 percent) - ATSDR 1993
- Dieldrin (0.077, or 7.7 percent) - ATSDR 1989

The variable values used to estimate intakes were obtained from site-specific sources, when available (LAW, 1993a). These sources included the Senior Post Controller, Pesticide Workers, Materials Coordinator, DEH Chief of Maintenance, and the Grounds Foreman for the DEH at Fort Riley. When site-specific information regarding potential exposure-related activities was not available, standard default exposure values from the "Supplemental Guidance to the Human Health Evaluation Manual" (USEPA, 1991) were used to calculate chemical-specific intakes. To estimate chemical-specific intakes for each pathway, the exposure variables were multiplied by the exposure point concentrations. The specific variable values used to estimate intakes are presented, by exposure pathway, in Appendix A. The chemical-specific intake estimates are also presented, by pathway, in Appendix A.

4.1.4 Toxicity Assessment

The Toxicity Assessment is an integral part of the risk assessment. For this residual risk assessment, the Toxicity Assessment consists of a summary of the applicable toxicity information for the chemicals of concern (Tables 4-4 and 4-5 for noncarcinogens and carcinogens, respectively). A discussion of the toxicology of the contaminants of concern is presented in the RI (LAW, 1993a). The hierarchy of sources used to obtain the toxicity information is that suggested by USEPA (USEPA, 1989a), and is listed below:

- Integrated Risk Information System (IRIS)
- Health Effects Assessment Summary Tables (HEAST)
- USEPA Environmental Criteria and Assessment Office (ECAO)
- USEPA Criteria Documents
- Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles

Toxicity information for the dermal exposure route is typically not available. Therefore, in accordance with USEPA Region VII guidance (USEPA, 1992a), oral reference doses (RfDs) and cancer slope factors (CSFs) were used directly as dermal toxicity values.

4.1.5 Risk Characterization

The risk characterization integrates the results of the exposure and toxicity assessments into quantitative and qualitative expressions of risk. To characterize potential noncarcinogenic risks, the estimated chemical intakes are compared to (i.e., divided by) the RfDs and reference concentrations (RfCs) for the COCs. To characterize potential carcinogenic risks, the estimated chemical intakes are multiplied by the chemical-specific slope factors for the COCs. These risk quantitation methods, and the results of the risk characterization, are discussed and presented in the following sections.

4.1.5.1 Noncarcinogenic Effects Characterization - Noncarcinogenic effects are characterized by comparing the estimated chemical intakes to the appropriate RfD or RfC value. The RfD and RfC values are, by definition, an estimate of a daily exposure level for the human population that is likely to be without appreciable risk of deleterious effects. Therefore, when the estimated chronic daily intake of a chemical exceeds the appropriate RfD/RfC, there may be a concern for

TABLE 4-4

TOXICITY VALUES FOR CHRONIC NONCARCINOGENIC EFFECTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	Chronic RfD (mg/kg-day)	Confidence Level[a]	Critical Effect	Uncertainty Factor[b]	Source	Study[c]
Oral Route:						
Chlordane	6.0E-05	low	Regional liver hypertrophy in females	1000	IRIS	Velsicol Chem. Co., 1983
4,4'-DDD	no data				IRIS	
4,4'-DDE	no data				IRIS	
4,4'-DDT	5.0E-04	medium	Liver lesions	100	IRIS	Laug, 1950
Dieldrin	5.0E-05	medium	Liver lesions	100	IRIS	Walker, 1989
Heptachlor	5.0E-04	low	Liver weight increases	300	IRIS	Velsicol Chem. Co., 1955
Benzene	no data					
Methylene chloride	6.0E-02	medium	Histological alterations of the liver	100	IRIS	National Coffee Ass., 1982
Toluene	2.0E-01	medium	Changes in liver and kidney weights	1000	IRIS	NTP, 1989
Benzo[a]anthracene	no data				IRIS	
bis(2-Ethylhexyl)phthalate	2.0E-02	medium	Increased relative liver weights	1000	IRIS	Carpenter, 1953
Chrysene	no data				IRIS	
Diethylphthalate	8.0E-01	low	Altered organ weights	1000	IRIS	Brown, 1978
Fluoranthene	4.0E-02	low	Liver weight increases	3000	IRIS	USEPA, 1978
Phenanthrene	no data				IRIS	
Pyrene	3.0E-02	low	Kidney effects	3000	IRIS	USEPA, 1989
Aluminum	2.9E+00				EPA	
Arsenic	3.0E-04	medium	Hyperpigmentation, keratosis, vascular complications	3	IRIS	Tseng, 1977
Barium	7.0E-02	medium	Increased blood pressure	3	IRIS	Wones, 1990
Beryllium	5.0E-03	low	No adverse effects	100	IRIS	Schroeder & Mitchner, 1975
Cadmium	1.0E-03 (food) 5.0E-04 (water)	high	Significant proteinuria	10	IRIS	USEPA, 1985
Chromium	5.0E-03	low	No effects reported	500	IRIS	Mackenzie, 1958
Lead	no data				IRIS	
Manganese	1.4E-01 (food) 5.0E-03 (water)		Central nervous system effects	1	IRIS	WHO, 1973
Mercury	pending (3.0E-04)		Kidney effects	1000	HEAST	USEPA, 1988
Selenium	5.0E-03	high	Clinical selenosis	3	IRIS	Yang, 1989
Silver	withdrawn (5.0E-03)	low	Argyria	3	IRIS	Gaul & Staud, 1935
Thallium	7.0E-05	low	Increased levels of SGOT & LDH	3000	IRIS	USEPA, 1986
Vanadium	9.0E-03	low	Decreased hair cystine	100	IRIS	Stokinger, 1953
Nitrate	1.6E+00	high	Methemoglobinemia	1	IRIS	Walton, 1951

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TABLE 4-4

TOXICITY VALUES FOR CHRONIC NONCARCINOGENIC EFFECTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	Chronic RfD (mg/kg-day)	Confidence Level[a]	Critical Effect	Uncertainty Factor[b]	Source	Study[c]
<u>Inhalation Route:</u>						
Chlordane	pending				IRIS	
4,4'-DDD	no data				IRIS	
4,4'-DDE	no data				IRIS	
4,4'-DDT	no data				IRIS	
Dieldrin	no data				IRIS	
Heptachlor	no data				IRIS	
Benzene	1.4E-04				EPA	
Methylene chloride	8.6E-01		Liver toxicity	100	HEAST	Nitschke, 1988
Toluene	1.1E-01	medium	Neurological effects	300	IRIS	Foo, 1990
Benzo[a]anthracene	no data				IRIS	
bis(2-Ethylhexyl)phthalate	no data				IRIS	
Chrysene	no data				IRIS	
Diethylphthalate	no data				IRIS	
Fluoranthene	no data				IRIS	
Phenanthrene	no data				IRIS	
Pyrene	no data				IRIS	
Aluminum	no data				IRIS	
Arsenic	no data				IRIS	
Barium	pending (1.4E-04)		Fetotoxicity	1000	HEAST	USEPA, 1984
Beryllium	no data				IRIS	
Cadmium	pending				IRIS	
Chromium	pending				IRIS	
Lead	no data				IRIS	
Manganese	1.4E-05	medium	Increased prevalence of respiratory symptoms and psychomotor disturbances	300	IRIS	Roels, 1992
Mercury	pending (8.6E-05)		Neurotoxicity		HEAST	USEPA, 1990
Selenium	no data				IRIS	
Silver	no data				IRIS	
Thallium	no data				IRIS	
Vanadium	no data				IRIS	
Nitrate	no data				IRIS	

(a) Confidence Level (i.e., high, medium, or low) as reported in IRIS
(b) Uncertainty Factors (UF) are assigned by USEPA in multiples of 10 based on the following limitations in the database used to develop the RfC/RfD:
A - Animal to human extrapolation (UF of 10)
H - Variations in human sensitivity (UF of 10)
S - Extrapolation from a subchronic NOAEL instead of a chronic NOAEL (UF of 10)
L - Extrapolation from a LOAEL to a NOAEL (UF of 10)

Withdrawn - Withdrawn (from IRIS) as a result of further review
Pending - Under review by an EPA work group

Source: IRIS = Integrated Risk Information System (10/94)
HEAST = Health Effects Assessment Summary Tables (FY-1994 Annual)

(c) Study used to develop the RfD or RfC, as cited by IRIS and/or HEAST.

TABLE 4-5

TOXICITY VALUES FOR POTENTIAL CARCINOGENIC EFFECTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	Slope Factor [a] (kg-day/mg)	Weight of Evidence Classification [d]	Type of Cancer	Source[e]	Study[e]
Oral Route:					
Chlordane	1.3E+00	B2	Liver tumors	IRIS	NCI, 1979
4,4'-DDD	2.4E-01	B2	Lung, liver, and thyroid tumors in rodents	IRIS	Tomatis, 1974
4,4'-DDE	3.4E-01	B2	Liver tumors, liver cancer, and thyroid tumors	IRIS	Rossi, 1983
4,4'-DDT	3.4E-01	B2	Liver tumors	IRIS	Cabral, 1982
Dieldrin	1.6E+01	B2	Liver cancer	IRIS	Walker, 1972
Heptachlor	4.5E+00	B2	Liver tumors	IRIS	NCI, 1977
Benzene	2.9E-02	A	Increased incidence of nonlymphocytic leukemia	IRIS	Wong, 1983
Methylene chloride	7.5E-03	B2	Increased incidence of hepatocellular neoplasms	IRIS	NTP, 1986
Toluene	no data			IRIS	
Benzo[a]anthracene	1.1E+00 *	B2	Tumors in mice via various routes	IRIS	Wislocki, 1986
bis(2-Ethylhexyl)phthalate	1.4E-02	B2	Increases in liver tumor responses	IRIS	NTP, 1982
Chrysene	2.9E-02 *	B2	Malignant lymphoma, skin cancers, in mice	IRIS	Wislocki, 1986
Diethylphthalate	no data			IRIS	
Fluoranthene	no data			IRIS	
Phenanthrene	no data			IRIS	
Pyrene	no data			IRIS	
Aluminum [b]	no data			EPA	
Arsenic	1.8E+00	A	Skin cancer	EPA	
Barium	no data			IRIS	
Beryllium	4.3E+00	B2	Lung cancer in rats/monkeys via inhalation	IRIS	Schroeder & Mitchener, 1975
Cadmium	no data			IRIS	
Chromium [c]	no data			IRIS	
Lead	no data	B2	Renal tumors, affects gene expression	IRIS	
Manganese	no data			IRIS	
Mercury	no data			IRIS	
Selenium	no data			IRIS	
Silver	no data			IRIS	
Thallium	no data			IRIS	
Vanadium	no data			IRIS	

TABLE 4–5

TOXICITY VALUES FOR POTENTIAL CARCINOGENIC EFFECTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	Slope Factor [a] (kg–day/mg)	Weight of Evidence Classification [d]	Type of Cancer	Source[e]	Study[e]
Inhalation Route:					
Chlordane	1.3E+00	B2	Liver tumors	IRIS	USEPA, 1986
4,4'–DDD	no data			IRIS	
4,4'–DDE	no data			IRIS	
4,4'–DDT	3.4E–01	B2	Liver tumors	IRIS	USEPA, 1985
Dieldrin	1.6E+01	B2	Liver cancer	IRIS	USEPA, 1986
Heptachlor	4.6E+00	B2	Liver tumors	IRIS	USEPA, 1986
Benzene	2.9E–02	A	Increased incidence of nonlymphocytic leukemia	IRIS	Wong, 1983
Methylene chloride	1.6E–03	B2	Increased incidence of hepatocellular neoplasms	IRIS	NTP, 1986
Toluene	no data			IRIS	
Benzo[a]anthracene	no data			IRIS	
bis(2–Ethylhexyl)phthalate	no data			IRIS	
Chrysene	no data			IRIS	
Diethylphthalate	no data			IRIS	
Fluoranthene	no data			IRIS	
Phenanthrene	no data			IRIS	
Pyrene	no data			IRIS	
Aluminum [b]	no data			EPA	
Arsenic	1.5E+01	A	Lung cancer	IRIS	Lee–Feldstein, 1983
Barium	no data			IRIS	
Beryllium	8.4E+00	B2	Lung cancer in rats/monkeys (inh)	IRIS	Wagoner, 1980
Cadmium	6.3E+00	B1	Carcinogenic in mice by various routes	IRIS	Thun, 1985
Chromium [c]	4.2E+01	A	Lung cancer	IRIS	Mancuso, 1975
Lead	no data	B2	Renal tumors, affects gene expression	IRIS	
Manganese	no data			IRIS	
Mercury	no data			IRIS	
Selenium	no data			IRIS	
Silver	no data			IRIS	
Thallium	no data			IRIS	
Vanadium	no data			IRIS	
Nitrate	no data			IRIS	

No Data – No value listed in reference
(Values listed in parentheses are from HEAST, and are used in the absence of current IRIS values)
* CSF generated using toxicity equivalency factors, based on benzo[a]pyrene toxicity (see LAW, 1993)
(a) Slope factors provided in terms of unit risk are converted prior to input on this table as follows:
for oral route: UNIT RISK (L/ug) * 1,000 ug/mg * day/2 L * 70 kg = CSF (kg–day/mg)
for inhalation route: UNIT RISK (m^3/ug) * 1,000 ug/mg * day/20 m^3 * 70 kg = CSF (kg–day/mg)
(b) IRIS or HEAST listing not available for this chemical
(c) Value is for hexavalent chromium
(d) Weight of Evidence Classification:
A – Human Carcinogen
B1 – Probable human carcinogen; limited human data available
B2 – Probable human carcinogen; inadequate or no evidence in humans
C – Possible human carcinogen
D – Not classifiable as to human carcinogenicity

Source: IRIS = Integrated Risk Information System (11/91)
HEAST = Health Effects Assessment Summary Tables (FY–1992 Annual)
EPA = Memorandum to Assistant Administrators. Recommended Agency Policy on the Carcinogenicity Risk Associated with the Ingestion of Inorganic Arsenic. USEPA, Office of the Administrator, Washington, D.C. June 21, 1988.

(e) Study used to develop slope factor, as cited by IRIS.

potential noncancer effects from exposure to that chemical. The ratio of the chronic daily intake to the chronic RfD/RfC is referred to as the "hazard quotient" (HQ). Because the USEPA assumes additivity of effects in evaluating potential noncarcinogenic effects from a mixture of chemicals, the chemical-specific HQs are summed. This summation yields an overall pathway risk called a hazard index (HI). If an HI exceeds 1, segregation of the chemicals by effect or mechanism should be considered (USEPA, 1989a).

A summary of the HI estimates, by pathway, is presented in Table 4-6. None of the exposure pathways evaluated had a HI estimate greater than 1, the standard point of departure below which adverse health effects are not expected. The chemical-specific hazard quotient and hazard index calculations are presented, by pathway, in Appendix A.

4.1.5.2 Carcinogenic Risk Characterization - Chemical-specific cancer risks are estimated by multiplying the slope factor by the chronic daily intake estimates, and are interpreted as probabilities of excess cancers as a result of exposure to chemicals from the site. The carcinogenic slope factor correlates estimated total chronic daily intake to incremental cancer risk. The results of the risk characterization are expressed as upper-bound estimates of the potential carcinogenic risk for each exposure point.

To assess the overall potential for cancer effects posed by the mixture of chemicals present at the site, USEPA assumes additivity. Therefore, cancer risks are estimated for each chemical, then the chemical-specific risks are summed to yield an estimate of the overall pathway-specific cancer risk.

A summary of the cancer risk estimates, by pathway, is presented in Table 4-7. None of the exposure pathways evaluated had a risk greater than 1×10^{-6}, the most conservative (i.e., health-protective) point-of-departure typically used to assess unacceptable risk. Chemical-specific risk calculations are presented by pathway in Appendix A.

4.1.6 Uncertainties

There are a number of assumptions required in developing quantitative estimates of risk. These assumptions lend a certain amount of uncertainty to the risk assessment. The assumptions and/or uncertainties are briefly discussed below.

- The exposure point concentrations used in the calculations of risk for surface soil are greater than can be reasonably expected. This is because concentration data were not obtained from areas that were backfilled with clean soil after being excavated during the removal action. This bias in the surface soil data set will tend to cause an overestimation of potential risks due to exposure to surface soil.

TABLE 4-6

SUMMARY OF HAZARD INDICES
SOIL RESIDUAL RISK ASSESSMENT
Pesticide Storage Facility
Fort Riley, Kansas

RECEPTOR	EXPOSURE ROUTE AND MEDII	HAZARD INDEX[a]	BASELINE HAZARD INDEX
Current Site Worker	Incidental Ingestion of surface soil	1E-03	2E-02
Current Site Worker	Dermal contact with surface soil	1E-02	9E+00
Future Site Worker	Incidental ingestion of surface soil	2E-03	6E-02
Future Site Worker	Dermal contact with surface soil	1E-02	3E+01
Future Site Worker	Inhalation of fugitive dust	NA	4E-07
Future Site Worker	Dermal contact with sediments	3E-05	2E-02
Current Utility Worker	Dermal contact with surface soil	2E-05	4E-02
Current Utility Worker	Dermal contact with subsurface soil	5E-06	2E-02
Future Utility Worker	Dermal contact with surface soil	5E-05	2E-01
Future Utility Worker	Dermal contact with subsurface soil	2E-05	7E-02
Current Landscaper	Dermal contact with surface soil	1E-05	1E-02
Current Landscaper	Dermal contact with subsurface soil	4E-06	2E-02
Future Landscaper	Dermal contact with surface soil	5E-05	1E-01
Future Landscaper	Dermal contact with subsurface soil	2E-05	1E-01
Future Construction Worker	Incidental ingestion of surface soil	8E-03	3E-01
Future Construction Worker	Dermal contact with surface soil	6E-03	2E+01
Future Construction Worker	Dermal contact with subsurface soil	2E-03	7E+00
Current/Future Recreational Child	Dermal contact with surface soil	7E-04	2E+00

NA - Not assessed because toxicity data for inhalation of the chemicals of concern (RfCs) were not available.
[a] Estimates based on new site data and revised absorption factors for pesticides.
[b] Hazard Index estimates from the Baseline Risk Assessment (prior to the Rapid Response Removal Action).

TABLE 4-7

SUMMARY OF CANCER RISKS
SOIL RESIDUAL RISK ASSESSMENT
Pesticide Storage Facility
Fort Riley, Kansas

RECEPTOR	EXPOSURE ROUTE AND MEDIU	CANCER RISK[a]	BASELINE CANCER RISK[b]
Current Site Worker	Incidental ingestion of surface soil	2E-07	1E-06
Current Site Worker	Dermal contact with surface soil	1E-06	8E-04
Future Site Worker	Incidental ingestion of surface soil	2E-07	6E-06
Future Site Worker	Dermal contact with surface soil	1E-06	4E-03
Future Site Worker	Inhalation of fugitive dust	2E-10	1E-06
Future Site Worker	Dermal contact with sediments	8E-09	2E-06
Current Utility Worker	Dermal contact with surface soil	2E-09	4E-06
Current Utility Worker	Dermal contact with subsurface soil	1E-09	2E-06
Future Utility Worker	Dermal contact with surface soil	6E-09	2E-05
Future Utility Worker	Dermal contact with subsurface soil	4E-09	8E-06
Current Landscaper	Dermal contact with surface soil	1E-09	1E-06
Current Landscaper	Dermal contact with subsurface soil	1E-09	2E-06
Future Landscaper	Dermal contact with surface soil	5E-09	2E-05
Future Landscaper	Dermal contact with subsurface soil	4E-09	7E-06
Future Construction Worker	Incidental ingestion of surface soil	4E-08	1E-06
Future Construction Worker	Dermal contact with surface soil	2E-08	7E-05
Future Construction Worker	Dermal contact with subsurface soil	2E-08	4E-05
Current/Future Recreational Child	Dermal contact with surface soil	NA	NA

NA - Not assessed because cancer risks are not estimated for children.
[a] Estimates based on new site data and revised absorption factors for pesticides.
[b] Risk estimates from the Baseline Risk Assessment (prior to the Rapid Response Removal Action).

- In evaluating risks from future exposures to soil and sediment contaminants, the assumption was made that future constituent concentrations will remain the same as current concentrations. Dilution, decay, degradation, and attenuation of constituents occurs naturally over time, and site contaminants would thus present a reduced risk in future scenarios.

- While the absorption factors have been revised downward from those used in the RI Report (LAW, 1993a), the use of the revised absorption factors still results in a probable overestimation of exposure. This is because the current absorption factors are derived from studies in which pesticides were dissolved in acetone prior to application; absorption factors derived from studies in which the pesticides were mixed with soil prior to application are approximately an order of magnitude (i.e., 10 times) less than the factors used in the residual risk assessment (ATSDR, 1987-1993).

- The risk estimates for the current scenarios are overestimations because the site is not being used at present. The estimations of risks for the future scenarios probably represent an overestimation because the exposure parameter values used comprise a worst-case scenario.

This risk assessment should not be viewed as an absolute quantitative measure of the risk to public health presented by site-specific contaminants. The assumptions and inherent uncertainties in the risk assessment process do not allow this level of confidence. This risk assessment provides a conservative indication of the potential for risk due to exposure to site-specific chemicals and should help guide the management of the site.

4.1.7 Summary of Soil Residual Risk Assessment

None of the exposure pathways for which risks were assessed in the Residual Risk Assessment exceeded a cancer risk of 1×10^{-6}. Similarly, none exceeded a hazard index of 1. Risk estimates for two pathways, however, were approximately equivalent to 1×10^{-6}. These were potential dermal exposure to surface soil by current and future site workers. Because the potential increased risk at the site resulting from exposure to site-related constituents (including soil, surface-water, and sediment pathways not reevaluated in this Residual Risk Assessment) is less than or equal to the most conservative point of departure used in risk assessment, risks at the site are considered to be within acceptable limits.

4.2 HUMAN HEALTH RISK ASSESSMENT - GROUNDWATER (FOR INFORMATION ONLY)

4.2.1 Introduction

This section presents the results of the risk assessment for hypothetical exposures to the groundwater in the uppermost aquifer at the site. However, as stated in Section 4, these risks are being considered for information purposes only. This is because the uppermost aquifer at the site is not currently being used as a source of potable water - and because its future use for this purpose is considered unlikely. The risk assessment approach used to evaluate these potential impacts to human health is consistent with the approach presented in the USEPA "Risk Assessment Guidance for Superfund" document (USEPA, 1989a) and with the risk assessment conducted as part of the RI Report (LAW, 1993a).

4.2.2 Identification of Chemicals of Concern

The groundwater data used for this residual risk assessment include the data reported in the RI Report, [i.e., baseline (July 1992) through third quarter (May 1993) sampling results], plus the results from the most recent sampling event (September 1994). The same chemicals identified as COCs in the RI Report (LAW, 1993a) have been retained as COCs for this risk assessment (Table 4-8). Pesticides were not detected in the groundwater during any previous or the recent sampling effort (September 1994) above the laboratory reporting limit.

4.2.3 Exposure Assessment

Typically, an exposure assessment is used to characterize the magnitude of potential exposures at a site. However, the groundwater beneath the PSF site is not currently used as a potable water supply. Fort Riley obtains its potable water from well fields approximately 1.8 miles upgradient from the PSF, and the city of Ogden obtains its water supply from wells located approximately 3 miles downgradient from the site. Therefore, it is unlikely that chemicals detected in the groundwater beneath the site currently have an impact on human populations.

In addition, the potential for future impacts on human populations is also considered to be limited. The PSF is presently supplied by the Fort Riley water system. According to the "Emergency Expansion Capability Report and Environmental/Analytical Assessment - Ft. Riley" (CEMRK, 1994), the safe available yield of water from the aquifer serving Fort Riley is estimated at 50 million gallons per day, which exceeds the combined requirements of Fort Riley

TABLE 4-8

CHEMICALS DETECTED IN GROUNDWATER SAMPLES
DETECTION FREQUENCIES AND CONCENTRATION RANGES
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER	Frequency of Detection	Minimum Detected Concentration (mg/L)	Maximum Detected Concentration (mg/L)	Maximum Detected Background Concentration (mg/L)
Metals:				
Aluminum	10/20	0.11	0.8	0.26
Antimony	1/20	ND	0.032	0.022
Arsenic	5/20	0.0027	0.016	ND
Barium	20/20	0.042	0.130	0.2
Beryllium	15/20	0.001	0.005	0.002
Cadmium	2/20	0.004	0.006	0.004
Chromium	2/20	0.012	0.014	0.010
Manganese	18/20	0.017	0.091	0.034
Nitrate (as N)	19/20	0.0092	165 (33)*	6.4
Selenium	16/20	0.011	0.0036	0.008
Thallium	2/20	0.0025	0.0029	0.0024
Vanadium	4/20	0.008	0.027	0.011

* Maximum detected concentration for nitrate when second quarter data are censored.
ND – Not detected

and the surrounding communities. Fort Riley is currently served by a total of eight wells with a combined total well capacity of 8,400,000 gallons per day, which is reduced to approximately 7,900,000 gallons per day when adjusted for fire fighting requirements. In comparison, the actual daily consumption is approximately 3,400,000 gallons per day, or approximately 42 percent of the available capacity. Based on this, installation of new water supply wells is neither reasonable nor foreseeable. There are no records to indicate that water supply wells for either drinking water or other purposes have ever been installed at the site, and considering the available capacity, installation of a potable water well in proximity to the PSF site is not considered a reasonable possibility.

This above information, in conjunction with the low yield of the uppermost aquifer (estimated at 0.12 to 5.2 gpm in Section 3), render the installation of a water supply well in the uppermost aquifer at the site improbable. The limited yield is due to the soil type beneath the site (clays, instead of the characteristic silts and fine sands of the alluvial deposits). Therefore, the assessment of the potential (future) use of groundwater at the site is provided for information purposes only and not because exposure to groundwater is considered likely.

Risks due to hypothetical future exposures to groundwater in the uppermost aquifer will be calculated for adult and child residential receptors, via ingestion and dermal contact during typical household activities. The quantification of potential groundwater exposures will be performed using the same approach used for the soil residual risk assessment. That is, exposure point concentrations are estimated using 95th percent UCL or maximum detected concentration and intake variable values selected so that the resultant risk estimate represents a reasonable maximum value. The variable values selected for this risk assessment are standard default exposure values (USEPA, 1991) and are the same as the values used in the RI Report (LAW, 1993a). The chemical-specific intake estimates for each of the scenarios are presented in Appendix A.

The exposure point concentrations used in the groundwater risk assessment are presented on Table 4-9. A comparison of these values with the exposure point concentrations used in the RI Report (LAW, 1993a) [i.e., without the results of the most recent sampling effort (September 1994)] is presented in Table 4-10. This comparison indicates that the data obtained in September 1994 are consistent with the four previous rounds of data. The relatively minor fluctuations between the two sets of exposure point concentrations are the result of different laboratory reporting limits for analytes that were not detected.

For nitrate, two exposure point concentrations have been calculated. The first, 130.74 mg/L, includes data from all five of the sampling efforts. The second, 33 mg/L, is the maximum concentration detected when the second quarter nitrate data is excluded from the data set (in this case, the 95th percent UCL is greater than the maximum concentration). This second exposure point concentration has been included for evaluation because Quality Assurance data from the U.S. Army Corp of Engineers laboratory indicated a discrepancy in the second quarter data (CEMRD, 1993).

TABLE 4-9

ESTIMATED EXPOSURE POINT CONCENTRATIONS
GROUNDWATER
Pesticide Storage Facility
Fort Riley, Kansas

Medium	Exposure Pathway	Parameter	Exposure Concentration	Comments
Ground Water	Ingestion of Drinking Water, Dermal Contact	Aluminum	0.32 mg/L	Concentrations are the 95% UCL of measured concentrations in all ground water samples collected from the monitoring wells for the site (PSF92-02, PSF92-03, PSF92-04, and PSF92-05) (PSF92-01 is a background well, and was not included)
		Arsenic	0.0080 mg/L	
		Barium	0.10 mg/L	
		Beryllium	0.0027 mg/L	
		Chromium	0.0070 mg/L	
		Manganese	0.059 mg/L	
		Nitrate	131 mg/L (33 mg/L)* (1)	*When the 95% UCL exceeded the maximum detected concentration, the maximum concentration was used as the exposure point concentration.
		Thallium	0.0029 mg/L* (2)	
		Vanadium	0.017 mg/L	(1) Calculated with Second Quarter data censored. Value is from well PSF9202, Baseline Quarter. (2) Value is from well PSF9202, Third quarter.

Note: Exposure point concentration calculations are presented in Appendix A.

TABLE 4-10

COMPARISON OF GROUNDWATER EXPOSURE POINT CONCENTRATIONS
Pesticide Storage Facility
Fort Riley, Kansas

	Through December 1993 (μg/L)	Through November 1994 (μg/L)
Arsenic	3.95	5.04
Aluminum	440.90	319.42
Barium	104.68	103.13
Beryllium	2.77	2.72
Chromium	6.96	7.02
Manganese	56.84	58.83
Thallium	2.9*	2.9*
Vanadium	9.67	16.53
Nitrate (as N)	165*	130.74 (33)**

* Denotes that the greatest concentration detected has been/will be used as the exposure point concentration.
** The exposure point concentration is the maximum detected concentration when the second quarter data is censored.

4.2.4 Toxicity Assessment

Pertinent information related to the toxicity assessment of the COCs in the groundwater at the site have been presented previously in the RI Report (LAW, 1993a) and in Section 4.1.4. Applicable toxicity information (i.e., RfDs and CSFs) were listed on Tables 4-4 and 4-5. Toxicity via dermal absorption of contaminants in groundwater is treated in a manner similar to soil-bound contaminants, except that the absorption factor (for exposure to contaminants in soil) is "replaced" by a permeability constant (PC) for groundwater exposures. The PC value for the COCs in the groundwater, which are all metals, is 0.001 cm/hour (USEPA, 1992b). The use of this value for PC is consistent with the value used in the RI Report (LAW, 1993a).

4.2.5 Risk Characterization

4.2.5.1 Noncarcinogenic Effects Characterization - The HI estimates for the hypothetical use of the groundwater in the uppermost aquifer at the site are 4.4 and 21 for adults and children, respectively (Table 4-11). Of the two exposure routes that make up these scenarios (i.e., ingestion and dermal contact), ingestion comprises approximately 99 percent of the HI estimates. The chemicals contributing most to these HI estimates are, in decreasing order, nitrate, thallium, arsenic, and manganese. If the data for nitrate from the second quarter sampling effort are censored, the HIs for adults and children decrease to 2.8 and 13, respectively, and the order of the chemicals contributing most to the HIs is thallium, arsenic, nitrate, and manganese.

4.2.5.2 Carcinogenic Risk Characterization - The cancer risk estimates for the hypothetical use of the groundwater in the uppermost aquifer at the site are 3×10^{-4} and 6×10^{-7} for the ingestion and dermal contact exposure routes, respectively (Table 4-12). The chemicals contributing to the risk, in decreasing order, are arsenic and beryllium.

4.2.6 Uncertainties

There are a number of assumptions required in developing quantitative estimates of risk. These assumptions lend a certain amount of uncertainty to the risk assessment. The assumptions and/or uncertainties pertaining to potential risks due to exposure to the groundwater beneath the site are briefly discussed below.

TABLE 4-11

SUMMARY OF HAZARD INDICES
GROUNDWATER
Pesticide Storage Facility
Fort Riley, Kansas

RECEPTOR	EXPOSURE ROUTE AND MEDIUM	HAZARD INDEX[a]	BASELINE HAZARD INDEX[b]
Hypothetical Site Resident (Adult)	Ingestion of ground water	4.4E+00 (2.8E+00)*	4.6E+00
Hypothetical Site Resident (Adult)	Dermal contact	8.6E−03 (5.4E−03)*	9.0E−03
Hypothetical Site Resident (Child)	Ingestion of ground water	2.1E+01 (1.3E+01)*	2.2E+01
Hypothetical Site Resident (Child)	Dermal contact	1.8E−02 (1.1E−02)*	1.9E−02

NA – Not assessed because toxicity data for inhalation of the chemicals of concern (RfCs) were not available.
* Estimated hazard index when second quarter nitrate data is censored.
[a] Estimates calculated using five quarters of data.
[b] Estimates from the Baseline Risk Assessment (using the four quarters of data available at that time).

TABLE 4-12

SUMMARY OF CANCER RISKS
GROUNDWATER
Pesticide Storage Facility
Fort Riley, Kansas

RECEPTOR	EXPOSURE ROUTE AND MEDIUM	CANCER RISK[a]	BASELINE CANCER RISK[b]
Hypothetical Site Resident (Adult)	Ingestion of ground water	3E-04	2E-04
Hypothetical Site Resident (Adult)	Dermal contact	6E-07	4E-07
Hypothetical Site Resident (Child)	Ingestion of ground water	NA	NA
Hypothetical Site Resident (Child)	Dermal contact	NA	NA

NA - Not assessed because cancer risks are not estimated for children.
[a] Estimates calculated using five quarters of data.
[b] Estimates from the Baseline Risk Assessment (using the four quarters of data available at that time).

- The assumption of the exclusive use of the groundwater beneath the site as a potable water source is conservative. Currently, a public supply of potable water is already available to serve the PSF. A well placed in the aquifer beneath the PSF site would have a limited yield estimated at 0.12 to 5.2 gpm. It is therefore, not reasonable to assume that a drinking water well would be needed in the vicinity of the PSF under continued Fort Riley operations. Evaluating risk based on using site groundwater as a source of future potable water results in an overestimation of risk.

- Data from the background well (PSF92-01) indicate that the concentrations of some of the inorganic constituents detected in the groundwater in on-site wells are naturally occurring. Specifically:

  - Beryllium was detected in the background well at 0.002 mg/L. The 95 percent UCL for beryllium is 0.00272 mg/L.

  - Manganese was detected in the background well at 0.034 mg/L. The 95 percent UCL for manganese is 0.05883 mg/L.

  - Thallium was detected in the background well at 0.0024 mg/L. The exposure point concentration for thallium is 0.0029 mg/L. (In addition, thallium was detected in on-site wells only twice out of 20 samples, leading to the use of the maximum detected concentration as the exposure point concentration.)

  - Antimony was only detected once during the first four sampling rounds. In the second round (February 3, 1993) sampling event, antimony was detected at 0.032 mg/L in well PSF92-05 and at 0.022 mg/L in the upgradient background well. Antimony was analyzed using USEPA Method 6010 for the first four sampling rounds, with a detection limit of 0.031 mg/L during the baseline event, and 0.022 mg/L during the first through third quarters. During the September 1994 sampling event antimony was analyzed using USEPA Method 7041 with a lower detection limit (0.005 mg/L), and antimony was not detected in any samples. Since antimony was not detected during the September 1994 sampling event, it is concluded from the single detection at the site and the comparable concentration in the background well that antimony is probably naturally occurring at the PSF. Antimony has also been detected in the Ogden drinking water wells at levels exceeding the MCL. Published USEPA data (USEPA, 1990) indicate that the typical range of naturally occurring antimony in soils in Kansas is 2 to 10 mg/kg. This information suggests that antimony is naturally occurring.

- Cadmium was only detected during the third quarter sampling event in the upgradient background well (at 0.004 mg/L) and in wells PSF92-04 (0.004 mg/L) and PSF92-05 (0.006 mg/L). Considering that the single exceedance was within the background concentration range and detected at the same time, cadmium is believed to be naturally occurring.

Antimony and cadmium were not considered in the risk calculations because they were only detected in a single sampling round at levels consistent with the upgradient well. If it were assumed that beryllium, manganese, and thallium were not site-related and, therefore, should not be included in the risk calculations, then the following reductions in risks/hazards would be realized:

- Adult HI reduced from 4.4 to 3.4 (24 percent) [or 2.8 to 1.8 (37 percent) if second quarter nitrate data are censored]

- Adult cancer risk reduced from 3E-04 to 2E-04 (33 percent)

- Child HI reduced from 20.8 to 14.6 (30 percent) [or 12.9 to 6.7 (48 percent) if second quarter nitrate data are censored]

- The large quarterly variations in the nitrate data give rise to uncertainty in the exposure point concentration(s) used to estimate risk. In addition, the discrepancy in the second quarter QA data for nitrate indicates that the second quarter nitrate data may not be valid. If the second quarter nitrate data are censored, the HIs are reduced by approximately 50 percent.

4.2.7 Summary of Groundwater Risk Assessment

At the present time, risks due to exposure to the groundwater beneath the site do not exist because a complete exposure pathway does not exist. This is because potable water supply wells do not exist at the site for either residential or occupational uses. However, if residential water supply wells were installed at the site in the future, the possibility of adverse human health effects is indicated.

4.3 ECOLOGICAL RISK ASSESSMENT

The Ecological Risk Assessment (ERA) for the PSF (LAW, 1993a) was conducted in accordance with the guidance provided in the "Risk Assessment Guidance for Superfund, Vol. II - Environmental Evaluation Manual" (USEPA, 1989b). The objective of the "residual" ERA was to reevaluate the ERA conducted for the RI based on site conditions after the Rapid Response removal action. A summary of the ERA is presented below, followed by a reevaluation of potential risks to ecological receptors.

4.3.1 Previous Ecological Risk Assessment Summary

In the ERA, potential receptors present in the vicinity of the PSF and the potential pathways by which these receptors might be exposed to chemicals of concern present in surface soils (specifically pesticides), surface water, and sediments were identified. Possible risks to environmental receptors arising from exposure to site contaminants were characterized. The objectives of the previous ERA (LAW, 1993a) were to:

1. Determine the value or uses of nearby natural resources (land, air, water, biota).
2. Identify potential environmental impacts.
3. Assess the significance of any environmental impacts.

The ERA comprised the following tasks:

- Ecological Receptor Identification
- Exposure Pathway Evaluation
- Selection of Relevant Exposures
- Toxicity Assessment and Identification of ARARs
- Risk Characterization

The potential ecological receptors that may be affected by contamination present at the PSF site are presented below. Most of the information presented here is taken from the "Survey of Threatened and Endangered Species on Fort Riley Military Reservation" (U.S. Fish & Wildlife Service [USFWS], 1992a) conducted by the U.S. Fish & Wildlife Service.

Terrestrial Vegetation - Fort Riley is located within the Flint Hills region of the Central Plains. The ecological region is known as a tall grass prairie. Terrestrial systems associated with the PSF and surrounding area consisted of two major habitat types: grassland/prairie habitats and riverain habitats. The grassland/prairie habitats include various grass species including switchgrass (*Panicum virginatum*), Indian grass (*Sorgastrum nutans*), thistle (*Canduus hataus*), Johnson grass (*Sorghum halepense*), and sunflower (*Helianthus* sp.). Vegetation typically noted in riverain and densely vegetated drainage habitats in the Fort Riley area include cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), box elder (*Acer negundo*), and hackberry (*Celtis occidentalis*) as canopy cover and dominated by redbud (*Cercis canadensis*), dogwood (*Cornus* sp.), greenbrier (*Smilax* sp.), poison ivy (*Rhus radicans*), Virginia creeper (*Parthenocissus quinquefolia*), and seedling overstory species.

The PSF site consists primarily of cleared areas, vegetated by grasses and other herbaceous vegetation intermixed with nonvegetated areas. A wooded area, located to the east of the site, can be classified as riparian woodland.

Terrestrial Wildlife - On the basis of site observations and literature information, the animal community considered to frequent the general area of the site includes many species of birds (rock doves, starlings, song birds, pigeons, wild turkey), insects, and small mammals (deer, an occasional bobcat, bats, raccoons, possums, rabbits, squirrels, and other rodents) (USFWS, 1992a; DEH, 1993d). The areas in the immediate vicinity of the PSF do not provide suitable habitats for most species, because these areas are industrialized "high traffic" areas (USFWS, 1992b). That is, the PSF area is within a vehicle compound area (the DEH yard), an area where there is a high frequency of movement and activity during the day. The daytime activities at the site should not affect the habits of nocturnal animals using the area. Therefore, although a variety of animals may pass through the PSF site and DEH yard during hunting/foraging activities, they are not thought to inhabit the immediate area of the DEH yard in significant numbers.

Endangered Species - A recent survey conducted by the U.S. Fish and Wildlife Service (USFWS, 1992a) provided much of the necessary background information regarding the potential for threatened and endangered species on site. According to this report, eight federally-listed threatened and endangered species along with twelve federal category 2 candidate species could potentially occur on Fort Riley. Category 2 candidate species are those which the U.S. Fish and Wildlife Service is seeking additional information regarding their biological status, in order to determine if listing of these species is warranted. A listing of the threatened and endangered species known to occur in the Fort Riley area, along with their typical habitats, is provided in Table 4-13.

As shown in Table 4-13, the PSF site does not provide a suitable habitat for most of the species listed. It is possible that the wooded area east of the site may be utilized although not inhabited by species favoring riparian forests (the bald eagle). The loggerhead shrike may similarly pass near the PSF, because this species favors manmade perches such as fence posts and power lines. Both the bald eagle and the loggerhead shrike have been sighted on various areas of Fort Riley. However, there are no confirmed sightings of these species at the PSF. And although the confluence of the drainage ditch to the east of the PSF and the Kansas River provides a suitable habitat for the sturgeon chub (USFWS, 1992b), a federal category 2 species, the summary report on threatened and endangered species states that the occurrence of the sturgeon chub at Fort Riley is very unlikely (USFWS, 1992a). Therefore, although threatened and endangered species

TABLE 4-13

ENDANGERED AND THREATENED SPECIES (AND ASSOCIATED HABITATS) POTENTIALLY OCCURRING AT FORT RILEY AREA

Pesticide Storage Facility
Fort Riley, Kansas

SPECIES	HABITAT
Piping Plover	Open unvegetated beach or sandbar
Least Tern	Sparsely vegetated sandbars in a wide channel with good visibility
Bald Eagle	Near water bodies (rivers, lakes, etc.) utilizing riparian forest
Peregrine Falcon	Large river or waterfowl management areas, cropland, meadows and prairies, river bottoms, marshes, and lakes
Whooping Crane	Wetland, riverine base sandbars, shallow water, slow river flow
Eskimo Curlew	Wet meadows, fields, pastures, drier parts of salt and brackish marshes
Western Prairie Fringed Orchid	Tallgrass prairie and sedge meadow (fire adapted)
Prairie Mole Cricket*	Tallgrass prairie, ungrazed or unmowed native tallgrass with silt-sandy loam soils
Regal Fritillary Butterfly*	Prairie meadows (wet), moist tallgrass prairie, virgin grassland where violets act as host plants
Sturgeon Chub*	Areas of shallow strong currents and gravel bottoms, turbulent areas where shallow water flows across sandbars
Texas Horned Lizard*	Dry-flat areas with sandy, loamy, or rocky surfaces with little vegetation
Loggerhead Shrike*	Grassland or shrubby fields with scattered woody vegetation for perching and nesting
White-faced Ibis*	Small ponds with stands of cattail or bulrush
Western Snowy Plover*	Unvegetated riverine
Eastern Spotted Skunk*	Open level cultivated farmland, upland sites with preference for fallen logs and brushpiles
Topeka Shiner*	Turbulent areas in rivers where shallow water flows across sand bars
American Burying Beetle	Tallgrass prairie, ungrazed or unmowed native tallgrass with silt-sandy loam soils
Black Tern*	Wetland areas
Henslow's Sparrow*	Native grassland with few trees
Hairy False Mallow*	Rocky outcrops and dry areas in prairies

Source: U.S. Fish & Wildlife Service, 1992a

Underlined species are known to occur on Fort Riley.

* Candidate species for endangered and threatened status.

are known to occur in the Fort Riley area, the actual habitation of these species on the PSF site and surrounding area is unlikely to occur.

Aquatic Species - Because of the intermittent flow within the drainage channel, aquatic organisms at the site are most likely limited both in quantity and species richness. However, benthic organisms may be supported by these intermittent streams. The drainage ditch could also potentially provide habitat and a drinking water source for amphibians and other bank dwelling species.

In summary, negative impacts to fauna and flora at the PSF site were not readily apparent during the site characterization phase of the RI. Terrestrial and aquatic life in the area of the drainage ditch may potentially suffer adverse effects from constituents detected in site surface-water and sediment samples. However, other (larger) sources of surface water are located nearby, and ecological receptors would probably favor these sources over the intermittent stream on site. Therefore, the environmental impact of the contamination detected in the surface water and sediment on site appears to be low. In addition, the contamination present in site surface water and sediment is not expected to impact downstream media because the natural character of the drainage ditch (i.e., its intermittent flow) does not consistently discharge surface water and flush sediments to downstream points.

Similarly, potential risks to environmental receptors due to exposure to soil at the site is considered to be minimal. The area most impacted by soil contamination prior to the removal action [the small stressed area of vegetation noted in the RI (LAW, 1993a)] was of very limited extent (approximately 20 feet by 20 feet), and there are areas adjacent to the site that provide suitable habitats and food supplies for animal species that may pass by or frequent the site. This area of stressed vegetation experienced regrowth during the 1993 growing season. Therefore, the effects of the (previous) soil contamination do not appear to be significant or long-lasting.

4.3.2 Reevaluation of Ecological Risks Based on Current Conditions

Prior to the Rapid Response soil removal action, the ecological risks due to potential exposures at the site were judged to be minimal. The soil removal action replaced contaminated surface and subsurface soil with clean backfill and included the removal of soil from the area where stressed vegetation had been observed. Therefore, based on current site conditions, it is expected that ecological risks are not a concern at the PSF site.

5.0 DEVELOPMENT AND DESCRIPTION OF ALTERNATIVES

Pesticide-contaminated soils were excavated and removed from the site during a non-time-critical removal action completed in June 1994, as discussed in Section 1. Consideration of additional remedial actions at the PSF in this section is based on the current site description as discussed in Section 3, and the conclusions of the RRA as presented in Section 4. This section addresses four main areas: (1) development of risk based remediation goals (RGs); (2) identification of applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) requirements; (3) development of remedial action objectives (RAOs); and (4) identification of alternatives for consideration.

In Section 4, current site risks were reevaluated for the exposure pathways of concern previously presented in the RI risk assessment. For soil media, none of the exposure pathways which were assessed had a cancer risk which exceeded 1×10^{-6}. Similarly, none exceeded a hazard index of 1. The future construction worker exposure scenario had the highest estimated residual risk at 2×10^{-8} for subsurface soil exposure. Although these risks did not exceed 1×10^{-6} in the RRA, risk-based RGs are calculated for these receptors because they represented the pathways with the highest risks calculated during the BLRA. Therefore, risk-based RGs are calculated for the future site worker and the future construction worker for comparison to the residual concentrations of contaminants in surface and subsurface soils at the site.

For surface-water and sediment exposures at the PSF, risk estimates were calculated to be below 1×10^{-6} and 1.0 for carcinogenic and noncarcinogenic risks, respectively. Ecological risks were also determined to be minimal. Since the human health and ecological risks were not unacceptable for these media, development of RGs, RAOs, ARARs, or alternatives addressing surface water and sediment at the PSF are not warranted.

As stated in Section 4.2, there are currently no potable water wells at the PSF site and Fort Riley's water supply wells are located approximately 1.8 miles upgradient from the site. The DEH yard and PSF site are served by the existing Fort Riley water distribution system, which is anticipated to meet the foreseeable future water supply needs of Fort Riley, and is currently operating at approximately 42 percent of the available capacity. The current designated uses (storage area) are to be maintained in the future in the DEH yard including the PSF site. Future groundwater use is not considered a likely possibility, and the calculated risk estimates for a hypothetical future groundwater use were calculated in Section 4 for information only. Because carcinogenic risk estimates exceeded 1×10^{-6}, and the calculated hazard indices exceeded 1.0 for this groundwater use scenario, risk-based RGs are calculated to provide a comparison with on-site concentrations for information only, since the groundwater use pathway is incomplete under current or likely future land use scenarios.

5.1 CALCULATION OF RISK-BASED REMEDIATION GOALS

RGs are concentrations defining allowable residual contamination that can remain at the site for individual COCs for specific medium and land use combinations. Risk-based RGs are concentrations developed using risk assessment-based calculations. Ecological effects may also be considered when appropriate to develop RGs. At the PSF ecological impacts were not evident and were not considered in the development of the RGs. Contaminant-specific RGs are derived to protect human health; no consideration is given to ecological effects when developing the RGs. The calculations result in concentration limits for the COCs under specific exposure conditions.

Risk-based remediation goals for the COCs in the soil and groundwater at the PSF site were developed following guidance available from USEPA (USEPA, 1989a; USEPA, 1991). The contaminant-specific toxicity values used in the RG calculations were obtained from the USEPA's Integrated Risk Information System database. This method involves estimating exposure for reasonable scenarios at the PSF site. The exposure variable values used for calculating the RGs for the PSF site are consistent with the values used in the RRA presented in Section 4.1 of this report. For surface soil, RGs have been developed for future workers at the site. For subsurface soil, RGs have been developed for future construction workers at the site. These evaluations have been conducted in a manner that is consistent with the Baseline and Residual Risk Assessments, and incorporate the potential cumulative effects of exposure via ingestion, dermal contact, and inhalation. Therefore, this represents a conservative approach to the development of the RGs (i.e., protective of human health). The soil RGs developed for this FS differ from those used during the removal action in the following ways:

- More realistic dermal absorption factors were used for the pesticides that were identified as COCs in soil.

- Surface and subsurface soils are considered separately in developing the current RGs (the RGs used during the removal action were based on surface soil exposure only, and, therefore, were conservative).

- A target risk level of 10^{-5} was used to develop the current RGs (versus 10^{-6} during the removal action).

This 10^{-5} target risk level was established considering NCP requirements, conservative assumptions incorporated into the calculations, and site-specific conditions.

The NCP [NCP 300.430 (e)(2)(i)(D)] states: "In cases involving multiple contaminants or pathways where attainment of chemical-specific ARARs will result in cumulative risk in excess of 10^{-4}, criteria in paragraph 300.430 (e)(2)(i)(A) may also be considered when determining the cleanup level to be attained." This referenced criterion in NCP 300.430 (e)(2)(i)(A)(2) specifically addresses "concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect...incorporating an adequate margin of safety." This section of the NCP also states: "For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}. The 10^{-6} risk level shall be used as the point of departure for determining remedial goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure."

In summary, these sections of the NCP allow risk levels of between 10^{-4} and 10^{-6} to be considered for establishing remedial goals to be attained by alternatives which consider multiple contaminants and pathways of exposure at the site. This intent is further stated in the preamble discussion to the NCP (Federal Register Vol. 55 No. 46) which describes the point of departure as a cumulative risk level "used as a starting point (or initial "protectiveness goal") for determining the most appropriate risk level that alternatives should be allowed to attain." The preamble to the NCP also states "preliminary and final remedial goals, i.e, target risk levels, however, may vary from the point of departure depending upon site-specific circumstances."

Risk-based remedial goal concentrations calculated at the 10^{-5} risk level incorporate consideration of the presence of multiple contaminants and routes of exposure. The current and probable future use of the PSF site as a light industrial area, used by workers, makes it unlikely that sensitive subgroups of the population would be exposed to site contaminants. The receptors are likely to be healthy adults and not sensitive populations (such as children and the elderly). These sensitive subgroups were considered in the development of the cancer slope factors by the USEPA which are included in the calculation methods used for the RGs (USEPA, 1989; RAGS, Part A, Vol. I, HHR). Adsorption factors used in the RG calculations for pesticides were derived from studies which used pesticides dissolved in acetone prior to application. Adsorption factors derived from studies using pesticides mixed with soil prior to application were approximately 10 times less than the factors used in the calculated RGs (ATSDR, 1987-1993). These factors result in calculated RG concentrations which are conservative. From these considerations, the 10^{-5} risk level is appropriate for the PSF site. Risk-based RGs at the 10^{-5} risk level for hypothetical future residential groundwater use are also presented for comparison with on-site groundwater for information only.

Tables 5-1 and 5-2 present the RGs for surface and subsurface soil for the COCs at the PSF site. Table 5-3 presents the risk-based RGs for the hypothetical residential groundwater use for information only. The derivation of the risk-based RG equations and the calculation of the risk-based RGs are provided in Appendix B.

TABLE 5-1

RISK-BASED REMEDIATION GOALS - SURFACE SOILS (SITE WORKER)
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE SITE WORKER

Constituent	Dermal Absorption Factor (unitless) [a]	Reference Dose (oral) (mg/kg-day)	Reference Dose (inhalation) (mg/kg-day)	Remediation Goals (mg/kg) Non-cancer Effects [b]	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Cancer Slope Factor (inhalation) $(mg/kg-day)^{-1}$	10^{-5} Risk Remediation Goals Carcinogenic Effects (mg/kg)	Risk-Based (Lowest) Remediation Goal (mg/kg)
Pesticides:								
Chlordane	0.109	6.00E-05	--	3.38E+01	1.30E+00	1.30E+00	1.23E+01	1.23E+01
4,4'-DDD	0.378	--	--	--	2.40E-01	--	2.40E+01	2.40E+01
4,4'-DDE	0.378	--	--	--	3.40E-01	--	1.69E+01	1.69E+01
4,4'-DDT	0.378	5.00E-04	--	1.01E+02	3.40E-01	3.40E-01	1.69E+01	1.69E+01
Dieldrin	0.077	5.00E-05	--	3.58E+01	1.60E+01	1.60E+01	1.27E+00	1.27E+00
Heptachlor	0.109	5.00E-04	--	2.82E+02	4.50E+00	4.60E+00	3.56E+00	3.56E+00

a - Absorption factors are percentages expressed as numerical values (i.e. chlordane 10.9% / 100 = 0.109).
b - Remedial goal concentrations calculated using H.I. = 1.0.

TABLE 5-2

RISK-BASED REMEDIATION GOALS - SUBSURFACE SOILS (CONSTRUCTION WORKER)
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE CONSTRUCTION WORKER

Constituent	Dermal Absorption Factor (unitless) [a]	Reference Dose (oral) (mg/kg-day)	Reference Dose (inhalation) (mg/kg-day)	Remediation Goals (mg/kg) Non-cancer Effects [c]	Cancer Slope Factor (oral) $(mg/kg-day)^{-1}$	Cancer Slope Factor (inhalation) $(mg/kg-day)^{-1}$	10^{-5} Risk Remediation Goals Carcinogenic Effects (mg/kg)	Risk-Based (Lowest) Remediation Goal (mg/kg)
Pesticides:								
Chlordane	0.109	6.00E-05	--	2.09E+01	1.30E+00	1.30E+00	1.89E+02	2.09E+01
4,4'-DDD	0.378	--	--	--	2.40E-01	--	6.69E+02	6.69E+02
4,4'-DDE	0.378	--	--	--	3.40E-01	--	4.73E+02	4.73E+02
4,4'-DDT	0.378	5.00E-04	--	1.14E+02	3.40E-01	3.40E-01	4.73E+02	1.14E+02
Dieldrin	0.077	5.00E-05	--	1.86E+01	1.60E+01	1.60E+01	1.64E+01	1.64E+01
Heptachlor	0.109	5.00E-04	--	1.74E+02	4.50E+00	4.60E+00	5.46E+01	5.46E+01
Volatile Compounds:								
Benzene	1	--	e 1.43E-04	4.99E+05	2.90E-02	2.90E-02	3.08E+03	3.08E+03
Methylene chloride	1	6.00E-02	h 8.60E-01	7.61E+03	7.50E-03	1.64E-03	1.19E+04	7.61E+03
Toluene	1	2.00E-01	1.14E-01	2.54E+04	--	--	--	2.54E+04
Semi-Volatile Compounds:								
Benzo[a]anthracene	1	--	--	--	1.10E+00	--	8.12E+01	8.12E+01
bis(2-Ethylhexyl)phthalate	1	2.00E-02	--	2.54E+03	1.40E-02	--	6.38E+03	2.54E+03
Chrysene	1	--	--	--	2.90E-02	--	3.08E+03	3.08E+03
Diethylphthalate	1	8.00E-01	--	1.01E+05	--	--	--	1.01E+05
Fluoranthene	1	4.00E-02	--	5.07E+03	--	--	--	5.07E+03
Pyrene	1	3.00E-02	--	3.80E+03	--	--	--	3.80E+03
Metals:								
Arsenic	0.01	3.00E-04	--	1.30E+02	1.75E+00	1.50E+01	1.74E+02	1.30E+02
Barium	0.01	7.00E-02	h 1.40E-04	2.85E+04	--	--	--	2.85E+04
Chromium	0.01	5.00E-03	--	2.16E+03	--	4.20E+01	5.85E+04	2.16E+03
Lead	0.01	--	--	--	--	--	--	1.00E+03 [b]
Mercury	0.01	3.00E-04	h 8.57E-05	1.30E+02	--	--	--	1.30E+02
Silver	0.01	p 5.00E-03	--	2.16E+03	--	--	--	2.16E+03

a - Absorption factors are percentages expressed as numerical values (i.e. chlordane 10.9% / 100 = 0.109).
b - OSWER Directive #9355.4-02, Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites, September 1989.
c - Remediation goal concentrations calculated using H.I. = 1.0.
e - Value is from EPA-ECAO
h - Value is from HEAST (1994)
p - IRIS lists toxicity value as pending; value listed here is obtained from HEAST (1992).

TABLE 5-3

RISK-BASED REMEDIATION GOALS - HYPOTHETICAL GROUNDWATER USE (RESIDENTIAL)
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE

Constituent	Noncarcinogenic			Carcinogenic		Child Noncarcinogenic Risk-Based Remediation Goal (mg/L)	Adult Noncarcinogenic Risk-Based Remediation Goal (mg/L) [a]	Adult Carcinogenic Risk-Based Remediation Goal (mg/L)[b]	Risk-Based (Lowest) Remediation Goal (mg/L)
	Adult RG Calculation	Child RG Calculation	Oral RfD (mg/kg-day)	Adult RG Calculation	Oral Slope Factor $(mg/kg-day)^{-1}$				
Aluminum	36.43*(RfD_o)	7.81*(RfD_o)	2.90E+00	8.48E-4/(CSF_o)	---	2.26E+01	1.06E+02	---	1.06E+02
Arsenic	36.43*(RfD_o)	7.81*(RfD_o)	3.00E-04	8.48E-4/(CSF_o)	1.80E+00	2.34E-03	1.09E-02	4.71E-04	4.71E-04
Barium	36.43*(RfD_o)	7.81*(RfD_o)	7.00E-02	8.48E-4/(CSF_o)	---	5.47E-01	2.55E+00	---	2.55E+00
Beryllium	36.43*(RfD_o)	7.81*(RfD_o)	5.00E-03	8.48E-4/(CSF_o)	4.30E+00	3.91E-02	1.82E-01	1.97E-04	1.97E-04
Chromium	36.43*(RfD_o)	7.81*(RfD_o)	5.00E-03	8.48E-4/(CSF_o)	---	3.91E-02	1.82E-01	---	1.82E-01
Manganese	36.43*(RfD_o)	7.81*(RfD_o)	5.00E-03	8.48E-4/(CSF_o)	---	3.91E-02	1.82E-01	---	1.82E-01
Nitrate	36.43*(RfD_o)	7.81*(RfD_o)	1.60E+00	8.48E-4/(CSF_o)	---	1.25E+01	5.83E+01	---	5.83E+01
Thallium	36.43*(RfD_o)	7.81*(RfD_o)	8.00E-05	8.48E-4/(CSF_o)	---	6.25E-04	2.91E-03	---	2.91E-03
Vanadium	36.43*(RfD_o)	7.81*(RfD_o)	7.00E-03	8.48E-4/(CSF_o)	---	5.47E-02	2.55E-01	---	2.55E-01

--- Criteria not available for this constituent.
CSF_o - Oral Cancer Slope Factor
RFD_o - Oral Reference Dose
(a) Remediation goal concentrations calculated using HI = 1.0
(b) Remedial goal concentration calculated using a target carcinogenic risk of 1×10^{-5}

5.2 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND TO BE CONSIDERED (TBC) REQUIREMENTS

Superfund remedial response actions must address the requirements of the environmental laws which are determined to be "applicable" or "relevant and appropriate." The identification of ARARs involves the comparison of a number of factors, including the type of hazardous substances present (chemical-specific), the types of remedial actions considered (action-specific), and the physical nature of the site (location-specific), to the statutory or regulatory requirements of the relevant environmental laws. Three types of ARARs are addressed in the following sections: chemical-specific, location-specific and action-specific.

According to the USEPA "CERCLA Compliance with Other Laws Manual: Interim Final" (USEPA, 1988b), a requirement under other environmental laws may be either "applicable" or "relevant and appropriate," but not both. Identification of ARARs must be done on a site-specific basis and involves a two-part analysis. First, a determination whether a given requirement is applicable. If it is not directly applicable, a determination is made whether it is both relevant and appropriate.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. A state requirement must be promulgated to qualify as a potential ARAR. Promulgated requirements are found in state statutes and regulations that have been adopted by authorized state agencies, and are identified by state statute numbers, enactment dates, and effective dates for enforcement of the requirement. To qualify as an ARAR, a promulgated requirement must also be consistently applied and apply to a broader universe than Superfund sites (USEPA, 1988c, Chapter 6).

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

The determination that a requirement is relevant and appropriate is a two-step process: 1) determination if a requirement is relevant and (2) determination if a requirement is appropriate. As stated earlier, this involves a comparison of a number of site-specific factors, including the characteristics of the remedial action, the hazardous substances present at the site, or the physical circumstances of the site, with those addressed in the statutory or regulatory requirement. As stated in the NCP, Section 300.400 (g)(2)(viii), the use or potential use of the affected resource shall be considered in the determination of relevant and appropriate requirements. In some cases, a requirement may be relevant, but not appropriate, given site-specific circumstances; such a requirement would not be an ARAR for the site. In addition, there is more discretion in the determination of relevant and appropriate; it is possible for only part of a requirement to be considered relevant and appropriate in a given case. When the analysis results in a determination that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.

In addition to the ARARs, TBCs are also identified during the process of determining remedial response objectives. The TBCs are nonpromulgated advisories or guidance issued by the state or federal government that are not legally binding and thus do not have the status of potential ARARs. TBCs are used, however, in conjunction with ARARs to aid in the determination of cleanup levels necessary to protect human health and the environment. Examples of TBCs include health advisories, guidance policy documents developed to implement regulations, and calculated risk-based levels such as contaminant-specific remediation goals.

5.2.1 <u>Determination of Contaminant-Specific ARARs and TBC Requirements</u>

Constituents that have the potential for causing adverse human health and environmental effects have been detected at the site. This section briefly summarizes the available guidelines and standards which have been established by USEPA and the state of Kansas for these constituents.

Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. The primary contaminants of concern are the pesticides chlordane, DDT and metabolites, dieldrin, and heptachlor in soil media. Based on the risk estimates calculated in Section 4, remedial actions addressing surface water and sediments are not warranted, and ARARs for these media are not identified. Calculated risk estimates for a hypothetical future groundwater use identified arsenic, beryllium, manganese, nitrate, and thallium as substantial contributors to the total risks. Although the groundwater use pathway is incomplete, concentration levels for these constituents will be compared to MCLGs/MCLs for information only. Volatile organics were not detected at levels of concern, and were not identified as COCs, and the metals and pesticides do not readily volatilize. Therefore, ARARs pertaining to air media would not apply and were not evaluated.

<u>Drinking Water</u>

In accordance with the Safe Drinking Water Act, the USEPA has established MCLs and Maximum Contaminant Level Goals (MCLGs) for a number of constituents (Federal Register, 1987). MCLs define the maximum levels of various constituents allowed in "public water systems," defined as systems which provide piped water for human consumption with at least 15 service connections, or serving at least 25 persons. By definition, MCLGs equal to zero are nonenforceable health goals while the MCLs are the enforceable standards which must be set as close to the MCLGs as feasible. MCLs are not applicable to the site because the PSF groundwater is not directly provided to a public water supply system. State water regulations (KAR 28.15) which set state MCLs for constituents detected on the site generally reflect the federal MCLs. However, discussions with the Kansas Department of Health and Environment, Bureau of Water Protection, indicated that the state of Kansas failed to meet the federally mandated deadline for completing revisions to the drinking water health advisories (KDHE, 1992). Therefore, by default, Kansas is required to enforce the federally established MCLs. The NCP Section 300.430 (e)(2)(B) sets forth the requirement that nonzero MCLGs or MCLs (when the MCLG is zero) be attained by remedial actions for groundwaters that are potential sources of drinking water when MCLGs/MCLs are determined to be ARARs for the site. The ARAR determination is based on the consideration of use or potential future use of the groundwater at the site, as discussed above. As stated previously, future use of the on-site aquifer was not considered a reasonable possibility considering the available water system, low yield, and future operations at Fort Riley. Therefore, MCLGs/MCLs are not relevant or appropriate at the site because there is no actual, planned, or potential use of groundwater as a potable water source (USEPA, 1988c, pgs. 1-68 to 1-69).

Promulgated requirements in accordance with the NCP Section 300.400 (g)(4) were not identified by Kansas State statutes recognizing the on-site groundwater as a potential water source. Since Kansas has not promulgated regulations recognizing subsurface waters as potential potable water sources, MCLGs/MCLs are therefore not applicable to the site. Because MCLs were compared to detected groundwater constituents for information only, they are not considered TBCs at the site.

In addition to MCLs, the state of Kansas has developed Kansas Action Levels (KALs), Kansas Notification Levels (KNLs), Alternate Kansas Action Levels (AKALs), and Alternate Kansas Notification Levels (AKNLs). The KNL or AKNL is used to constitute administrative confirmation that groundwater contamination exists. The KAL or AKAL is applied to represent the level at which long-term exposure to contaminant concentrations is considered unacceptable. The KNL/KAL apply to fresh water and usable water aquifers in the state, whereas the AKNL/AKAL apply to alluvial aquifers and/or specific aquifers which surface through springs or seeps to become contributors to the surface waters of the state (KDHE, 1988a). The KALs, KNLs, AKALs, and AKNLs for constituents detected in the groundwater samples collected from the site are not promulgated regulations and are, therefore, considered TBC requirements. AKNLs/AKALs for antimony, arsenic, beryllium, cadmium, manganese, nitrate, or thallium are not available (KDHE, 1988a); therefore, no evaluations are necessary.

A list of the constituent concentrations detected in the groundwater is presented and compared with regulatory criteria identified for these constituents in Table 5-4. The MCL was established on January 1, 1995, at 0.006 mg/L for antimony. Antimony was detected once at a concentration above the MCL (0.032 mg/L) and was also detected in the upgradient well above the MCL (0.022 mg/L). The 95 percent UCL concentration for beryllium (0.0027 mg/L)

TABLE 5–4

COMPARISON OF GROUNDWATER DATA (BASELINE THROUGH SEPTEMBER 1994) WITH REGULATORY AND GUIDANCE CRITERIA FOR GROUNDWATER
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	Maximum Detected Concentration (mg/L)	Calculated 95% UCL Concentration (mg/L)	Maximum Detected Background Concentration (mg/L)	Federal Maximum Contaminant Level[a] (mg/L)	Federal Maximum Contaminant Level Goal[a] (mg/L)	Kansas Maximum Contaminant Level[b] (mg/L)	Kansas Action Level[c] (mg/L)	Kansas Notification Level[c] (mg/L)	Alternate Kansas Action Level[c] (mg/L)	Alternate Kansas Notification Level[c] (mg/L)
Aluminum	0.80	0.32	0.26	$\boxed{0.05 - 0.2\ S}$	--	--	5	--	0.75	$\boxed{0.087}$
Antimony	0.032	0.0236	0.022	$\boxed{0.006}$	0.006	$\boxed{0.006}$[g]	0.143	--	--	--
Arsenic	0.016	0.00797	ND	0.05	--	0.05	0.05	0.05	--	--
Barium	0.13	0.103	0.2	2	2	2[g]	1	--	--	--
Beryllium	0.005	0.0027	0.002	0.004	0.004	0.004[g]	$\boxed{0.00013}$	--	--	--
Cadmium	0.006	0.0028	0.004	0.005	0.005	0.005[g]	--	--	--	--
Chromium, Total	0.014	0.007	0.01	0.1	0.1	0.05[g]	0.05	--	--	--
Manganese	0.091	0.059	0.034	$\boxed{0.05\ S}$	--	--	0.05	--	--	--
Selenium	0.0036	0.002	0.008	0.05	0.05	0.05[g]	--	--	--	--
Thallium	0.0029	0.0029	0.0024	$\boxed{0.002}$	0.0005	0.002[g]	--	--	--	--
Vanadium	0.027	0.017	0.011	0.255[d]	--	--	--	--	--	--
Inorganic Chloride	399	138	147	250 S	--	--	250	--	--	--
Nitrate (as N)	165	33/130.7[e]	6.4	$\boxed{10}$	$\boxed{10}$	$\boxed{10/20}$[f]	$\boxed{10}$	--	--	--
Sulfate	386	211	160	250 S	--	--	250	--	--	--

S Secondary MCL
$\boxed{\quad}$ Boxed area indicates exceeds regulatory or guidance criteria by the 95% UCL concentration.
a Drinking Water Regulations and Health Advisories; USEPA Office of Water, January 1995
b Kansas Drinking Water Rules (KAR 28.15), last amended January 9, 1995
c KDHE Memorandum, dated 5 December 1988; Revised Groundwater Contaminant Cleanup Target concentrations for aluminum and selenium
d Remediation goal concentration calculated using a target hazard index of 1.0. No regulatory or guidance criteria has been established.
e Reported values censored and included the second quarter (February 1993) data, respectively.
f Noncommunity public water supply systems may be allowed an MCL of 20 mg/kg under certain conditions specified in KAR 28.15.13(b)(2).
g MCL shall apply only to community and nontransient, noncommunity public water supply systems [KAR 28.15.13(b)(4)].
ND Not detected
-- Not available

exceeded its Kansas Action Level, and the maximum detected concentration of beryllium (0.005 mg/L) was slightly greater than the federal MCL of 0.004 mg/L; however, the 95 percent UCL concentration for beryllium was less than the MCL. Cadmium, with a maximum detected concentration of 0.006 mg/L, exceeded its MCL of 0.005 mg/L once, and the 95 percent UCL (0.0028 mg/L) was less than the MCL for this constituent. Thallium exhibited a maximum detected hit of 0.0029 mg/L, which also defined the 95 percent MCL concentration and exceeded its MCL of 0.002. The maximum detected hit of nitrate, 165 mg/L (as N), and the 95 percent UCL concentration range, with the second quarter samples censored and included (33 and 130.7 mg/L, respectively) exceeded the state of Kansas nitrate MCL of 10 to 20 mg/L (as N). The 20 mg/L standard may be allowed under certain conditions for noncommunity public water supply systems. Since Kansas is required to enforce the federal MCLs, 10 mg/L is used for comparison.

The maximum detected concentrations for aluminum, manganese, inorganic chloride, and sulfate exceeded the secondary MCLs established by the federal government. The 95 percent UCL concentration for manganese (0.059 mg/L) exceeded the secondary MCL. Secondary MCLs are used to define the aesthetic quality of drinking water, and are not enforceable standards. The detected concentrations of arsenic, barium, chromium, and selenium were less than current MCLs, and there are currently no criteria values for bicarbonate and vanadium.

Soils

Currently, there are no federal regulations (ARARs) governing the levels of contaminants in soils. Risk-based RGs developed in Section 5.1 are considered TBCs at the PSF site. The KDHE Bureau of Environmental Remediation issued interim soil cleanup standards in August 1993 (KDHE, 1993a) meant to provide guidance for establishing soil cleanup standards. Constituents included in these standards did not include the pesticides which were COCs at the site, and were therefore not TBCs for soil.

5.2.2 Discussion of Potential Location-Specific ARARs and TBC Requirements

Location-specific ARARs are restrictions placed on the concentration of constituents or the activities to be performed at a site because the site occurs in a special location such as a floodplain, wetland area, historic places, and fragile ecosystems or habitats. Federal requirements that have been evaluated for this site are considered ARARs and are listed below:

- Endangered Species Act of 1973

- Fish and Wildlife Coordination Act Requirements

- Storm-Water Discharge Requirements National Pollutant Discharge Elimination System Requirements

- Floodplain Management Requirements (Executive Order 11988)

- National Historic Preservation Act (16 U.S.C. 469)

An additional state of Kansas requirement that has been evaluated is:

- Kansas Surface Water Use Designations (KAR 28.16.28d)

Currently, there are no location-specific To Be Considered (TBC) requirements under examination for this site. The ARARs are summarized with the appropriate citations in Table 5-5. Descriptions of reasons for the applicability of a given location-specific ARAR to this site are provided in the following paragraphs.

5.2.2.1 Endangered Species Act of 1973 - These regulations protect or conserve endangered or threatened species. Fort Riley falls within an area that eight federally endangered species and thirteen additional candidate species for the federal endangerment listing are likely to inhabit. Of these 21 total species, two federally endangered species and eight candidate species are known to occur on Fort Riley. Examples of these species include the bald eagle, the peregrine falcon, the prairie mole cricket, and Henslow's sparrow. The PSF does not provide a suitable habitat for most of the threatened and endangered species at Fort Riley. Both the bald eagle and loggerhead snake have been sighted on various areas of Fort Riley, but there have been no confirmed sightings of these species at the PSF site. Bald eagles have been sighted in riparian areas in the vicinity of the PSF. Eagles may pass through the PSF area, but are unlikely to inhabit the PSF site due to the limited areas of woodlands and the frequent human activities in the area. Considering that no confirmed sightings have been made at the PSF site, the available habitat areas are limited, and the frequent activities in the PSF area, the Endangered Species Act of 1973 is not considered an ARAR.

5.2.2.2 The Fish and Wildlife Protection Act - This act conserves fish and wildlife when remedial actions result in the modification of a body of water; it is applicable to this site because several different species of animals have been identified at Fort Riley, including the American burying beetle, the Texas horned lizard, the loggerhead shrike, and the regal fritillary butterfly.

TABLE 5-5

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND TO BE CONSIDERED (TBC) REQUIREMENTS
Pesticide Storage Facility
Fort Riley, Kansas

Type of ARARs	ARARs	TBC Requirements
Chemical-Specific	None Identified	Risk-Based RGs for constituents in soils and groundwater
		Kansas Notification Levels (KNLs)
		Alternate Kansas Notifications Levels (AKNLs)
		Kansas Action Levels (KALs)
		Alternate Kansas Action Levels (AKALs)
Location-Specific	Fish and Wildlife Coordination Act Requirements (33 CFR 320-330; 40 CFR 6.302)	None Identified
	Stormwater Discharge Requirements National Pollutant Discharge Elimination System (CWA 40 CFR 122)	
	Flood Plain Management (Executive Order 11988 16 USC 661 et. deq. 40 CFR 6.302, Appendix A)	
	Surface Water Use Designations (KAR 28.16.28d)	
Action-Specific		
General Requirements (Applicable to all on-site activities)	Occupational Safety and Health Administration - Hazardous Waste Operations and Emergency Response (OSHA 29 CFR 1910.120)	
No Action	None Identified	None Identified

TABLE 5-5

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND TO BE CONSIDERED (TBC) REQUIREMENTS
Pesticide Storage Facility
Fort Riley, Kansas

Type of ARARs	ARARs	TBC Requirements
Institutional Action (Groundwater Restrictions)	None Identified	None Identified
Institutional Action and Groundwater Monitoring	RCRA-Releases from SWMUs (40 CFR 264 Subpart F) Monitoring and Analytical Requirements for Inorganics in Groundwater (40 CFR 141.23 Subpart C) Kansas Hazardous Waste Regulations (KAR 28.31)	

5.2.2.3 Storm-Water Discharge Requirements National Pollutant Discharge Elimination System - The PSF is located approximately one-half mile north of the Kansas River; an ephemeral drainage way, draining toward the Kansas River, is located east of the PSF. The federal Storm-Water Discharge Requirements and National Pollution Discharge Elimination System requirements, therefore, apply to this site, because of the potential for storm water to drain off the site, acquiring chemical contaminants by contact with contaminated surface soils (left exposed under certain remedial alternatives), into the Kansas River. This drainage would constitute a surface-water discharge.

5.2.2.4 Protection of Wetlands (Executive Order 11990) - Federal requirements for protection of wetlands (Executive Order 11990) regulate action involving management of property in wetland areas to avoid adverse effects, minimize potential harm, and preserve and protect wetlands to the extent possible; these requirements may apply because although no formally delineated wetlands appear to exist at the site, the Kansas River and its associated biota could constitute a wetlands region. The Corps of Engineers has conducted a wetlands delineation survey (CEMRK, 1993). Results generated from this survey indicated that no jurisdictional wetlands areas exist within the limits of the PSF site, and Executive Order 11990 is not an ARAR for the PSF site.

5.2.2.5 Flood Plain Management (Executive Order 11988) - Federal requirements for floodplain management (Executive Order 11988) regulate action that will occur within a floodplain to avoid adverse effects due to flooding. This ARAR is applicable because portions of the PSF site are located within the 50-year floodplain. The 50-year flood peak in this region has been estimated at 1,067 feet above mean sea level (msl). Portions of the site are located on land situated within the confines of the floodplain.

5.2.2.6 National Historic Preservation Act (16 U.S.C. 469) - These regulations were enacted to protect and preserve significant artifacts and historic properties. The historical and archaeological significance of Ft. Riley, in addition to its inclusion on the National Register of Historic Places, makes this ARAR potentially applicable to the PSF site, since the Main Post Area, encompassing the DEH yard, is identified. The PSF area has been extensively altered by filling, grading, and construction of the limestone channel during the past 60 years. Building 348, constructed in 1941, has not been identified as a historical structure. Considering these past activities, it is likely that any historic or cultural resources at the PSF site have been disturbed. Therefore, this ARAR is not relevant or appropriate to the PSF, as no concerns within the study area have been identified. This ARAR is applicable, but not expected to have a significant impact on actions at the site. Proposed actions would have to be reviewed per Section 106 and activities may have to be monitored.

5.2.2.7 Kansas Surface Water Use Designations (KAR 28.16.28d) - These regulations provide criteria for approved uses of certain types of waters. Surface waters located at the PSF site exist principally in isolated small areas of localized ponding and within the lined ditch adjacent to the site. The Kansas River is classified for "non-contact recreational use" and "consumptive recreational use" in the Fort Riley area. In addition, the Kansas River is also designated as an expected aquatic life region. This ARAR is not applicable because flows in the lined channel are intermittent, and this ditch does not have a classified use, but is relevant and appropriate, because site excavation and grading activities may ultimately impact water quality in the downstream Kansas River.

5.2.3 Action-Specific ARARs

Action-specific ARARs are technology-based or activity-based requirements or limitations on proposed remedial actions at the site. By definition, action-specific ARARs are dependent on the proposed remedial actions at the site. Currently, there are three remedial alternatives under consideration for this site; these are listed below:

- No Action
- Institutional Action (Groundwater Restrictions)
- Institutional Action and Groundwater Monitoring

Federal and state of Kansas ARARs that apply to each alternative are summarized in Table 5-4. A discussion of ARARs applicable to each remedial alternative under consideration is provided in the following paragraphs. Also provided is a discussion of specific reasons why each ARAR or TBC requirement applies to a specific remedial alternative.

5.2.3.1 No Action - There have been no ARARs or TBCs identified for this remedial alternative.

5.2.3.2 Institutional Action (Groundwater Restrictions) - There have been no ARARs or TBCs identified for this remedial alternative.

5.2.3.3 Institutional Action and Groundwater Monitoring - There have been no ARARs or TBCs identified for institutional actions. The following federal ARARs apply to the groundwater monitoring action for the reasons stated below:

Releases from SWMUs (RCRA 40 CFR 264 Subpart F) - These regulations contain standards and specifications for groundwater monitoring from SWMUs. This ARAR would not be directly applicable to the PSF, as it is not a RCRA-permitted facility, yet it would be relevant and appropriate to the PSF because similar constituents (i.e., metals) would be expected to be detected in PSF groundwater as would likely be present in similar, RCRA-permitted facilities. The portion of this section requiring the analysis of groundwater for all Appendix IX constituents would be neither applicable, for reasons described above, nor relevant and appropriate, because only certain metals have been detected at levels above MCLs and therefore only the metals exceeding MCLs would be included in the monitoring program.

Monitoring and Analytical Requirements for Inorganics in Groundwater (SDWA 40 CFR 141.23 Subpart C) - These regulations specify the sample collection and analytical testing methods for quantification of metals and other inorganics in groundwater. They will be applicable to this action in that metals are the constituents for which monitoring is being conducted.

The following state of Kansas ARARs apply to this action for the reasons stated below:

Kansas Hazardous Waste Regulations (KAR 28.31) - These are state standards that incorporate 40 CFR 264-265 by reference. They are applicable to this site for the same reasons that RCRA Subpart F is, and these regulations further instruct the facility owner/operator to maintain the integrity of environmental monitoring equipment installed on site.

There are no state of Kansas or federal TBC requirements identified for this action.

5.2.3.4 General - The following general ARAR applies to on-site activities. These activities include monitoring well installation, development, and sampling [OSHA Hazardous Waste Operations and Emergency Response (29 CFR 1910.120)].

These regulations define the training, health and safety, and monitoring requirements for workers involved in on-site activities on hazardous waste sites. It is applicable to remedial alternatives under which worker exposure to hazardous constituents may occur, and is applicable to this site because of the constituents detected in the soils.

5.3 DETERMINATION OF REMEDIATION GOALS

RGs are site-specific, media-specific contaminant concentrations established for COCs at the PSF site which define the cleanup levels established for each COC used to establish appropriate RAOs. At the PSF site, the following considerations were used to establish RGs:

- For inorganics in soil and groundwater, background concentration ranges which exceeded risk-based or regulatory levels were used to establish RGs.

- For soil media, risk-based RGs were calculated using a carcinogenic risk range of 1×10^{-5} to 1×10^{-6} and a noncarcinogenic HI of 1.0. The lowest of the calculated values for the carcinogenic risk level and HI at the 10^{-5} and 10^{-6} risk levels were used for the range.

- For hypothetical groundwater use, upgradient and Fort Riley background concentrations discussed in Section 3 and the MCLs were used for comparison to detected site concentrations. For vanadium, an MCL was not available, and a concentration level with a noncarcinogenic HI of 1.0 was used.

The 10^{-5} risk level is considered appropriate for this industrial area, as discussed in Section 5.1. Both the 10^{-5} and 10^{-6} point of departure levels are presented for information and comparison. The selection of risk level has a very minor impact on the evaluation and results.

Risk-based remediation goals were presented in Tables 5-1 and 5-2 for surface and subsurface soils, respectively. Tables 5-6 and 5-7 present summaries of the current detections of COCs in surface soils and subsurface soils, respectively, and comparisons of the detected concentrations of these contaminants to the calculated RG concentration ranges to identify exceedances. Graphical comparisons of the RG concentrations calculated at the 10^{-6} risk level to the residual soil sample concentrations and calculated 95 percent UCL concentrations for surface soil COCs are presented in the histograms shown on Figures 5-1 to 5-5, and the subsurface soils comparisons are presented on Figures 5-6 to 5-10. In Figures 5-7 through 5-9, the calculated RGs greatly exceeded the sampled concentrations, and are not shown to scale. As seen on these figures, RG concentrations calculated at the 10^{-6} risk level for pesticides were exceeded by a single sample of dieldrin in surface soils. Histograms for heptachlor in surface and subsurface soils and arsenic were not drawn due to the infrequent detections at levels significantly below the RG. A single arsenic sample in subsurface soil at 20 mg/kg under existing pavement slightly exceeded the RG concentration at the 10^{-6} risk level which was 17.4 mg/kg. The locations of these samples are shown on Figure 5-11. Exposure point concentrations for dieldrin and arsenic were below the calculated RGs as shown on Tables 5-6 and 5-7.

Table 5-3 presented risk-based remediation goals for groundwater, and a comparison of detected constituents in groundwater with regulatory criteria was presented in Table 5-4. The maximum detected concentrations for aluminum, inorganic chloride, and sulfate exceeded their respective secondary MCLs. Secondary MCLs define the aesthetic qualities of a drinking water source and are not enforceable standards which were identified as TBCs. The maximum detected

TABLE 5-6

CONTAMINANTS OF CONCERN DETECTION SUMMARY - SURFACE SOILS AND COMPARISON TO RISK-BASED REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

Pesticide Constituent	Detection Frequency[a]	Maximum Detected Concentration (mg/kg)	Exposure Point Concentration (mg/kg)	10^{-5} Risk-Based Remediation Goal (mg/kg)	10^{-6} Risk-Based Remediation Goal (mg/kg)	10^{-5} Risk Exceedance Frequency[b]	10^{-6} Risk Exceedance Frequency
Chlordane	17/52	1.12	0.12	12.3	1.23	0/52	0/52
4,4'-DDD	7/18	0.454	0.45	24.0	2.4	0/18	0/18
4,4'-DDE	12/18	0.847	0.37	16.9	1.69	0/18	0/18
4,4'-DDT	35/52	1.29	1.29	16.9	1.69	0/52	0/52
Dieldrin	20/52	0.158	0.04	1.27	0.127	0/52	1/52
Heptachlor	2/52	0.0093	0.0022	3.56	0.356	0/52	0/52

a Number of times the analyte was detected/number of times the analyte was sampled.
b Number of times the analyte concentration exceeded the remediation goal concentration/number of times the analyte was sampled.

TABLE 5-7

CONTAMINANTS OF CONCERN DETECTION SUMMARY - SUBSURFACE SOILS AND COMPARISON TO GOVERNING RISK-BASED REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

Constituent	Detection Frequency [a]	Maximum Detected Concentration (mg/kg)	Exposure Point Concentration (mg/kg)	10^{-5} Risk-Based Remediation Goals (mg/kg)	10^{-6} Risk-Based Remediation Goal (mg/kg)	10^{-5} Risk Exceedance Frequency[b]	10^{-6} Risk Exceedance Frequency
Pesticides:							
Chlordane	41/126	10.2	0.220	20.9	18.9 (d)	0/126	0/126
4,4'-DDD	16/100	0.925	0.017	669	66.9	0/100	0/100
4,4'-DDE	31/101	0.666	0.033	473	47.3	0/101	0/100
4,4'-DDT	42/126	1.95	0.150	114	47.3 (d)	0/126	0/126
Dieldrin	12/126	0.077	0.0048	16.4	1.64	0/126	0/126
Heptachlor	8/126	0.3	0.0029	54.6	5.46	0/126	0/126
Volatile Compounds:							
Benzene	2/29	0.0066	0.0023	3080	308	0/29	0/29
Methylene chloride	13/29	0.031	0.019	7610	1,190 (d)	0/29	0/29
Toluene	7/29	0.038	0.0067	25,400 (d)	25,400 (d)	0/29	0/29
Semi-Volatile Compounds:							
Benzo[a]anthracene	3/29	0.33	0.1	81.2	8.12	0/29	0/29
bis(2-Ethylhexyl)phthalate	3/29	1.2	0.33	2540	638 (d)	0/29	0/29
Chrysene	3/29	0.29	0.092	3080	308	0/29	0/29
Diethylphthalate	1/29	0.43	0.24	101,000	10,100	0/29	0/29
Fluoranthene	3/29	0.53	0.13	5,070	507	0/29	0/29
Pyrene	5/29	0.57	0.12	3,800	380	0/29	0/29
Metals:							
Arsenic	31/31	20	4.6	130	17.4 (d)	0/31	1/31
Barium	29/29	190	105	28,500	2,850	0/29	0/29
Chromium	29/29	20	8.4	2,160 (d)	2,160 (d)	0/29	0/29
Lead	25/29	770	99.5	1,000 (c)	1,000 (c)	0/29	0/29
Mercury	1/29	0.1	0.054	130 (d)	130 (d)	0/29	0/29
Silver	3/29	1.2	0.46	2,160 (d)	2,160 (d)	0/29	0/29

a - Number of times the analyte was detected / number of times the analyte was sampled.
b - Number of times the analyte concentration exceeded the remedial goal / number of times the analyte was sampled.
c - OSWER Directive #9355.4-02, Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites, September 1989.
d - Remediation goal based on hazard index of 1.0.

2536-0308.21

FIGURE 5-1

CONCENTRATIONS SUMMARY HISTOGRAM OF DETECTED CHLORDANE IN SURFACE SOILS
Pesticide Storage Facility
Fort Riley, Kansas

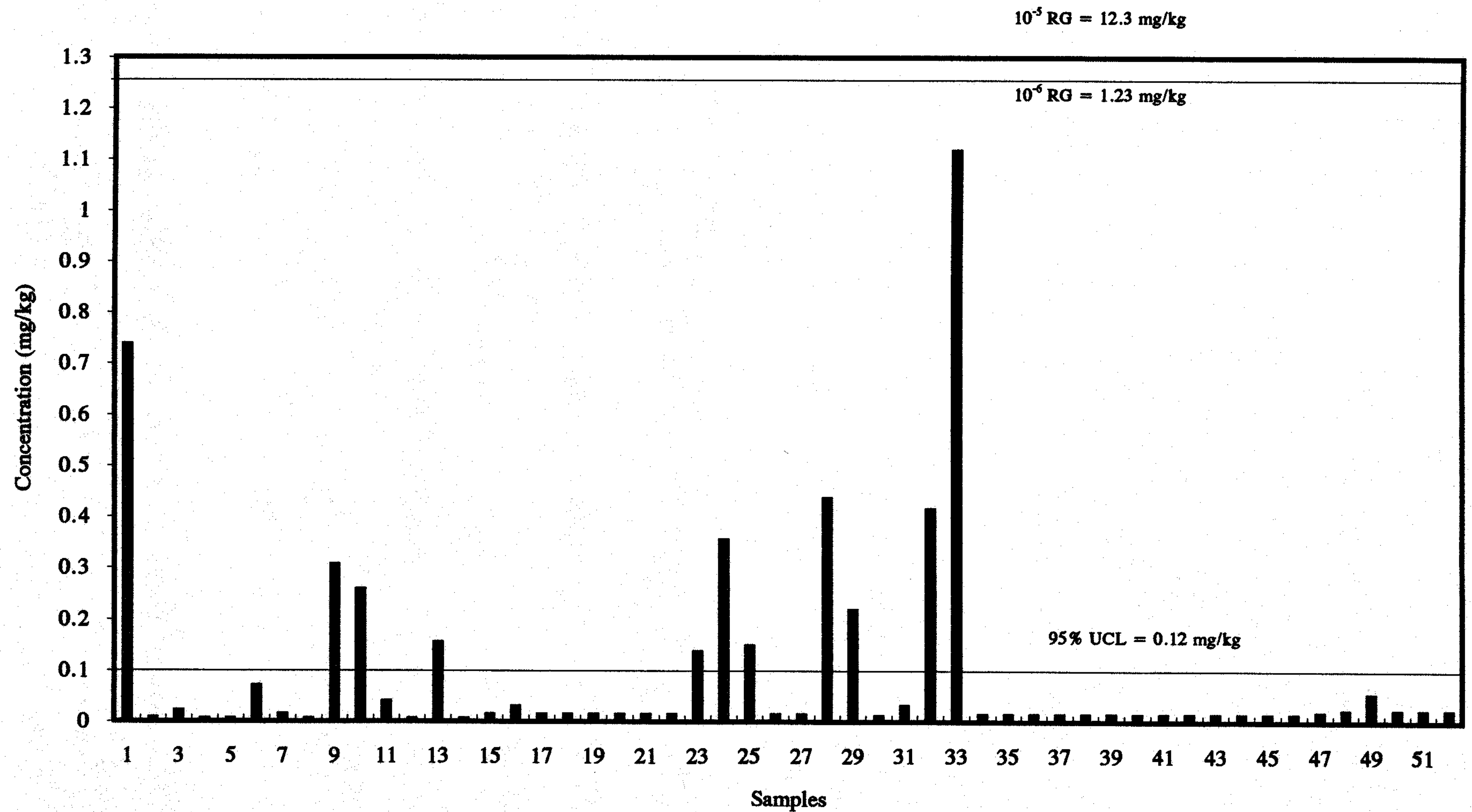

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FIGURE 5-2

CONCENTRATIONS SUMMARY HISTOGRAM OF DETECTED DDD IN SURFACE SOILS
Pesticide Storage Facility
Fort Riley, Kansas

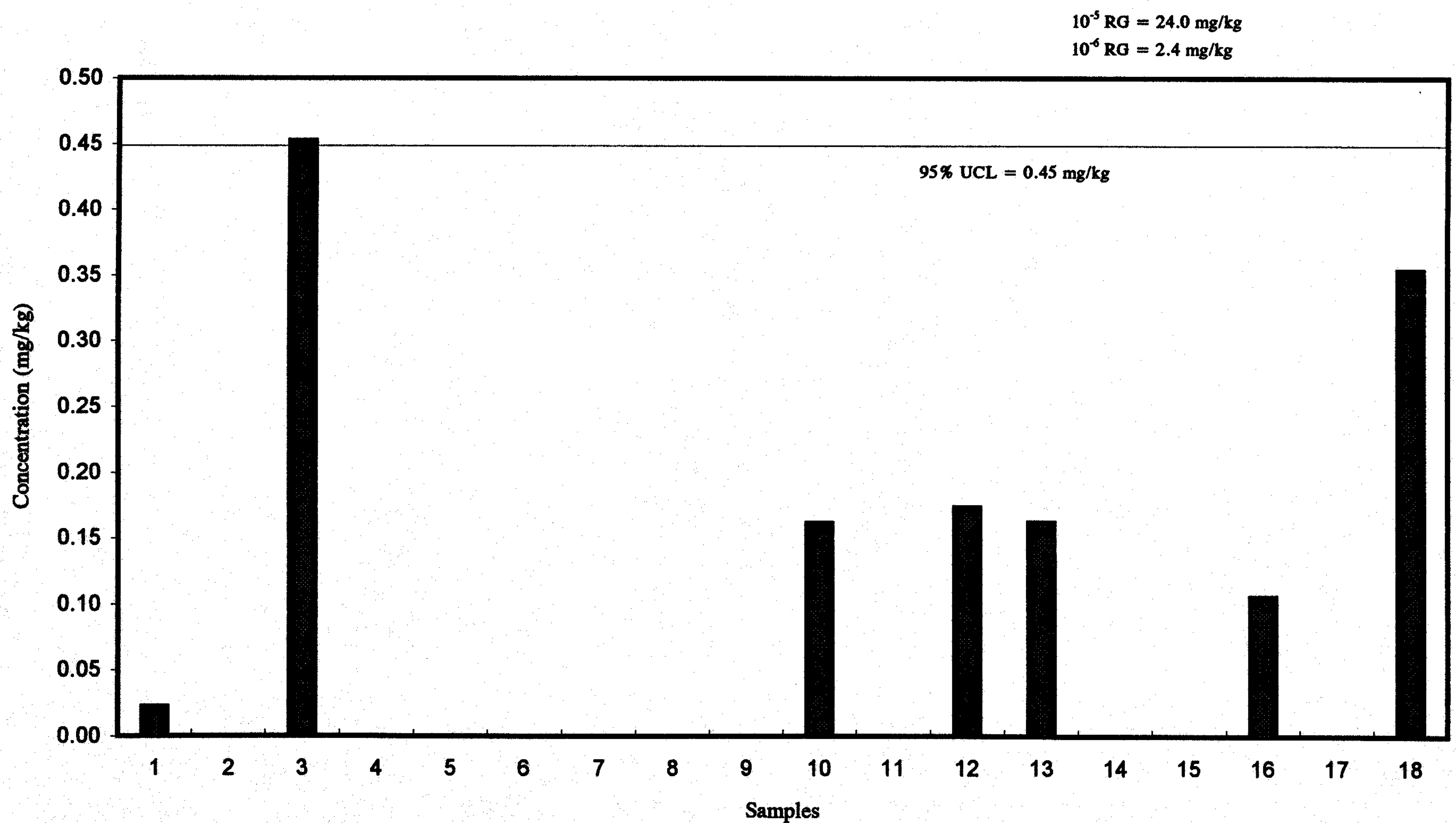

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FIGURE 5-3

CONCENTRATIONS SUMMARY HISTOGRAM OF DETECTED DDE IN SURFACE SOILS
Pesticide Storage Facility
Fort Riley, Kansas

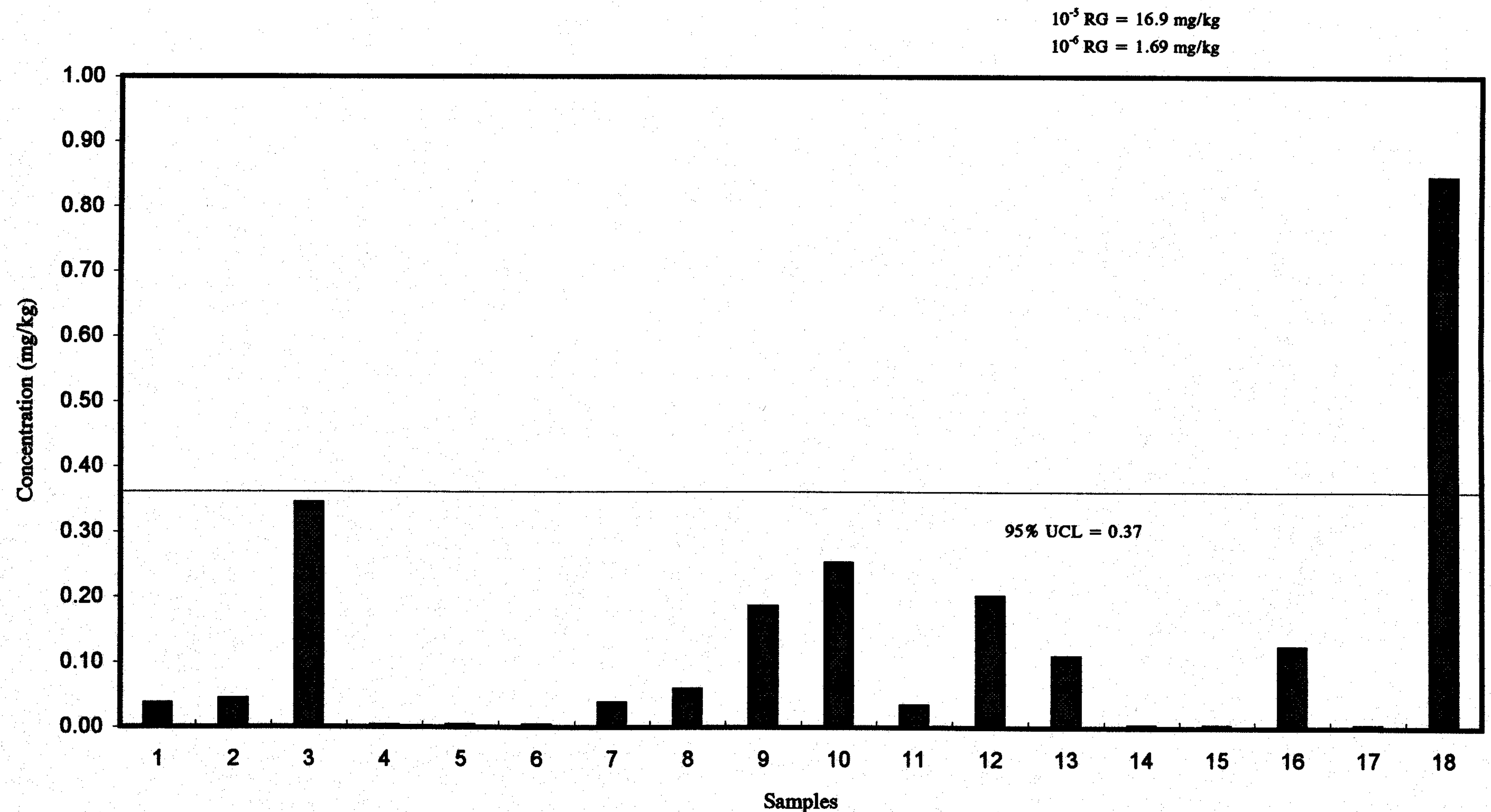

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FIGURE 5-4

CONCENTRATIONS SUMMARY HISTOGRAM OF DETECTED DDT IN SURFACE SOILS
Pesticide Storage Facility
Fort Riley, Kansas

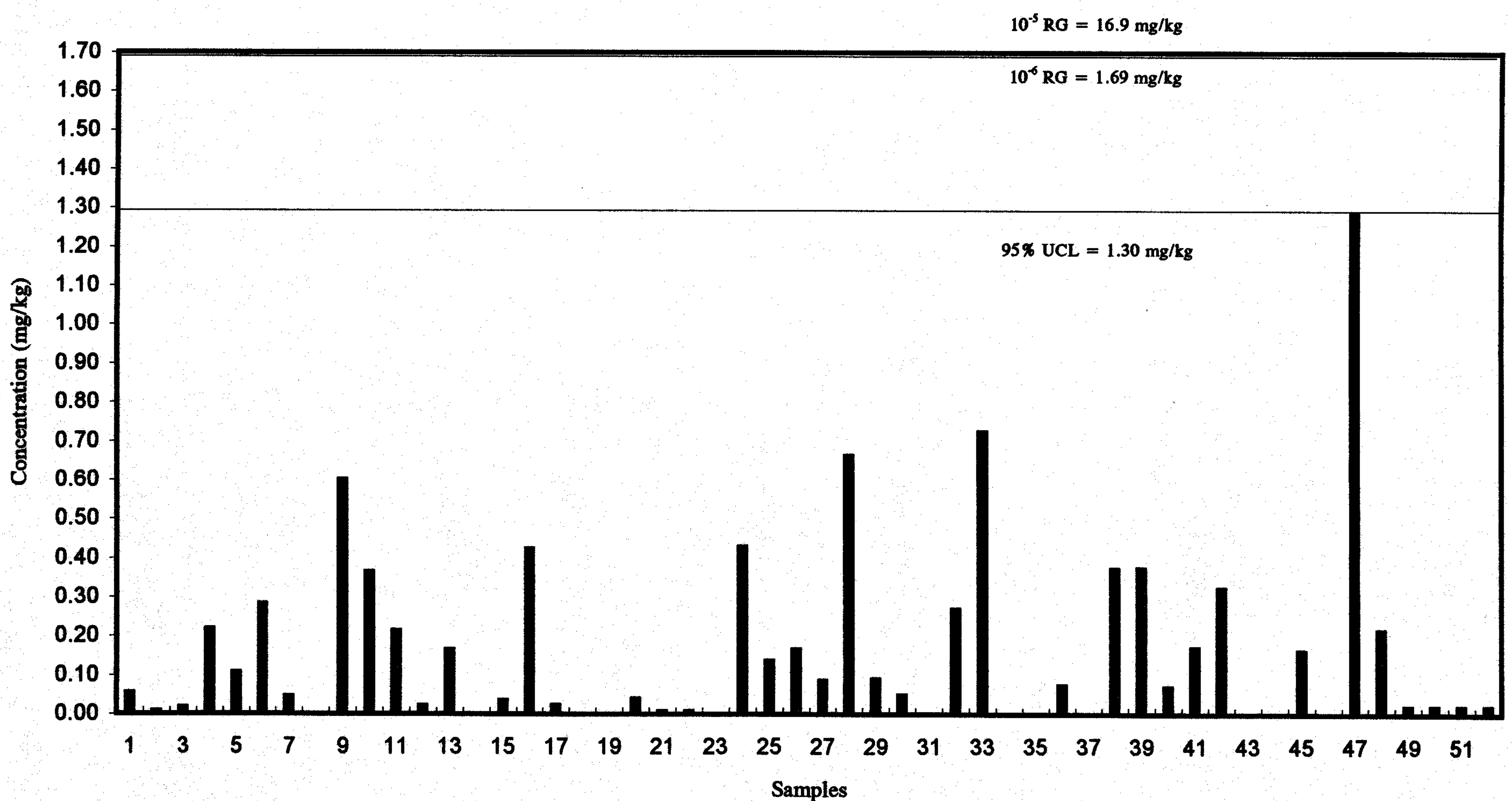

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FIGURE 5-5

CONCENTRATIONS SUMMARY HISTOGRAM OF DETECTED DIELDRIN IN SURFACE SOILS
Pesticide Storage Facility
Fort Riley, Kansas

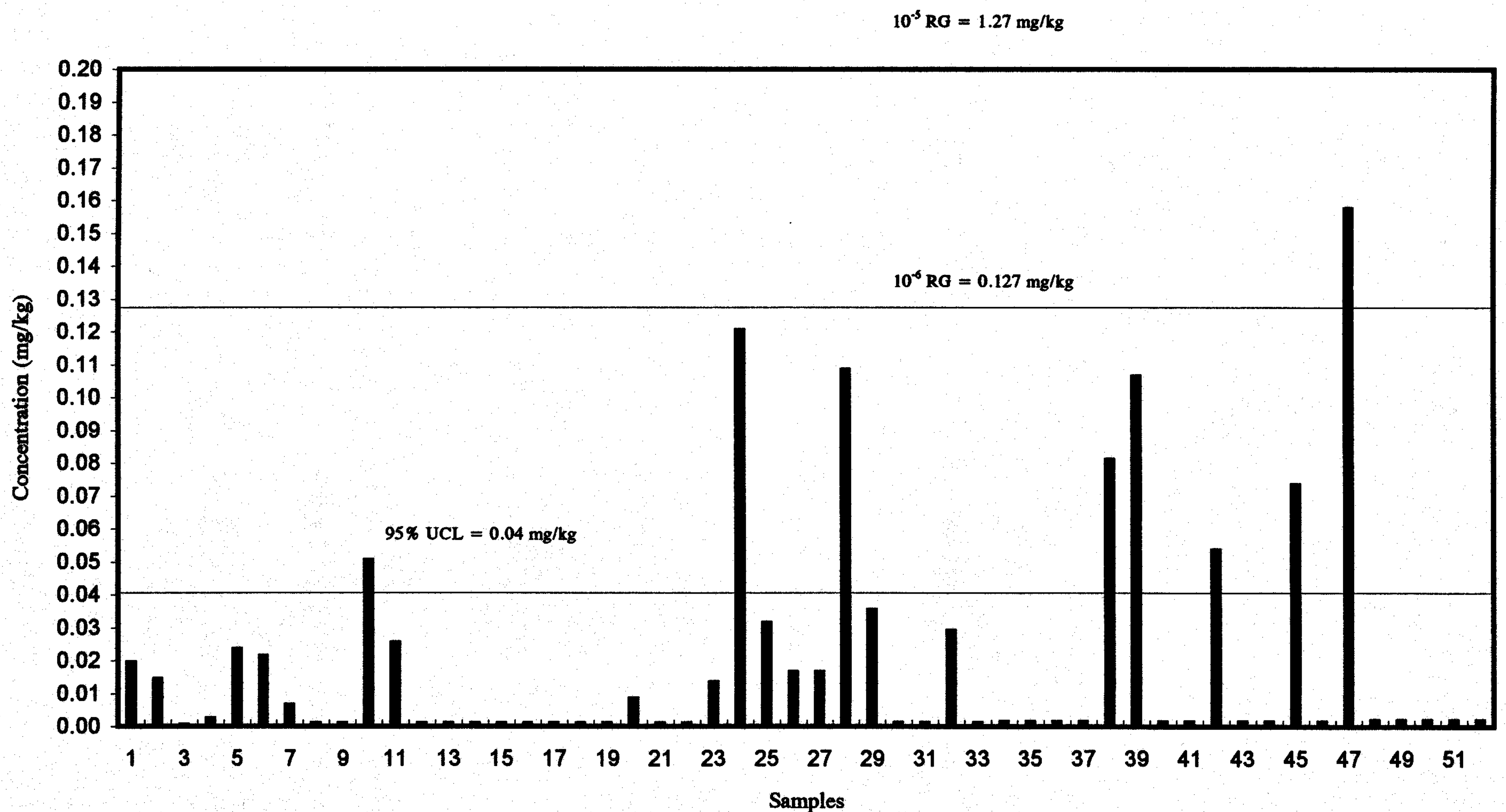

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FIGURE 5-6

CONCENTRATIONS SUMMARY HISTOGRAM OF DETECTED CHLORDANE IN SUBSURFACE SOILS
Pesticide Storage Facility
Fort Riley, Kansas

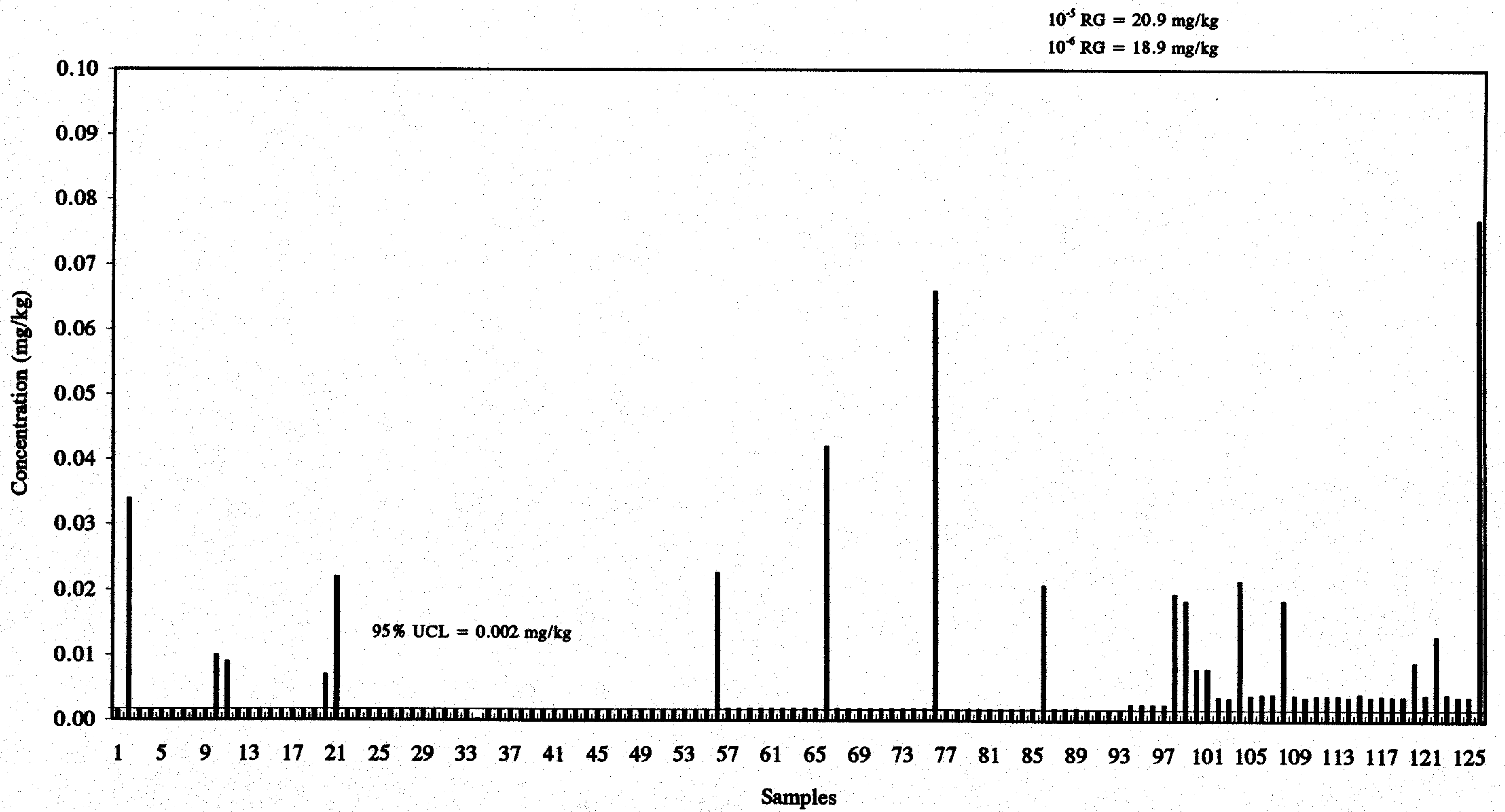

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FIGURE 5-7

CONCENTRATIONS SUMMARY HISTOGRAM OF DETECTED DDD IN SUBSURFACE SOILS
Pesticide Storage Facility
Fort Riley, Kansas

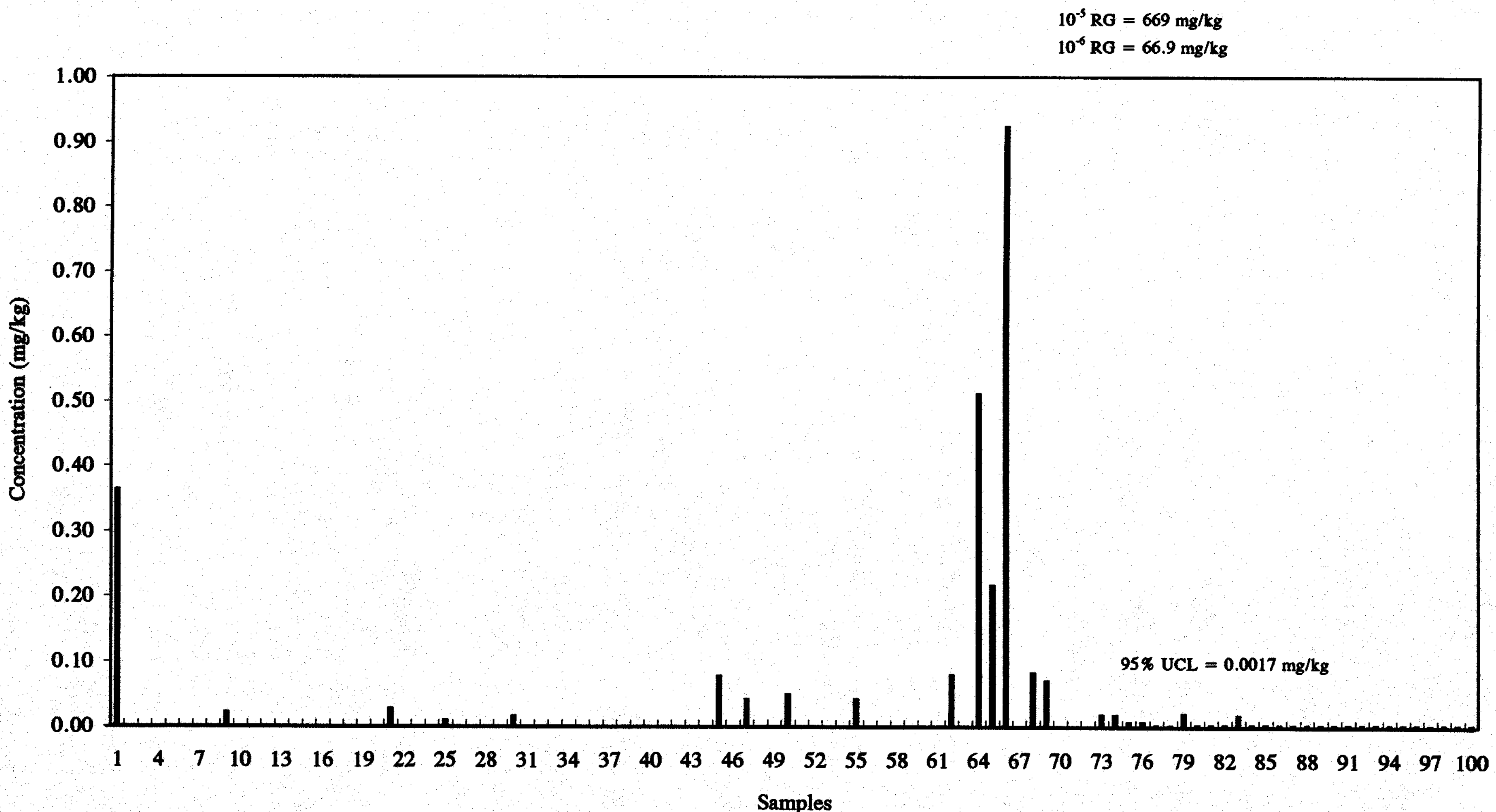

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FIGURE 5-8

CONCENTRATIONS SUMMARY HISTOGRAM OF DETECTED DDE IN SUBSURFACE SOILS
Pesticide Storage Facility
Fort Riley, Kansas

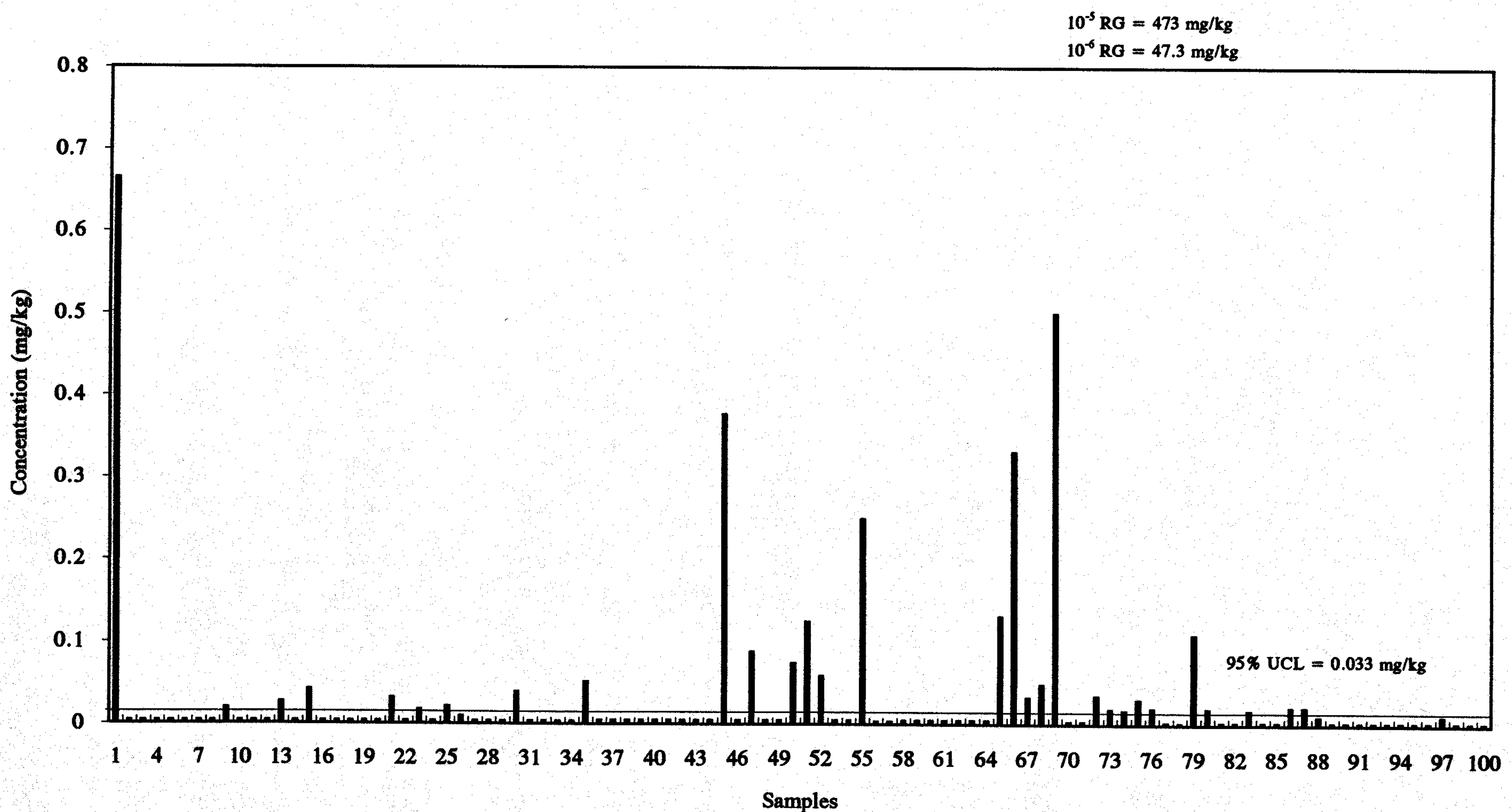

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FIGURE 5-9

CONCENTRATIONS SUMMARY HISTOGRAM OF DETECTED DDT IN SUBSURFACE SOILS
Pesticide Storage Facility
Fort Riley, Kansas

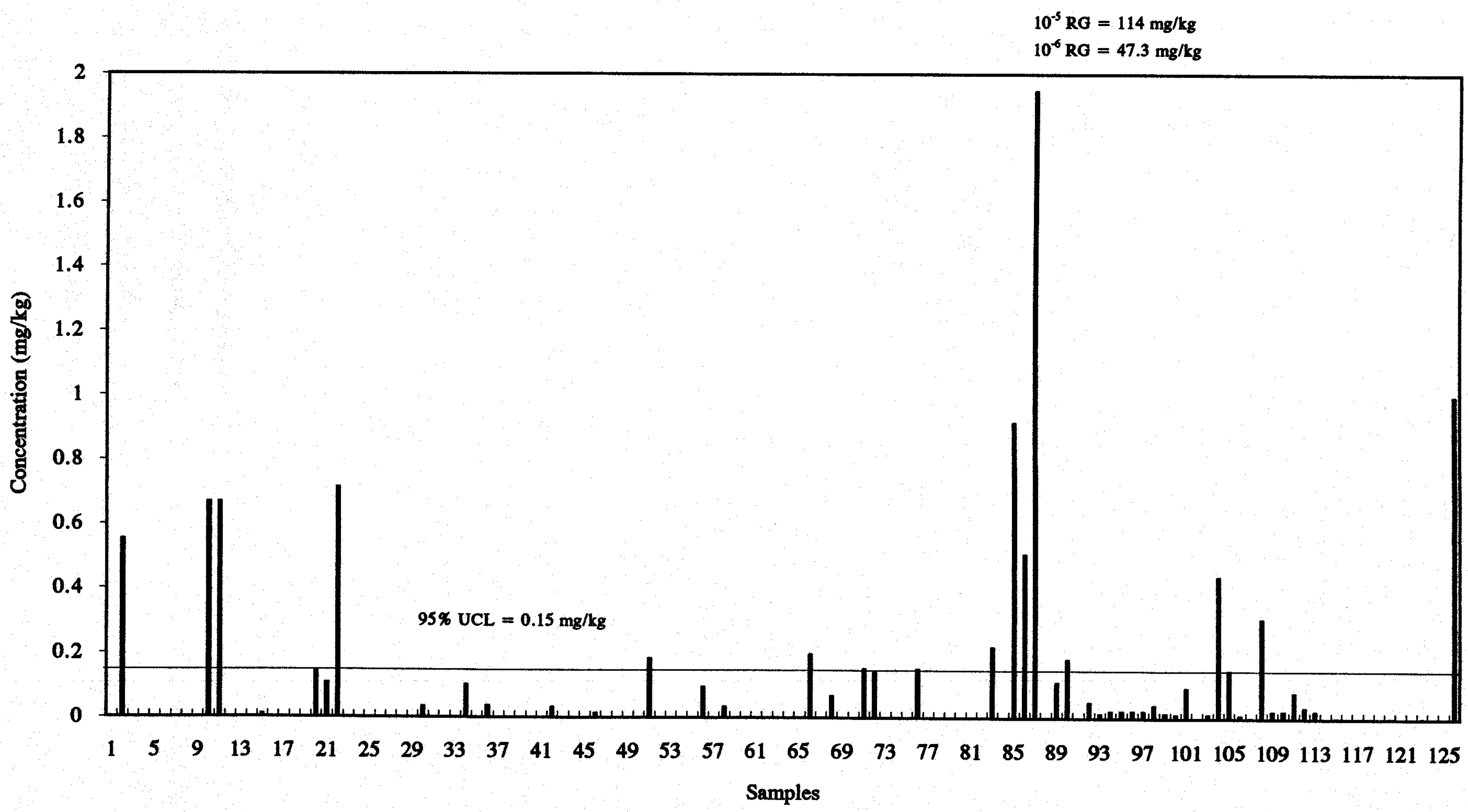

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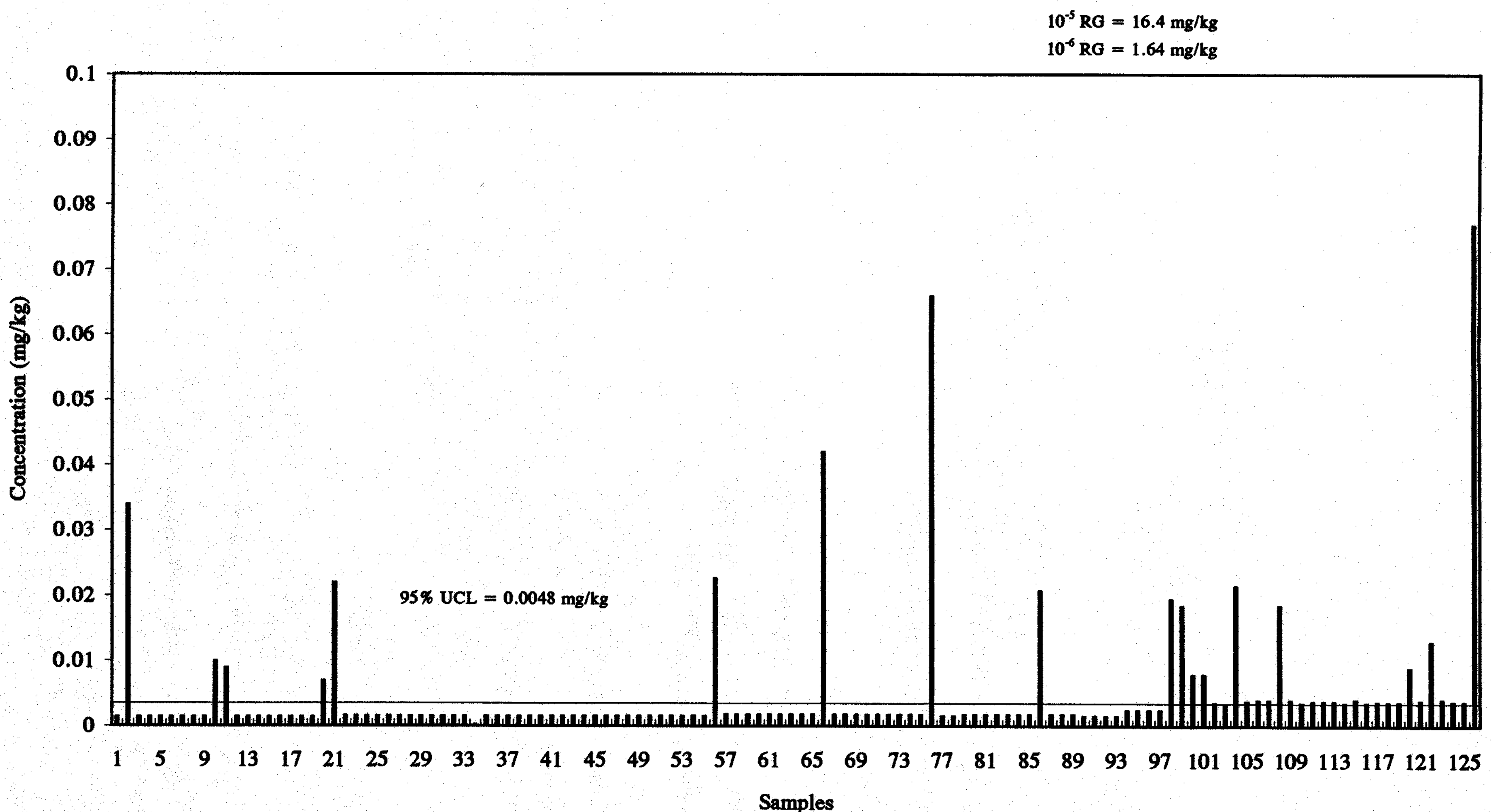
FIGURE 5-10

CONCENTRATIONS SUMMARY HISTOGRAM OF DETECTED DIELDRIN IN SUBSURFACE SOILS
Pesticide Storage Facility
Fort Riley, Kansas

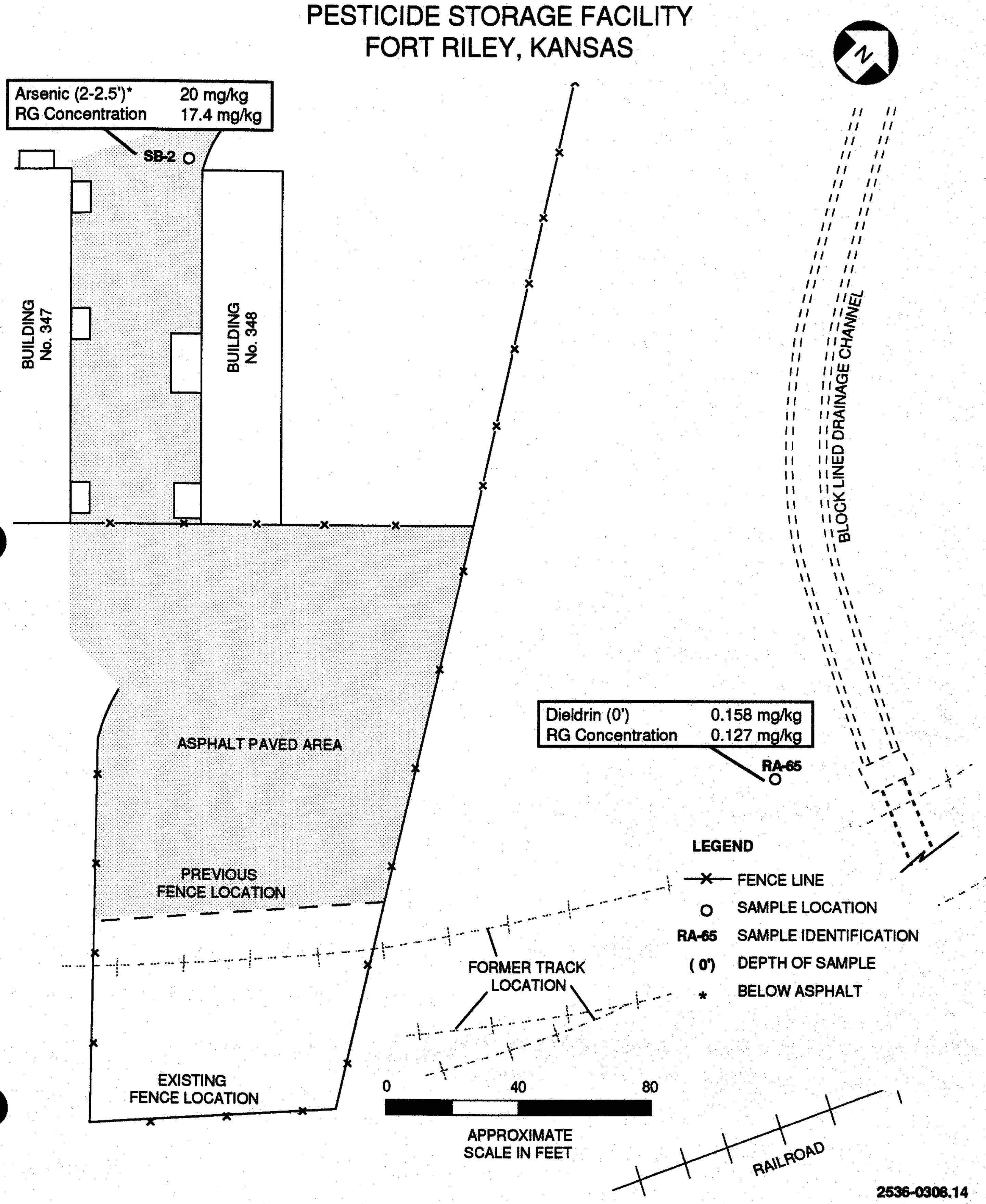


2536-0308.21

FIGURE 5-11

REMAINING SOIL SAMPLES EXCEEDING 10^{-6} REMEDIAL GOAL CONCENTRATIONS

PESTICIDE STORAGE FACILITY
FORT RILEY, KANSAS



concentrations of antimony and cadmium exceeded the MCLs for these constituents infrequently. These constituents were likely due to natural background conditions as discussed in Section 3 and will not be considered further. The detected concentrations of arsenic, barium, chromium, and selenium were less than current MCLs, as shown in Table 5-4; therefore, these constituents are not considered further. Table 5-8 provides a comparison of the detected concentrations of the COCs in groundwater identified in the risk assessment with background concentrations and the MCLs.

5.4 POST REMOVAL ACTION REMEDIAL ACTION OBJECTIVES

RAOs are developed for the site media with contaminant concentrations exceeding the established RGs. To develop the RAOs, the exceedance frequency in the media is considered, along with the location (e.g., depth) and estimated volumes of the contaminants at the site. The potential for future exposure to the contaminants above RGs considering the identified future uses of the site, the possible future migration of contaminants from source areas at the site, and a consideration of the expected natural attenuation and degradation rates of the contaminants are included in the development of the RAOs. Exceedance frequencies for residual constituents in soils and detected constituents in groundwater were presented in Tables 5-6 through 5-8. Additional consideration factors used to establish RAOs are described in the following section.

5.4.1 Extent of Contamination Exceeding Remediation Goals

Considering the RGs and post-removal action site conditions, the extent of remaining contamination at the PSF is limited, as shown on Figure 5-11. Constituent concentrations in the PSF soil samples were compared to contaminant-specific RGs at risk levels of 10^{-5} and 10^{-6} as discussed above. At the 10^{-5} risk level, no surface or subsurface soil sample exceedances were noted. At the 10^{-6} risk level, a single surface soil sample analyzed for dieldrin (0.158 mg/L) exceeds the RG concentration (0.127 mg/L). One subsurface soil sample under existing pavement exceeds the arsenic RG of 17.4 mg/kg at 20 mg/kg. No other detected concentrations of the constituents of concern in the PSF soil samples exceeded contaminant-specific RGs. Exposure point concentrations were less than the RGs at the 10^{-6} risk level for these constituents.

The soil from the stressed vegetation area including the location of surface soil sample SS-04 discussed in the RI report had been excavated to a depth of approximately 4 to 7 feet during the removal action and clean fill placed in this area. PAHs detected in soils at depths from the surface to 4.5 feet during the RI represented less than 2 percent of the estimated risk or hazard indices in the BLRA. These soils were excavated and substantially removed from the site during the removal action, thus eliminating significantly the exposure risks.

In groundwater, arsenic did not exceed the MCL in any samples. Beryllium and thallium were detected at comparable concentrations and frequencies in the background and downgradient

TABLE 5-8

GROUNDWATER CONSTITUENT DETECTION SUMMARY AND COMPARISON TO MAXIMUM CONTAMINANT LEVELS ESTABLISHING REMEDIATION GOALS

Pesticide Storage Facility
Fort Riley, Kansas

Analyte	Maximum Detected Background Concentration (mg/L)[f]	Downgradient Detection Frequency[a]	Maximum Detected Concentration (mg/L)	Calculated 95% UCL Concentration[b] (mg/L)	Federal Maximum Contaminant Level (MCL)[c] (mg/L)	MCL Exceedance Frequency[d]
Arsenic	0.039	5/20	0.016	0.00797	0.05	0/20
Beryllium	0.002	15/20	0.005	0.0027	0.004	1/20
Manganese	0.52	18/20	0.091	0.059	0.05[S]	5/20
Thallium	0.0025	2/20	0.0029	0.0029	0.002	2/20
Nitrate (as N)	10.0	19/20	165	33.7/130.7[e]	10	17/20

a Number of times the analyte was detected/number of times the analyte was sampled.
b 95% Upper Confidence Limit concentration, not including the background well detections.
c Governing remediation goals are the Federal Maximum Contaminant Levels (MCLs).
d Number of times the analyte exceeded the MCL/number of times the analyte was sampled, not including the background well.
e The 95% UCL concentration (33 mg/L) is equal to the maximum detected concentration when the second round sample data are censored. The 130.7 mg/L concentration includes all data.
f Includes Well PSF92-01 and Building 354 wells TS029201 and TS029202.
ND Not detected
S Secondary MCL

wells, as discussed in Section 3, and are likely naturally occurring background concentrations at the site. These constituents are therefore not considered further.

Nitrate showed an increase in the second quarter sampling, and exceeded the MCL (10 mg/L [as N]) in the other four sampling rounds a total of 17 times. The high nitrate levels detected during the second quarter sampling event were from two and one-half to five times the range of detected concentrations observed in all wells during the other four and believed to be an anomaly as discussed previously in Section 1.5.

5.4.2 Remedial Action Objectives

The primary goal at the site is to protect human health and the environment. RAOs are media-specific goals developed to achieve this protection. The RAOs presented were developed considering information in the RI Report (LAW, 1993a) supplemented by the additional soil data obtained during the removal action completed by Fort Riley. RAOs are developed in the following sections, considering current site conditions, the results of the RRA presented in Section 4, and the ARARs identified above.

5.4.2.1 Soil - Following the removal action, residual risks in soils did not exceed 10^{-6} or a hazard index of 1.0. As discussed in Section 5.4.1, detected concentrations, with two exceptions, and calculated exposure point concentrations of constituents in PSF soils were less than RGs at the 10^{-6} risk level. The minimal ecological risks determined in the RI Report (LAW, 1993a) were further reduced by the excavation and off-site disposal of contaminated soils during the removal action. Therefore, further remedial actions addressing soils are not warranted.

5.4.2.2 Groundwater - As discussed in Section 4, no exposure to on-site groundwater exists under the current site uses, and the future use of the PSF groundwater is considered unlikely. Except for nitrate, detections significantly above MCLs and/or background for metals have not been observed in the wells at the PSF, and the available data do not provide evidence of groundwater contamination or a contaminant plume. Nitrate was consistently detected and the 95 percent UCL concentration exceeds the MCL in downgradient wells. Collection of additional groundwater data at the PSF is not needed because available data from the PSF and other areas of Fort Riley show that except for nitrate, constituents in groundwater are likely naturally occurring background.

Possible sources of elevated nitrates in waters include decaying plant mass, animal wastes, agricultural drainage, and surface runoff from urban areas, and sewage. Fort Riley is currently investigating the sewer lines in the vicinity of the PSF, and has conducted an inspection and a smoke test in these lines. During this test, a camera was sent through the line for inspection, could not pass through the line segment, and was retrieved. Smoke was injected near Dickman Drive and was observed exiting a downstream manhole past the PSF study area which provides evidence that the line segment is not completely blocked. Smoke was not observed in the channel during this test. Flow measurements were also collected from the sewer in this area and downstream flows were higher than upstream flows which suggests that infiltration into this sewer was occurring at the time of measurement. From these observations, it is concluded that the sewer line could be an intermittent source of nitrate in the groundwater during periods of high flow as exfiltration is possible. The groundwater samples were taken following the exceedingly wet summer of 1992, and wet weather also occurred in 1993. It is also possible that nitrates stored in local soils during several years of dry conditions in the Fort Riley area prior to 1992 were released and transported to the groundwater by the recent infiltration of rainfall through the soils into the groundwater.

The RAO to prevent ingestion of groundwater exceeding drinking water standards is identified for the site. This RAO is currently being implemented, as the groundwater is not being used.

5.5 ALTERNATIVES IDENTIFICATION AND DESCRIPTION

CERCLA requires that each selected site remedy be protective of human health and the environment and comply with ARARs. Additionally, CERCLA requires that the selected site remedy be cost effective and, to the maximum extent practicable, utilize permanent solutions, alternative treatment technologies, and resource recovery alternatives. In addition, the statute includes a preference for the use of treatment, as practicable, as a principal element to reduce toxicity, mobility, or volume of the hazardous substances.

5.5.1 Identification of Alternatives

Since soil concentrations are below RGs, RAOs were not identified to address soil media at the PSF; therefore, alternatives addressing soil media were not considered for the PSF. As stated previously, it is not likely that future groundwater use would occur at the site. Considering the RAO established for the site, the following alternatives were identified to provide a range of alternatives to address the PSF site:

- Alternative 1 - No Action
- Alternative 2 - Institutional Action (Groundwater Restrictions)
- Alternative 3 - Institutional Action and Groundwater Monitoring

A five-year review program in accordance with CERCLA is specified in the Interagency Agreement and would be a component of the alternatives considered.

5.5.2 Description of Alternatives

The remedial alternatives identified in Section 5.5.1 are described in the following subsections.

5.5.2.1 Alternative 1 - No Action - The CERCLA program requires that the No Action alternative be considered as a baseline for comparison of other alternatives. As the name implies, this alternative does not involve any remedial action. The PSF site would remain in its current state and the residual constituents of concern would remain in place. Evaluation of the removal action results again RAOs for remedial action is accomplished by evaluating the No Action alternative. No activities addressing residual risks would be performed at the site, and contaminant concentrations would be gradually reduced by attenuation and natural degradation processes. Current site management and security activities established at the PSF (i.e., fencing, controlled site access, and work safety procedures) would be maintained which limit public access to the site.

5.5.2.2 Alternative 2 - Institutional Action (Groundwater Restrictions) - Alternative 2 includes the implementation of institutional action to restrict the future use of site groundwater. The PSF facility already has in place established site management and security procedures to limit public access, and a boundary fence already exists at the PSF which limits access to a portion of the area. Risks to on-site workers did not exceed the risk range (1×10^{-6} to 1×10^{-4}). Therefore, risks to trespassers crossing the site outside the fenced area will be less than for the on-site workers because their exposure to site constituents would be intermittent and infrequent. Additional fencing or site access restrictions are, therefore, not necessary at the PSF site.

Typically, deed restrictions are used to restrict future land uses. However, with this site, deed restrictions are not applicable because the site is part of a federally-owned military installation. To implement controls involving land use restrictions, administrative actions could be taken to prohibit groundwater use in the vicinity of the PSF, including prohibitions on installation of wells for drinking water purposes at the PSF.

5.5.2.3 Alternative 3 - Institutional Action and Groundwater Monitoring - This alternative includes the Institutional Action (Groundwater Restrictions) as described for Alternative 2, and also includes conducting additional groundwater monitoring at the site. The program would include groundwater sampling and analysis for nitrate, which is the constituent of concern in groundwater. Groundwater monitoring is included in Alternative 3 to provide a range of alternatives. This alternative could be used to monitor on-site groundwater, and would be similar to the groundwater sampling activities of the RI except the analyte list would be limited to nitrate. A groundwater monitoring program may use and maintain the existing monitoring wells installed for the RI/FS and/or any additional wells installed.

The five-year review program in accordance with CERCLA is specified in the Interagency Agreement (IAG), and groundwater monitoring would be reviewed as part of this five-year assessment. A monitoring plan, if implemented, should be coordinated with the completion of the sewer investigation and any repairs as PSF groundwater could be affected by continuing releases. The sampling plan to be considered will be flexible and be dependent on the cumulative review of groundwater data available after each sampling effort is completed. The sampling plan will be discontinued as soon as the data provide evidence of nitrate levels at the site which are not increasing.

Nitrate levels, if caused by releases from the sewer, would be expected to decrease, following repairs, due to natural attenuation and degradation within the aquifer. As the PSF groundwater is not being used, and the purpose of monitoring, if implemented, would be to provide additional groundwater data for a five-year review of the site, monitoring twice a year for an initial two-year period is considered. Groundwater monitoring should not be started for at least six months following the repair of the sewer to allow attenuation of contaminants. The monitoring period could be extended, based on sampling results, if needed. Since pesticide-contaminated soil source areas were significantly removed by the excavation of contaminated soils during the removal action, long-term groundwater monitoring is not necessary at the PSF.

6.0 DETAILED ANALYSIS OF ALTERNATIVES

The detailed analysis results in the presentation of the relevant information needed to allow decision makers to select a site remedy, rather than the decision-making process itself. During detailed analysis, the alternatives identified in Section 5 are assessed against the evaluation criteria described in this chapter. In this section, the results of the detailed analysis are also used to compare the alternatives to each other in the comparative analysis.

6.1 DESCRIPTION OF EVALUATION CRITERIA

During the detailed evaluation of remedial alternatives, each alternative will be assessed against the evaluation criteria listed and described below.

- 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 through treatment, engineering controls, or institutional controls.

- Compliance with applicable or relevant and appropriate requirements (ARARs) addresses whether or not a remedy will meet all of the applicable or relevant and appropriate requirements of other federal and state environmental statutes and requirements or provide grounds for invoking a waiver.

- Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met. The magnitude of residual risk and adequacy and reliability of controls used, if any, to manage residuals at the site is assessed.

- Reduction of toxicity, mobility, or volume through treatment is the anticipated performance of the treatment technologies a remedy may employ.

- Short-term effectiveness addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

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

- Cost includes estimated capital and operation and maintenance costs, and net present worth costs.

- Regulatory Agency acceptance indicates whether, based on its review of the RI/FS reports and Proposed Plan, the EPA and KDHE concur, oppose, or have no comment on the preferred alternative at the present time.

- Community acceptance will be assessed in the Record of Decision (ROD) following a review of the public comments received on the RI/FS reports and the Proposed Plan.

The last two criteria are not directly evaluated in the FS report. The agency acceptance and community acceptance criteria are evaluated, and the final decision on the proposed plan is selected in conjunction with the preparation of the Record of Decision (ROD). These final two criteria are extremely significant, however, and careful planning and consideration is required to gain adequate acceptance.

Alternative descriptions were previously provided in Section 5.5.

6.2 EVALUATION OF ALTERNATIVE 1 - NO ACTION

Overall Protection of Human Health and the Environment

Because no remedial actions are taken, with this alternative the human health and environmental risks for the site would be the same as those described in the RRA. The existing conditions are currently protective of human health and the environment because groundwater at the site is not currently used for drinking water purposes and there is no unacceptable human exposure to the site. Ecological risks were also determined to be minimal and are not a concern; therefore, existing site conditions are considered reasonably protective of the environment.

The No-Action Alternative would not be sufficiently protective of human health if the hypothetical use of PSF groundwater as a potable water source occurred, because the alternative would not address this potential future exposure, and would not meet the RAO of preventing future use of site groundwater. As stated previously, the groundwater beneath the site is not anticipated to be used as a potable water supply because the PSF area is served by an existing water distribution system with adequate capacity, which is anticipated to meet the future water use needs at Fort Riley. Also, the PSF aquifer has a limited yield, as discussed previously, making future use of the water unlikely. Consistent with Section 121(c) of CERCLA, a review every five years after the initiation of the final remedial action would be performed to assure that human health and the environment are being protected.

Compliance with ARARs

This alternative would be in compliance with ARARs because use of groundwater with concentrations above MCLs is not occurring and no soil exists at the site above individual constituent RGs. No action-specific or location-specific ARARs or TBCs apply to the site since no action is taken under this alternative. Alternative 1 would not, however, comply with contaminant-specific ARARs considering a potential, hypothetical, future groundwater use scenario.

Long-Term Effectiveness and Permanence

This alternative would not provide additional treatment. Evaluation of this alternative for long-term effectiveness and permanence is therefore not applicable. However, considering existing site conditions, the No Action Alternative would provide long-term effectiveness and permanence because contaminated soils were removed from the site during the removal action, and residual levels of contaminants would be expected to degrade in the future, due to natural attenuation. The excavation of contaminated soils significantly reduced the potential for transport of contaminants from source areas at the PSF into the groundwater.

Short-Term Effectiveness

Alternative 1 would provide short-term effectiveness because no actions would be taken, and no short-term risk to the community or to site workers would result, since remediation activities were completed previously.

Reduction of Toxicity, Mobility and Volume

This alternative would not involve treatment and, therefore, toxicity, volume of waste, and mobility would not be reduced. Toxicity, mobility, and volume of contaminants were reduced by the removal action.

Implementability

Alternative 1 is a No Action Alternative, so implementability would not be applicable.

Cost

There would be no costs associated with the implementation of this alternative.

6.3 EVALUATION OF ALTERNATIVE 2 - INSTITUTIONAL ACTION (GROUNDWATER RESTRICTIONS)

Overall Protection of Human Health and the Environment

This alternative is aimed at eliminating potential human contact with the PSF groundwater by prohibiting the future use of on-site groundwater as a source of drinking water. By implementing PSF groundwater use restrictions, this alternative would effectively prevent the future use of the PSF groundwater, and thus would be protective of human health. Consistent with Section 121(c) of CERCLA, a review every five years after the initiation of the final remedial action would be performed to assure that human health and the environment are being protected.

Compliance with ARARs

This alternative, if implemented, would be in compliance with ARARs because future use of groundwater with concentrations above MCLs would be prohibited and no soil currently exists at the site above individual constituent RGs.

Long-Term Effectiveness and Permanence

This alternative would incorporate controls effectively preventing the use of groundwater at the PSF site. Since the Fort Riley mission is expected to continue, and the Fort Riley installation is not scheduled for closure, groundwater use restrictions would prevent exposures to groundwater in the future. This alternative would not include treatment of groundwater; therefore, long-term effectiveness and permanence would not be applicable. Considering existing site soils, long-term effectiveness and permanence was provided by the removal action which removed contaminated soils from the site, considerably reducing the potential for transport of contaminants from soil sources into the groundwater. Residual levels of pesticides are expected to decrease over time, due to natural attenuation and degradation.

Short-Term Effectiveness

No disturbance of the site would occur during implementation of this alternative. Therefore, no additional risks to human health or the environment due to remedial activities would be caused by implementing this alternative.

Reduction of Toxicity, Mobility and Volume

Alternative 2 would not involve treatment and thus the toxicity, mobility, or volume of contaminants would not be reduced. Toxicity, mobility, and volume of contaminants was reduced by the removal action.

Implementability

This alternative could be readily implementable since formal procedures are in place at Fort Riley to address the modification of land use and master planning to revise designated uses in specific areas of the facility.

Cost

The cost of implementing this alternative would involve the administrative personnel and other miscellaneous expenses for instituting administrative and available legal actions to implement groundwater use restrictions. Present worth cost for this alternative was estimated at approximately $20,000 (Table 6-1 and Appendix C).

6.4 EVALUATION OF ALTERNATIVE 3 - INSTITUTIONAL ACTION AND GROUNDWATER MONITORING

Groundwater monitoring is not identified as a RAO for the PSF site, as soil source areas of potential groundwater contamination have been significantly eliminated by the removal action. Alternative 3 is included to provide a range of alternatives, and could provide additional nitrate data, as this constituent was detected in the PSF groundwater. As the PSF groundwater is not anticipated to be used as a potable water supply, this alternative includes a limited monitoring program, with groundwater samples collected twice a year for two years following the repairs to the sewer in the area and analyzed for nitrate only.

Groundwater monitoring would be similar to the groundwater sampling activities of the RI and may use and maintain the existing wells at the site. The monitoring program would be coordinated with the completion of the sewer investigation and any repairs and not be started for at least six months following repairs to allow attenuation of contaminants.

Overall Protection of Human Health and the Environment

This alternative would be primarily aimed at eliminating potential human contact with the PSF groundwater by prohibiting the future use of on-site groundwater as a source of drinking water as in Alternative 2, and would also include groundwater sampling to confirm that the groundwater concentrations observed at the PSF are not increasing following repairs to the sewer line in the area. Consistent with Section 121(c) of CERCLA, a review every five years after the initiation of the final remedial action would be performed to assure that human health and the environment are being protected.

TABLE 6-1

COST PROJECTION FOR ALTERNATIVE 2
DRAFT FINAL RI ADDENDUM AND FS
Pesticide Storage Facility
Fort Riley, Kansas

ALTERNATIVE 2 – INSTITUTIONAL ACTION (GROUNDWATER RESTRICTIONS)

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
IMPLEMENTATION COST FOR INSTITUTIONAL CONTROLS				
ADMINISTRATIVE AND LEGAL FEES	LUMP SUM	$20,000		$20,000

Compliance with ARARs

This alternative, if implemented, would be in compliance with ARARs because future use of groundwater with concentrations above MCLs would be prohibited. Groundwater monitoring activities would be conducted in accordance with the project safety plan and established sampling procedures which could meet identified ARARs.

Long-Term Effectiveness and Permanence

Alternative 3 would also incorporate controls effectively preventing the use of groundwater at the PSF site as discussed for Alternative 2. This alternative would not include treatment of groundwater, and long-term effectiveness and permanence is not applicable. Considering existing site soils, long-term effectiveness and permanence was provided by the removal action which removed contaminated soils from the site, and significantly reduced the potential for transport of contaminants from soil sources into the groundwater. Residual levels of pesticides are expected to decrease over time, due to natural attenuation and degradation.

Short-Term Effectiveness

No disturbance of the site would occur during implementation of this alternative. Therefore, no additional risks to human health or the environment due to remedial activities would be caused by implementing this alternative. The potential risk of exposure to the public during groundwater sampling events would be controlled by adherence to project plan safety procedures and OSHA requirements.

Reduction of Toxicity, Mobility and Volume

Alternative 3 would not involve treatment and thus the toxicity, mobility, or volume of contaminants would not be reduced. Toxicity, mobility, and volume of soil contaminants was reduced by the removal action completed at the PSF.

Implementability

This alternative could be readily implementable since formal procedures are in place at Fort Riley to address the modification of land use and master planning to revise designated uses in specific areas of the facility. The existing PSF wells would be used for additional groundwater monitoring associated with this alternative.

Cost

Costs of implementing this alternative would involve the administrative personnel and other miscellaneous expenses for instituting administrative and available legal actions to implement groundwater use restrictions. A two-year monitoring period, with a present worth factor of 7 percent, was assumed in the cost estimate to be conservative. Present worth costs for this alternative, including O&M costs, were estimated at approximately $64,500 (Table 6-2 and Appendix C). Well plugging and abandonment are not included in the cost estimate.

6.5 COMPARATIVE ANALYSIS

In the comparative analysis presented below, the results of the detailed analyses of the alternatives are compared to each other based on their ability to meet the seven criteria developed above for the evaluation.

Overall Protection of Human Health and the Environment

The existing conditions are currently protective of human health and the environment because groundwater at the site is not currently used for drinking water and there is no unacceptable human exposure at the site. Alternative 1 would also be expected to be protective of human health in the future because an existing potable water supply exists which is expected to meet the current and future water use needs of Fort Riley and the PSF area, and the present use of the DEH area, including the PSF, is scheduled to remain. The low-yielding wells at the PSF area are not likely to be used as a water supply, when high-yielding alluvial aquifers are locally available. Considering these factors, groundwater ingestion is unlikely and is not considered to represent the RME, and risk estimates pertaining to groundwater ingestion at the PSF were provided for information only. The No Action Alternative (Alternative 1) would not be protective of human health if the on-site groundwater at the PSF was used as a potable water source. Since thallium was detected above the MCL, and the constituents manganese, nitrate, and beryllium were also detected in the groundwater upgradient from the PSF site, these constituents likely represent local background conditions. Nitrate in groundwater was identified as the only contaminant of concern.

Alternatives 2 and 3 would provide protection against hypothetical future groundwater use and therefore meet the RAO established for the site. For Alternatives 2 and 3, protection of human health would be achieved with administrative and available legal actions prohibiting the future use of site groundwater. The groundwater monitoring program also included in Alternative 3 would not increase the overall protection of human health offered by this alternative over Alternative 2, since monitoring is a specific on-site activity not affecting hypothetical future exposures. Alternatives 1, 2, and 3 are rated equally for existing site uses. As stated, Alternative 1, if implemented, would also be likely to be protective of human health in the future, considering regional water use patterns and the future planned use of the PSF area. However, Alternatives 2 and 3 would include formal procedures addressing the future groundwater use limitations. Therefore, these alternatives are rated slightly higher than

TABLE 6–2

COST PROJECTION FOR ALTERNATIVE 3
DRAFT FINAL RI ADDENDUM AND FS
Pesticide Storage Facility
Fort Riley, Kansas

ALTERNATIVE 3 – INSTITUTIONAL ACTION AND GROUNDWATER MONITORING

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
IMPLEMENTATION COST FOR INSTITUTIONAL CONTROLS				
ADMINISTRATIVE AND LEGAL FEES	LUMP SUM	$20,000		$20,000
GROUNDWATER MONITORING (INCLUDES 5 EXISTING PSF WELLS, 2 BLANKS AND 2 DUPLICATES)				
PER SAMPLING EVENT				
PREPARATION/SUPPLIES	$/EVENT	$2,000	1	$2,000
TRAVEL/INCIDENTAL EXPENSES	$/EVENT	$1,800	1	$1,800
PER DIEM	$/EVENT	$200	2	$400
LABOR	$/EVENT	$3,900	1	$3,900
ANALYTICAL (Nitrate)	$/ANALYSIS	$50	9	$450
SHIPPING	$/EVENT	$900	1	$900
WATER HANDLING AND DISPOSAL	$/EVENT	$500	1	$500
QCSR	$/EVENT	$2,500	1	$2,500
SUBTOTAL				$12,450
CONTRACT ADMINISTRATION (USACE & FT. RILEY) @ 20%				$2,500
USACE FIELD OVERSIGHT @ 20%				$2,500
SAMPLING EVENT SUBTOTAL				$17,450
ANNUAL SAMPLING COST	2 TIMES/YEAR			$34,900
ANNUAL O&M COSTS (5 WELLS)	$/EVENT	$400	2	$800
2–YEAR NET PRESENT WORTH OF GW MONITORING AND O&M COSTS (@ 7% INTEREST)				**$64,500**

NOTE: Numbers are rounded to the nearest one hundreds value

Alternative 1 for overall protection to human health. At least every five years after the initiation of the selected final remedial action, a review would be performed to assure that human health and the environment are being protected.

Compliance with ARARs

Nitrate in groundwater was the only constituent at the site detected consistently above the MCL. All the alternatives, if implemented, would be in compliance with ARARs based on current uses at the PSF as on-site groundwater is not used. Alternative 1 (No Action), however, would not comply with ARARs if a hypothetical future groundwater use scenario was developed at the PSF. Because Alternatives 2 and 3 include controls prohibiting future groundwater use, these alternatives could prevent the future use of PSF groundwater. Neither alternative would actively address groundwater quality. Since Alternatives 2 and 3 would include formal provisions preventing hypothetical groundwater use, these alternatives are rated slightly above Alternative 1 for compliance with ARARs. Alternative 1 would also be expected to comply with ARARs, because hypothetical groundwater use is not expected to occur at the PSF, considering that an existing water supply system with adequate capacity for current and expected future water demands already serves the PSF area. Alternative 3 would include on-site groundwater monitoring activities which would be conducted in accordance with the project safety plan and established sampling procedures. Therefore, Alternatives 2 and 3 are rated equally for compliance with ARARs.

Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence was provided by the removal action, which removed contaminated soils from the site. Potential soil sources of contamination to the groundwater were significantly reduced when contaminated soils were removed from the site. None of the identified alternatives would provide additional treatment. Therefore, long-term effectiveness and permanence is not applicable to any of the alternatives.

Short-Term Effectiveness

Evaluation of Alternative 1 for short-term effectiveness is not applicable since this is a "no-action" alternative, and no activities are planned. Alternative 2 would not include any on-site activities and is therefore not applicable. Alternative 3 would involve only on-site activities associated with additional groundwater sampling from existing monitoring wells at the site. There would be no risk of exposure to the public during groundwater sampling. Groundwater sampling would be performed in compliance with project safety plan and OSHA requirements. The project safety plan and adherence to proper sampling procedures would ensure that personnel performing sampling and the public are not at risk. Alternatives 1 and 2 are not applicable, and Alternative 3 can be readily implemented.

Reduction in Toxicity, Mobility, or Volume

Toxicity, mobility, and volume of contaminants have already been reduced by the removal action which removed contaminated soil from the site. Alternatives 1, 2, and 3 do not involve treatment and thus will not further reduce the toxicity, mobility, or volume of constituents. Therefore, these alternatives are rated equally for this evaluation criterion.

Implementability

Alternative 1 is a "no-action" alternative, so implementability would not be applicable. The institutional controls and groundwater monitoring activities associated with Alternatives 2 and 3 may be readily implemented. Therefore, these alternatives are rated equally for this evaluation criterion.

Cost

The estimated capital, operation and maintenance, and present worth costs for each alternative are presented in Tables 6-1 and 6-2 and in Appendix C. No cost has been identified with the No Action Alternative (Alternative 1). Total costs of implementing groundwater use restrictions in Alternative 2 were estimated at $20,000. Alternative 3, Institutional Action and Groundwater Monitoring, was estimated at $64,500, including present worth and operation and maintenance (O&M) costs for a two-year monitoring period. Alternative 1 is ranked first, followed by Alternative 2, with Alternative 3 ranked last, based on estimated costs of implementation.

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APPENDIX A

RESIDUAL RISK ASSESSMENT CALCULATIONS

TABLE A-1
CURRENT OCCUPATIONAL EXPOSURE: INCIDENTAL INGESTION OF SOILS INGESTION INTAKES
Pesticide Storage Facility
Fort Riley, Kansas

$$\text{INGESTION INTAKE (a)} = \frac{C * FI * IR * EF * ED * CF}{BW * AT}$$

Where:

C	=	Concentration of constituent in soil, mg/kg
FI	=	Fraction Ingested from source, unitless
IR	=	Ingestion Rate, mg/day
EF	=	Exposure Frequency, days/year
ED	=	Exposure Duration, years
CF	=	Conversion Factor, kg/10^6 mg
BW	=	Body Weight, kg
AT	=	Averaging Time, days

Exposure Variable	Incidental Ingestion of Soil Site Worker
FI	78%[b]
IR	50[d]
EF	250[b,c]
ED	25[d]
CF	10^{-6}
BW	70[d]
AT (Noncarcinogen)	9,125[d]
AT (Carcinogen)	25,550[d]

PATHWAY-SPECIFIC INTAKES:

Incidental Ingestion of Soil (current):

Site Worker (Noncarcinogens):	C (mg/kg) *	3.82E-07 kg/kg-day
Site Worker (Carcinogens):	C (mg/kg) *	1.36E-07 kg/kg-day

(a) Chemical-specific intakes are calculated in the risk calculation tables (Appendix A)
(b) DEH, 1993c
(c) DEH, 1993d
(d) USEPA, 1991

TABLE A–2
FUTURE OCCUPATIONAL EXPOSURE: INCIDENTAL INGESTION OF SOILS
INGESTION INTAKES
Pesticide Storage Facility
Fort Riley, Kansas

$$\text{INGESTION INTAKE (a)} = \frac{C * FI * IR * EF * ED * CF}{BW * AT}$$

Where:

C	=	Concentration of constituent in soil, mg/kg
FI	=	Fraction Ingested from source, unitless
IR	=	Ingestion Rate, mg/day
EF	=	Exposure Frequency, days/year
ED	=	Exposure Duration, years
CF	=	Conversion Factor, kg/10^6 mg
BW	=	Body Weight, kg
AT	=	Averaging Time, days

Exposure Variable	Incidental Ingestion of Soil: Site Worker	Incidental Ingestion of Soil: Construction Worker
FI	100%	100%
IR	50 [c]	480 [c]
EF	250 [b,c]	120 [d]
ED	25 [b,c]	1
CF	10^{-6}	10^{-6}
BW	70 [c]	70 [c]
AT (Noncarcinogen)	9,125 [c]	365 [c]
AT (Carcinogen)	25,550 [c]	25,550 [c]

PATHWAY–SPECIFIC INTAKES:

Incidental Ingestion of Soil (future):

Site Worker (Noncarcinogens): C (mg/kg) * 4.89E–07 kg/kg–day

Site Worker (Carcinogens): C (mg/kg) * 1.75E–07 kg/kg–day

Construction (Noncarcinogens): C (mg/kg) * 2.25E–06 kg/kg–day

Construction (Carcinogens): C (mg/kg) * 3.22E–08 kg/kg–day

(a) Chemical–specific intakes are calculated in the risk calculation tables (Appendix A)
(b) DEH, 1993e; DEH, 1993f
(c) USEPA, 1991
(d) DEH, 1993g; DEH, 1993h

TABLE A-3
FUTURE OCCUPATIONAL EXPOSURE:
INHALATION OF FUGITIVE DUST
INHALATION INTAKES
Pesticide Storage Facility
Fort Riley, Kansas

$$\text{INHALATION INTAKE (a)} = \frac{C * IR * ET * EF * ED * CF}{BW * AT}$$

Where:

C	=	Concentration of constituent in soil, mg/kg
IR	=	Inhalation Rate, m^3/hr
ET	=	Exposure Time, hours/day
EF	=	Exposure Frequency, days/year
ED	=	Exposure Duration, years
CF	=	Conversion Factor from Cowherd Model[b], kg/m^3
BW	=	Body Weight, kg
AT	=	Averaging Time, days

Exposure Variable	Inhalation of Fugitive Dust Site Worker
IR	2.5[e]
ET	8[c,d]
EF	250[d,f]
ED	25[d]
CF	3.06E-09
BW	70[d]
AT (Noncarcinogen)	9,125[d]
AT (Carcinogen)	25,550[d]

PATHWAY-SPECIFIC INTAKES:
Inhalation of Fugitive Dust (future):

Site Worker (Noncarcinogens):	C (mg/kg)	*	5.99E-10 kg/kg-day
Site Worker (Carcinogens):	C (mg/kg)	*	2.14E-10 kg/kg-day

(a) Chemical-specific intakes are calculated in the risk calculation tables (Appendix A)
(b) Cowherd et al, 1985
(c) DEH, 1993i; DEH, 1993j
(d) USEPA, 1991
(e) USEPA, 1989c
(f) DOC, 1993

TABLE A-4
CURRENT OCCUPATIONAL EXPOSURE:
DERMAL EXPOSURE TO SOILS
DERMAL INTAKES
Pesticide Storage Facility
Fort Riley, Kansas

DERMAL INTAKE (a) $= \dfrac{C * SA * AF * ABS * EF * ET_f * ED * CF}{BW * AT}$

Where:

C	=	Concentration of constituent in soil, mg/kg
SA	=	Surface Area of exposed skin, cm^2/day
AF	=	Soil to skin Adherence Factor, mg/cm^2
ABS	=	Absorption Factor, unitless
ET_f	=	Fraction of Day Exposed via Dermal Absorption, unitless
EF	=	Exposure Frequency, days/year
ED	=	Exposure Duration, years
CF	=	Conversion Factor, kg/10^6 mg
BW	=	Body Weight, kg
AT	=	Averaging Time, days

Exposure Variable	Dermal Exposure to Soil: Site Worker	Utility Worker	Landscaper
SA	3,600[b]	3,600[b]	3,600[b]
AF	1[e]	1[e]	1[e]
ABS		*** chemical specific ***	
ET_f	0.26	0.33	0.042
EF	250[c,d]	0.3[f]	2[c]
ED	25[d]	25[d]	25[d]
CF	10^{-6}	10^{-6}	10^{-6}
BW	70[d]	70[d]	70[d]
AT (Noncarcinogen)	9,125[d]	9,125[d]	9,125[d]
AT (Carcinogen)	25,550[d]	25,550[d]	25,550[d]

PATHWAY-SPECIFIC INTAKES:

Dermal Exposure to Soil (current):

Site Worker (Noncarcinogens):	C (mg/kg) * ABS *	9.16E-06 kg/kg-day
Site Worker (Carcinogens):	C (mg/kg) * ABS *	3.27E-06 kg/kg-day
Utility Worker (Noncarcinogens):	C (mg/kg) * ABS *	1.39E-08 kg/kg-day
Utility Worker (Carcinogens):	C (mg/kg) * ABS *	4.98E-09 kg/kg-day
Landscaper (Noncarcinogens):	C (mg/kg) * ABS *	1.18E-08 kg/kg-day
Landscaper (Carcinogens):	C (mg/kg) * ABS *	4.23E-09 kg/kg-day

(a) Chemical-specific intakes are calculated in the risk calculation tables (Appendix A)
(b) USEPA, 1989c (adult male's forearms, hands, head)
(c) DEH, 1993c
(d) USEPA, 1991
(e) USEPA, 1992b
(f) DEH, 1992a

TABLE A-5
FUTURE OCCUPATIONAL EXPOSURE:
DERMAL EXPOSURE TO SOILS
DERMAL INTAKES
Pesticide Storage Facility
Fort Riley, Kansas

$$\text{DERMAL INTAKE (a)} = \frac{C * SA * AF * ABS * EF * ET_f * ED * CF}{BW * AT}$$

Where:

C	=	Concentration of constituent in soil, mg/kg
SA	=	Surface Area of exposed skin, cm^2/day
AF	=	Soil to skin Adherence Factor, mg/cm^2
ABS	=	Absorption Factor, unitless
ET_f	=	Fraction of Day Exposed via Dermal Absorption, unitless
EF	=	Exposure Frequency, days/year
ED	=	Exposure Duration, years
CF	=	Conversion Factor, $kg/10^6$ mg
BW	=	Body Weight, kg
AT	=	Averaging Time, days

Exposure Variable	Dermal Exposure to Soil: Site Worker	Utility Worker	Landscaper	Construction Worker
SA	3,600[b]	3,600[b]	3,600[b]	3,600[b]
AF	1[c]	1[c]	1[c]	1[c]
ABS		*** chemical specific ***		
ET_f	0.33	0.33	0.042	0.33
EF	250[a,d]	1.12[e]	8[i,f]	120[h]
ED	25[d]	25[d]	25[d]	1[h]
CF	10^{-6}	10^{-6}	10^{-6}	10^{-6}
BW	70[d]	70[d]	70[d]	70[d]
AT (Noncarcinogen)	9,125[d]	9,125[d]	9,125[d]	365[h]
AT (Carcinogen)	25,550[d]	25,550[d]	25,550[d]	25,550[d]

PATHWAY-SPECIFIC INTAKES:

Dermal Exposure to Soil (future):

Site Worker (Noncarcinogens):	C (mg/kg) * ABS *	1.16E-05 kg/kg-day
Site Worker (Carcinogens):	C (mg/kg) * ABS *	4.15E-06 kg/kg-day
Utility Worker (Noncarcinogens):	C (mg/kg) * ABS *	5.21E-08 kg/kg-day
Utility Worker (Carcinogens):	C (mg/kg) * ABS *	1.86E-08 kg/kg-day
Landscaper (Noncarcinogens):	C (mg/kg) * ABS *	4.73E-08 kg/kg-day
Landscaper (Carcinogens):	C (mg/kg) * ABS *	1.69E-08 kg/kg-day
Construction Worker (Noncarcinogens):	C (mg/kg) * ABS *	5.58E-06 kg/kg-day
Construction Worker (Carcinogens):	C (mg/kg) * ABS *	7.97E-08 kg/kg-day

(a) Chemical-specific intakes are calculated in the risk calculation tables (Appendix A)
(b) USEPA, 1989c (adult male's forearms, hands, head)
(c) USEPA, 1992b
(d) USEPA, 1991
(e) DEH, 1993i; DEH, 1993j
(f) Riley County Extension Service, 1992
(g) DEH, 1993f; DEH, 1993e
(h) DEH, 1993g; DEH, 1993h
(i) DOC, 1993

TABLE A-6
CURRENT & FUTURE "RECREATIONAL" EXPOSURE:
DERMAL EXPOSURE TO SOILS
DERMAL INTAKES
Pesticide Storage Facility
Fort Riley, Kansas

$$\text{DERMAL INTAKE (a)} = \frac{C * SA * AF * ABS * EF * ET * ED * CF}{BW * AT}$$

Where:

C	=	Concentration of constituent in sediment, mg/kg
SA	=	Surface Area of exposed skin, cm^2/day
AF	=	Sediment to skin Adherence Factor, mg/cm^2
ABS	=	Absorption Factor, unitless
ET_f	=	Fraction of Day Exposed via Dermal Absorption, unitless
EF	=	Exposure Frequency, days/year
ED	=	Exposure Duration, years
CF	=	Conversion Factor, kg/10^6 mg
BW	=	Body Weight, kg
AT	=	Averaging Time, days

Exposure Variable	Dermal Exposure to Soil Recreational Child
SA	5,025 [b]
AF	1 [c]
ABS	*** chemical specific ***
ET_f	0.11
EF	7 [e, f]
ED	6 [e, f]
CF	10^{-6}
BW	15 [d]
AT (Noncarcinogen)	2,190 [d]
AT (Carcinogen)	NA

PATHWAY-SPECIFIC INTAKES:
Dermal Exposure to Soil (current & future):

Recreational Child (Noncarcinogens): C (mg/kg) * ABS * 7.07E-07 kg/kg-day

(a) Chemical-specific intakes are calculated in the risk calculation tables (Appendix A)
(b) USEPA, 1989c (child's head, hands, arms, legs)
(c) USEPA, 1992b
(d) USEPA, 1991
(e) USEPA, 1989a
(f) USEPA, 1993a

TABLE A–7
FUTURE OCCUPATIONAL EXPOSURE: DERMAL EXPOSURE TO SEDIMENTS DERMAL INTAKES
Pesticide Storage Facility
Fort Riley, Kansas

$$\text{DERMAL INTAKE (a)} = \frac{C * SA * AF * ABS * EF * ET * ED * CF}{BW * AT}$$

Where:

C	=	Concentration of constituent in sediment, mg/kg
SA	=	Surface Area of exposed skin, cm^2/day
AF	=	Sediment to skin Adherence Factor, mg/cm^2
ABS	=	Absorption Factor, unitless
ET_f	=	Fraction of Day Exposed via Dermal Absorption, unitless
EF	=	Exposure Frequency, days/year
ED	=	Exposure Duration, years
CF	=	Conversion Factor, kg/10^6 mg
BW	=	Body Weight, kg
AT	=	Averaging Time, days

Exposure Variable	Dermal Exposure to Sediment Site Worker
SA	1,980 [b]
AF	1 [c]
ABS	*** chemical specific ***
ET_f	0.33
EF	3 [f]
ED	25 [e]
CF	10^{-6}
BW	70 [e]
AT (Noncarcinogen)	9,125 [e]
AT (Carcinogen)	25,550 [e]

PATHWAY–SPECIFIC INTAKES:

Dermal Exposure to Sediment (future):

Site Worker (Noncarcinogens): C (mg/kg) * ABS * 7.67E–08 kg/kg–day

Site Worker (Carcinogens): C (mg/kg) * ABS * 2.74E–08 kg/kg–day

(a) Chemical–specific intakes are calculated in the risk calculation tables (Appendix A)
(b) USEPA, 1989c (adult male's hands and forearms)
(c) USEPA, 1992b
(d) USEPA, 1992a
(e) USEPA, 1991
(f) USEPA, 1992c

TABLE A-8a

UCLTABLE

Fort Riley Pesticide Storage Facility Surface Soil Samples	Chlorinated Pesticides Chlordane		Chlorinated Pesticides DDT		Chlorinated Pesticides Dieldrin		Chlorinated Pesticides Heptachlor		Chlorinated Pesticides DDD		Chlorinated Pesticides DDE	
Sample ID	Background =		Background =		Background =		Background =		Background =		Background =	
	Sample	ln	Sample	ln	Sample	ln	Sample	ln	Sample	ln	Sample	ln
402-1156	0.74	-0.3011	< 0.06	-2.8134	< 0.02	-3.9120	< 0.01	-4.6052	NT		NT	
402-1159	< 0.01	-4.6052	0.013	-4.3428	0.015	-4.1997	< 0.0005	-7.6009	NT		NT	
402-1160	0.024	-3.7297	0.022	-3.8167	< 0.001	-6.9078	< 0.0005	-7.6009	NT		NT	
JM4266	< 0.0086	-4.7560	0.222	-1.5051	< 0.003	-5.8091	< 0.0015	-6.5023	NT		NT	
JM4251	< 0.0086	-4.7560	0.112	-2.1893	0.024	-3.7297	< 0.0015	-6.5023	NT		NT	
JM4252	0.072	-2.6311	0.288	-1.2448	0.022	-3.8167	< 0.0015	-6.5023	NT		NT	
JM4253	< 0.0165	-4.1044	0.05	-2.9957	0.007	-4.9618	< 0.0035	-5.6550	NT		NT	
JM4254	< 0.0085	-4.7677	< 0.0015	-6.5023	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4255	0.309	-1.1744	0.605	-0.5025	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4256	0.26	-1.3471	0.369	-0.9970	0.051	-2.9759	< 0.002	-6.2146	NT		NT	
JM4259	< 0.0415	-3.1821	0.218	-1.5233	0.026	-3.6497	< 0.0085	-4.7677	NT		NT	
JM4263	< 0.0085	-4.7677	0.026	-3.6497	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4265	0.158	-1.8452	0.17	-1.7720	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4267	< 0.0085	-4.7677	< 0.0015	-6.5023	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4268	< 0.0165	-4.1044	0.04	-3.2189	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4269	0.033	-3.4112	0.429	-0.8463	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4270	< 0.0165	-4.1044	0.028	-3.5756	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4273	< 0.0165	-4.1044	< 0.0015	-6.5023	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4280	< 0.0165	-4.1044	< 0.0015	-6.5023	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4282	< 0.0165	-4.1044	0.044	-3.1236	0.009	-4.7105	< 0.0015	-6.5023	NT		NT	
JM4284	< 0.0165	-4.1044	0.012	-4.4228	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4408	< 0.0165	-4.1044	0.012	-4.4228	< 0.0015	-6.5023	< 0.0015	-6.5023	NT		NT	
JM4481	0.14	-1.9661	< 0.0015	-6.5023	0.014	-4.2687	< 0.0015	-6.5023	NT		NT	
JM4483	0.358	-1.0272	0.434	-0.8347	0.121	-2.1120	< 0.0015	-6.5023	NT		NT	
JM4486	0.151	-1.8905	0.143	-1.9449	0.032	-3.4420	< 0.0015	-6.5023	NT		NT	
JM4492	< 0.0165	-4.1044	0.172	-1.7603	0.017	-4.0745	< 0.0015	-6.5023	NT		NT	
JM4496	< 0.0165	-4.1044	0.091	-2.3969	0.017	-4.0745	< 0.0015	-6.5023	NT		NT	
JM4501	0.439	-0.8233	0.667	-0.4050	0.109	-2.2164	0.004	-5.5215	NT		NT	
JM4502	0.221	-1.5096	0.095	-2.3539	0.036	-3.3242	< 0.0015	-6.5023	NT		NT	

TABLE A−8a

UCLTABLE

Fort Riley Pesticide Storage Facility Surface Soil Samples	Chlorinated Pesticides Chlordane		Chlorinated Pesticides DDT		Chlorinated Pesticides Dieldrin		Chlorinated Pesticides Heptachlor		Chlorinated Pesticides DDD		Chlorinated Pesticides DDE	
	Background =		Background =		Background =		Background =		Background =		Background =	
Sample ID	Sample	ln	Sample	ln	Sample	ln	Sample	ln	Sample	ln	Sample	ln
18801−053	< 0.01415	−4.2580	0.054	−2.9188	< 0.0016	−6.4378	< 0.0015	−6.5023	0.0237	−3.7423	0.0385	−3.2571
18801−056	0.0337	−3.3903	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	0.0457	−3.0857
18801−060	0.418	−0.8723	0.273	−1.2983	0.0296	−3.5200	< 0.00044	−7.7287	0.454	−0.7897	0.346	−1.0613
18801−066	1.12	0.1133	0.73	−0.3147	< 0.0016	−6.4378	0.0093	−4.6777	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−073	< 0.017	−4.0745	< 0.0012	−6.7254	< 0.0019	−6.2659	< 0.00055	−7.5056	< 0.00155	−6.4695	< 0.0056	−5.1850
18801−076	< 0.017	−4.0745	< 0.0012	−6.7254	< 0.0019	−6.2659	< 0.00055	−7.5056	< 0.00155	−6.4695	< 0.0056	−5.1850
18801−083	< 0.017	−4.0745	0.0789	−2.5396	< 0.0019	−6.2659	< 0.00055	−7.5056	< 0.00155	−6.4695	0.0395	−3.2315
18801−085	< 0.017	−4.0745	< 0.0012	−6.7254	< 0.0019	−6.2659	< 0.00055	−7.5056	< 0.00155	−6.4695	0.0611	−2.7952
18801−087	< 0.017	−4.0745	0.378	−0.9729	0.0817	−2.5047	< 0.00055	−7.5056	< 0.00155	−6.4695	0.188	−1.6713
18801−092	< 0.017	−4.0745	0.379	−0.9702	0.107	−2.2349	< 0.00055	−7.5056	0.163	−1.8140	0.254	−1.3704
18801−095	< 0.017	−4.0745	0.075	−2.5903	< 0.0019	−6.2659	< 0.00055	−7.5056	< 0.00155	−6.4695	0.0356	−3.3354
18801−097	< 0.017	−4.0745	0.175	−1.7430	< 0.0019	−6.2659	< 0.00055	−7.5056	0.175	−1.7430	0.203	−1.5945
18801−099	< 0.017	−4.0745	0.327	−1.1178	0.0542	−2.9151	< 0.00055	−7.5056	0.164	−1.8079	0.111	−2.1982
18801−101	< 0.017	−4.0745	< 0.0012	−6.7254	< 0.0019	−6.2659	< 0.00055	−7.5056	< 0.00155	−6.4695	< 0.0056	−5.1850
18801−110	< 0.017	−4.0745	< 0.0012	−6.7254	< 0.0019	−6.2659	< 0.00055	−7.5056	< 0.00155	−6.4695	< 0.0056	−5.1850
18801−111	< 0.017	−4.0745	0.167	−1.7898	0.074	−2.6037	< 0.00055	−7.5056	0.107	−2.2349	0.126	−2.0715
18801−113	< 0.017	−4.0745	< 0.0012	−6.7254	< 0.0019	−6.2659	< 0.00055	−7.5056	< 0.00155	−6.4695	< 0.0056	−5.1850
19084−005	0.0207	−3.8776	1.29	0.2546	0.158	−1.8452	< 0.00044	−7.7287	0.355	−1.0356	0.847	−0.1661
402−0167	< 0.025	−3.6889	0.22	−1.5141	< 0.0025	−5.9915	< 0.0025	−5.9915	NT		NT	
402−0168	0.057	−2.8647	< 0.025	−3.6889	< 0.0025	−5.9915	< 0.0025	−5.9915	NT		NT	
402−0169	< 0.025	−3.6889	< 0.025	−3.6889	< 0.0025	−5.9915	< 0.0025	−5.9915	NT		NT	
402−0170	< 0.025	−3.6889	< 0.025	−3.6889	< 0.0025	−5.9915	< 0.0025	−5.9915	NT		NT	
402−0173	< 0.025	−3.6889	< 0.025	−3.6889	< 0.0025	−5.9915	< 0.0025	−5.9915	NT		NT	
< Not Detected – value used is 1/2 reported detection limit												

Pesticide Storage Facility Surface Soils	Chlorinated Pesticides Chlordane		Chlorinated Pesticides DDT		Chlorinated Pesticides Dieldrin		Chlorinated Pesticides Heptachlor		Chlorinated Pesticides DDD		Chlorinated Pesticides DDE	
FD – Frequency of Detection	FD 17 /	52	FD 35 /	52	FD 20 /	52	FD 2 /	52	FD 7 /	18	FD 12 /	18
	# above Backg.	0	# above Backg.	0	# above Backg.	0	# above Backg.	0	# above Backg.	0	# above Backg.	0
n=		52		52		52		52		52		52
s2y=		1.6480		4.7756		2.4775		0.6182		5.4888		2.7710
sy=		1.2837		2.1853		1.5740		0.7863		2.3428		1.6646
ybar=		−3.4072		−3.2442		−5.1442		−6.6714		−4.7046		−3.1741
H(0.95)=		2.737		3.812		3.077		2.202		4.588		3.437
95%UCL=		0.1235		1.3635		0.0397		0.0022		0.6344		0.3725
mean conc=	0.09901		0.16508		0.02078		0.001803		0.028043		0.044770	
min conc=	0.0085		0.001		0.001		0.00044		0		0	
max conc=	1.12		1.29		0.158		0.0100		0.454		0.847	
Exposure value in mg/kg=	**95% UCL**	0.12	**Conc.**	1.3	**95% UCL**	0.040	**95% UCL**	0.0022	**Conc.**	0.45	**95% UCL**	0.37

TABLE A-8b

UCLTABLE

Fort Riley Pesticide Storage Facility Subsurface Soil Samples	Metals Arsenic		Metals Barium		Metals Chromium		Metals Lead		Metals Mercury		Metals Silver	
	Background =		Background =		Background =		Background =		Background =		Background =	
Sample ID	Sample	ln	Sample	ln	Sample	ln	Sample	ln	Sample	ln	Sample	ln
PSFSB02A LAW	20	2.9957	97	4.5747	6.5	1.8718	13	2.5649	< 0.05	−2.9957	< 0.35	−1.0498
PSFSB02B	4.3	1.4586	82	4.4067	8.3	2.1163	11	2.3979	< 0.05	−2.9957	< 0.35	−1.0498
PSFSB04A	6.2	1.8245	100	4.6052	11	2.3979	12	2.4849	< 0.05	−2.9957	< 0.35	−1.0498
PSFSB04B	1.9	0.6419	98	4.5850	6.3	1.8405	9.9	2.2925	< 0.05	−2.9957	< 0.4	−0.9163
PSFSB06A	1.6	0.4700	77	4.3438	5.3	1.6677	4.7	1.5476	< 0.05	−2.9957	< 0.3	−1.2040
PSFSB06B	1.1	0.0953	39	3.6636	4.6	1.5261	4.7	1.5476	< 0.05	−2.9957	< 0.3	−1.2040
PSFSB08A	3.3	1.1939	160	5.0752	4.8	1.5686	770	6.6464	< 0.05	−2.9957	< 0.3	−1.2040
PSFSB08B	2.5	0.9163	130	4.8675	6.5	1.8718	270	5.5984	< 0.05	−2.9957	< 0.35	−1.0498
PSFSB14B	3	1.0986	100	4.6052	8.3	2.1163	140	4.9416	< 0.05	−2.9957	< 0.35	−1.0498
PSFSB15B	1.8	0.5878	130	4.8675	5.5	1.7047	7.6	2.0281	< 0.05	−2.9957	< 0.35	−1.0498
PSFSB16A	1.9	0.6419	47	3.8501	4.7	1.5476	18	2.8904	< 0.05	−2.9957	< 0.3	−1.2040
PSFSB16B	1.6	0.4700	120	4.7875	8.7	2.1633	12	2.4849	< 0.05	−2.9957	< 0.35	−1.0498
PSFSB17B	0.9	−0.1054	71	4.2627	5.7	1.7405	8	2.0794	< 0.05	−2.9957	< 0.3	−1.2040
PSFSB18B	1.6	0.4700	110	4.7005	6.8	1.9169	15	2.7081	< 0.05	−2.9957	< 0.4	−0.9163
PSFSB19B	1.4	0.3365	100	4.6052	6.9	1.9315	12	2.4849	< 0.05	−2.9957	< 0.35	−1.0498
PSFSB20B	1.9	0.6419	88	4.4773	6.9	1.9315	89	4.4886	< 0.05	−2.9957	< 0.35	−1.0498
MWSB01A	1	0.0000	61	4.1109	6.8	1.9169	5.1	1.6292	< 0.05	−2.9957	< 0.3	−1.2040
MWSB01B	2.5	0.9163	120	4.7875	8.7	2.1633	10	2.3026	< 0.05	−2.9957	< 0.4	−0.9163
MWSB02B/DUP	1.7	0.5306	60	4.0943	11	2.3979	4.7	1.5476	< 0.05	−2.9957	0.9	−0.1054
MWSB02C	1.7	0.5306	83	4.4188	4.8	1.5686	< 1.9	0.6419	< 0.05	−2.9957	< 0.35	−1.0498
MWSB02D	2.4	0.8755	100	4.6052	6.4	1.8563	< 2.15	0.7655	< 0.05	−2.9957	1.1	0.0953
MWSB02E	1.4	0.3365	72	4.2767	7.1	1.9601	< 1.9	0.6419	< 0.05	−2.9957	1.2	0.1823
MWSB03A	2	0.6931	190	5.2470	11	2.3979	8.5	2.1401	< 0.05	−2.9957	< 0.25	−1.3863
MWSB03B	0.5	−0.6931	68	4.2195	6.1	1.8083	5.9	1.7750	< 0.05	−2.9957	< 0.35	−1.0498
MWSB04A	3.1	1.1314	60	4.0943	20	2.9957	58	4.0604	< 0.05	−2.9957	< 0.3	−1.2040
MWSB04B	0.4	−0.9163	70	4.2485	6	1.7918	< 2.2	0.7885	< 0.05	−2.9957	< 0.4	−0.9163
MWSB05A	2.9	1.0647	96	4.5643	10	2.3026	30	3.4012	0.1	−2.3026	< 0.3	−1.2040
MWSB05B	0.6	−0.5108	44	3.7842	6.6	1.8871	5.9	1.7750	< 0.05	−2.9957	< 0.3	−1.2040
PSFSB02	16	2.7726	35	3.5553	6.9	1.9315	32	3.4657	< 0.05	−2.9957	< 0.3	−1.2040
SP-10-B	9.4	2.2407										
SP-10-C	2.2	0.7885										
< Not Detected – value used is 1/2 reported detection limit												

Pesticide Storage Facility Subsurface Soils	Metals Arsenic		Metals Barium		Metals Chromium		Metals Lead		Metals Mercury		Metals Silver	
FD – Frequency of Detection	FD 31 /	31	FD 29 /	29	FD 29 /	29	FD 25 /	29	FD 1 /	29	FD 3 /	29
	# above Backg.	0	# above Backg.	0	# above Backg.	0	# above Backg.	0	# above Backg.	0	# above Backg.	0
n=		31		29		29		29		29		29
s2y=		0.7519		0.1626		0.1023		2.1070		0.0166		0.1432
sy=		0.8671		0.4032		0.3198		1.4515		0.1287		0.3784
ybar=		0.7580		4.4236		1.9618		2.5559		−2.9718		−0.9816
H(0.95)=		2.432		1.968		1.882		3.612		1.749		1.968
95%UCL=		4.5674		105.0923		8.3866		99.5030		0.0539		0.4633
mean conc=	3.31612		89.9310		7.524137		53.97068		0.051724		0.410344	
min conc=	0.4		35		4.6		1.9		0.05		0.25	
max conc=	20		190		20		770		0.1		1.2	
Exposure value in mg/kg=	95% UCL	4.6	95% UCL	105.1	95% UCL	8.4	95% UCL	99.5	95% UCL	0.054	95% UCL	0.46

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TABLE A-8c

UCLTABLE

Fort Riley Pesticide Storage Facility Subsurface Soil Samples	Volatiles	Benzene		Volatiles	Methylene chloride		Volatiles	Toluene		Semi-Volatiles	Benzo(a)anthracene		Semi-Volatiles	bis(2-Ethylhexyl)phthalate	
Sample ID	Background =			Background =			Background =			Background =			Background =		
		Sample	ln		Sample	ln		Sample	ln		Sample	ln		Sample	ln
PSFSB02A LAW	<	0.0018	-6.3200	<	0.003	-5.8091	<	0.003	-5.8091	<	0.055	-2.9004	<	0.19	-1.6607
PSFSB02B	<	0.00115	-6.7680	<	0.00275	-5.8962	<	0.00275	-5.8962	<	0.06	-2.8134	<	0.195	-1.6348
PSFSB04A	<	0.00175	-6.3481	<	0.0029	-5.8430	<	0.0029	-5.8430	<	0.06	-2.8134	<	0.195	-1.6348
PSFSB04B	<	0.00175	-6.3481		0.022	-3.8167		0.0095	-4.6565	<	0.06	-2.8134	<	0.195	-1.6348
PSFSB06A	<	0.00165	-6.4070	<	0.0027	-5.9145	<	0.0027	-5.9145	<	0.055	-2.9004	<	0.185	-1.6874
PSFSB06B	<	0.0016	-6.4378		0.017	-4.0745	<	0.00265	-5.9332	<	0.055	-2.9004		1.2	0.1823
PSFSB08A	<	0.0017	-6.3771	<	0.0029	-5.8430	<	0.0029	-5.8430	<	0.065	-2.7334	<	0.21	-1.5606
PSFSB08B	<	0.00175	-6.3481	<	0.00295	-5.8260	<	0.00295	-5.8260	<	0.06	-2.8134	<	0.195	-1.6348
PSFSB14B	<	0.0019	-6.2659	<	0.0031	-5.7764	<	0.0031	-5.7764		0.33	-1.1087		0.41	-0.8916
PSFSB15B	<	0.0018	-6.3200	<	0.003	-5.8091		0.038	-3.2702	<	0.06	-2.8134	<	0.185	-1.6874
PSFSB16A	<	0.0016	-6.4378	<	0.0027	-5.9145		0.0089	-4.7217	<	0.055	-2.9004		0.96	-0.0408
PSFSB16B	<	0.0018	-6.3200	<	0.003	-5.8091		0.018	-4.0174	<	0.06	-2.8134	<	0.2	-1.6094
PSFSB17B	<	0.00165	-6.4070		0.029	-3.5405		0.0059	-5.1328	<	0.055	-2.9004	<	0.185	-1.6874
PSFSB18B	<	0.0017	-6.3771		0.031	-3.4738		0.0098	-4.6254	<	0.06	-2.8134	<	0.195	-1.6348
PSFSB19B	<	0.00175	-6.3481	<	0.00295	-5.8260	<	0.00295	-5.8260	<	0.06	-2.8134	<	0.195	-1.6348
PSFSB20B	<	0.00175	-6.3481	<	0.0029	-5.8430	<	0.0029	-5.8430		0.16	-1.8326	<	0.195	-1.6348
MWSB01A		0.0066	-5.0207	<	0.00375	-5.5860	<	0.00375	-5.5860	<	0.055	-2.9004	<	0.185	-1.6874
MWSB01B		0.0059	-5.1328	<	0.0032	-5.7446	<	0.0032	-5.7446	<	0.065	-2.7334	<	0.21	-1.5606
MWSB02B/DUP	<	0.00155	-6.4695		0.018	-4.0174	<	0.0027	-5.9145	<	0.055	-2.9004	<	0.185	-1.6874
MWSB02C	<	0.0017	-6.3771		0.019	-3.9633	<	0.0028	-5.8781	<	0.055	-2.9004	<	0.19	-1.6607
MWSB02D	<	0.00155	-6.4695		0.017	-4.0745	<	0.0026	-5.9522	<	0.055	-2.9004	<	0.185	-1.6874
MWSB02E	<	0.0017	-6.3771		0.011	-4.5099	<	0.0013	-6.6454	<	0.055	-2.9004	<	0.185	-1.6874
MWSB03A	<	0.00165	-6.4070		0.019	-3.9633	<	0.0028	-5.8781	<	0.065	-2.7334	<	0.21	-1.5606
MWSB03B	<	0.00175	-6.3481		0.022	-3.8167	<	0.00295	-5.8260	<	0.06	-2.8134	<	0.2	-1.6094
MWSB04A	<	0.00165	-6.4070		0.021	-3.8632	<	0.0027	-5.9145	<	0.055	-2.9004	<	0.18	-1.7148
MWSB04B	<	0.0018	-6.3200		0.02	-3.9120	<	0.003	-5.8091	<	0.06	-2.8134	<	0.205	-1.5847
MWSB05A	<	0.0017	-6.3771	<	0.0029	-5.8430	<	0.0029	-5.8430		0.11	-2.2073	<	0.185	-1.6874
MWSB05B	<	0.0017	-6.3771	<	0.0029	-5.8430	<	0.0029	-5.8430	<	0.055	-2.9004	<	0.185	-1.6874
PSFSB02	<	0.00255	-5.9717		0.024	-3.7297		0.006	-5.1160	<	0.6	-0.5108	<	0.85	-0.1625
< Not Detected - value used is 1/2 reported detection limit															
Pesticide Storage Facility Subsurface Soils	Volatiles	Benzene		Volatiles	Methylene chloride		Volatiles	Toluene		Semi-Volatiles	Benzo(a)anthracene		Semi-Volatiles	bis(2-Ethylhexyl)phthalate	
FD - Frequency of Detection	FD	2 /	29	FD	13 /	29	FD	7 /	29	FD	3 /	29	FD	3 /	29
	# above Backg.		0	# above Backg.		0	# above Backg.		0	# above Backg.		0	# above Backg.		0
n=			29			29			29			29			29
s2y=			0.1254			0.9726			0.4776			0.3163			0.2725
sy=			0.3542			0.9862			0.6911			0.5624			0.5220
ybar=			-6.2839			-4.9615			-5.5478			-2.6482			-1.4505
H(0.95)=			1.968			2.744			2.306			2.181			2.068
95%UCL=			0.0023			0.0190			0.0067			0.1045			0.3295
mean conc=		0.00203			0.01095			0.005465			0.091551			0.284310	
min conc=		0.00115			0.0027			0.0013			0.055			0.18	
max conc=		0.0066			0.031			0.038			0.6			1.2	
Exposure value in mg/kg=		**95% UCL**	**0.0023**		**95% UCL**	**0.019**		**95% UCL**	**0.0067**		**95% UCL**	**0.10**		**95% UCL**	**0.33**

TABLE A-8c

UCLTABLE

Fort Riley Pesticide Storage Facility Subsurface Soil Samples		Semi-Volatiles Chrysene			Semi-Volatiles Diethylphthalate			Semi-Volatiles Fluoranthene			Semi-Volatiles Phenanthrene			Semi-Volatiles Pyrene		
Sample ID		Background =			Background =			Background =			Background =			Background =		
			Sample	ln		Sample	ln		Sample	ln		Sample	ln		Sample	ln
PSFSB02A	LAW	<	0.055	−2.9004	<	0.19	−1.6607	<	0.075	−2.5903	<	0.075	−2.5903	<	0.055	−2.9004
PSFSB02B		<	0.06	−2.8134	<	0.195	−1.6348	<	0.08	−2.5257	<	0.08	−2.5257	<	0.06	−2.8134
PSFSB04A		<	0.06	−2.8134	<	0.195	−1.6348	<	0.08	−2.5257	<	0.08	−2.5257	<	0.06	−2.8134
PSFSB04B		<	0.06	−2.8134	<	0.195	−1.6348	<	0.05	−2.9957	<	0.08	−2.5257	<	0.06	−2.8134
PSFSB06A		<	0.055	−2.9004	<	0.185	−1.6874	<	0.075	−2.5903	<	0.075	−2.5903	<	0.055	−2.9004
PSFSB06B		<	0.05	−2.9957	<	0.175	−1.7430	<	0.07	−2.6593	<	0.07	−2.6593	<	0.05	−2.9957
PSFSB08A		<	0.065	−2.7334	<	0.21	−1.5606	<	0.085	−2.4651	<	0.085	−2.4651		0.17	−1.7720
PSFSB08B		<	0.06	−2.8134	<	0.195	−1.6348	<	0.08	−2.5257	<	0.08	−2.5257	<	0.06	−2.8134
PSFSB14B			0.29	−1.2379	<	0.21	−1.5606		0.53	−0.6349		0.25	−1.3863		0.57	−0.5621
PSFSB15B		<	0.06	−2.8134	<	0.195	−1.6348	<	0.08	−2.5257	<	0.08	−2.5257	<	0.06	−2.8134
PSFSB16A		<	0.055	−2.9004	<	0.185	−1.6874	<	0.075	−2.5903	<	0.075	−2.5903		0.11	−2.2073
PSFSB16B		<	0.06	−2.8134	<	0.2	−1.6094	<	0.08	−2.5257	<	0.08	−2.5257	<	0.06	−2.8134
PSFSB17B		<	0.055	−2.9004	<	0.185	−1.6874	<	0.075	−2.5903	<	0.075	−2.5903	<	0.055	−2.9004
PSFSB18B		<	0.06	−2.8134	<	0.195	−1.6348	<	0.08	−2.5257	<	0.08	−2.5257	<	0.06	−2.8134
PSFSB19B		<	0.06	−2.8134	<	0.195	−1.6348	<	0.08	−2.5257	<	0.08	−2.5257	<	0.06	−2.8134
PSFSB20B			0.2	−1.6094		0.43	−0.8440		0.31	−1.1712		0.23	−1.4697		0.31	−1.1712
MWSB01A		<	0.055	−2.9004	<	0.185	−1.6874	<	0.075	−2.5903	<	0.075	−2.5903	<	0.055	−2.9004
MWSB01B		<	0.065	−2.7334	<	0.21	−1.5606	<	0.085	−2.4651	<	0.085	−2.4651	<	0.065	−2.7334
MWSB02B/DUP		<	0.055	−2.9004	<	0.185	−1.6874	<	0.075	−2.5903	<	0.075	−2.5903	<	0.055	−2.9004
MWSB02C		<	0.055	−2.9004	<	0.19	−1.6607	<	0.075	−2.5903	<	0.075	−2.5903	<	0.055	−2.9004
MWSB02D		<	0.055	−2.9004	<	0.185	−1.6874	<	0.075	−2.5903	<	0.075	−2.5903	<	0.055	−2.9004
MWSB02E		<	0.055	−2.9004	<	0.185	−1.6874	<	0.075	−2.5903	<	0.075	−2.5903	<	0.055	−2.9004
MWSB03A		<	0.065	−2.7334	<	0.21	−1.5606	<	0.085	−2.4651	<	0.085	−2.4651	<	0.065	−2.7334
MWSB03B		<	0.06	−2.8134	<	0.2	−1.6094	<	0.08	−2.5257	<	0.08	−2.5257	<	0.06	−2.8134
MWSB04A		<	0.055	−2.9004	<	0.18	−1.7148	<	0.07	−2.6593	<	0.07	−2.6593	<	0.055	−2.9004
MWSB04B		<	0.06	−2.8134	<	0.205	−1.5847	<	0.08	−2.5257	<	0.08	−2.5257	<	0.06	−2.8134
MWSB05A			0.11	−2.2073	<	0.185	−1.6874		0.18	−1.7148	<	0.075	−2.5903		0.18	−1.7148
MWSB05B		<	0.055	−2.9004	<	0.185	−1.6874	<	0.075	−2.5903	<	0.075	−2.5903	<	0.055	−2.9004
PSFSB02		<	0.26	−1.3471	<	0.85	−0.1625	<	0.345	−1.0642	<	0.345	−1.0642	<	0.26	−1.3471

< Not Detected – value used is 1/2 reported detection limit

Pesticide Storage Facility Subsurface Soils	Semi-Volatiles Chrysene		Semi-Volatiles Diethylphthalate		Semi-Volatiles Fluoranthene		Semi-Volatiles Phenanthrene		Semi-Volatiles Pyrene	
FD – Frequency of Detection	FD 3 /	29	FD 1 /	29	FD 3 /	29	FD 2 /	29	FD 5 /	29
	# above Backg.	0	# above Backg.	0	# above Backg.	0	# above Backg.	0	# above Backg.	0
n=		29		29		29		29		29
s2y=		0.2159		0.0976		0.2811		0.1557		0.3893
sy=		0.4647		0.3124		0.5302		0.3946		0.6240
ybar=		−2.6771		−1.5676		−2.3769		−2.4270		−2.5647
H(0.95)=		2.068		1.882		2.068		1.968		2.181
95%UCL=		0.0919		0.2447		0.1315		0.1105		0.1209
mean conc=	0.079655		0.22379		0.11310		0.09810		0.10103	
min conc=	0.05		0.175		0.05		0.07		0.05	
max conc=	0.29		0.85		0.53		0.345		0.57	
Exposure value in mg/kg=	95% UCL	0.092	95% UCL	0.24	95% UCL	0.13	95% UCL	0.11	95% UCL	0.12

TABLE A−8d

UCLTABLE

Fort Riley Pesticide Storage Facility Subsurface Soil Samples	Chlorinated Pesticides Chlordane		Chlorinated Pesticides DDT		Chlorinated Pesticides Dieldrin		Chlorinated Pesticides Heptachlor		Chlorinated Pesticides DDD		Chlorinated Pesticides DDE	
Sample ID	Background =		Background =		Background =		Background =		Background =		Background =	
	Sample	ln	Sample	ln	Sample	ln	Sample	ln	Sample	ln	Sample	ln
JM4275 OHM	< 0.0165	−4.1044	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4279	0.329	−1.1117	0.553	−0.5924	0.034	−3.3814	< 0.0015	−6.5023	NT		NT	
JM4281	< 0.0165	−4.1044	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4283	< 0.0165	−4.1044	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4274	< 0.0165	−4.1044	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4487	< 0.0085	−4.7677	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4472	< 0.0085	−4.7677	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4475	< 0.0085	−4.7677	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4474	< 0.0085	−4.7677	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4490	0.07	−2.6593	0.67	−0.4005	0.01	−4.6052	< 0.0015	−6.5023	NT		NT	
JM4494	0.081	−2.5133	0.67	−0.4005	0.009	−4.7105	< 0.0015	−6.5023	NT		NT	
JM4471	< 0.008	−4.8283	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4473	< 0.0085	−4.7677	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4476	< 0.008	−4.8283	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4480	< 0.008	−4.8283	0.011	−4.5099	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4482	< 0.0085	−4.7677	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4484	0.14	−1.9661	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4488	< 0.0085	−4.7677	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4489	< 0.0165	−4.1044	< 0.0015	−6.5023	< 0.0015	−6.5023	< 0.0015	−6.5023	NT		NT	
JM4491	< 0.0165	−4.1044	0.143	−1.9449	0.007	−4.9618	< 0.0015	−6.5023	NT		NT	
JM4499	0.08	−2.5257	0.109	−2.2164	0.022	−3.8167	< 0.0015	−6.5023	NT		NT	
18801−003	5.89	1.7733	0.715	−0.3355	< 0.0016	−6.4378	0.0232	−3.7636	0.365	−1.0079	0.666	−0.4065
18801−011	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−012	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−015	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−016	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−019	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−020	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−024	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	0.0013	−6.6454	< 0.00465	−5.3709
18801−027	< 0.01415	−4.2580	0.0359	−3.3270	< 0.0016	−6.4378	< 0.00044	−7.7287	0.0228	−3.7810	0.0199	−3.9170
18801−028	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−029	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−030	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−039	0.272	−1.3020	0.105	−2.2538	< 0.000315	−8.0629	0.0012	−6.7254	< 0.000255	−8.2742	0.0271	−3.6082
18801−040	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−043	0.325	−1.1239	0.0387	−3.2519	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	0.0432	−3.1419
18801−044	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−045	0.302	−1.1973	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−046	10.2	2.3224	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−047	2.98	1.0919	< 0.001	−6.9078	< 0.0016	−6.4378	0.0082	−4.8036	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−048	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−049	0.298	−1.2107	0.0349	−3.3553	< 0.0016	−6.4378	< 0.00044	−7.7287	0.0285	−3.5579	0.0327	−3.4204
18801−050	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−054	0.0491	−3.0139	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	0.0183	−4.0009
18801−055	< 0.01415	−4.2580	< 0.001	−6.9078	< 0.0016	−6.4378	< 0.00044	−7.7287	< 0.0013	−6.6454	< 0.00465	−5.3709
18801−057	< 0.01415	−4.2580	0.0165	−4.1044	< 0.0016	−6.4378	< 0.00044	−7.7287	0.011	−4.5099	0.0223	−3.8032

TABLE A-8d

UCLTABLE

Fort Riley Pesticide Storage Facility Subsurface Soil Samples	Chlorinated Pesticides Chlordane			Chlorinated Pesticides DDT			Chlorinated Pesticides Dieldrin			Chlorinated Pesticides Heptachlor			Chlorinated Pesticides DDD			Chlorinated Pesticides DDE		
	Background =			Background =			Background =			Background =			Background =			Background =		
Sample ID		Sample	ln		Sample	ln		Sample	ln		Sample	ln		Sample	ln		Sample	ln
18801-058	<	0.01415	-4.2580	<	0.001	-6.9078	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454		0.0104	-4.5659
18801-061		0.0872	-2.4396	<	0.001	-6.9078	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454	<	0.00465	-5.3709
18801-062	<	0.01415	-4.2580	<	0.001	-6.9078	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454	<	0.00465	-5.3709
18801-064	<	0.01415	-4.2580	<	0.001	-6.9078	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454	<	0.00465	-5.3709
18801-065	<	0.01415	-4.2580		0.186	-1.6820	<	0.0016	-6.4378	<	0.00044	-7.7287		0.0168	-4.0864		0.0405	-3.2065
18801-067	<	0.01415	-4.2580	<	0.001	-6.9078	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454	<	0.00465	-5.3709
18801-068	<	0.01415	-4.2580	<	0.001	-6.9078	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454	<	0.00465	-5.3709
18801-070	<	0.01415	-4.2580	<	0.001	-6.9078	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454	<	0.00465	-5.3709
18801-071	<	0.01415	-4.2580	<	0.001	-6.9078	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454	<	0.00465	-5.3709
18801-072	<	0.017	-4.0745		0.0979	-2.3238		0.0227	-3.7854	<	0.00055	-7.5056	<	0.00155	-6.4695		0.0529	-2.9394
18801-074	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-075	<	0.017	-4.0745		0.0364	-3.3132	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-077	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-078	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-080	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-081	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-082	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-084	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-086	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-089	<	0.017	-4.0745		0.198	-1.6195		0.0421	-3.1677	<	0.00055	-7.5056		0.0792	-2.5358		0.378	-0.9729
18801-091	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-093	<	0.017	-4.0745		0.0695	-2.6664	<	0.0019	-6.2659	<	0.00055	-7.5056		0.0436	-3.1327		0.089	-2.4191
18801-096	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-098	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-100	<	0.017	-4.0745		0.154	-1.8708	<	0.0019	-6.2659	<	0.00055	-7.5056		0.0506	-2.9838		0.0757	-2.5810
18801-102		0.562	-0.5763		0.144	-1.9379	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695		0.126	-2.0715
18801-104	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695		0.0597	-2.8184
18801-103	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-105	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18801-106	<	0.017	-4.0745		0.153	-1.8773		0.066	-2.7181	<	0.00055	-7.5056		0.0436	-3.1327		0.251	-1.3823
18801-116	<	0.01415	-4.2580	<	0.001	-6.9078	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454	<	0.00465	-5.3709
18801-117	<	0.01415	-4.2580	<	0.001	-6.9078	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454	<	0.00465	-5.3709
18859-001	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18859-002	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18859-004	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18859-006	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18859-007		0.623	-0.4732		0.221	-1.5096	<	0.0019	-6.2659	<	0.00055	-7.5056		0.0811	-2.5121	<	0.0056	-5.1850
18859-008	<	0.017	-4.0745	<	0.0012	-6.7254	<	0.0019	-6.2659	<	0.00055	-7.5056	<	0.00155	-6.4695	<	0.0056	-5.1850
18859-017		8.71	2.1645		0.917	-0.0866	<	0.0019	-6.2659	<	0.00055	-7.5056		0.513	-0.6675	<	0.0056	-5.1850
18859-018		2.67	0.9821		0.509	-0.6753		0.0208	-3.8728		0.129	-2.0479		0.218	-1.5233		0.132	-2.0250
18859-019		3.36	1.2119		1.95	0.6678	<	0.0019	-6.2659	<	0.00055	-7.5056		0.925	-0.0780		0.332	-1.1026
18859-027		5.35	1.6771	<	0.0012	-6.7254	<	0.0019	-6.2659		0.0379	-3.2728	<	0.00155	-6.4695		0.0339	-3.3843
18859-023/DUP		0.329	-1.1117		0.112	-2.1893	<	0.0019	-6.2659	<	0.00055	-7.5056		0.0843	-2.4734		0.0495	-3.0058
19084-006		0.0263	-3.6382		0.184	-1.6928	<	0.0016	-6.4378	<	0.00044	-7.7287		0.0722	-2.6283		0.501	-0.6911
19084-012	<	0.01415	-4.2580	<	0.001	-6.9078	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454	<	0.00465	-5.3709
19084-017		0.0478	-3.0407		0.0506	-2.9838	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454	<	0.00465	-5.3709
19084-016		0.0589	-2.8319		0.0163	-4.1166	<	0.0016	-6.4378	<	0.00044	-7.7287	<	0.0013	-6.6454		0.0358	-3.3298
402-0166	<	0.025	-3.6889	<	0.025	-3.6889	<	0.0025	-5.9915	<	0.0025	-5.9915		NT			NT	
402-0171	<	0.025	-3.6889	<	0.025	-3.6889	<	0.0025	-5.9915	<	0.0025	-5.9915		NT			NT	
402-0172	<	0.025	-3.6889	<	0.025	-3.6889	<	0.0025	-5.9915	<	0.0025	-5.9915		NT			NT	
402-0174	<	0.025	-3.6889	<	0.025	-3.6889	<	0.0025	-5.9915	<	0.0025	-5.9915		NT			NT	

TABLE A–8d

UCLTABLE

Fort Riley Pesticide Storage Facility Subsurface Soil Samples	Chlorinated Pesticides **Chlordane**			Chlorinated Pesticides **DDT**			Chlorinated Pesticides **Dieldrin**			Chlorinated Pesticides **Heptachlor**			Chlorinated Pesticides **DDD**			Chlorinated Pesticides **DDE**		
Sample ID	Background =			Background =			Background =			Background =			Background =			Background =		
		Sample	ln		Sample	ln		Sample	ln		Sample	ln		Sample	ln		Sample	ln
PSFSB02A LAW		0.42	−0.8675		0.042	−3.1701	<	0.0195	−3.9373		0.045	−3.1011	<	0.0195	−3.9373	<	0.0195	−3.9373
PSFSB02B		0.32	−1.1394	<	0.0185	−3.9900	<	0.0185	−3.9900		0.028	−3.5756	<	0.0185	−3.9900	<	0.0185	−3.9900
PSFSB04A		0.181	−1.7093		0.014	−4.2687	<	0.008	−4.8283	<	0.0039	−5.5468	<	0.008	−4.8283		0.031	−3.4738
PSFSB04B		0.125	−2.0794		0.096	−2.3434	<	0.008	−4.8283	<	0.0039	−5.5468	<	0.008	−4.8283		0.021	−3.8632
PSFSB06A	<	0.0037	−5.5994	<	0.00365	−5.6130	<	0.00365	−5.6130	<	0.00185	−6.2926	<	0.00365	−5.6130	<	0.00365	−5.6130
PSFSB06B		0.008	−4.8283		0.014	−4.2687	<	0.0035	−5.6550	<	0.00175	−6.3481	<	0.0035	−5.6550	<	0.0035	−5.6550
PSFSB08A		0.07	−2.6593		0.44	−0.8210	<	0.0215	−3.8397	<	0.0105	−4.5564	<	0.0215	−3.8397		0.11	−2.2073
PSFSB08B		0.012	−4.4228		0.15	−1.8971	<	0.0039	−5.5468	<	0.00195	−6.2399	<	0.0039	−5.5468		0.02	−3.9120
PSFSB14B		0.01	−4.6052		0.012	−4.4228	<	0.0041	−5.4968	<	0.00205	−6.1899	<	0.0041	−5.4968	<	0.0041	−5.4968
PSFSB15B	<	0.0041	−5.4968	<	0.0041	−5.4968	<	0.0041	−5.4968	<	0.00205	−6.1899	<	0.0041	−5.4968	<	0.0041	−5.4968
PSFSB16A		0.138	−1.9805		0.31	−1.1712	<	0.0185	−3.9900	<	0.00925	−4.6831	<	0.0185	−3.9900	<	0.0185	−3.9900
PSFSB16B		0.013	−4.3428		0.025	−3.6889	<	0.00405	−5.5090	<	0.002025	−6.2022	<	0.00405	−5.5090	<	0.00405	−5.5090
PSFSB17B		0.016	−4.1352		0.025	−3.6889	<	0.0037	−5.5994	<	0.00185	−6.2926	<	0.0037	−5.5994	<	0.0037	−5.5994
PSFSB18B		0.036	−3.3242		0.082	−2.5010	<	0.0039	−5.5468	<	0.00195	−6.2399	<	0.0039	−5.5468		0.022	−3.8167
PSFSB19B		0.025	−3.6889		0.036	−3.3242	<	0.00395	−5.5340	<	0.002	−6.2146	<	0.00395	−5.5340		0.022	−3.8167
PSFSB20B		0.026	−3.6497		0.025	−3.6889	<	0.0039	−5.5468	<	0.00195	−6.2399	<	0.0039	−5.5468		0.011	−4.5099
MWSB01A	<	0.0037	−5.5994	<	0.0037	−5.5994	<	0.0037	−5.5994	<	0.00185	−6.2926	<	0.0037	−5.5994	<	0.0037	−5.5994
MWSB01B	<	0.0042	−5.4727	<	0.0042	−5.4727	<	0.0042	−5.4727	<	0.0021	−6.1658	<	0.0042	−5.4727	<	0.0042	−5.4727
MWSB02B/DUP	<	0.0037	−5.5994	<	0.0037	−5.5994	<	0.0037	−5.5994	<	0.00185	−6.2926	<	0.0037	−5.5994	<	0.0037	−5.5994
MWSB02C	<	0.0039	−5.5468	<	0.00385	−5.5597	<	0.00385	−5.5597	<	0.00195	−6.2399	<	0.00385	−5.5597	<	0.00385	−5.5597
MWSB02D	<	0.0037	−5.5994	<	0.00375	−5.5860	<	0.00375	−5.5860	<	0.00185	−6.2926	<	0.00375	−5.5860	<	0.00375	−5.5860
MWSB02E	<	0.0037	−5.5994	<	0.00375	−5.5860	<	0.00375	−5.5860	<	0.00185	−6.2926	<	0.00375	−5.5860	<	0.00375	−5.5860
MWSB03A		0.0051	−5.2785	<	0.0042	−5.4727		0.009	−4.7105	<	0.0021	−6.1658	<	0.0042	−5.4727	<	0.0042	−5.4727
MWSB03B	<	0.004	−5.5215	<	0.004	−5.5215	<	0.004	−5.5215	<	0.002	−6.2146	<	0.004	−5.5215	<	0.004	−5.5215
MWSB04A		0.033	−3.4112	<	0.0036	−5.6268		0.013	−4.3428	<	0.0018	−6.3200	<	0.0036	−5.6268		0.012	−4.4228
MWSB04B	<	0.0042	−5.4727	<	0.00415	−5.4846	<	0.00415	−5.4846	<	0.0021	−6.1658	<	0.00415	−5.4846	<	0.00415	−5.4846
MWSB05A	<	0.0038	−5.5728	<	0.0038	−5.5728	<	0.0038	−5.5728	<	0.0019	−6.2659	<	0.0038	−5.5728	<	0.0038	−5.5728
MWSB05B	<	0.0038	−5.5728	<	0.0038	−5.5728	<	0.0038	−5.5728	<	0.0019	−6.2659	<	0.0038	−5.5728	<	0.0038	−5.5728
****PSFSB02****		3.2	1.1632		1	0.0000		0.077	−2.5639		0.3	−1.2040		NT			0.27	−1.3093

< Not Detected – value used is 1/2 reported detection limit

Pesticide Storage Facility Subsurface Soils	Chlorinated Pesticides **Chlordane**		Chlorinated Pesticides **DDT**		Chlorinated Pesticides **Dieldrin**		Chlorinated Pesticides **Heptachlor**		Chlorinated Pesticides **DDD**		Chlorinated Pesticides **DDE**	
FD – Frequency of Detection	FD 41 /	126	FD 42 /	126	FD 12 /	126	FD 8 /	126	FD 16 /	100	FD 31 /	101
	# above Backg.	0	# above Backg.	0	# above Backg.	0	# above Backg.	0	# above Backg.	0	# above Backg.	0
n=		126		126		126		126		126		126
s2y=		3.0832		4.8235		0.8113		1.3952		2.3478		1.7066
sy=		1.7559		2.1962		0.9007		1.1812		1.5323		1.3064
ybar=		−3.5512		−5.0128		−5.9185		−6.8087		−5.6259		−4.5652
H(0.95)=		3.2		3.533		2.206		2.58		2.881		2.58
95%UCL=		0.2216		0.1485		0.0048		0.0029		0.0173		0.0330
mean conc=	0.38594		0.08429		0.005190		0.005690		0.022323		0.030879	
min conc=	0.0037		0.001		0.000315		0.00044		0		0	
max conc=	10.2		1.95		0.077		0.3		0.925		0.666	
Exposure value in mg/kg=	**95% UCL**	**0.22**	**95% UCL**	**0.15**	**95% UCL**	**0.0048**	**95% UCL**	**0.0029**	**95% UCL**	**0.017**	**95% UCL**	**0.033**

TABLE A-8e

PESTICIDE STORAGE FACILITY – FT RILEY
SEDIMENT SAMPLES
Gilbert's method for lognormal distributions

n= @COUNT(list)
s2y= @COUNT(list)/(@COUNT(list)-1)*@VAR(list)
sy= @SQRT(@COUNT(list)/(@COUNT(list)-1)*@VAR(list))
ybar= @AVG(list)
H(0.95)= From Table A12
95%UCL= @EXP(ybar+(0.5*s2y)+((sy*H)/@SQRT(N-1)))
First column is sediment sample data in mg/kg
Second column is natural log-transformed data

	4,4'-DDD		4,4'-DDE		4,4'-DDT		Dieldrin		alpha-Chlordane		gamma-Chlordane		Benzo[a]anthracene	
SD01A	0.00445	-5.41485	0.00445	-5.41485	0.011	-4.50986	0.00445	-5.41485	0.0094	-4.66704	0.014	-4.26870	0.33	-1.10866
SD01B	0.00455	-5.39262	0.00455	-5.39262	0.00455	-5.39262	0.00455	-5.39262	0.00225	-6.09682	0.00225	-6.09682	0.07	-2.65926
SD02A	0.0087	-4.74443	0.00425	-5.46083	0.00425	-5.46083	0.00425	-5.46083	0.0058	-5.14989	0.0076	-4.87960	0.13	-2.04022
SD02B	0.00405	-5.50903	0.00405	-5.50903	0.00405	-5.50903	0.00405	-5.50903	0.002	-6.21460	0.002	-6.21460	0.06	-2.81341
SD04A	0.091	-2.39689	0.021	-3.86323	0.016	-4.13516	0.02	-3.91202	0.033	-3.41124	0.037	-3.29683	0.06	-2.81341
SD04B	0.013	-4.34280	0.0044	-5.42615	0.0044	-5.42615	0.0044	-5.42615	0.0022	-6.11929	0.0022	-6.11929	0.06	-2.81341
SD05A	0.1	-2.30258	0.28	-1.27296	0.48	-0.73396	0.056	-2.88240	0.067	-2.70306	0.065	-2.73336	0.12	-2.12026
SD05B	0.00395	-5.53403	0.046	-3.07911	0.037	-3.29683	0.00395	-5.53403	0.002	-6.21460	0.002	-6.21460	0.16	-1.83258
SD06A	0.015	-4.19970	0.0046	-5.38169	0.0046	-5.38169	0.0046	-5.38169	0.0071	-4.94766	0.0085	-4.76768	0.07	-2.65926
SD06B	0.031	-3.47376	0.0047	-5.36019	0.0047	-5.36019	0.0047	-5.36019	0.0096	-4.64599	0.012	-4.42284	0.07	-2.65926
SD07A	0.024	-3.72970	0.011	-4.50986	0.017	-4.07454	0.0041	-5.49676	0.022	-3.81671	0.028	-3.57555	0.06	-2.81341
SD07B	0.0039	-5.54677	0.0039	-5.54677	0.0086	-4.75599	0.0039	-5.54677	0.0095	-4.65646	0.012	-4.42284	0.06	-2.81341
SD08A	0.004	-5.52146	0.004	-5.52146	0.04	-3.21887	0.004	-5.52146	0.011	-4.50986	0.024	-3.72970	0.16	-1.83258
SD08B	0.0042	-5.47267	0.0042	-5.47267	0.017	-4.07454	0.0042	-5.47267	0.01	-4.60517	0.021	-3.86323	0.13	-2.04022
mean=	0.022271		0.02865		0.046653		0.009082		0.013775		0.016967		0.11	
n=	14		14		14		14		14		14		14	
s2y=	1.373464		1.585133		1.749748		0.605178		1.155635		1.351507		0.283132	
sy=	1.171948 *		1.259020 *		1.322780 *		0.777932 *		1.075004 *		1.162582 *		0.532101 *	
ybar=	-4.54152		-4.80081		-4.38073		-5.16511		-4.83988		-4.61469		-2.35852	
H(0.95)=	3.165		3.163		3.163		2.443		2.744		3.163		2.068	
95%UCL=	0.059246		0.054816		0.095804		0.013096		0.031938		0.053967		0.147818	

	Chrysene		Fluoranthene		Phenanthrene		Pyrene		bis-2(Ethylhexyl)phthalate	
SD01A	0.33	-1.10866	0.44	-0.82098	0.44	-0.82098	0.88	-0.12783	1.1	0.095310
SD01B	0.07	-2.65926	0.09	-2.40794	0.09	-2.40794	0.07	-2.65926	0.225	-1.49165
SD02A	0.17	-1.77195	0.17	-1.77195	0.085	-2.46510	0.34	-1.07880	0.64	-0.44628
SD02B	0.06	-2.81341	0.08	-2.52572	0.08	-2.52572	0.12	-2.12026	0.2	-1.60943
SD04A	0.12	-2.12026	0.21	-1.56064	0.08	-2.52572	0.25	-1.38629	0.45	-0.79850
SD04B	0.06	-2.81341	0.08	-2.52572	0.08	-2.52572	0.06	-2.81341	0.57	-0.56211
SD05A	0.16	-1.83258	0.25	-1.38629	0.08	-2.52572	0.29	-1.23787	0.205	-1.58474
SD05B	0.16	-1.83258	0.27	-1.30933	0.2	-1.60943	0.31	-1.17118	0.195	-1.63475
SD06A	0.07	-2.65926	0.09	-2.40794	0.09	-2.40794	0.07	-2.65926	0.23	-1.46967
SD06B	0.07	-2.65926	0.19	-1.66073	0.095	-2.35387	0.14	-1.96611	0.235	-1.44816
SD07A	0.12	-2.12026	0.08	-2.52572	0.08	-2.52572	0.16	-1.83258	0.205	-1.58474
SD07B	0.12	-2.12026	0.08	-2.52572	0.08	-2.52572	0.12	-2.12026	0.47	-0.75502
SD08A	0.24	-1.42711	0.36	-1.02165	0.36	-1.02165	0.44	-0.82098	0.2	-1.60943
SD08B	0.13	-2.04022	0.29	-1.23787	0.21	-1.56064	0.38	-0.96758	0.21	-1.56064
mean=	0.134285		0.191428		0.146428		0.259285		0.366785	
n=	14		14		14		14		14	
s2y=	0.278714		0.399889		0.368740		0.633081		0.321041	
sy=	0.527933 *		0.632368 *		0.607239 *		0.795651 *		0.566604 *	
ybar=	-2.14132		-1.83487		-2.12871		-1.64012		-1.17570	
H(0.95)=	2.068		2.181		2.181		2.443		2.181	
95%UCL=	0.182836		0.285814		0.206589		0.456354		0.510458	

TABLE A-8c

	Carbon Disulfide		Toluene		Methylene Chloride		Arsenic		Selenium		Barium		Cadmium	
SD01A	0.00165	-6.40697	0.006	-5.11599	0.049	-3.01593	2.2	0.788457	0.2	-1.60943	88	4.477336	2.1	0.741937
SD01B	0.0019	-6.26590	0.0087	-4.74443	0.047	-3.05760	1.4	0.336472	0.1	-2.30258	74	4.304065	0.4	-0.91629
SD02A	0.0018	-6.31996	0.0098	-4.62537	0.055	-2.90042	1.5	0.405465	0.1	-2.30258	110	4.700480	1.3	0.262364
SD02B	0.00185	-6.29256	0.0071	-4.94766	0.066	-2.71810	0.8	-0.22314	0.1	-2.30258	55	4.007333	0.35	-1.04982
SD04A	0.00175	-6.34813	0.013	-4.34280	0.038	-3.27016	0.9	-0.10536	0.1	-2.30258	110	4.700480	1.2	0.182321
SD04B	0.0069	-4.97623	0.012	-4.42284	0.077	-2.56394	2.7	0.993251	0.1	-2.30258	150	5.010635	0.45	-0.79850
SD05A	0.0018	-6.31996	0.013	-4.34280	0.082	-2.50103	3.4	1.223775	0.1	-2.30258	93	4.532599	0.4	-0.91629
SD05B	0.00185	-6.29256	0.0074	-4.90627	0.086	-2.45340	3.8	1.335001	0.1	-2.30258	74	4.304065	0.35	-1.04982
SD06A	0.00185	-6.29256	0.0031	-5.77635	0.012	-4.42284	1.7	0.530628	0.3	-1.20397	44	3.784189	1.3	0.262364
SD06B	0.0021	-6.16581	0.00355	-5.64080	0.03	-3.50655	1.8	0.587786	0.1	-2.30258	110	4.700480	0.4	-0.91629
SD07A	0.00185	-6.29256	0.0031	-5.77635	0.027	-3.61191	1.4	0.336472	0.1	-2.30258	76	4.330733	0.4	-0.91629
SD07B	0.00185	-6.29256	0.0031	-5.77635	0.021	-3.86323	1.4	0.336472	0.1	-2.30258	52	3.951243	0.35	-1.04982
SD08A	0.0018	-6.31996	0.003	-5.80914	0.021	-3.86323	2.6	0.955511	0.2	-1.60943	97	4.574710	1.9	0.641853
SD08B	0.0019	-6.26590	0.0032	-5.74460	0.023	-3.77226	2.5	0.916290	0.3	-1.20397	130	4.867534	3.3	1.193922
mean=	0.002203		0.006860		0.048285		2.041666		0.141666		91.75		0.975	
n=	14		14		14		12		12		12		12	
s2y=	0.127544		0.352137		0.366208		0.242407		0.199833		0.147493		0.639373	
sy=	0.357133 *		0.593411 *		0.605152 *		0.492349 *		0.447026 *		0.384049 *		0.799608 *	
ybar=	-6.20369		-5.14084		-3.25147		0.607679		-2.06172		4.455373		-0.34616	
H(0.95)=	1.968		2.181		2.181		2.141		2.026		2.026		2.57	
95%UCL=	0.002618		0.009993		0.067050		2.848271		0.184753		117.1812		1.809629	

	Chromium		Lead		Silver		Mercury		1,2-Dichloropropane		1,1,2,2-Tetrachloroethane	
SD01A	13	2.564949	60	4.094344	0.35	-1.04982	0.05	-2.99573	0.00165	-6.40697	0.0028	-5.87813
SD01B	7.6	2.028148	10	2.302585	0.4	-0.91629	0.05	-2.99573	0.0019	-6.26590	0.00315	-5.76035
SD02A	19	2.944438	130	4.867534	0.35	-1.04982	0.05	-2.99573	0.084	-2.47693	0.039	-3.24419
SD02B	4.2	1.435084	24	3.178053	0.35	-1.04982	0.05	-2.99573	0.00185	-6.29256	0.0031	-5.77635
SD04A	25	3.218875	210	5.347107	0.8	-0.22314	0.1	-2.30258	0.00175	-6.34813	0.0029	-5.84304
SD04B	14	2.639057	64	4.158883	0.45	-0.79850	0.05	-2.99573	0.002	-6.21460	0.0033	-5.71383
SD05A	10	2.302585	72	4.276666	0.4	-0.91629	0.05	-2.99573	0.0018	-6.31996	0.00305	-5.79261
SD05B	8	2.079441	56	4.025351	0.35	-1.04982	0.05	-2.99573	0.00185	-6.29256	0.0031	-5.77635
SD06A	7.7	2.041220	66	4.189654	0.35	-1.04982	0.4	-0.91629	0.00185	-6.29256	0.0031	-5.77635
SD06B	8.4	2.128231	61	4.110873	0.4	-0.91629	0.2	-1.60943	0.0021	-6.16581	0.00355	-5.64080
SD07A	9.4	2.240709	24	3.178053	0.4	-0.91629	0.1	-2.30258	0.00185	-6.29256	0.0031	-5.77635
SD07B	6.1	1.808288	15	2.708050	0.35	-1.04982	0.05	-2.99573	0.00185	-6.29256	0.0031	-5.77635
SD08A	14	2.639057	88	4.477336	0.35	-1.04982	0.05	-2.99573	0.0018	-6.31996	0.003	-5.80914
SD08B	17	2.833213	140	4.941642	0.35	-1.04982	0.4	-0.91629	0.0019	-6.26590	0.0032	-5.74460
mean=	11.9		79.16666		0.408333		0.129166		0.008716		0.006125	
n=	12		12		12		12		12		12	
s2y=	0.260939		0.606857		0.056169		0.684281		1.208641		0.532487	
sy=	0.510822 *		0.779010 *		0.237000 *		0.827213 *		1.099382 *		0.729717 *	
ybar=	2.359183		4.121600		-0.92660		-2.41810		-5.96451		-5.55583	
H(0.95)=	2.141		2.57		1.843		2.57		2.915		2.414	
95%UCL=	16.76691		152.7301		0.464485		0.238121		0.012351		0.008578	

TABLE A-8c

SCREENING FOR CHEMICALS OF CONCERN – SEDIMENTS
Pesticide Storage Facility
Fort Riley, Kansas

Constituent	Maximum Detected Concentration	Reference Dose	Cancer Slope Factor	Non-cancer Risk	Non-cancer Risk (% Total risk)	Cancer Risk	Non-cancer Risk (% Total risk)
Arsenic	3.8	3.00E-04	1.75E+00	1.27E+04	40.79	6.65E+00	81.27
Barium	150	7.00E-02		2.14E+03	6.90		
Cadmium	3.3	5.00E-04		6.60E+03	21.25		
Chromium	25	5.00E-03		5.00E+03	16.10		
Lead	210						
Mercury	0.4						
Selenium	0.3	5.00E-03		6.00E+01	0.19		
Silver	0.8	5.00E-03		1.60E+02	0.52		
Chlordane, alpha-	0.067	6.00E-05	1.30E+00	1.12E+03	3.60	8.71E-02	1.06
Chlordane, gamma-	0.065	6.00E-05	1.30E+00	1.08E+03	3.49	8.45E-02	1.03
DDD	0.1		2.40E-01			2.40E-02	0.29
DDE	0.28		3.00E-01			8.40E-02	1.03
DDT	0.48	5.00E-04	3.40E-01	9.60E+02	3.09	1.63E-01	1.99
1,2-Dichloropropane	0.084 I	1.10E-03		7.64E+01	0.25		
Dieldrin	0.056	5.00E-05	1.60E+01	1.12E+03	3.61	8.96E-01	10.95
Carbon Disulfide	0.006	1.00E-01		6.00E-02	0.00		
1,1,2,2-Tetrachloroethane	0.039		2.00E-01			7.80E-03	0.10
Toluene	0.013	2.00E-01		6.50E-02	0.00		
Benzo[a]anthracene	0.16		1.06E+00 *			1.70E-01	2.07
Chrysene	0.24		2.90E-02 *			6.96E-03	0.09
Fluoranthene	0.36	4.00E-02		9.00E+00	0.03		
Phenanthrene	0.36						
Pyrene	0.88	3.00E-02		2.93E+01	0.09		
bis(2-Eth/hex)phthalate	0.64	2.00E-02	1.40E-02	3.20E+01	0.10	8.96E-03	0.11
				3.11E+04	100.00	8.18E+00	100.00

* Derived from Toxicity Equivalency Factors (TEFs), based on benzo[a]pyrene.

TABLE A-8f

UCLTABLE

Fort Riley Groundwater-Metals		Total Metals Chromium		Total Metals Iron		Total Metals Lead		Total Metals Magnesium		Total Metals Manganese		Total Metals Potassium	
Sample ID		Background =	10	Background =	220	Background =<	2.5	Background =	26000	Background =	34	Background =	5300
		Sample	ln	Sample	ln	Sample	ln	Sample	ln	Sample		Sample	
PSF9202/9206	BL	12 *	2.4849	68	4.2195	< 2.5	0.9163	56000 *	10.9331	56 *	4.0254	6300 *	8.7483
PSF9203		< 5	1.6094	290 *	5.6699	< 2.5	0.9163	29000 *	10.2751	91 *	4.5109	5900 *	8.6827
PSF9204		< 5	1.6094	90	4.4998	< 0.5	−0.6931	19000	9.8522	36 *	3.5835	3900	8.2687
PSF9205		< 5	1.6094	230 *	5.4381	< 2.5	0.9163	28000 *	10.2400	43 *	3.7612	20000 *	9.9035
PSF9202/9206	FQ	< 5	1.6094	290 *	5.6699	< 0.5	−0.6931	40000 *	10.5966	41 *	3.7136	4800	8.4764
PSF9203		< 5	1.6094	990 *	6.8977	< 0.5	−0.6931	25000	10.1266	71 *	4.2627	5000	8.5172
PSF9204		< 5	1.6094	< 25	3.2189	< 0.5	−0.6931	21000	9.9523	26	3.2581	3700	8.2161
PSF9205		< 5	1.6094	910 *	6.8134	< 0.5	−0.6931	23000	10.0432	47 *	3.8501	11000 *	9.3057
PSF9202/9206	SQ	< 5	1.6094	66	4.1897	< 0.5	−0.6931	49000 *	10.7996	34	3.5264	6800 *	8.8247
PSF9203		< 5	1.6094	1500 *	7.3132	< 0.5	−0.6931	27000 *	10.2036	77 *	4.3438	6500 *	8.7796
PSF9204		< 5	1.6094	< 25	3.2189	< 0.5	−0.6931	20000	9.9035	24	3.1781	4000	8.2940
PSF9205		< 5	1.6094	84	4.4308	< 0.5	−0.6931	22000	9.9988	23	3.1355	12000 *	9.3927
PSF9202/9206	TQ	14 *	2.6391	190	5.2470	< 0.5	−0.6931	51000 *	10.8396	53 *	3.9703	6200 *	8.7323
PSF9203		< 5	1.6094	330 *	5.7991	2.1	0.7419	28000 *	10.2400	50 *	3.9120	5700 *	8.6482
PSF9204		< 5	1.6094	< 25	3.2189	2	0.6931	18000	9.7981	26	3.2581	4000	8.2940
PSF9205		< 5	1.6094	< 25	3.2189	< 0.5	−0.6931	23000	10.0432	32	3.4657	9900 *	9.2003
PSF9202/9206	4Q	< 1.6	0.4700	160	5.0752	< 1.5	0.4055	29000 *	10.2751	< 7.5	2.0149	< 2500	7.8240
PSF9203		< 1.6	0.4700	170	5.1358	< 1.5	0.4055	25000	10.1266	29	3.3673	5800 *	8.6656
PSF9204		< 1.6	0.4700	< 50	3.9120	< 1.5	0.4055	20000	9.9035	< 7.5	2.0149	< 2500	7.8240
PSF9205		< 1.6	0.4700	610 *	6.4135	< 1.5	0.4055	22000	9.9988	17	2.8332	10000 *	9.2103

< Not Detected – value used is 1/2 reported detection limit
* above background
All concentrations are in ug/L.

Fort Riley Groundwater	Total Metals Chromium		Total Metals Iron		Total Metals Lead		Total Metals Magnesium		Total Metals Manganese		Total Metals Potassium	
FD – Frequency of Detection	FD 2 /	20	FD 14 /	20	FD 2 /	20	FD 20 /	20	FD 18 /	20	FD 18 /	20
	# above Backg.	2	# above Backg.	8	# above Backg.	0	# above Backg.	9	# above Backg.	10	# above Backg.	12
n=		20		20		20		20		20		20
s2y=		0.3509		1.6714		0.4909		0.1125		0.4450		0.2737
sy=		0.5924		1.2928		0.7006		0.3354		0.6671		0.5232
ybar=		1.4768		4.9800		−0.0909		10.2075		3.4993		8.6904
H(0.95)=		2.181		3.163		2.306		1.882		2.306		2.068
95%UCL=		7.0195		857.3552		1.6907		33140.8628		58.8309		8738.6705
mean conc=	5.12		306.4		1.155		28750		39.55		6825	
min conc=	1.6		25		0.5		18000		7.5		2500	
max conc=	14		1500		2.5		56000		91		20000	
Exposure value=	95% UCL	7.02	95% UCL	857.36	95% UCL	1.69	95% UCL	33140.86	95% UCL	58.83	95% UCL	8738.67

LE A−8f

UCLTABLE

Fort Riley Groundwater−Metals		Total Metals Selenium		Total Metals Sodium		Total Metals Thallium		Total Metals Vanadium		Total Metals Zinc	
Sample ID		Background =	8	Background =	22000	Background =	2.4	Background =	11	Background =	13
		Sample		Sample		Sample		Sample		Sample	
PSF9202/9206	BL	2.2	0.7885	90000 *	11.4076	< 50 *	3.9120	< 3.5	1.2528	98 *	4.5850
PSF9203		1.7	0.5306	47000 *	10.7579	< 50 *	3.9120	< 3.5	1.2528	< 3.5	1.2528
PSF9204		2.1	0.7419	25000 *	10.1266	< 50 *	3.9120	< 3.5	1.2528	< 3.5	1.2528
PSF9205		2.7	0.9933	42000 *	10.6454	< 50 *	3.9120	27 *	3.2958	< 3.5	1.2528
PSF9202/9206	FQ	2.2	0.7885	57000 *	10.9508	< 31.5 *	3.4500	< 5	1.6094	16 *	2.7726
PSF9203		1.2	0.1823	37000 *	10.5187	< 31.5 *	3.4500	8	2.0794	21 *	3.0445
PSF9204		1.1	0.0953	31000 *	10.3417	< 31.5 *	3.4500	< 5	1.6094	15 *	2.7081
PSF9205		1.7	0.5306	31000 *	10.3417	< 31.5 *	3.4500	12 *	2.4849	13	2.5649
PSF9202/9206	SQ	3	1.0986	100000 *	11.5129	< 31.5 *	3.4500	< 5	1.6094	7	1.9459
PSF9203		1.7	0.5306	44000 *	10.6919	< 31.5 *	3.4500	< 5	1.6094	14 *	2.6391
PSF9204		1.4	0.3365	30000 *	10.3090	< 31.5 *	3.4500	< 5	1.6094	< 3.5	1.2528
PSF9205		1.9	0.6419	32000 *	10.3735	< 31.5 *	3.4500	14 *	2.6391	4	1.3863
PSF9202/9206	TQ	3.6	1.2809	130000 *	11.7753	2.9 *	1.0647	< 5	1.6094	< 3.5	1.2528
PSF9203		2.2	0.7885	54000 *	10.8967	2.5 *	0.9163	< 5	1.6094	< 3.5	1.2528
PSF9204		1.3	0.2624	28000 *	10.2400	< 0.5	−0.6931	< 5	1.6094	< 3.5	1.2528
PSF9205		2.3	0.8329	29000 *	10.2751	< 0.5	−0.6931	< 5	1.6094	< 3.5	1.2528
PSF9202/9206	4Q	< 2.5	0.9163	36000 *	10.4913	< 0.5	−0.6931	< 25 *	3.2189	< 10	2.3026
PSF9203		< 2.5	0.9163	31000 *	10.3417	< 0.5	−0.6931	< 25 *	3.2189	< 10	2.3026
PSF9204		< 2.5	0.9163	30000 *	10.3090	< 0.5	−0.6931	< 25 *	3.2189	< 10	2.3026
PSF9205		< 2.5	0.9163	28000 *	10.2400	< 0.5	−0.6931	< 25 *	3.2189	< 10	2.3026
< Not Detected − value used is 1/2 reported detection limit * above background All concentrations are in ug/L.						Due to large DLs & large number of NDs, a calculation of the UCL was not performed for thallium.					

Fort Riley Groundwater	Total Metals Selenium		Total Metals Sodium		Total Metals Thallium		Total Metals Vanadium		Total Metals Zinc	
FD − Frequency of Detection	FD 16 /	20	FD 20 /	20	FD 2 /	20	FD 4 /	20	FD 8 /	20
	# above Backg.	0	# above Backg.	20	# above Backg.	14	# above Backg.	7	# above Backg.	5
n=		20		20		20		20		20
s2y=		0.0978		0.2172		4.0502		0.5889		0.7775
sy=		0.3128		0.4660		2.0125		0.7674		0.8818
ybar=		0.7044		10.6273		2.0535		2.0809		2.0439
H(0.95)=		1.882		2.068		4.564		2.443		2.589
95%UCL=		2.4312		57356.4646		NA		16.5342		19.2293
mean conc=	2.115		46600		23.02		10.825		12.8	
min conc=	1.1		25000		0.5		3.5		3.5	
max conc=	3.6		130000		50		27		98	
Exposure value=	95% UCL	2.43	95% UCL	57356.46	Conc.	2.9	95% UCL	16.53	95% UCL	19.23

TABLE

UCLTABLE

Fort Riley Groundwater		Wet Inorganics Inorganic Chloride		Wet Inorganics Nitrate		Wet Inorganics Nitrate#		Wet Inorganics Sulfate		Wet Inorganics Total Sulfide		Wet Inorganics Bicarbonate	
Sample ID		Background = 147		Background = 6.4		Background = 6.4		Background = 160		Background = < 0.5		Background = 249	
		Sample	ln	Sample	ln	Sample	ln	Sample	ln	Sample	ln	Sample	ln
PSF9202/9206	BL	272 *	5.6058	33 *	3.4965	33 *	3.4965	386 *	5.9558	< 0.5	−0.6931	466 *	6.1442
PSF9203		70.4	4.2542	11.6 *	2.4510	11.6 *	2.4510	171 *	5.1417	< 0.5	−0.6931	421 *	6.0426
PSF9204		139	4.9345	< 0.1	−2.3026	< 0.1	−2.3026	125	4.8283	52.5 *	3.9608	236	5.4638
PSF9205		56.7	4.0378	18.4 *	2.9124	18.4 *	2.9124	119	4.7791	< 0.5	−0.6931	493 *	6.2005
PSF9202/9206	FQ	122	4.8040	20.3 *	3.0106	20.3 *	3.0106	336 *	5.8171	< 0.5	−0.6931	331 *	5.8021
PSF9203		55.3	4.0128	11.1 *	2.4069	11.1 *	2.4069	197 *	5.2832	< 0.5	−0.6931	315 *	5.7526
PSF9204		41.5	3.7257	13.8 *	2.6247	13.8 *	2.6247	142	4.9558	< 0.5	−0.6931	300 *	5.7038
PSF9205		48.6	3.8836	10.7 *	2.3702	10.7 *	2.3702	108	4.6821	< 0.5	−0.6931	348 *	5.8522
PSF9202/9206	SQ	262 *	5.5683	165 *	5.1059			326 *	5.7869	< 0.5	−0.6931	331 *	5.8021
PSF9203		76.5	4.3373	50.6 *	3.9240			188 *	5.2364	< 0.5	−0.6931	315 *	5.7526
PSF9204		40.1	3.6914	65.6 *	4.1836			131	4.8752	< 0.5	−0.6931	300 *	5.7038
PSF9205		47.7	3.8649	45.9 *	3.8265			109	4.6913	< 0.5	−0.6931	348 *	5.8522
PSF9202/9206	TQ	399 *	5.9890	25 *	3.2189	25 *	3.2189	199 *	5.2933	< 0.5	−0.6931	416 *	6.0307
PSF9203		76.4	4.3360	15.5 *	2.7408	15.5 *	2.7408	148	4.9972	< 0.5	−0.6931	376 *	5.9296
PSF9204		38.5	3.6507	12.2 *	2.5014	12.2 *	2.5014	111	4.7095	< 0.5	−0.6931	293 *	5.6802
PSF9205		46.9	3.8480	10.6 *	2.3609	10.6 *	2.3609	109	4.6913	< 0.5	−0.6931	327 *	5.7900
PSF9202/9206	4Q	44	3.7842	9.2 *	2.2192	9.2 *	2.2192	240 *	5.4806			< 10	2.3026
PSF9203		47	3.8501	11 *	2.3979	11 *	2.3979	160	5.0752			< 5	1.6094
PSF9204		49	3.8918	12 *	2.4849	12 *	2.4849	100	4.6052			< 5	1.6094
PSF9205		62	4.1271	9.4 *	2.2407	9.4 *	2.2407	100	4.6052			< 5	1.6094
< Not Detected – value used is 1/2 reported detection limit * above background Inorganics are in mg/L. Metals are in ug/L.						# Second Quarter results censored due to QA/QC discrepancy							

Fort Riley Groundwater	Wet Inorganics Inorganic Chloride		Wet Inorganics Nitrate		Wet Inorganics Nitrate		Wet Inorganics Sulfate		Wet Inorganics Total Sulfide		Wet Inorganics Bicarbonate	
FD – Frequency of Detection	FD 20 /	20	FD 19 /	20	FD 15 /	16	FD 16 /	20	FD 1 /	16	FD 16 /	20
	# above Backg.	3	# above Backg.	19	# above Backg.	15	# above Backg.	8	# above Backg.	1	# above Backg.	15
n=		20		20		16		20		16		20
s2y=		0.4911		1.9907		1.6513		0.1764		1.3537		2.8248
sy=		0.7008		1.4109		1.2850		0.4200		1.1635		1.6807
ybar=		4.3099		2.7087		2.3209		5.0745		−0.4023		5.0317
H(0.95)=		2.306		3.612		3.163		1.968		3.163		4.081
95%UCL=		137.8474		130.7474		66.4221		211.1078		3.4034		3034.15
mean conc=	99.73		27.55		13.9937		175.25		3.75		282.05	
min conc=	38.5		0.1		0.1		100		0.5		5	
max conc=	399		165		33		386		52.5		493	
Exposure value=	95% UCL	137.85	95% UCL	130.75	Conc.	33.00	95% UCL	211.11	95% UCL	3.40	Conc.	493

TABLE A-

UCLTABLE

Fort Riley Groundwater		Total Metals Antimony		Total Metals Cobalt		Total Metals Copper		Total Metals Nickel	
Sample ID		Background = 22		Background = < 5		Background = 11		Background = 19	
		Sample	ln	Sample	ln	Sample	ln	Sample	ln
PSF9202/9206	BL	< 15.5	2.7408	< 5	1.6094	< 2.5	0.9163	< 9	2.1972
PSF9203		< 15.5	2.7408	< 5	1.6094	< 2.5	0.9163	< 9	2.1972
PSF9204		< 15.5	2.7408	< 5	1.6094	< 2.5	0.9163	< 9	2.1972
PSF9205		< 15.5	2.7408	< 5	1.6094	< 2.5	0.9163	< 9	2.1972
PSF9202/9206	FQ	< 15.5	2.7408	< 5	1.6094	< 2.5	0.9163	< 9	2.1972
PSF9203		< 15.5	2.7408	< 5	1.6094	< 2.5	0.9163	< 9	2.1972
PSF9204		< 15.5	2.7408	< 5	1.6094	< 2.5	0.9163	24 *	3.1781
PSF9205		< 15.5	2.7408	< 5	1.6094	< 2.5	0.9163	< 9	2.1972
PSF9202/9206	SQ	< 15.5	2.7408	< 5	1.6094	4	1.3863	22 *	3.0910
PSF9203		< 15.5	2.7408	< 5	1.6094	< 2.5	0.9163	13	2.5649
PSF9204		< 15.5	2.7408	< 5	1.6094	< 2.5	0.9163	< 9	2.1972
PSF9205		32 *	3.4657	9 *	2.1972	6	1.7918	17	2.8332
PSF9202/9206	TQ	< 15.5	2.7408	< 5	1.6094	12 *	2.4849	< 9	2.1972
PSF9203		< 15.5	2.7408	< 5	1.6094	9	2.1972	< 9	2.1972
PSF9204		< 15.5	2.7408	< 5	1.6094	8	2.0794	< 9	2.1972
PSF9205		< 15.5	2.7408	< 5	1.6094	10	2.3026	< 9	2.1972
PSF9202/9206	4Q	< 2.5	0.9163	< 25 *	3.2189	< 12.5 *	2.5257	< 20 *	2.9957
PSF9203		< 2.5	0.9163	< 25 *	3.2189	< 12.5 *	2.5257	< 20 *	2.9957
PSF9204		< 2.5	0.9163	< 25 *	3.2189	< 12.5 *	2.5257	< 20 *	2.9957
PSF9205		< 2.5	0.9163	< 25 *	3.2189	< 12.5 *	2.5257	< 20 *	2.9957

< Not Detected – value used is 1/2 reported detection limit
* above background
Inorganics are in mg/L.
Metals are in ug/L.

Fort Riley Groundwater	Total Metals Antimony		Total Metals Cobalt		Total Metals Copper		Total Metals Nickel	
FD – Frequency of Detection	FD 1 /	20	FD 1 /	20	FD 6 /	20	FD 4 /	20
	# above Backg.	1	# above Backg.	5	# above Backg.	5	# above Backg.	6
n=		20		20		20		20
s2y=		0.6148		0.4336		0.5282		0.1583
sy=		0.7841		0.6585		0.7268		0.3978
ybar=		2.4122		1.9607		1.5754		2.5008
H(0.95)=		2.443		2.306		2.306		1.968
95%UCL=		23.5475		12.5020		9.2442		15.7937
mean conc=	13.725		9.2		6.2		13.2	
min conc=	2.5		5		2.5		9	
max conc=	32		25		12.5		24	
Exposure value=	95% UCL	23.55	95% UCL	12.50	95% UCL	9.24	95% UCL	15.79

UCLTABLE

TABLE [illegible]f

Fort Riley Groundwater–Metals

Sample ID		Total Metals Arsenic: Background = < 1			Total Metals Aluminum: Background = 260		
			Sample	ln		Sample	ln
PSF9202/9206	BL	<	1	0.0000	<	55	4.0073
PSF9203		<	1	0.0000		270 *	5.5984
PSF9204		<	1	0.0000		160	5.0752
PSF9205			16 *	2.7726		210	5.3471
PSF9202/9206	FQ	<	1	0.0000		190	5.2470
PSF9203		<	1	0.0000		550 *	6.3099
PSF9204		<	1	0.0000	<	50	3.9120
PSF9205			4.4 *	1.4816		550 *	6.3099
PSF9202/9206	SQ		2.7 *	0.9933	<	50	3.9120
PSF9203		<	1	0.0000		800 *	6.6846
PSF9204		<	1	0.0000	<	50	3.9120
PSF9205			3.8 *	1.3350		110	4.7005
PSF9202/9206	TQ	<	1	0.0000		170	5.1358
PSF9203		<	1	0.0000		180	5.1930
PSF9204		<	1	0.0000	<	50	3.9120
PSF9205			3.8 *	1.3350	<	50	3.9120
PSF9202/9206	4Q	<	5 *	1.6094	<	100	4.6052
PSF9203		<	5 *	1.6094	<	100	4.6052
PSF9204		<	5 *	1.6094	<	100	4.6052
PSF9205		<	5 *	1.6094	<	100	4.6052

Sample ID		Total Metals Barium: Background = 200			Total Metals Beryllium: Background = 2		
			Sample	ln		Sample	ln
PSF9202/9206	BL		84	4.4308		3 *	1.0986
PSF9203			81	4.3944		1.5	0.4055
PSF9204			85	4.4427		1.4	0.3365
PSF9205			130	4.8675		1.6	0.4700
PSF9202/9206	FQ		68	4.2195		3 *	1.0986
PSF9203			94	4.5433		2	0.6931
PSF9204			100	4.6052		1	0.0000
PSF9205			130	4.8675		2	0.6931
PSF9202/9206	SQ		60	4.0943		5 *	1.6094
PSF9203			63	4.1431		2	0.6931
PSF9204			93	4.5326		2	0.6931
PSF9205			110	4.7005		3 *	1.0986
PSF9202/9206	TQ		100	4.6052		3 *	1.0986
PSF9203			68	4.2195		2	0.6931
PSF9204			91	4.5109	<	1	0.0000
PSF9205			130	4.8675		2	0.6931
PSF9202/9206	4Q		42	3.7377	<	2.5 *	0.9163
PSF9203			59	4.0775	<	2.5 *	0.9163
PSF9204			93	4.5326	<	2.5 *	0.9163
PSF9205			120	4.7875	<	2.5 *	0.9163

Sample ID		Total Metals Cadmium: Background = 4			Total Metals Calcium: Background = 150000	
			Sample	ln	Sample	ln
PSF9202/9206	BL	<	2.5	0.9163	350000 *	12.7657
PSF9203		<	2.5	0.9163	180000 *	12.1007
PSF9204		<	2.5	0.9163	140000	11.8494
PSF9205		<	2.5	0.9163	180000 *	12.1007
PSF9202/9206	FQ	<	2	0.6931	240000 *	12.3884
PSF9203		<	2	0.6931	160000 *	11.9829
PSF9204		<	2	0.6931	150000	11.9184
PSF9205		<	2	0.6931	150000	11.9184
PSF9202/9206	SQ	<	2	0.6931	290000 *	12.5776
PSF9203		<	2	0.6931	170000 *	12.0436
PSF9204		<	2	0.6931	150000	11.9184
PSF9205		<	2	0.6931	150000	11.9184
PSF9202/9206	TQ	<	2	0.6931	150000	11.9184
PSF9203		<	2	0.6931	280000 *	12.5425
PSF9204		<	2	0.6931	170000 *	12.0436
PSF9205			4	1.3863	130000	11.7753
PSF9202/9206	4Q		6 *	1.7918	150000	11.9184
PSF9203		<	2.5	0.9163	190000 *	12.1548
PSF9204		<	2.5	0.9163	170000 *	12.0436
PSF9205		<	2.5	0.9163	150000	11.9184

< Not Detected – value used is 1/2 reported detection limit
* above background
All concentrations are in ug/L.

Fort Riley Groundwater	Total Metals Arsenic	Total Metals Aluminum	Total Metals Barium	Total Metals Beryllium	Total Metals Cadmium	Total Metals Calcium
FD – Frequency of Detection	FD 5 / 20	FD 10 / 20	FD 20 / 20	FD 15 / 20	FD 2 / 20	FD 20 / 20
	# above Backg. 9	# above Backg. 4	# above Backg. 0	# above Backg. 9	# above Backg. 1	# above Backg. 11
n=	20	20	20	20	20	20
s2y=	0.7627	0.7472	0.0920	0.1499	0.0761	0.0723
sy=	0.8733	0.8644	0.3034	0.3871	0.2759	0.2689
ybar=	0.7178	4.8795	4.4590	0.7520	0.8720	12.0899
H(0.95)=	2.589	2.589	1.882	1.968	1.882	1.882
95%UCL=	5.0421	319.4235	103.1315	2.7230	2.7987	207339.5749
mean conc=	3.085	194.75	90.05	2.275	2.5	185000
min conc=	1	50	42	1	2	130000
max conc=	16	800	130	5	6	350000
Exposure value=	95% UCL 5.04	95% UCL 319.42	95% UCL 103.13	95% UCL 2.72	95% UCL 2.80	95% UCL 207339.57

TABLE A-9
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE OCCUPATIONAL ADULT (Site Worker): Dermal Contact with Sediments

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day)		Intake (mg/kg-day)		Toxicity Value		Hazard Index (unitless)	Cancer Risk (unitless)
			Noncarcinogen	Carcinogen	Noncarcinogen	Carcinogen	RfD (mg/kg-day)	CSF $(mg/kg\text{-}day)^{-1}$		
Chlordane	0.086	0.109	7.67E-08	2.74E-08	7.19E-10	2.57E-10	6.0E-05	1.3E+00	1.20E-05	3.34E-10
DDD	0.059	0.378	7.67E-08	2.74E-08	1.71E-09	6.11E-10	--	2.4E-01	--	1.47E-10
DDE	0.055	0.378	7.67E-08	2.74E-08	1.59E-09	5.70E-10	--	3.4E-01	--	1.94E-10
DDT	0.096	0.378	7.67E-08	2.74E-08	2.78E-09	9.94E-10	5.0E-04	3.4E-01	5.57E-06	3.38E-10
Dieldrin	0.013	0.077	7.67E-08	2.74E-08	7.68E-11	2.74E-11	5.0E-05	1.6E+01	1.54E-06	4.39E-10
Benzo(a)anthracene	0.15	1	7.67E-08	2.74E-08	1.15E-08	4.11E-09	--	1.1E+00 *	--	4.52E-09
Chrysene	0.18	1	7.67E-08	2.74E-08	1.38E-08	4.93E-09	--	2.9E-02 *	--	1.43E-10
Phenanthrene	0.21	1	7.67E-08	2.74E-08	1.61E-08	5.75E-09	--	--	--	--
Arsenic	2.8	0.01	7.67E-08	2.74E-08	2.15E-09	7.67E-10	3.0E-04	1.8E+00	7.16E-06	1.34E-09
Barium	117	0.01	7.67E-08	2.74E-08	8.97E-08	3.21E-08	7.0E-02	--	1.28E-06	--
Cadmium	1.8	0.01	7.67E-08	2.74E-08	1.38E-09	4.93E-10	1.0E-03	--	1.38E-06	--
Chromium	17	0.01	7.67E-08	2.74E-08	1.30E-08	4.66E-09	5.0E-03	--	2.61E-06	--
Lead	153	0.01	7.67E-08	2.74E-08	1.17E-07	4.19E-08	--	--	--	--
Mercury	0.24	0.01	7.67E-08	2.74E-08	1.84E-10	6.58E-11	3.0E-04 h	--	6.14E-07	--
									3.2E-05	**7.5E-09**

RfD and CSF values are from IRIS (1994)
* - CSF is based on TEF, using Benzo(a)pyrene toxicity
h - Value is from HEAST (1994)

TABLE A–10
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT & FUTURE RECREATIONAL CHILD : Dermal Contact with Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg–day) Noncarcinogen	Intake Factor (kg/kg–day) Carcinogen	Intake (mg/kg–day) Noncarcinogen	Intake (mg/kg–day) Carcinogen	Toxicity Value RfD (mg/kg–day)	Toxicity Value CSF $(mg/kg–day)^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.12	0.109	7.07E–07	––	9.25E–09	––	6.0E–05	1.3E+00	1.54E–04	––
DDD	0.45	0.378	7.07E–07	––	1.20E–07	––	––	2.4E–01	––	––
DDE	0.37	0.378	7.07E–07	––	9.89E–08	––	––	3.4E–01	––	––
DDT	1.3	0.378	7.07E–07	––	3.47E–07	––	5.0E–04	3.4E–01	6.95E–04	––
Dieldrin	0.040	0.077	7.07E–07	––	2.18E–09	––	5.0E–05	1.6E+01	4.36E–05	––
Heptachlor	0.0022	0.109	7.07E–07	––	1.70E–10	––	5.0E–04	4.5E+00	3.39E–07	––
									7.4E–04	––

RfD and CSF values are from IRIS (1994)

TABLE A-11
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE OCCUPATIONAL ADULT (Site Worker): Dermal Contact with Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day)		Intake (mg/kg-day)		Toxicity Value		Hazard Index (unitless)	Cancer Risk (unitless)
			Noncarcinogen	Carcinogen	Noncarcinogen	Carcinogen	RfD (mg/kg-day)	CSF $(mg/kg-day)^{-1}$		
Chlordane	0.12	0.109	1.16E-05	4.15E-06	1.52E-07	5.43E-08	6.0E-05	1.3E+00	2.53E-03	7.06E-08
DDD	0.45	0.378	1.16E-05	4.15E-06	1.97E-06	7.06E-07	--	2.4E-01	--	1.69E-07
DDE	0.37	0.378	1.16E-05	4.15E-06	1.62E-06	5.80E-07	--	3.4E-01	--	1.97E-07
DDT	1.3	0.378	1.16E-05	4.15E-06	5.70E-06	2.04E-06	5.0E-04	3.4E-01	1.14E-02	6.93E-07
Dieldrin	0.040	0.077	1.16E-05	4.15E-06	3.57E-08	1.28E-08	5.0E-05	1.6E+01	7.15E-04	2.05E-07
Heptachlor	0.0022	0.109	1.16E-05	4.15E-06	2.78E-09	9.95E-10	5.0E-04	4.5E+00	5.56E-06	4.48E-09
									1.2E-02	**1.3E-06**

RfD and CSF values are from IRIS (1994)

TABLE A-12
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE OCCUPATIONAL ADULT (Utility Worker): Dermal Contact with Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day) Noncarcinogen	Intake Factor (kg/kg-day) Carcinogen	Intake (mg/kg-day) Noncarcinogen	Intake (mg/kg-day) Carcinogen	Toxicity Value RfD (mg/kg-day)	Toxicity Value CSF $(mg/kg-day)^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.12	0.109	5.21E-08	1.86E-08	6.81E-10	2.43E-10	6.0E-05	1.3E+00	1.14E-05	3.16E-10
DDD	0.45	0.378	5.21E-08	1.86E-08	8.86E-09	3.16E-09	--	2.4E-01	--	7.59E-10
DDE	0.37	0.378	5.21E-08	1.86E-08	7.29E-09	2.60E-09	--	3.4E-01	--	8.84E-10
DDT	1.3	0.378	5.21E-08	1.86E-08	2.56E-08	9.14E-09	5.0E-04	3.4E-01	5.12E-05	3.11E-09
Dieldrin	0.040	0.077	5.21E-08	1.86E-08	1.60E-10	5.73E-11	5.0E-05	1.6E+01	3.21E-06	9.17E-10
Heptachlor	0.0022	0.109	5.21E-08	1.86E-08	1.25E-11	4.46E-12	5.0E-04	4.5E+00	2.50E-08	2.01E-11
									5.4E-05	**5.7E-09**

RfD and CSF values are from IRIS (1994)

TABLE A-13
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE OCCUPATIONAL ADULT (Landscaper): Dermal Contact with Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day) Noncarcinogen	Intake Factor (kg/kg-day) Carcinogen	Intake (mg/kg-day) Noncarcinogen	Intake (mg/kg-day) Carcinogen	Toxicity Value RfD (mg/kg-day)	Toxicity Value CSF $(mg/kg-day)^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.12	0.109	4.73E-08	1.69E-08	6.19E-10	2.21E-10	6.0E-05	1.3E+00	1.03E-05	2.87E-10
DDD	0.45	0.378	4.73E-08	1.69E-08	8.05E-09	2.87E-09	--	2.4E-01	--	6.90E-10
DDE	0.37	0.378	4.73E-08	1.69E-08	6.62E-09	2.36E-09	--	3.4E-01	--	8.04E-10
DDT	1.3	0.378	4.73E-08	1.69E-08	2.32E-08	8.30E-09	5.0E-04	3.4E-01	4.65E-05	2.82E-09
Dieldrin	0.040	0.077	4.73E-08	1.69E-08	1.46E-10	5.21E-11	5.0E-05	1.6E+01	2.91E-06	8.33E-10
Heptachlor	0.0022	0.109	4.73E-08	1.69E-08	1.13E-11	4.05E-12	5.0E-04	4.5E+00	2.27E-08	1.82E-11
									4.9E-05	**5.2E-09**

RfD and CSF values are from IRIS (1994)

TABLE A-14
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE OCCUPATIONAL ADULT (Construction Worker): Dermal Contact with Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day)		Intake (mg/kg-day)		Toxicity Value		Hazard Index (unitless)	Cancer Risk (unitless)
			Noncarcinogen	Carcinogen	Noncarcinogen	Carcinogen	RfD (mg/kg-day)	CSF $(mg/kg-day)^{-1}$		
Chlordane	0.12	0.109	5.58E-06	7.97E-08	7.30E-08	1.04E-09	6.0E-05	1.3E+00	1.22E-03	1.36E-09
DDD	0.45	0.378	5.58E-06	7.97E-08	9.49E-07	1.36E-08	--	2.4E-01	--	3.25E-09
DDE	0.37	0.378	5.58E-06	7.97E-08	7.80E-07	1.11E-08	--	3.4E-01	--	3.79E-09
DDT	1.3	0.378	5.58E-06	7.97E-08	2.74E-06	3.92E-08	5.0E-04	3.4E-01	5.48E-03	1.33E-08
Dieldrin	0.040	0.077	5.58E-06	7.97E-08	1.72E-08	2.45E-10	5.0E-05	1.6E+01	3.44E-04	3.93E-09
Heptachlor	0.0022	0.109	5.58E-06	7.97E-08	1.34E-09	1.91E-11	5.0E-04	4.5E+00	2.68E-06	8.60E-11
									5.8E-03	**2.4E-08**

RfD and CSF values are from IRIS (1994)

TABLE A-15
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT OCCUPATIONAL ADULT (Landscaper): Dermal Contact with Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day) Noncarcinogen	Intake Factor (kg/kg-day) Carcinogen	Intake (mg/kg-day) Noncarcinogen	Intake (mg/kg-day) Carcinogen	Toxicity Value RfD (mg/kg-day)	Toxicity Value CSF $(mg/kg-day)^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.12	0.109	1.18E-08	4.23E-09	1.54E-10	5.53E-11	6.0E-05	1.3E+00	2.57E-06	7.19E-11
DDD	0.45	0.378	1.18E-08	4.23E-09	2.01E-09	7.20E-10	--	2.4E-01	--	1.73E-10
DDE	0.37	0.378	1.18E-08	4.23E-09	1.65E-09	5.92E-10	--	3.4E-01	--	2.01E-10
DDT	1.3	0.378	1.18E-08	4.23E-09	5.80E-09	2.08E-09	5.0E-04	3.4E-01	1.16E-05	7.07E-10
Dieldrin	0.040	0.077	1.18E-08	4.23E-09	3.63E-11	1.30E-11	5.0E-05	1.6E+01	7.27E-07	2.08E-10
Heptachlor	0.0022	0.109	1.18E-08	4.23E-09	2.83E-12	1.01E-12	5.0E-04	4.5E+00	5.66E-09	4.56E-12
									1.2E-05	**1.3E-09**

RfD and CSF values are from IRIS (1994)

TABLE A-16
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT OCCUPATIONAL ADULT (Site Worker): Dermal Contact with Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day) Noncarcinogen	Intake Factor (kg/kg-day) Carcinogen	Intake (mg/kg-day) Noncarcinogen	Intake (mg/kg-day) Carcinogen	Toxicity Value RfD (mg/kg-day)	Toxicity Value CSF $(mg/kg\text{-}day)^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.12	0.109	9.16E-06	3.27E-06	1.20E-07	4.28E-08	6.0E-05	1.3E+00	2.00E-03	5.56E-08
DDD	0.45	0.378	9.16E-06	3.27E-06	1.56E-06	5.56E-07	--	2.4E-01	--	1.33E-07
DDE	0.37	0.378	9.16E-06	3.27E-06	1.28E-06	4.57E-07	--	3.4E-01	--	1.55E-07
DDT	1.3	0.378	9.16E-06	3.27E-06	4.50E-06	1.61E-06	5.0E-04	3.4E-01	9.00E-03	5.46E-07
Dieldrin	0.040	0.077	9.16E-06	3.27E-06	2.82E-08	1.01E-08	5.0E-05	1.6E+01	5.64E-04	1.61E-07
Heptachlor	0.0022	0.109	9.16E-06	3.27E-06	2.20E-09	7.84E-10	5.0E-04	4.5E+00	4.39E-06	3.53E-09
									9.6E-03	**1.0E-06**

RfD and CSF values are from IRIS (1994)

TABLE A-17
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT OCCUPATIONAL ADULT (Utility Worker): Dermal Contact with Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day) Noncarcinogen	Intake Factor (kg/kg-day) Carcinogen	Intake (mg/kg-day) Noncarcinogen	Intake (mg/kg-day) Carcinogen	Toxicity Value RfD (mg/kg-day)	Toxicity Value CSF $(mg/kg-day)^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.12	0.109	1.39E-08	4.98E-09	1.82E-10	6.51E-11	6.0E-05	1.3E+00	3.03E-06	8.47E-11
DDD	0.45	0.378	1.39E-08	4.98E-09	2.36E-09	8.47E-10	--	2.4E-01	--	2.03E-10
DDE	0.37	0.378	1.39E-08	4.98E-09	1.94E-09	6.97E-10	--	3.4E-01	--	2.37E-10
DDT	1.3	0.378	1.39E-08	4.98E-09	6.83E-09	2.45E-09	5.0E-04	3.4E-01	1.37E-05	8.32E-10
Dieldrin	0.040	0.077	1.39E-08	4.98E-09	4.28E-11	1.53E-11	5.0E-05	1.6E+01	8.56E-07	2.45E-10
Heptachlor	0.0022	0.109	1.39E-08	4.98E-09	3.33E-12	1.19E-12	5.0E-04	4.5E+00	6.67E-09	5.37E-12
									1.5E-05	**1.5E-09**

RfD and CSF values are from IRIS (1994)

TABLE A-18
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE OCCUPATIONAL ADULT (Site Worker): Inhalation of Fugitive Dust from Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Intake (kg/kg-day) Noncarcinogen	Intake (kg/kg-day) Carcinogen	Chronic Intake (mg/kg-day) Noncarcinogen	Chronic Intake (mg/kg-day) Carcinogen	Toxicity Value Inhalation RfD (mg/kg-day)	Toxicity Value Inhalation CSF $(mg/kg-day)^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.12	5.99E-10	2.14E-10	7.19E-11	2.57E-11	--	1.30E+00	--	3.34E-11
DDD	0.45	5.99E-10	2.14E-10	2.70E-10	9.63E-11	--	--	--	--
DDE	0.37	5.99E-10	2.14E-10	2.22E-10	7.92E-11	--	--	--	--
DDT	1.3	5.99E-10	2.14E-10	7.79E-10	2.78E-10	--	--	--	--
Dieldrin	0.040	5.99E-10	2.14E-10	2.40E-11	8.56E-12	--	3.40E-01	--	9.46E-11
Heptachlor	0.0022	5.99E-10	2.14E-10	1.32E-12	4.71E-13	--	1.60E+01	--	1.37E-10
							4.60E+00	--	2.17E-12
								--	**2.3E-10**

RfD and CSF values are from IRIS (1994)

TABLE A-19
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE OCCUPATIONAL ADULT (Construction Worker): Incidental Ingestion of Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Intake Factor (kg/kg-day) Noncarcinogen	Intake Factor (kg/kg-day) Carcinogen	Intake (mg/kg-day) Noncarcinogen	Intake (mg/kg-day) Carcinogen	Toxicity Value RfD (mg/kg-day)	Toxicity Value CSF (mg/kg-day)$^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.12	2.25E-06	3.22E-08	2.70E-07	3.86E-09	6.0E-05	1.3E+00	4.50E-03	5.02E-09
DDD	0.45	2.25E-06	3.22E-08	1.01E-06	1.45E-08	--	2.4E-01	--	3.48E-09
DDE	0.37	2.25E-06	3.22E-08	8.32E-07	1.19E-08	--	3.4E-01	--	4.05E-09
DDT	1.3	2.25E-06	3.22E-08	2.93E-06	4.19E-08	5.0E-04	3.4E-01	5.85E-03	1.42E-08
Dieldrin	0.040	2.25E-06	3.22E-08	9.00E-08	1.29E-09	5.0E-05	1.6E+01	1.80E-03	2.06E-08
Heptachlor	0.0022	2.25E-06	3.22E-08	4.95E-09	7.08E-11	5.0E-04	4.5E+00	9.90E-06	3.19E-10
								7.7E-03	**4.3E-08**

RfD and CSF values are from IRIS (1994)

TABLE A-20
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE OCCUPATIONAL ADULT (Site Worker): Incidental Ingestion of Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Intake Factor (kg/kg-day)		Intake (mg/kg-day)		Toxicity Value		Hazard Index (unitless)	Cancer Risk (unitless)
		Noncarcinogen	Carcinogen	Noncarcinogen	Carcinogen	RfD (mg/kg-day)	CSF $(mg/kg-day)^{-1}$		
Chlordane	0.12	4.89E-07	1.75E-07	5.87E-08	2.10E-08	6.0E-05	1.3E+00	9.78E-04	2.73E-08
DDD	0.45	4.89E-07	1.75E-07	2.20E-07	7.88E-08	--	2.4E-01	--	1.89E-08
DDE	0.37	4.89E-07	1.75E-07	1.81E-07	6.47E-08	--	3.4E-01	--	2.20E-08
DDT	1.3	4.89E-07	1.75E-07	6.36E-07	2.27E-07	5.0E-04	3.4E-01	1.27E-03	7.74E-08
Dieldrin	0.040	4.89E-07	1.75E-07	1.96E-08	7.00E-09	5.0E-05	1.6E+01	3.91E-04	1.12E-07
Heptachlor	0.0022	4.89E-07	1.75E-07	1.08E-09	3.85E-10	5.0E-04	4.5E+00	2.15E-06	1.73E-09
								1.7E-03	**2.3E-07**

RfD and CSF values are from IRIS (1994)

TABLE A-21
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT OCCUPATIONAL ADULT (Site Worker): Incidental Ingestion of Surface Soils

Parameter	Exposure Point Concentration (mg/kg)	Intake Factor (kg/kg-day)		Intake (mg/kg-day)		Toxicity Value		Hazard Index (unitless)	Cancer Risk (unitless)
		Noncarcinogen	Carcinogen	Noncarcinogen	Carcinogen	RfD (mg/kg-day)	CSF $(mg/kg-day)^{-1}$		
Chlordane	0.12	3.82E-07	1.36E-07	4.58E-08	1.63E-08	6.0E-05	1.3E+00	7.64E-04	2.12E-08
DDD	0.45	3.82E-07	1.36E-07	1.72E-07	6.12E-08	--	2.4E-01	--	1.47E-08
DDE	0.37	3.82E-07	1.36E-07	1.41E-07	5.03E-08	--	3.4E-01	--	1.71E-08
DDT	1.3	3.82E-07	1.36E-07	4.97E-07	1.77E-07	5.0E-04	3.4E-01	9.93E-04	6.01E-08
Dieldrin	0.040	3.82E-07	1.36E-07	1.53E-08	5.44E-09	5.0E-05	1.6E+01	3.06E-04	8.70E-08
Heptachlor	0.0022	3.82E-07	1.36E-07	8.40E-10	2.99E-10	5.0E-04	4.5E+00	1.68E-06	1.35E-09
								1.3E-03	**1.8E-07**

RfD and CSF values are from IRIS (1994)

TABLE A-22
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE OCCUPATIONAL ADULT (Utility Worker): Dermal Contact with Subsurface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day)		Intake (mg/kg-day)		Toxicity Value		Hazard Index (unitless)	Cancer Risk (unitless)
			Noncarcinogen	Carcinogen	Noncarcinogen	Carcinogen	RfD (mg/kg-day)	CSF $(mg/kg-day)^{-1}$		
Chlordane	0.22	0.109	5.21E-08	1.86E-08	1.25E-09	4.46E-10	6.0E-05	1.3E+00	2.08E-05	5.80E-10
DDD	0.017	0.378	5.21E-08	1.86E-08	3.35E-10	1.20E-10	--	2.4E-01	--	2.87E-11
DDE	0.033	0.378	5.21E-08	1.86E-08	6.50E-10	2.32E-10	--	3.4E-01	--	7.89E-11
DDT	0.15	0.378	5.21E-08	1.86E-08	2.95E-09	1.05E-09	5.0E-04	3.4E-01	5.91E-06	3.59E-10
Dieldrin	0.0048	0.077	5.21E-08	1.86E-08	1.93E-11	6.87E-12	5.0E-05	1.6E+01	3.85E-07	1.10E-10
Heptachlor	0.0029	0.109	5.21E-08	1.86E-08	1.65E-11	5.88E-12	5.0E-04	4.5E+00	3.29E-08	2.65E-11
Benzene	0.0023	1	5.21E-08	1.86E-08	1.20E-10	4.28E-11	--	2.9E-02	--	1.24E-12
Methylene chloride	0.019	1	5.21E-08	1.86E-08	9.90E-10	3.53E-10	6.0E-02	7.5E-03	1.65E-08	2.65E-12
Toluene	0.0067	1	5.21E-08	1.86E-08	3.49E-10	1.25E-10	2.0E-01	--	1.75E-09	--
Benzo(a)anthracene	0.10	1	5.21E-08	1.86E-08	5.21E-09	1.86E-09	--	1.1E+00 *	--	2.05E-09
bis(2-Ethylhexyl)phthalate	0.33	1	5.21E-08	1.86E-08	1.72E-08	6.14E-09	2.0E-02	1.4E-02	8.60E-07	8.59E-11
Chrysene	0.092	1	5.21E-08	1.86E-08	4.79E-09	1.71E-09	--	2.9E-02 *	--	4.96E-11
Diethylphthalate	0.24	1	5.21E-08	1.86E-08	1.25E-08	4.46E-09	8.0E-01	--	1.56E-08	--
Fluoranthene	0.13	1	5.21E-08	1.86E-08	6.77E-09	2.42E-09	4.0E-02	--	1.69E-07	--
Phenanthrene	0.11	1	5.21E-08	1.86E-08	5.73E-09	2.05E-09	--	--	--	--
Pyrene	0.12	1	5.21E-08	1.86E-08	6.25E-09	2.23E-09	3.0E-02	--	2.08E-07	--
Arsenic	4.6	0.01	5.21E-08	1.86E-08	2.40E-09	8.56E-10	3.0E-04	1.8E+00	7.99E-06	1.50E-09
Barium	105.1	0.01	5.21E-08	1.86E-08	5.48E-08	1.95E-08	7.0E-02	--	7.82E-07	--
Chromium	8.4	0.01	5.21E-08	1.86E-08	4.38E-09	1.56E-09	5.0E-03	--	8.75E-07	--
Lead	99.5	0.01	5.21E-08	1.86E-08	5.18E-08	1.85E-08	--	--	--	--
Mercury	0.054	0.01	5.21E-08	1.86E-08	2.81E-11	1.00E-11	3.0E-04 h	--	9.38E-08	--
Silver	0.46	0.01	5.21E-08	1.86E-08	2.40E-10	8.56E-11	5.0E-03	--	4.79E-08	--
									1.7E-05	**4.3E-09**

RfD and CSF values are from IRIS (1994)

* - CSF is based on TEF, using Benzo(a)pyrene toxicity

h - Value is from HEAST (1994)

TABLE A-23
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE OCCUPATIONAL ADULT (Landscaper): Dermal Contact with Subsurface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day) Noncarcinogen	Intake Factor (kg/kg-day) Carcinogen	Intake (mg/kg-day) Noncarcinogen	Intake (mg/kg-day) Carcinogen	Toxicity Value RfD (mg/kg-day)	Toxicity Value CSF (mg/kg-day)$^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.22	0.109	4.73E-08	1.69E-08	1.13E-09	4.05E-10	6.0E-05	1.3E+00	1.89E-05	5.27E-10
DDD	0.017	0.378	4.73E-08	1.69E-08	3.04E-10	1.09E-10	--	2.4E-01	--	2.61E-11
DDE	0.033	0.378	4.73E-08	1.69E-08	5.90E-10	2.11E-10	--	3.4E-01	--	7.17E-11
DDT	0.15	0.378	4.73E-08	1.69E-08	2.68E-09	9.58E-10	5.0E-04	3.4E-01	5.36E-06	3.26E-10
Dieldrin	0.0048	0.077	4.73E-08	1.69E-08	1.75E-11	6.25E-12	5.0E-05	1.6E+01	3.50E-07	9.99E-11
Heptachlor	0.0029	0.109	4.73E-08	1.69E-08	1.50E-11	5.34E-12	5.0E-04	4.5E+00	2.99E-08	2.40E-11
Benzene	0.0023	1	4.73E-08	1.69E-08	1.09E-10	3.89E-11	--	2.9E-02	--	1.13E-12
Methylene chloride	0.019	1	4.73E-08	1.69E-08	8.99E-10	3.21E-10	6.0E-02	7.5E-03	1.50E-08	2.41E-12
Toluene	0.0067	1	4.73E-08	1.69E-08	3.17E-10	1.13E-10	2.0E-01	--	1.58E-09	--
Benzo(a)anthracene	0.10	1	4.73E-08	1.69E-08	4.73E-09	1.69E-09	--	1.1E+00 *	--	1.86E-09
bis(2-Ethylhexyl)phthalate	0.33	1	4.73E-08	1.69E-08	1.56E-08	5.58E-09	2.0E-02	1.4E-02	7.80E-07	7.81E-11
Chrysene	0.092	1	4.73E-08	1.69E-08	4.35E-09	1.55E-09	--	2.9E-02 *	--	4.51E-11
Diethylphthalate	0.24	1	4.73E-08	1.69E-08	1.14E-08	4.06E-09	8.0E-01	--	1.42E-08	--
Fluoranthene	0.13	1	4.73E-08	1.69E-08	6.15E-09	2.20E-09	4.0E-02	--	1.54E-07	--
Phenanthrene	0.11	1	4.73E-08	1.69E-08	5.20E-09	1.86E-09	--	--	--	--
Pyrene	0.12	1	4.73E-08	1.69E-08	5.68E-09	2.03E-09	3.0E-02	--	1.89E-07	--
Arsenic	4.6	0.01	4.73E-08	1.69E-08	2.18E-09	7.77E-10	3.0E-04	1.8E+00	7.25E-06	1.36E-09
Barium	105.1	0.01	4.73E-08	1.69E-08	4.97E-08	1.78E-08	7.0E-02	--	7.10E-07	--
Chromium	8.4	0.01	4.73E-08	1.69E-08	3.97E-09	1.42E-09	5.0E-03	--	7.95E-07	--
Lead	99.5	0.01	4.73E-08	1.69E-08	4.71E-08	1.68E-08	--	--	--	--
Mercury	0.054	0.01	4.73E-08	1.69E-08	2.55E-11	9.13E-12	3.0E-04 h	--	8.51E-08	--
Silver	0.46	0.01	4.73E-08	1.69E-08	2.18E-10	7.77E-11	5.0E-03	--	4.35E-08	--
									1.6E-05	**3.9E-09**

RfD and CSF values are from IRIS (1994)

* – CSF is based on TEF, using Benzo(a)pyrene toxicity

h – Value is from HEAST (1994)

TABLE A-24
Pesticide Storage Facility
Fort Riley, Kansas

FUTURE OCCUPATIONAL ADULT (Construction Worker): Dermal Contact with Subsurface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day) Noncarcinogen	Intake Factor (kg/kg-day) Carcinogen	Intake (mg/kg-day) Noncarcinogen	Intake (mg/kg-day) Carcinogen	Toxicity Value RfD (mg/kg-day)	Toxicity Value CSF $(mg/kg-day)^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.22	0.109	5.58E-06	7.97E-08	1.34E-07	1.91E-09	6.0E-05	1.3E+00	2.23E-03	2.48E-09
DDD	0.017	0.378	5.58E-06	7.97E-08	3.59E-08	5.12E-10	--	2.4E-01	--	1.23E-10
DDE	0.033	0.378	5.58E-06	7.97E-08	6.96E-08	9.94E-10	--	3.4E-01	--	3.38E-10
DDT	0.15	0.378	5.58E-06	7.97E-08	3.16E-07	4.52E-09	5.0E-04	3.4E-01	6.33E-04	1.54E-09
Dieldrin	0.0048	0.077	5.58E-06	7.97E-08	2.06E-09	2.95E-11	5.0E-05	1.6E+01	4.12E-05	4.71E-10
Heptachlor	0.0029	0.109	5.58E-06	7.97E-08	1.76E-09	2.52E-11	5.0E-04	4.5E+00	3.53E-06	1.13E-10
Benzene	0.0023	1	5.58E-06	7.97E-08	1.28E-08	1.83E-10	--	2.9E-02	--	5.32E-12
Methylene chloride	0.019	1	5.58E-06	7.97E-08	1.06E-07	1.51E-09	6.0E-02	7.5E-03	1.77E-06	1.14E-11
Toluene	0.0067	1	5.58E-06	7.97E-08	3.74E-08	5.34E-10	2.0E-01	--	1.87E-07	--
Benzo(a)anthracene	0.10	1	5.58E-06	7.97E-08	5.58E-07	7.97E-09	--	1.1E+00 *	--	8.77E-09
bis(2-Ethylhexyl)phthalate	0.33	1	5.58E-06	7.97E-08	1.84E-06	2.63E-08	2.0E-02	1.4E-02	9.21E-05	3.68E-10
Chrysene	0.092	1	5.58E-06	7.97E-08	5.13E-07	7.33E-09	--	2.9E-02 *	--	2.13E-10
Diethylphthalate	0.24	1	5.58E-06	7.97E-08	1.34E-06	1.91E-08	8.0E-01	--	1.67E-06	--
Fluoranthene	0.13	1	5.58E-06	7.97E-08	7.25E-07	1.04E-08	4.0E-02	--	1.81E-05	--
Phenanthrene	0.11	1	5.58E-06	7.97E-08	6.14E-07	8.77E-09	--	--	--	--
Pyrene	0.12	1	5.58E-06	7.97E-08	6.70E-07	9.56E-09	3.0E-02	--	2.23E-05	--
Arsenic	4.6	0.01	5.58E-06	7.97E-08	2.57E-07	3.67E-09	3.0E-04	1.8E+00	8.56E-04	6.42E-09
Barium	105.1	0.01	5.58E-06	7.97E-08	5.86E-06	8.38E-08	7.0E-02	--	8.38E-05	--
Chromium	8.4	0.01	5.58E-06	7.97E-08	4.69E-07	6.69E-09	5.0E-03	--	9.37E-05	--
Lead	99.5	0.01	5.58E-06	7.97E-08	5.55E-06	7.93E-08	--	--	--	--
Mercury	0.054	0.01	5.58E-06	7.97E-08	3.01E-09	4.30E-11	3.0E-04 h	--	1.00E-05	--
Silver	0.46	0.01	5.58E-06	7.97E-08	2.57E-08	3.67E-10	5.0E-03	--	5.13E-06	--
									1.9E-03	**1.8E-08**

RfD and CSF values are from IRIS (1994)

* – CSF is based on TEF, using Benzo(a)pyrene toxicity

h – Value is from HEAST (1994)

TABLE A-25
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT OCCUPATIONAL ADULT (Utility Worker): Dermal Contact with Subsurface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg−day) Noncarcinogen	Intake Factor (kg/kg−day) Carcinogen	Intake (mg/kg−day) Noncarcinogen	Intake (mg/kg−day) Carcinogen	Toxicity Value RfD (mg/kg−day)	Toxicity Value CSF $(mg/kg-day)^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.22	0.109	1.39E−08	4.98E−09	3.33E−10	1.19E−10	6.0E−05	1.3E+00	5.56E−06	1.55E−10
DDD	0.017	0.378	1.39E−08	4.98E−09	8.93E−11	3.20E−11	−−	2.4E−01	−−	7.68E−12
DDE	0.033	0.378	1.39E−08	4.98E−09	1.73E−10	6.21E−11	−−	3.4E−01	−−	2.11E−11
DDT	0.15	0.378	1.39E−08	4.98E−09	7.88E−10	2.82E−10	5.0E−04	3.4E−01	1.58E−06	9.60E−11
Dieldrin	0.0048	0.077	1.39E−08	4.98E−09	5.14E−12	1.84E−12	5.0E−05	1.6E+01	1.03E−07	2.94E−11
Heptachlor	0.0029	0.109	1.39E−08	4.98E−09	4.39E−12	1.57E−12	5.0E−04	4.5E+00	8.79E−09	7.08E−12
Benzene	0.0023	1	1.39E−08	4.98E−09	3.20E−11	1.15E−11	−−	2.9E−02	−−	3.32E−13
Methylene chloride	0.019	1	1.39E−08	4.98E−09	2.64E−10	9.46E−11	6.0E−02	7.5E−03	4.40E−09	7.10E−13
Toluene	0.0067	1	1.39E−08	4.98E−09	9.31E−11	3.34E−11	2.0E−01	−−	4.66E−10	−−
Benzo(a)anthracene	0.10	1	1.39E−08	4.98E−09	1.39E−09	4.98E−10	−−	1.1E+00 *	−−	5.48E−10
bis(2−Ethylhexyl)phthalate	0.33	1	1.39E−08	4.98E−09	4.59E−09	1.64E−09	2.0E−02	1.4E−02	2.29E−07	2.30E−11
Chrysene	0.092	1	1.39E−08	4.98E−09	1.28E−09	4.58E−10	−−	2.9E−02 *	−−	1.33E−11
Diethylphthalate	0.24	1	1.39E−08	4.98E−09	3.34E−09	1.20E−09	8.0E−01	−−	4.17E−09	−−
Fluoranthene	0.13	1	1.39E−08	4.98E−09	1.81E−09	6.47E−10	4.0E−02	−−	4.52E−08	−−
Phenanthrene	0.11	1	1.39E−08	4.98E−09	1.53E−09	5.48E−10	−−	−−	−−	−−
Pyrene	0.12	1	1.39E−08	4.98E−09	1.67E−09	5.98E−10	3.0E−02	−−	5.56E−08	−−
Arsenic	4.6	0.01	1.39E−08	4.98E−09	6.39E−10	2.29E−10	3.0E−04	1.8E+00	2.13E−06	4.01E−10
Barium	105.1	0.01	1.39E−08	4.98E−09	1.46E−08	5.23E−09	7.0E−02	−−	2.09E−07	−−
Chromium	8.4	0.01	1.39E−08	4.98E−09	1.17E−09	4.18E−10	5.0E−03	−−	2.34E−07	−−
Lead	99.5	0.01	1.39E−08	4.98E−09	1.38E−08	4.96E−09	−−	−−	−−	−−
Mercury	0.054	0.01	1.39E−08	4.98E−09	7.51E−12	2.69E−12	3.0E−04 h	−−	2.50E−08	−−
Silver	0.46	0.01	1.39E−08	4.98E−09	6.39E−11	2.29E−11	5.0E−03	−−	1.28E−08	−−
									4.6E−06	**1.1E−09**

RfD and CSF values are from IRIS (1994)
* − CSF is based on TEF, using Benzo(a)pyrene toxicity
h − Value is from HEAST (1994)

TABLE A-26
Pesticide Storage Facility
Fort Riley, Kansas

CURRENT OCCUPATIONAL ADULT (Landscaper): Dermal Contact with Subsurface Soils

Parameter	Exposure Point Concentration (mg/kg)	Absorption Factor (unitless)	Intake Factor (kg/kg-day) Noncarcinogen	Intake Factor (kg/kg-day) Carcinogen	Intake (mg/kg-day) Noncarcinogen	Intake (mg/kg-day) Carcinogen	Toxicity Value RfD (mg/kg-day)	Toxicity Value CSF $(mg/kg-day)^{-1}$	Hazard Index (unitless)	Cancer Risk (unitless)
Chlordane	0.22	0.109	1.18E-08	4.23E-09	2.83E-10	1.01E-10	6.0E-05	1.3E+00	4.72E-06	1.32E-10
DDD	0.017	0.378	1.18E-08	4.23E-09	7.58E-11	2.72E-11	--	2.4E-01	--	6.52E-12
DDE	0.033	0.378	1.18E-08	4.23E-09	1.47E-10	5.28E-11	--	3.4E-01	--	1.79E-11
DDT	0.15	0.378	1.18E-08	4.23E-09	6.69E-10	2.40E-10	5.0E-04	3.4E-01	1.34E-06	8.15E-11
Dieldrin	0.0048	0.077	1.18E-08	4.23E-09	4.36E-12	1.56E-12	5.0E-05	1.6E+01	8.72E-08	2.50E-11
Heptachlor	0.0029	0.109	1.18E-08	4.23E-09	3.73E-12	1.34E-12	5.0E-04	4.5E+00	7.46E-09	6.02E-12
Benzene	0.0023	1	1.18E-08	4.23E-09	2.71E-11	9.73E-12	--	2.9E-02	--	2.82E-13
Methylene chloride	0.019	1	1.18E-08	4.23E-09	2.24E-10	8.04E-11	6.0E-02	7.5E-03	3.74E-09	6.03E-13
Toluene	0.0067	1	1.18E-08	4.23E-09	7.91E-11	2.83E-11	2.0E-01	--	3.95E-10	--
Benzo(a)anthracene	0.10	1	1.18E-08	4.23E-09	1.18E-09	4.23E-10	--	1.1E+00 *	--	4.65E-10
bis(2-Ethylhexyl)phthalate	0.33	1	1.18E-08	4.23E-09	3.89E-09	1.40E-09	2.0E-02	1.4E-02	1.95E-07	1.95E-11
Chrysene	0.092	1	1.18E-08	4.23E-09	1.09E-09	3.89E-10	--	2.9E-02 *	--	1.13E-11
Diethylphthalate	0.24	1	1.18E-08	4.23E-09	2.83E-09	1.02E-09	8.0E-01	--	3.54E-09	--
Fluoranthene	0.13	1	1.18E-08	4.23E-09	1.53E-09	5.50E-10	4.0E-02	--	3.84E-08	--
Phenanthrene	0.11	1	1.18E-08	4.23E-09	1.30E-09	4.65E-10	--	--	--	--
Pyrene	0.12	1	1.18E-08	4.23E-09	1.42E-09	5.08E-10	3.0E-02	--	4.72E-08	--
Arsenic	4.6	0.01	1.18E-08	4.23E-09	5.43E-10	1.95E-10	3.0E-04	1.8E+00	1.81E-06	3.41E-10
Barium	105.1	0.01	1.18E-08	4.23E-09	1.24E-08	4.45E-09	7.0E-02	--	1.77E-07	--
Chromium	8.4	0.01	1.18E-08	4.23E-09	9.91E-10	3.55E-10	5.0E-03	--	1.98E-07	--
Lead	99.5	0.01	1.18E-08	4.23E-09	1.17E-08	4.21E-09	--	--	--	--
Mercury	0.054	0.01	1.18E-08	4.23E-09	6.37E-12	2.28E-12	3.0E-04 h	--	2.12E-08	--
Silver	0.46	0.01	1.18E-08	4.23E-09	5.43E-11	1.95E-11	5.0E-03	--	1.09E-08	--
									3.9E-06	**9.7E-10**

RfD and CSF values are from IRIS (1994)

* - CSF is based on TEF, using Benzo(a)pyrene toxicity

h - Value is from HEAST (1994)

TABLE A-27

FUTURE RESIDENTIAL EXPOSURE:
INGESTION OF GROUND WATER
INGESTION INTAKES
Pesticide Storage Facility
Fort Riley, Kansas

INGESTION INTAKE (a) = $\dfrac{C * IR * EF * ED}{BW * AT}$

Where:

C	=	Concentration of constituent in ground water, mg/L
IR	=	Ingestion Rate, L/day
EF	=	Exposure Frequency, days/year
ED	=	Exposure Duration, years
BW	=	Body Weight, kg
AT	=	Averaging Time, days

Exposure Variable	Ingestion of Ground Water Adult	Child
IR	2 [b]	2 [b]
EF	350 [b]	350 [b]
ED	30 [b]	6 [b]
BW	70 [b]	15 [b]
AT (Noncarcinogen)	10,950 [b]	2,190 [b]
AT (Carcinogen)	25,550 [b]	NA

PATHWAY-SPECIFIC INTAKES:

Ingestion of Ground Water (future):

Residential Adult (Noncarcinogens): C (mg/L) * 2.74E-02 day^{-1}

Residential Adult (Carcinogens): C (mg/L) * 1.17E-02 day^{-1}

Residential Child (Noncarcinogens): C (mg/L) * 1.28E-01 day^{-1}

(a) Chemical-specific intakes are calculated in the risk calculation tables (Appendix A)
(b) USEPA, 1991

TABLE A-28

FUTURE RESIDENTIAL EXPOSURE:
DERMAL EXPOSURE TO GROUND WATER
DERMAL INTAKES
Pesticide Storage Facility
Fort Riley, Kansas

$$\text{DERMAL INTAKE (a)} = \frac{C * SA * PC * ET * EF * ED * CF}{BW * AT}$$

Where:

C	=	Concentration of constituent in ground water, mg/L
SA	=	Surface Area of exposed skin, cm^2
PC	=	Permeability Constant, cm/hour
ET	=	Exposure Time, hours/day
EF	=	Exposure Frequency, days/year
ED	=	Exposure Duration, years
CF	=	Conversion Factor, $1L/10^3\ cm^3$
BW	=	Body Weight, kg
AT	=	Averaging Time, days

Exposure Variable	Dermal Exposure to Ground Water Adult		Dermal Exposure to Ground Water Child
SA	19,400 [b]		8,660 [b]
PC	*****	0.001 (metals) [e]	*****
ET	0.2 [c]		0.2 [c]
EF	350 [d]		350 [d]
ED	30 [d]		6 [d]
CF	10^{-3}		10^{-3}
BW	70 [d]		15 [d]
AT (Noncarcinogen)	10,950 [d]		2,190 [d]
AT (Carcinogen)	25,550 [d]		NA

PATHWAY-SPECIFIC INTAKES:

Dermal Exposure to Ground Water (future):

Residential Adult (Noncarcinogens):	C (mg/L) * 5.32E-05 day^{-1}
Residential Adult (Carcinogens):	C (mg/L) * 2.28E-05 day^{-1}
Residential Child (Noncarcinogens):	C (mg/L) * 1.11E-04 day^{-1}

(a) Chemical-specific intakes are calculated in the risk calculation tables (Appendix A)
(b) USEPA, 1989c (total body surface area)
(c) USEPA, 1992b
(d) USEPA, 1991
(e) The only constituents of concern in ground water are metals. Of these metals, only two (cadmium and chromium) have chemical specific PC values. Since both cadmium and chromium have the same PC value as the default value for metals (0.001 cm/hr), the default value is used for all constituents detected in ground water (source - default value, USEPA, 1992)

TABLE A-29

RISK CALCULATIONS
FUTURE RESIDENTIAL ADULT EXPOSURE: INGESTION OF GROUND WATER
Pesticide Storage Facility
Fort Riley, Kansas

Ground Water:

Parameter	Exposure Point Concentrations (mg/L)	Intake Factor (kg/kg-day) Noncarc.	Intake Factor (kg/kg-day) Carcinogen (Lifetime)	Intake (mg/kg-day) [a] Noncarcinogen	Intake (mg/kg-day) [a] Carcinogen	Toxicity Values [b] Oral RfD (mg/kg-day)	Toxicity Values [b] Oral Slope Factor $(mg/kg-day)^{-1}$	Adult Hazard Index [c] (unitless)	Excess Cancer Risk [d] (unitless)
Aluminum	3.19E-01	2.74E-02	1.17E-02	8.74E-03	3.73E-03	2.90E+00	---	3.01E-03	---
Arsenic	7.97E-03	2.74E-02	1.17E-02	2.18E-04	9.32E-05	3.00E-04	1.80E+00	7.28E-01	1.68E-04
Barium	1.03E-01	2.74E-02	1.17E-02	2.82E-03	1.21E-03	7.00E-02	---	4.03E-02	---
Beryllium	2.72E-03	2.74E-02	1.17E-02	7.45E-05	3.18E-05	5.00E-03	4.30E+00	1.49E-02	1.37E-04
Chromium	7.02E-03	2.74E-02	1.17E-02	1.92E-04	8.21E-05	5.00E-03	---	3.85E-02	---
Manganese	5.88E-02	2.74E-02	1.17E-02	1.61E-03	6.88E-04	5.00E-03	---	3.22E-01	---
Nitrate	1.31E+02	2.74E-02	1.17E-02	3.59E+00	1.53E+00	1.60E+00	---	2.24E+00	---
Thallium	2.90E-03	2.74E-02	1.17E-02	7.95E-05	3.39E-05	8.00E-05	---	9.93E-01	---
Vanadium	1.65E-02	2.74E-02	1.17E-02	4.52E-04	1.93E-04	7.00E-03	---	6.46E-02	---
							Total:	**4.4**	**3E-04**

(a) Intake = Exposure Point Concentration x Intake Factor
(b) Toxicity values from IRIS, 1994.
(c) Hazard Index (Noncarcinogens) = Intake/RfD
(d) Excess Cancer Risk (Carcinogens) = Slope Factor x Intake

TABLE A-30

RISK CALCULATIONS
FUTURE RESIDENTIAL CHILD EXPOSURE: INGESTION OF GROUND WATER
Pesticide Storage Facility
Fort Riley, Kansas

Ground Water:

Parameter	Exposure Point Concentrations (mg/L)	Intake Factor (kg/kg-day) Noncarc.	Intake (mg/kg-day) [a] Noncarcinogen	Toxicity Values [b] Oral RfD (mg/kg-day)	Toxicity Values [b] Oral Slope Factor $(mg/kg-day)^{-1}$	Child Hazard Index [c] (unitless)
Aluminum	3.19E-01	1.28E-01	4.08E-02	2.90E+00	---	1.41E-02
Arsenic	7.97E-03	1.28E-01	1.02E-03	3.00E-04	1.80E+00	3.40E+00
Barium	1.03E-01	1.28E-01	1.32E-02	7.00E-02	---	1.88E-01
Beryllium	2.72E-03	1.28E-01	3.48E-04	5.00E-03	4.30E+00	6.96E-02
Chromium	7.02E-03	1.28E-01	8.99E-04	5.00E-03	---	1.80E-01
Manganese	5.88E-02	1.28E-01	7.53E-03	5.00E-03	---	1.51E+00
Nitrate	1.31E+02	1.28E-01	1.68E+01	1.60E+00	---	1.05E+01
Thallium	2.90E-03	1.28E-01	3.71E-04	8.00E-05	---	4.64E+00
Vanadium	1.65E-02	1.28E-01	2.11E-03	7.00E-03	---	3.02E-01
					Total:	**20.8**

(a) Intake = Exposure Point Concentration x Intake Factor
(b) Toxicity values from IRIS, 1994.
(c) Hazard Index (Noncarcinogens) = Intake/RfD

TABLE A-31

RISK CALCULATIONS
FUTURE RESIDENTIAL ADULT EXPOSURE: DERMAL CONTACT WITH GROUND WATER
Pesticide Storage Facility
Fort Riley, Kansas

Ground Water:

Parameter	Exposure Point Concentrations (mg/L)	Intake Factor (kg/kg-day) Noncarc.	Intake Factor (kg/kg-day) Carcinogen (Lifetime)	Intake (mg/kg-day) [a] Noncarcinogen	Intake (mg/kg-day) [a] Carcinogen	Toxicity Values [b] Oral RfD (mg/kg-day)	Toxicity Values [b] Oral Slope Factor $(mg/kg-day)^{-1}$	Adult Hazard Index [c] (unitless)	Excess Cancer Risk [d] (unitless)
Aluminum	3.19E-01	5.32E-05	2.28E-05	1.70E-05	7.27E-06	2.90E+00	---	5.85E-06	---
Arsenic	7.97E-03	5.32E-05	2.28E-05	4.24E-07	1.82E-07	3.00E-04	1.80E+00	1.41E-03	3.27E-07
Barium	1.03E-01	5.32E-05	2.28E-05	5.48E-06	2.35E-06	7.00E-02	---	7.83E-05	---
Beryllium	2.72E-03	5.32E-05	2.28E-05	1.45E-07	6.20E-08	5.00E-03	4.30E+00	2.89E-05	2.67E-07
Chromium	7.02E-03	5.32E-05	2.28E-05	3.73E-07	1.60E-07	5.00E-03	---	7.47E-05	---
Manganese	5.88E-02	5.32E-05	2.28E-05	3.13E-06	1.34E-06	5.00E-03	---	6.26E-04	---
Nitrate	1.31E+02	5.32E-05	2.28E-05	6.97E-03	2.99E-03	1.60E+00	---	4.36E-03	---
Thallium	2.90E-03	5.32E-05	2.28E-05	1.54E-07	6.61E-08	8.00E-05	---	1.93E-03	---
Vanadium	1.65E-02	5.32E-05	2.28E-05	8.78E-07	3.76E-07	7.00E-03	---	1.25E-04	---
							Total:	**0.0086**	**6E-07**

(a) Intake = Exposure Point Concentration x Intake Factor
(b) Oral Toxicity Values used (i.e., no route-to-route extrapolation was performed).
(c) Hazard Index (Noncarcinogens) = Intake/RfD
(d) Excess Cancer Risk (Carcinogens) = Slope Factor x Intake

TABLE A-32

RISK CALCULATIONS
FUTURE RESIDENTIAL CHILD EXPOSURE: DERMAL CONTACT WITH GROUND WATER
Pesticide Storage Facility
Fort Riley, Kansas

Ground Water:

Parameter	Exposure Point Concentrations (mg/L)	Intake Factor (kg/kg-day) Noncarc.	Intake (mg/kg-day) [(a)] Noncarcinogen	Toxicity Values [(b)] Oral RfD (mg/kg-day)	Toxicity Values [(b)] Oral Slope Factor $(mg/kg-day)^{-1}$	Child Hazard Index [(c)] (unitless)
Aluminum	3.19E-01	1.11E-04	3.54E-05	2.90E+00	---	1.22E-05
Arsenic	7.97E-03	1.11E-04	8.85E-07	3.00E-04	1.80E+00	2.95E-03
Barium	1.03E-01	1.11E-04	1.14E-05	7.00E-02	---	1.63E-04
Beryllium	2.72E-03	1.11E-04	3.02E-07	5.00E-03	4.30E+00	6.04E-05
Chromium	7.02E-03	1.11E-04	7.79E-07	5.00E-03	---	1.56E-04
Manganese	5.88E-02	1.11E-04	6.53E-06	5.00E-03	---	1.31E-03
Nitrate	1.31E+02	1.11E-04	1.45E-02	1.60E+00	---	9.09E-03
Thallium	2.90E-03	1.11E-04	3.22E-07	8.00E-05	---	4.02E-03
Vanadium	1.65E-02	1.11E-04	1.83E-06	7.00E-03	---	2.62E-04
					Total:	0.018

(a) Intake = Exposure Point Concentration x Intake Factor
(b) Oral Toxicity Values used (i.e., no route-to-route extrapolation was performed).
(c) Hazard Index (Noncarcinogens) = Intake/RfD

TABLE A-29A*

RISK CALCULATIONS
FUTURE RESIDENTIAL ADULT EXPOSURE: INGESTION OF GROUND WATER
Pesticide Storage Facility
Fort Riley, Kansas

Ground Water:

Parameter	Exposure Point Concentrations (mg/L)	Intake Factor (kg/kg-day) Noncarc.	Intake Factor (kg/kg-day) Carcinogen (Lifetime)	Intake (mg/kg-day) [a] Noncarcinogen	Intake (mg/kg-day) [a] Carcinogen	Toxicity Values [b] Oral RfD (mg/kg-day)	Toxicity Values [b] Oral Slope Factor $(mg/kg-day)^{-1}$	Adult Hazard Index [c] (unitless)	Excess Cancer Risk [d] (unitless)
Aluminum	3.19E-01	2.74E-02	1.17E-02	8.74E-03	3.73E-03	2.90E+00	---	3.01E-03	---
Arsenic	7.97E-03	2.74E-02	1.17E-02	2.18E-04	9.32E-05	3.00E-04	1.80E+00	7.28E-01	1.68E-04
Barium	1.03E-01	2.74E-02	1.17E-02	2.82E-03	1.21E-03	7.00E-02	---	4.03E-02	---
Beryllium	2.72E-03	2.74E-02	1.17E-02	7.45E-05	3.18E-05	5.00E-03	4.30E+00	1.49E-02	1.37E-04
Chromium	7.02E-03	2.74E-02	1.17E-02	1.92E-04	8.21E-05	5.00E-03	---	3.85E-02	---
Manganese	5.88E-02	2.74E-02	1.17E-02	1.61E-03	6.88E-04	5.00E-03	---	3.22E-01	---
Nitrate	3.30E+01	2.74E-02	1.17E-02	9.04E-01	3.86E-01	1.60E+00	---	5.65E-01	---
Thallium	2.90E-03	2.74E-02	1.17E-02	7.95E-05	3.39E-05	8.00E-05	---	9.93E-01	---
Vanadium	1.65E-02	2.74E-02	1.17E-02	4.52E-04	1.93E-04	7.00E-03	---	6.46E-02	---
							Total:	2.8	3E-04

(a) Intake = Exposure Point Concentration x Intake Factor
(b) Toxicity values from IRIS, 1994.
(c) Hazard Index (Noncarcinogens) = Intake/RfD
(d) Excess Cancer Risk (Carcinogens) = Slope Factor x Intake
* This table presents a recalculation of the risks calculated on Table B-27, using nitrate data for the Baseline, First, Third, and Fourth Quarters only.

TABLE A-30A*

RISK CALCULATIONS
FUTURE RESIDENTIAL CHILD EXPOSURE: INGESTION OF GROUND WATER
Pesticide Storage Facility
Fort Riley, Kansas

Ground Water:

Parameter	Exposure Point Concentrations (mg/L)	Intake Factor (kg/kg-day)	Intake (mg/kg-day) (a)	Toxicity Values (b)		Child Hazard Index (c) (unitless)
		Noncarc.	Noncarcinogen	Oral RfD (mg/kg-day)	Oral Slope Factor $(mg/kg-day)^{-1}$	
Aluminum	3.19E-01	1.28E-01	4.08E-02	2.90E+00	---	1.41E-02
Arsenic	7.97E-03	1.28E-01	1.02E-03	3.00E-04	1.80E+00	3.40E+00
Barium	1.03E-01	1.28E-01	1.32E-02	7.00E-02	---	1.88E-01
Beryllium	2.72E-03	1.28E-01	3.48E-04	5.00E-03	4.30E+00	6.96E-02
Chromium	7.02E-03	1.28E-01	8.99E-04	5.00E-03	---	1.80E-01
Manganese	5.88E-02	1.28E-01	7.53E-03	5.00E-03	---	1.51E+00
Nitrate	3.30E+01	1.28E-01	4.22E+00	1.60E+00	---	2.64E+00
Thallium	2.90E-03	1.28E-01	3.71E-04	8.00E-05	---	4.64E+00
Vanadium	1.65E-02	1.28E-01	2.11E-03	7.00E-03	---	3.02E-01
					Total:	**12.9**

(a) Intake = Exposure Point Concentration x Intake Factor
(b) Toxicity values from IRIS, 1994.
(c) Hazard Index (Noncarcinogens) = Intake/RfD
* This table presents a recalculation of the risks calculated on Table B-28, using nitrate data for the Baseline, First, Third, and Fourth Quarters only.

TABLE A-31A*

RISK CALCULATIONS
FUTURE RESIDENTIAL ADULT EXPOSURE: DERMAL CONTACT WITH GROUND WATER
Pesticide Storage Facility
Fort Riley, Kansas

Ground Water:

Parameter	Exposure Point Concentrations (mg/L)	Intake Factor (kg/kg-day) Noncarc.	Intake Factor (kg/kg-day) Carcinogen (Lifetime)	Intake (mg/kg-day) (a) Noncarcinogen	Intake (mg/kg-day) (a) Carcinogen	Toxicity Values (b) Oral RfD (mg/kg-day)	Toxicity Values (b) Oral Slope Factor $(mg/kg-day)^{-1}$	Adult Hazard Index (c) (unitless)	Excess Cancer Risk (d) (unitless)
Aluminum	3.19E-01	5.32E-05	2.28E-05	1.70E-05	7.27E-06	2.90E+00	---	5.85E-06	---
Arsenic	7.97E-03	5.32E-05	2.28E-05	4.24E-07	1.82E-07	3.00E-04	1.80E+00	1.41E-03	3.27E-07
Barium	1.03E-01	5.32E-05	2.28E-05	5.48E-06	2.35E-06	7.00E-02	---	7.83E-05	---
Beryllium	2.72E-03	5.32E-05	2.28E-05	1.45E-07	6.20E-08	5.00E-03	4.30E+00	2.89E-05	2.67E-07
Chromium	7.02E-03	5.32E-05	2.28E-05	3.73E-07	1.60E-07	5.00E-03	---	7.47E-05	---
Manganese	5.88E-02	5.32E-05	2.28E-05	3.13E-06	1.34E-06	5.00E-03	---	6.26E-04	---
Nitrate	3.30E+01	5.32E-05	2.28E-05	1.76E-03	7.52E-04	1.60E+00	---	1.10E-03	---
Thallium	2.90E-03	5.32E-05	2.28E-05	1.54E-07	6.61E-08	8.00E-05	---	1.93E-03	---
Vanadium	1.65E-02	5.32E-05	2.28E-05	8.78E-07	3.76E-07	7.00E-03	---	1.25E-04	---
							Total:	0.0054	6E-07

(a) Intake = Exposure Point Concentration x Intake Factor
(b) Oral Toxicity Values used (i.e., no route-to-route extrapolation was performed).
(c) Hazard Index (Noncarcinogens) = Intake/RfD
(d) Excess Cancer Risk (Carcinogens) = Slope Factor x Intake
* This table presents a recalculation of the risks calculated on Table B-29, using nitrate data for the Baseline, First, Third, and Fourth Quarters only.

TABLE A-32A*

RISK CALCULATIONS
FUTURE RESIDENTIAL CHILD EXPOSURE: DERMAL CONTACT WITH GROUND WATER
Pesticide Storage Facility
Fort Riley, Kansas

Ground Water:

Parameter	Exposure Point Concentrations (mg/L)	Intake Factor (kg/kg-day) Noncarc.	Intake (mg/kg-day) (a) Noncarcinogen	Toxicity Values (b) Oral RfD (mg/kg-day)	Toxicity Values (b) Oral Slope Factor $(mg/kg-day)^{-1}$	Child Hazard Index (c) (unitless)
Aluminum	3.19E-01	1.11E-04	3.54E-05	2.90E+00	---	1.22E-05
Arsenic	7.97E-03	1.11E-04	8.85E-07	3.00E-04	1.80E+00	2.95E-03
Barium	1.03E-01	1.11E-04	1.14E-05	7.00E-02	---	1.63E-04
Beryllium	2.72E-03	1.11E-04	3.02E-07	5.00E-03	4.30E+00	6.04E-05
Chromium	7.02E-03	1.11E-04	7.79E-07	5.00E-03	---	1.56E-04
Manganese	5.88E-02	1.11E-04	6.53E-06	5.00E-03	---	1.31E-03
Nitrate	3.30E+01	1.11E-04	3.66E-03	1.60E+00	---	2.29E-03
Thallium	2.90E-03	1.11E-04	3.22E-07	8.00E-05	---	4.02E-03
Vanadium	1.65E-02	1.11E-04	1.83E-06	7.00E-03	---	2.62E-04
					Total:	**0.011**

(a) Intake = Exposure Point Concentration x Intake Factor
(b) Oral Toxicity Values used (i.e., no route-to-route extrapolation was performed).
(c) Hazard Index (Noncarcinogens) = Intake/RfD
* This table presents a recalculation of the risks calculated on Table B-30, using nitrate data for the Baseline, First, Third, and Fourth Quarters only.

APPENDIX B

RISK-BASED REMEDIATION GOAL CALCULATIONS

Table B-1
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF COMMERCIAL/INDUSTRIAL SOIL EXPOSURES – NONCARCINOGENIC EFFECTS

$$THI = \frac{C * 10^{-6}\ kg/mg * IR_{SOIL} * EF * ED}{RfD_O * BW * AT * 365\ days/yr} + \frac{C * EF * ET_f * ED * AF * ABS * SA * 10^{-6}\ kg/mg}{RfD_O * BW * AT * 365\ days/yr} + \frac{C * EF * ET * ED * IR_{AIR} * 1/PEF}{RfD_I * BW * AT * 365\ days/yr}$$

C (mg/kg) (risk-based) =

$$C = \frac{THI * BW * AT * 365\ days/yr}{EF * ED * [(1/RfD_O * 10^{-6}\ kg/mg * IR_{SOIL}) + (1/RfD_O * ET_f * AF * ABS * SA * 10^{-6}\ kg/mg) + (1/RfD_I * IR_{AIR} * ET * 1/PEF)]}$$

where:

Parameter		Definition
C	=	chemical concentration in soil (mg/kg)
THI	=	target hazard index (unitless)
RfD_O	=	oral chronic reference dose (mg/kg-day)
IR_{SOIL}	=	daily soil ingestion rate (mg/day)
SA	=	surface area of exposed skin (cm^2/day)
AF	=	soil to skin adherence factor (mg/cm^2)
ABS	=	absorption factor (unitless)

Parameter		Definition
IR_{AIR}	=	inhalation rate (m^3/day)
RfD_I	=	inhalation chronic reference dose (mg/kg-day)
PEF	=	particulate emission factor (m^3/kg)
ET	=	exposure time (hrs/day)
ET_f	=	fraction of day exposed via dermal absorption (unitless)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yrs)
BW	=	body weight (kg)
AT	=	averaging time (yrs)

Future Exposure

	Site Worker	Construction Worker
THI	1	1
RfD_O	*** chemical specific ***	
EF	250 [a]	120 [f]
ED	25 [b]	1 [f]
ET	8 [a]	8 [f]
ET_f	0.33	0.33
IR_{SOIL}	50 [b]	480 [b]
AF	1 [c]	1 [c]
ABS	*** chemical specific ***	
SA	3,600 [d]	3,600 [d]
RfD_I	*** chemical specific ***	
IR_{AIR}	2.5 [d]	2.5 [d]
PEF	*** 3.26×10^{8} [e] ***	
BW	70 [b]	70 [b]
AT	25 [b]	1 [f]

a – DEH, 1993c
b – USEPA, 1991
c – USEPA, 1992b
d – USEPA, 1989c
e – USEPA, 1989a
f – DEH, 1993g; DEH, 1993h

Table B-1 (continued)
REDUCED EQUATIONS: COMMERCIAL/INDUSTRIAL SOIL - NONCARCINOGENIC EFFECTS

FUTURE SITE WORKER

Risk-based RG (mg/kg; THI = 1)

$$\text{Risk-based RG (mg/kg; THI = 1)} = \frac{1 * 70\ \text{kg} * 25\ \text{yrs} * 365\ \text{days/yr}}{250\ \text{days/yr} * 25\ \text{yr} * [(1/RfD_O) * 10^{-6}\ \text{kg/mg} * 50\ \text{mg/day}) + (1/RfD_O * 0.33 * 1\ \text{mg/cm}^2 * ABS * 3600\ \text{cm}^2 * 10^{-6}\ \text{kg/mg}) + (1/RfD_I * 2.5\ \text{m}^3/\text{hr} * 8\ \text{hr/day} * (1/3.26 \times 10^6\ \text{m}^3/\text{kg}))]}$$

$$\text{Risk-based RG (mg/kg; THI = 1)} = \frac{102}{(5.0 \times 10^{-5}/RfD_o) + (1.2 \times 10^{-3} * ABS/RfD_o) + (6.1 \times 10^{-6}/RfD_i)}$$

FUTURE CONSTRUCTION WORKER

$$\text{Risk-based RG (mg/kg; THI = 1)} = \frac{1 * 70\ \text{kg} * 1\ \text{yr} * 365\ \text{days/yr}}{120\ \text{days/yr} * 1\ \text{yr} * [(1/RfD_O) * 10^{-6}\ \text{kg/mg} * 480\ \text{mg/day}) + (1/RfD_O * 0.33 * 1\ \text{mg/cm}^2 * ABS * 3{,}600\ \text{cm}^2/\text{day} * 10^{-6}\ \text{kg/mg}) + (1/RfD_I * 2.5\ \text{m}^3/\text{hr} * 8\ \text{hr/day} * (1/3.26 \times 10^6\ \text{m}^3/\text{kg}))]}$$

$$\text{Risk-based RG (mg/kg; THI = 1)} = \frac{213}{(4.8 \times 10^{-4}/RfD_o) + (1.2 \times 10^{-3} * ABS/RfD_o) + (6.1 \times 10^{-6}/ RfD_i)}$$

Table B-2
REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF COMMERCIAL/INDUSTRIAL SOIL EXPOSURES – CARCINOGENIC EFFECTS

$$TR = \frac{SF_O * C * 10^{-6}\ kg/mg * IR_{SOIL} * EF * ED}{BW * AT * 365\ days/yr} + \frac{SF_O * C * EF * ET_f * ED * AF * ABS * SA * 10^{-6}\ kg/mg}{BW * AT * 365\ days/yr} + \frac{SF_I * C * EF * ET * ED * IR_{AIR} * 1/PEF}{BW * AT * 365\ days/yr}$$

C (mg/kg) (risk-based) =

$$\frac{TR * BW * AT * 365\ days/yr}{EF * ED * [(SF_O * 10^{-6}\ mg/kg * IR_{SOIL}) + (SF_O * ET_f * AF * ABS * SA * 10^{-6}\ mg/kg) + (SF_I * ET * IR_{AIR} * 1/PEF)]}$$

where:

Parameter		Definition	Parameter		Definition
C	=	chemical concentration in soil (mg/kg)	IR_{AIR}	=	inhalation rate (m^3/day)
TR	=	target excess individual lifetime cancer risk (unitless)	SF_I	=	inhalation cancer slope factor $(mg/kg-day)^{-1}$
SF_O	=	oral cancer slope factor $(mg/kg-day)^{-1}$	PEF	=	particulate emission factor (m^3/kg)
IR_{SOIL}	=	daily soil ingestion rate (mg/day)	ET	=	exposure time (hrs/day)
SA	=	surface area of exposed skin (cm^2/day)	ET_f	=	fraction of day exposed via dermal absortion (unitless)
AF	=	soil to skin adherence factor (mg/cm^2)	EF	=	exposure frequency (days/yr)
ABS	=	absorption factor (unitless)	ED	=	exposure duration (yrs)
AT	=	averaging time (yrs)	BW	=	body weight (kg)

Future Exposure

	Site Worker	Construction Worker
TR	10^{-5}	10^{-5}
SF_O	*** chemical specific ***	
EF	250 [a]	120 [b]
ED	25 [b]	1 [f]
ET	8 [b]	8 [f]
ET_f	0.33	0.33
IR_{SOIL}	50 [c]	480 [b]
AF	1	1 [c]
ABS	*** chemical specific ***	
SA	3,600 [d]	3,600 [d]
SF_I	*** chemical specific ***	
IR_{AIR}	2.5 [d]	2.5 [d]
PEF	*** 3.26×10^9 [e] ***	
BW	70 [b]	70 [b]
AT	70 [b]	70 [b]

a – DEH, 1993c
b – USEPA, 1991
c – USEPA, 1992b
d – USEPA, 1989c
e – USEPA, 1989a
f – DEH, 1993g; DEH, 1993h

Table B–2 (continued)
REDUCED EQUATIONS: COMMERCIAL/INDUSTRIAL SOIL – CARCINOGENIC EFFECTS

FUTURE SITE WORKER

$$\text{Risk-based RG } (\text{mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\ \text{kg} * 70\ \text{yrs} * 365\ \text{days/yr}}{250\ \text{days/yr} * 25\ \text{yr} * [(SF_o * 10^{-6}\ \text{kg/mg} * 50\ \text{mg/day}) + (SF_o * 1\ \text{mg/cm}^2 * \text{ABS} * 3600\ \text{cm}^2\text{/day} * 0.33 * 10^{-6}\ \text{kg/mg}) + (SF_i * 2.5\ \text{m}^3\text{/hr} * 8\ \text{hr/day} * (1/3.26 \times 10^{9}\ \text{m}^3\text{/kg}))]}$$

$$\boxed{\text{Risk-based RG } (\text{mg/kg; TR} = 10^{-6}) = \frac{2.9 \times 10^{-3}}{(5.0 \times 10^{-5} * SF_o) + (1.2 \times 10^{-3} * SF_o * \text{ABS}) + (6.1 \times 10^{-9} * SF_i)}}$$

FUTURE CONSTRUCTION WORKER

$$\text{Risk-based RG } (\text{mg/kg; TR} = 10^{-6}) = \frac{10^{-6} * 70\ \text{kg} * 70\ \text{yrs} * 365\ \text{days/yr}}{120\ \text{days/yr} * 1\ \text{yr} * [(SF_o * 10^{-6}\ \text{kg/mg} * 480\ \text{mg/day}) + (SF_o * 1\ \text{mg/cm}^2 * \text{ABS} * 3{,}600\ \text{cm}^2\text{/day} * 0.33 * 10^{-6}\ \text{kg/mg}) + (SF_i * 2.5\ \text{m}^3\text{/hr} * 8\ \text{hr/day} * (1/3.26 \times 10^{9}\ \text{m}^3\text{/kg}))]}$$

$$\boxed{\text{Risk-based RG } (\text{mg/kg; TR} = 10^{-6}) = \frac{1.5 \times 10^{-1}}{(4.8 \times 10^{-4} * SF_o) + (1.2 \times 10^{-3} * SF_o * \text{ABS}) + (6.1 \times 10^{-9} * SF_i)}}$$

TABLE B-3

REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF RESIDENTIAL GROUNDWATER EXPOSURES - CARCINOGENIC EFFECTS FOR ADULTS

$$TR = \frac{CSF_o * C * IR * EF * ED}{BW * AT * 365\ days/yr} + \frac{CSF_o * C * EF * ED * ET * SA * PC * CF}{BW * AT * 365\ days/yr}$$

$$\begin{array}{c}C\ (mg/L)\\ risk\text{-}based\end{array} = \frac{TR * AT * 365\ days/yr * BW}{(CSF_o * IR * EF * ED) + (CSF_o * EF * ED * ET * SA * PC * CF)}$$

$$\begin{array}{c}C\ (mg/L)\\ risk\text{-}based\end{array} = \frac{(1.0E{-}05)(70)(365)(70)}{(CSF_o)(350)(30)\ [2 + (0.2)(19{,}400)(0.001)(1.0E{-}03)]}$$

$$= \frac{8.48E{-}04}{CSF_o}$$

where:

Parameter		Definition	Adult
TR	=	target risk (unitless)	1.0E-05
C	=	chemical concentration in groundwater (mg/L)	
CSF_o	=	oral cancer slope factor (kg-day/mg)	chemical specific
IR	=	daily water ingestion rate (L/day)	2
SA	=	surface area of exposed skin (cm^2)	19,400
PC	=	permeability constant (cm/hr)	chemical specific (0.001 for metals)
EF	=	exposure frequency (days/yr)	350
ET	=	exposure time (hrs/day)	0.2
ED	=	exposure duration (yrs)	30
BW	=	body weight (kg)	70
AT	=	averaging time (yrs)	70
CF	=	conversion factor (L/cm^3)	10^{-3}

TABLE B-4

REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF RESIDENTIAL GROUNDWATER EXPOSURES - NONCARCINOGENIC EFFECTS FOR ADULTS

$$THI = \frac{C * IR * EF * ED}{RfD_o * BW * AT * 365\ days/yr} + \frac{C * EF * ED * ET * SA * PC * CF}{RfD_o * BW * AT * 365\ days/yr}$$

$$\begin{array}{c}C\ (mg/L)\\ \text{risk-based}\end{array} = \frac{THI * AT * 365\ days/yr * RFD_o * BW}{(IR * EF * ED) + (EF * ED * ET * SA * PC * CF)}$$

$$= \frac{(1)(30)(365)(70)(RFD_o)}{(350)(30)\ [2 + (0.2)(19{,}400)(0.001)(1.0E{-}03)]}$$

$$= 36.43(RFD_o)$$

where:

Parameter		Definition	Adult
THI	=	target hazard index (unitless)	1
C	=	chemical concentration in groundwater (mg/L)	
RfD_o	=	oral chronic reference dose (mg/kg-day)	chemical specific
IR	=	daily water ingestion rate (L/day)	2
SA	=	surface area of exposed skin (cm^2)	19,400
PC	=	permeability constant (cm/hr)	chemical specific (0.001 for metals)
EF	=	exposure frequency (days/yr)	350
ET	=	exposure time (hrs/day)	0.2
ED	=	exposure duration (yrs)	30
BW	=	body weight (kg)	70
AT	=	averaging time (yrs)	30
CF	=	conversion factor (L/cm^3)	10^{-3}

TABLE B-5

REMEDIATION GOALS
Pesticide Storage Facility
Fort Riley, Kansas

CALCULATION OF RESIDENTIAL GROUNDWATER EXPOSURES - NONCARCINOGENIC EFFECTS FOR CHILDREN

$$THI = \frac{C * IR * EF * ED}{RfD_o * BW * AT * 365\ days/yr} + \frac{C * EF * ED * ET * SA * PC * CF}{RfD_o * BW * AT * 365\ days/yr}$$

$$\underset{\text{risk-based}}{C\ (mg/L)} = \frac{THI * AT * 365\ days/yr * RFD_o * BW}{(IR * EF * ED) + (PC * SA * ET * EF * ED * CF)}$$

$$\underset{\text{risk-based}}{C\ (mg/L)} = \frac{(1)(6)(365)(RFD_o)(15)}{(350)(6)\ [2 + (8{,}660)(0.2)(1.0E{-}03)(0.001)]}$$

$$= 7.81\ (RFD_o)$$

Where:

Parameter		Definition	Parameter Value (Child)
THI	=	target hazard index (unitless)	1
C	=	chemical concentration in surface water (mg/L)	
IR	=	daily water ingestion rate	2
SA	=	surface area of exposed skin (cm^2)	8,660
PC	=	permeability constant (cm/hr)	chemical specific (0.001 for metals)
EF	=	exposure frequency (days/yr)	350
ET	=	exposure time (hrs/day)	0.2
ED	=	exposure duration (yrs)	6
RfD_o	=	oral chronic reference dose (mg/kg-day)	chemical specific
BW	=	body weight (kg)	15
AT	=	averaging time (yrs)	6
CF	=	conversion factor (L/cm^3)	10^{-3}

APPENDIX C

COST ESTIMATE SUPPORT

APPENDIX C

COST ESTIMATE SUPPORT

Appendix C provides a summary of the basis and evaluation of contingencies considered for the cost estimates associated with Alternatives 2 and 3 for the PSF. The cost estimates, provided in Tables C-1 and C-2, are opinions of cost based on a limited conceptual level design performed as a part of a Feasibility Study to identify approximate cost ranges for alternatives comparison.

Institutional Action (Alternatives 2 and 3)

The institutional action associated with Alternatives 2 and 3 involves changes to implement institutional controls at Fort Riley to restrict groundwater uses within the PSF area. This would involve the following:

- Review of current Army regulations and policies which have been implemented at other sites for this purpose
- Preparation of an area map designating the restricted area
- Preparation of administrative regulations and policies
- Army administrative and legal reviews
- Army approve printing and distribution of the regulations and policies
- Formal notification of the regulations and policies to Fort-wide personnel and operations managers

The costs associated with implementing institutional controls to prevent use of groundwater include the administrative and legal fees necessary to complete these activities.

Construction Costs (Alternative 3)

The Scope of Work, Section 2.8.3, lists the following eight factors of costs to be associated with each alternative cost estimate:

- Off-site utility connections and fees
- Mobilization/demobilization
- Health and safety

- Permits and fees
- Testing and analyses
- Operation and maintenance
- Transportation costs
- Disposal costs

Identified applicable cost elements associated with groundwater monitoring include mobilization/demobilization, health and safety, testing and analyses, operation and maintenance, transportation costs, and disposal costs. Reporting costs and Army administrative requirements were also considered in the estimate.

No off-site utility connections or fees, or any permits and their associated fees are likely to be included with a groundwater monitoring program at the PSF. A discussion of the identified relevant construction cost factors is presented below.

Mobilization/Demobilization (Alternative 3)

Costs for mobilization/demobilization are included in the travel/incidental expenses and labor items of Table C-2. It has been assumed that two persons will depart from Georgia for an 8-hour, one-way trip to reach the site. It should be noted that airline and rental costs are variable, and dependent on the point of origin relative to the Fort Riley location. Travel from Georgia was considered representative of average costs associated with an Army contractor performing the work.

Health and Safety (Alternative 3)

It is assumed that the existing PSF site health and safety plan can be utilized for the sampling events. Thus, no costs are associated with the preparation of a specific health and safety plan for sample collection at the PSF.

Testing and Analyses (Alternative 3)

Current laboratory fees were obtained from Law Environmental National Laboratories, Kennesaw, Georgia, and include the costs for preparation of sample bottles and analyses of samples for nitrate. The costs have been estimated for a standard 30-day laboratory turnaround time.

Operation and Maintenance (Alternative 3)

Costs for operation and maintenance (O&M) pertain to the maintenance of the five site wells. The costs provided in Table C-2 include maintenance of the bladder pumps dedicated to each well, general maintenance of the exterior of the well, inspections twice a year, painting, and lock replacement annually. These costs are based on past experience with sample collections at the PSF site.

Transportation Costs (Alternative 3)

Transportation costs associated with sampling include those necessary to ship supplies to Fort Riley from Georgia (i.e., sample bottles) and to ship samples to the designated laboratory. Costs are estimated for overnight delivery.

Disposal Costs (Alternative 3)

Disposal costs are provided for disposal of two drums (55 gallons each) of purge and decontamination water associated with purging and sampling the five wells per sampling event. Disposal costs have included the costs for purchase of two drums, analytical sampling prior to disposal, and transportation and disposal costs to transport the drums to the Fort Riley Main Post Wastewater Treatment Facility for disposal as nonhazardous waste. This is based on sampling results to date.

Markups

The Scope of Work lists the following five markups to be applied to the construction costs associated with each alternative:

- Cost growth to construction midpoint
- Construction contingency
- Supervision and administration
- Engineering and design during construction
- Quality assurance (QA)

Cost growth to construction midpoint, construction contingency, and engineering and design are not applicable to the estimate of cost for Alternative 3 evaluated for the PSF.

Supervision and Administration

Elements identified for supervision and administration include the following:

- U.S. Army Corps of Engineers, Kansas City District Contract Management Services, and review of data/analysis

- U.S. Army Corps of Engineers, Kansas City District field geologist providing oversight assistance

- Fort Riley IRP Program Management Activities associated with project management, review of data/information, and regulatory interface with USEPA Region VII and KDHE

Appropriate supervision, administration, and oversight cost elements have been assumed at 20 percent for contract administration and USACE field geologist oversight in the estimate. This 20 percent factor was obtained from the U.S. Army Corps of Engineers, Kansas City District, and Fort Riley IRP Program Management.

Quality Assurance (QA)

QA costs consist of duplicate and blank samples to be collected during the sampling activity and analyzed. QA testing is incorporated by including costs for five samples from five wells, two duplicate samples, and two field blanks during each sampling event.

TABLE C-1

COST PROJECTION FOR ALTERNATIVE 2
DRAFT FINAL RI ADDENDUM AND FS
Pesticide Storage Facility
Fort Riley, Kansas

ALTERNATIVE 2 – INSTITUTIONAL ACTION (GROUNDWATER RESTRICTIONS)

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
IMPLEMENTATION COST FOR INSTITUTIONAL CONTROLS				
ADMINISTRATIVE AND LEGAL FEES	LUMP SUM	$20,000		$20,000

TABLE C-2

COST PROJECTION FOR ALTERNATIVE 3
DRAFT FINAL RI ADDENDUM AND FS
Pesticide Storage Facility
Fort Riley, Kansas

ALTERNATIVE 3 – INSTITUTIONAL ACTION AND GROUNDWATER MONITORING

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COSTS SUBTOTAL LINE TOTAL
IMPLEMENTATION COST FOR INSTITUTIONAL CONTROLS				
ADMINISTRATIVE AND LEGAL FEES	LUMP SUM	$20,000		$20,000
GROUNDWATER MONITORING (INCLUDES 5 EXISTING PSF WELLS, 2 BLANKS AND 2 DUPLICATES)				
PER SAMPLING EVENT				
PREPARATION/SUPPLIES	$/EVENT	$2,000	1	$2,000
TRAVEL/INCIDENTAL EXPENSES	$/EVENT	$1,800	1	$1,800
PER DIEM	$/EVENT	$200	2	$400
LABOR	$/EVENT	$3,900	1	$3,900
ANALYTICAL (Nitrate)	$/ANALYSIS	$50	9	$450
SHIPPING	$/EVENT	$900	1	$900
WATER HANDLING AND DISPOSAL	$/EVENT	$500	1	$500
QCSR	$/EVENT	$2,500	1	$2,500
SUBTOTAL				$12,450
CONTRACT ADMINISTRATION (USACE & FT. RILEY) @ 20%				$2,500
USACE FIELD OVERSIGHT @ 20%				$2,500
SAMPLING EVENT SUBTOTAL				$17,450
ANNUAL SAMPLING COST	2 TIMES/YEAR			$34,900
ANNUAL O&M COSTS (5 WELLS)	$/EVENT	$400	2	$800
2-YEAR NET PRESENT WORTH OF GW MONITORING AND O&M COSTS (@ 7% INTEREST)				**$64,500**

NOTE: Numbers are rounded to the nearest one hundreds value

APPENDIX D-1

COMPARISON OF BASELINE, FIRST QUARTER, SECOND QUARTER, THIRD QUARTER, AND SEPTEMBER 1994 GROUNDWATER POSITIVE RESULTS

TABLE D-1

COMPARISON OF BASELINE, FIRST QUARTER, SECOND QUARTER, THIRD QUARTER, AND SEPTEMBER 1994 GROUNDWATER POSITIVE RESULTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter						Sample	Duplicate	Sample
		PSF9201	PSF9201	PSF9201	PSF9201	PSF9201	PSF9202	PSF9206	PSF9202
	Date Collected	7-16-92	11-05-92	2-3-93	5-5-93	9-27-94	7-14-92	7-14-92	11-05-92
VOLATILE ORGANICS (µg/L):									
Acetone		--	--	--	--	--	--	--	--
Methylene Chloride		9.3 (T)	5.0 (T)	--	11 (T)	--	--	--	5.0 (T)
Trichloroethene		--	--	--	--	--	--	--	--
SEMI-VOLATILE ORGANICS (µg/L):		--	--	--	--	NA	--	--	--
DISSOLVED FURNACE METALS (µg/L):									
Antimony		NA	NA	NA	NA	--	NA	NA	NA
Arsenic		--	--	--	NA	--	--	--	--
Lead		-- (M2)	-- (M2)	--	NA	--	-- (M2)	-- (M2)	-- (M2)
Selenium		1.1	--	1.9	NA	6.6	2.2	2.1	2.1
Thallium		NA	NA	NA	NA	--	--	--	--
DISSOLVED ICP METALS (µg/L):									
Aluminum		--	--	--	NA	--	284	--	--
Antimony		--	--	--	NA	NA	--	--	--
Barium		88	120	180	NA	130	100	83	49
Beryllium		--	1	3	NA	--	3.0	2.9	2.0
Cadmium		--	--	--	NA	--	--	--	--
Calcium		88,000	96,000	130,000	NA	140,000	340,000	340,000	240,000
Chromium		--	--	--	NA	--	--	--	--
Copper		6	--	6	NA	--	--	--	--
Iron		--	58	61	NA	--	--	--	--
Magnesium		14,000	16,000	22,000	NA	23,000	55,000	55,000	39,000
Manganese		24	19	25	NA	--	54	52	34
Nickel		--	--	11	NA	--	--	--	--
Potassium		3,300	3,400	4,900	NA	--	6,100	6,200	4,700
Silver		--	--	4	NA	--	--	--	--
Sodium		11,000	16,000	19,000	NA	19,000	89,000	90,000	56,000
Vanadium		--	--	7	NA	--	--	--	--
Zinc		13 (B1)	13	12	NA	--	16 (B1)	14 (B1)	10
TOTAL RECOVERABLE FURNANCE METALS (µg/L):									
Antimony		NA	NA	NA	NA	--	NA	NA	NA
Arsenic		--	--	--	--	--	--	--	--
Lead		-- (M2)	-- (M2)	--	--	--	-- (M2)	-- (M2)	-- (M2)
Selenium		1.6	2.0	2.3	2.9	8.0	2.2	2.2	2.1
Thallium		NA	NA	NA	--	2.4	NA	NA	NA
TOTAL RECOVERABLE ICP METALS (µg/L):									
Aluminum		--	--	--	--	260	--	--	170
Antimony		--	--	22	--	NA	--	--	--
Barium		100	120	160	200	140	84	82	68
Beryllium		1.4	2.0	2.0	2.0	--	3.0	2.8	3.0
Cadmium		--	--	--	4.0	--	--	--	--
Calcium		89,000	100,000	120,000	150,000	140,000	350,000	330,000	240,000
Chromium		10	--	--	--	--	--	12	--
Copper		--	5.0	--	11	--	--	--	--
Iron		52	60	61	71	220	68	--	280
Magnesium		14,000	17,000	20,000	26,000	24,000	56,000	54,000	40,000
Manganese		26	24	22	34	--	56	50	41
Nickel		--	19	30	--	--	--	--	--

TABLE D-1

COMPARISON OF BASELINE, FIRST QUARTER, SECOND QUARTER, THIRD QUARTER, AND SEPTEMBER 1994 GROUNDWATER POSITIVE RESULTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter / Date Collected	PSF9201 7-16-92	PSF9201 11-05-92	PSF9201 2-3-93	PSF9201 5-5-93	PSF9201 9-27-94	Sample PSF9202 7-14-92	Duplicate PSF9206 7-14-92	Sample PSF9202 11-05-92
Potassium	3,400	3,700	5,300	4,900	--	6,300	6,000	4,800
Silver	--	--	4.0	--	--	--	--	--
Sodium	11,000	16,000	17,000	22,000	20,000	90,000	87,000	57,000
Vanadium	8.3	11	6.0	--	--	--	--	--
Zinc	12 (B1)	23	7.0	--	--	98	16 (B1)	16
DISSOLVED MERCURY (µg/L):	--	--	--	NA	--	--	--	--
TOTAL RECOVERABLE MERCURY (µg/L):	--	--	--	--	--	--	--	--
WET CHEMICAL INORGANICS (mg/L):								
Bicarbonate	239	190	232	249	--	466	466	327
Inorganic Chloride	10.3	63.5	129	147	31	267	272	122
Nitrate as N	4.5	3.8	6.4	2.2	5.9	32.6	33	20.3
Sulfate	84.7	70.8	52.2	52.9	160	380	386	336
PESTICIDES/PCBs (µg/L):								
beta-BHC	--	--	--	--	--	--	--	--
delta BHC	--	--	--	--	0.01 (J)	--	--	--
Endosulfan	--	--	--	--	--	--	--	--
Heptachlor	--	--	--	--	--	--	--	--
ACID HERBICIDES (µG/L):	--	--	--	--	NA	--	--	--
ORGANOPHOSPHORUS PESTICIDES (µg/L):	--	--	--	--	NA	--	--	--

* Reporting limits vary between sampling events. Caution should be exercized when comparing non-detects. See raw data tables in Appendices for data on PQLs and MDLs.
-- Not detected.
NA - Not analyzed.
B1 - Sample results are less than 5 times the amount detected in the method blank. Result is estimated.
M2 - Matrix spike recovery is low due to sample matrix effect. Sample result is estimated.
T - Sample results are less than 10 times the amount detected in the trip blank. Result is estimated.
J - Estimated quantity based on QC data.
JL - Estimated quantity; holding time exceeded.

TABLE D-1

COMPARISON OF BASELINE, FIRST QUARTER, SECOND QUARTER, THIRD QUARTER, AND SEPTEMBER 1994 GROUNDWATER POSITIVE RESULTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter / Date Collected	Duplicate PSF9201 11-5-92	Sample PSF9202 2-3-93	Duplicate PSF9206 2-3-93	Sample PSF9202 5-6-93	Duplicate PSF9206 5-6-93	Sample PSF9202 9-26-94	Duplicate PSF9202 9-26-94	PSF9203 7-16-92
VOLATILE ORGANICS (µg/L):								
Acetone	--	--	--	--	--	--	--	--
Methylene Chloride	--	--	--	--	--	--	--	21 (T)
Trichloroethene	--	--	--	--	--	--	--	--
SEMI-VOLATILE ORGANICS (µg/L):	--	--	--	--	--			--
DISSOLVED FURNACE METALS (µg/L):								
Antimony	NA	NA	NA	NA	NA	--	--	NA
Arsenic	--	--	--	NA	NA	--	--	--
Lead	-- (M2)	--	--	NA	NA	--	--	-- (M2)
Selenium	2.2	2.1	2.2	NA	NA	--	--	1.5
Thallium	--	NA	NA	NA	NA	--	--	NA
DISSOLVED ICP METALS (µg/L):								
Aluminum	--	--	--	NA	NA	--	--	--
Antimony	--	--	--	NA	NA	NA	NA	--
Barium	70	64	59	NA	NA	42	41	92
Beryllium	3.0	5.0	4.0	NA	NA	--	--	1.6
Cadmium	--	--	--	NA	NA	--	--	--
Calcium	240,000	290,000	290,000	NA	NA	190,000	190,000	180,000
Chromium	--	--	--	NA	NA	--	--	--
Copper	--	10	--	NA	NA	--	--	--
Iron	--	--	--	NA	NA	--	--	--
Magnesium	40,000	50,000	50,000	NA	NA	28,000	29,000	29,000
Manganese	34	35	34	NA	NA	--	--	83
Nickel	--	--	15	NA	NA	--	--	--
Potassium	4,800	6,000	6,200	NA	NA	--	--	5,700
Silver	--	11	11	NA	NA	--	--	--
Sodium	57,000	110,000	110,000	NA	NA	36,000	37,000	47,000
Vanadium	--	9.0	--	NA	NA	--	--	--
Zinc	11	5.0	4.0	NA	NA	--	--	11 (B1)
TOTAL RECOVERABLE FURNANCE METALS (µg/L):								
Antimony	NA	NA	NA	NA	NA	--	--	NA
Arsenic	--	--	2.7	--	--	--	--	--
Lead	-- (M2)	--	--	--	--	--	--	-- (M2)
Selenium	2.2	3.0	2.6	3.6	3.5	--	--	1.7
Thallium	NA	NA	NA	2.9	--	--	--	NA
TOTAL RECOVERABLE ICP METALS (µg/L):								
Aluminum	190	--	--	--	170	--		270
Antimony	--	--	--	--	--	NA	--	--
Barium	47	60	55	100	100	40	42	81
Beryllium	2.0	5	4	3	3.0	--	--	1.5
Cadmium	--	--	--	--	--	--	--	--
Calcium	230,000	290,000	290,000	280,000	280,000	180,000	190,000	180,000
Chromium	--	--	--	--	14	--	--	--
Copper	--	4	--	12	12	--	--	--
Iron	290	--	66	170	190	160	140	290
Magnesium	38,000	49,000	49,000	50,000	51,000	280,000	29,000	29,000
Manganese	39	34	32	52	53	--	--	91
Nickel	--	15	22	--	--	--	--	--

TABLE D-1

COMPARISON OF BASELINE, FIRST QUARTER, SECOND QUARTER, THIRD QUARTER, AND SEPTEMBER 1994 GROUNDWATER POSITIVE RESULTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	Date Collected	Duplicate PSF9201 11-5-92	Sample PSF9202 2-3-93	Duplicate PSF9206 2-3-93	Sample PSF9202 5-6-93	Duplicate PSF9206 5-6-93	Sample PSF9202 9-26-94	Duplicate PSF9202 9-26-94	PSF9203 7-16-92
Potassium		4,600	6,800	6,600	6,200	6,200	--	--	5,900
Silver		--	7	9	--	--	--	--	--
Sodium		54,000	100,000	100,000	130,000	130,000	35,000	36,000	47,000
Vanadium		--	--	--	--	--	--	--	--
Zinc		15	7	--	--	--	--	--	18 (B1)
DISSOLVED MERCURY (µg/L):		--	--	--	NA	NA	--	--	--
TOTAL RECOVERABLE MERCURY (µg/L):		--	--	--	--	--	--	--	--
WET CHEMICAL INORGANICS (mg/L):									
Bicarbonate		381	416	418	400	416	--	--	421
Inorganic Chloride		121	262	262	395	399	44	44	70.4
Nitrate as N		20.2	165	165	24.7	25	9.2 (JL)	9.1 (JL)	11.6
Sulfate		330	326	324	199	199	240	230	171
PESTICIDES/PCBs (µg/L):									
beta-BHC		--	--	--	--	--	--	--	--
delta BHC		--	--	--	--	--	--	--	--
Endosulfan		--	--	--	--	--	--	--	--
Heptachlor		--	--	--	--	--	--	--	--
ACID HERBICIDES (µG/L):		--	--	--	--	--	NA	NA	--
ORGANOPHOSPHORUS PESTICIDES (µg/L):		--	--	--	--	--	NA	NA	--

* Reporting limits vary between sampling events. Caution should be exercized when comparing non-detects. See raw data tables in Appendices for data on PQLs and MDLs.
-- Not detected.
NA - Not analyzed.
B1 - Sample results are less than 5 times the amount detected in the method blank. Result is estimated.
M2 - Matrix spike recovery is low due to sample matrix effect. Sample result is estimated.
T - Sample results are less than 10 times the amount detected in the trip blank. Result is estimated.
J - Estimated quantity based on QC data.
JL - Estimated quantity; holding time exceeded.

TABLE D–1

COMPARISON OF BASELINE, FIRST QUARTER, SECOND QUARTER,
THIRD QUARTER, AND SEPTEMBER 1994
GROUNDWATER POSITIVE RESULTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter / Date Collected	PSF9203 11–5–92	PSF9203 2–3–93	PSF9203 5–6–93	PSF9203 9–27–94	PSF9204 7–23–92	PSF9204 11–5–92	PSF9204 2–3–93	PSF9204 5–6–93
VOLATILE ORGANICS (µg/L):								
Acetone	--	--	--	--	--	--	--	--
Methylene Chloride	5.3 (T)	--	--	--	5.4 (T)	5 (T)	--	--
Trichloroethene	--	--	--	--	--	--	--	--
SEMI–VOLATILE ORGANICS (µg/L):	--	--	--	NA	--	--	--	--
DISSOLVED FURNACE METALS (µg/L):								
Antimony	NA	NA	NA	--	NA	NA	NA	NA
Arsenic	--	--	NA	--	--	--	--	NA
Lead	-- (M2)	--	NA	--	-- (M2)	-- (M2)	--	NA
Selenium	1.3	1.2	NA	--	1.2	1.0	1.2	NA
Thallium	NA	NA	NA	--	NA	NA	NA	NA
DISSOLVED ICP METALS (µg/L):								
Aluminum	--	--	NA	--	--	--	--	NA
Antimony	--	28	NA	NA	--	--	--	NA
Barium	68	58	NA	58	84	98	91	NA
Beryllium	2.0	3.0	NA	--	1.6	1.0	2.0	NA
Cadmium	--	--	NA	--	--	--	--	NA
Calcium	160,000	170,000	NA	160,000	140,000	150,000	140,000	NA
Chromium	--	--	NA	--	--	--	--	NA
Copper	--	5.0	NA	--	--	--	8.0	NA
Iron	--	--	NA	--	78	--	--	NA
Magnesium	25,000	28,000	NA	25,000	18,000	20,000	19,000	NA
Manganese	51	50	NA	21	31	24	23	NA
Nickel	34	13	NA	--	--	--	--	NA
Potassium	4,800	5,900	NA	5,800	3,800	3,600	3,800	NA
Silver	--	7	NA	--	--	--	--	NA
Sodium	37,000	46,000	NA	32,000	25,000	30,000	28,000	NA
Vanadium	--	--	NA	--	--	--	11 (B1)	NA
Zinc	10	8.0	NA	--	11 (B1)	8.0	8.0	NA
TOTAL RECOVERABLE FURNANCE METALS (µg/L):								
Antimony	NA	NA	NA	--	NA	NA	NA	NA
Arsenic	--	--	--	--	--	--	--	--
Lead	-- (M2)	--	2.1	--	-- (M2)	-- (M2)	--	2
Selenium	1.2	1.7	2.2	--	2.1	1.1	1.4	1.3
Thallium	NA	NA	2.5	--	NA	NA	NA	--
TOTAL RECOVERABLE ICP METALS (µg/L):								
Aluminum	550	800	180	--	160	--	--	--
Antimony	--	--	--	NA	--	--	--	--
Barium	94	63	68	59	85	100	93	91
Beryllium	2.0	2.0	2.0	--	1.4	1.0	2.0	--
Cadmium	--	--	--	--	--	--	--	4.0
Calcium	160,000	170,000	170,000	170,000	140,000	150,000	150,000	130,000
Chromium	--	--	--	--	--	--	--	--
Copper	--	--	9.0	--	--	--	6.0 (B1)	8.0
Iron	990	1,500	330	170	90	--	--	--
Magnesium	25,000	27,000	28,000	25,000	19,000	21,000	20,000	18,000
Manganese	71	77	50	29	36	26	24	26
Nickel	--	13	--	--	--	24	--	--

TABLE D-1

COMPARISON OF BASELINE, FIRST QUARTER, SECOND QUARTER, THIRD QUARTER, AND SEPTEMBER 1994 GROUNDWATER POSITIVE RESULTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	PSF9203	PSF9203	PSF9203	PSF9203	PSF9204	PSF9204	PSF9204	PSF9204
Date Collected	11-5-92	2-3-93	5-6-93	9-27-94	7-23-92	11-5-92	2-3-93	5-6-93
Potassium	5,000	6,500	5,700	5,800	3,900	3,700	4,000	4,000
Silver	--	5	--	--	--	--	3.0	--
Sodium	37,000	44,000	54,000	31,000	25,000	31,000	30,000	28,000
Vanadium	8.0	--	--	--	--	--	9.0 (B1)	--
Zinc	21	14	--	--	7.8 (B1)	15	--	--
DISSOLVED MERCURY (µg/L):	--	--	NA	--	--	--	--	NA
TOTAL RECOVERABLE MERCURY (µg/L):	--	--	--	--	--	--	--	--
WET CHEMICAL INORGANICS (mg/L):								
Bicarbonate	315	342	376	--	236	300	300	293
Inorganic Chloride	55.3	76.5	76.4	47	139	41.5	40.1	38.5
Nitrate as N	11.1	50.6	15.5	11	--	13.8	65.6	12.2
Sulfate	197	188	148	160	125	142	131	111
PESTICIDES/PCBs (µg/L):								
beta-BHC	--	--	--	--	--	--	--	--
delta BHC	--	--	--	--	--	--	--	--
Endosulfan	--	--	--	--	--	--	--	--
Heptachlor	--	--	--	--	--	--	--	--
ACID HERBICIDES (µG/L):	--	--	--	NA	--	--	--	--
ORGANOPHOSPHORUS PESTICIDES (µg/L):	--	--	--	NA	--	--	--	--

* Reporting limits vary between sampling events. Caution should be exercized when comparing non-detects. See raw data tables in Appendices for data on PQLs and MDLs.
-- Not detected.
NA - Not analyzed.
B1 - Sample results are less than 5 times the amount detected in the method blank. Result is estimated.
M2 - Matrix spike recovery is low due to sample matrix effect. Sample result is estimated.
T - Sample results are less than 10 times the amount detected in the trip blank. Result is estimated.
J - Estimated quantity based on QC data.
JL - Estimated quantity; holding time exceeded.

TABLE D-1

COMPARISON OF BASELINE, FIRST QUARTER, SECOND QUARTER, THIRD QUARTER, AND SEPTEMBER 1994 GROUNDWATER POSITIVE RESULTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	PSF9204	PSF9205	PSF9205	PSF9205	PSF9205	PSF9205
Date Collected	9-27-94	7-16-92	11-5-92	2-3-93	5-6-93	9-27-94
VOLATILE ORGANICS (µg/L):						
Acetone	12 J	--	--	--	--	--
Methylene Chloride	--	18 (T)	--	--	--	--
Trichloroethene	--	3.0	--	--	--	--
SEMI-VOLATILE ORGANICS (µg/L):	NA	--	--	--	--	NA
DISSOLVED FURNACE METALS (µg/L):						
Antimony	--	NA	NA	NA	NA	--
Arsenic	--	15	4.3	2.8	NA	--
Lead	--	-- (M2)	-- (M2)	--	NA	4.7
Selenium	--	2.6	1.7	1.2	NA	--
Thallium	--	NA	NA	NA	NA	1.1
DISSOLVED ICP METALS (µg/L):						
Aluminum	--	170	--	--	NA	--
Antimony	NA	--	--	36	NA	NA
Barium	86	120	140	120	NA	120
Beryllium	--	1.5	2.0	2.0	NA	--
Cadmium	--	--	--	--	NA	--
Calcium	140,000	170,000	140,000	150,000	NA	160,000
Chromium	--	--	--	--	NA	--
Copper	--	--	--	--	NA	--
Iron	--	--	--	--	NA	--
Magnesium	18,000	27,000	22,000	23,000	NA	24,000
Manganese	--	40	26	23	NA	--
Nickel	--	--	--	--	NA	--
Potassium	--	19,000	10,000	11,000	NA	11,000
Silver	--	--	--	6.0	NA	--
Sodium	28,000	41,000	31,000	33,000	NA	32,000
Vanadium	--	24	14	7.0	NA	--
Zinc	--	15 (B1)	10	6.0	NA	--
TOTAL RECOVERABLE FURNANCE METALS (µg/L):						
Antimony	--	NA	NA	NA	NA	--
Arsenic	--	16	4.4	3.8	3.8	--
Lead	--	-- (M2)	-- (M2)	--	--	--
Selenium	--	2.7	1.7	1.9	2.3	--
Thallium	--	NA	NA	NA	--	--
TOTAL RECOVERABLE ICP METALS (µg/L):						
Aluminum	--	210	550	110	--	--
Antimony	NA	--	--	32	--	NA
Barium	93	130	130	110	130	120
Beryllium	--	1.6	2.0	3.0	2.0	--
Cadmium	--	--	--	--	6.0	--
Calcium	150,000	180,000	150,000	150,000	150,000	150,000
Chromium	--	--	--	--	--	--
Copper	--	--	--	6.0	10	--
Iron	--	230	910	84	--	610
Magnesium	20,000	28,000	23,000	22,000	23,000	22,000
Manganese	--	43	47	23	32	17
Nickel	--	--	--	17	--	--

TABLE D-1

COMPARISON OF BASELINE, FIRST QUARTER, SECOND QUARTER, THIRD QUARTER, AND SEPTEMBER 1994
GROUNDWATER POSITIVE RESULTS
Pesticide Storage Facility
Fort Riley, Kansas

Parameter	Date Collected	PSF9204 9-27-94	PSF9205 7-16-92	PSF9205 11-5-92	PSF9205 2-3-93	PSF9205 5-6-93	PSF9205 9-27-94
Potassium		--	20,000	11,000	12,000	9,900	10,000
Silver		--	--	--	12	--	--
Sodium		30,000	42,000	31,000	32,000	29,000	28,000
Vanadium		--	27	12	14	--	--
Zinc		--	9.7 (B1)	13	4.0	--	--
DISSOLVED MERCURY (μg/L):		--	--	--	--	NA	--
TOTAL RECOVERABLE MERCURY (μg/L):		--	--	--	--	--	--
WET CHEMICAL INORGANICS (mg/L):							
Bicarbonate		--	493	348	359	327	--
Inorganic Chloride		49	56.7	48.6	47.7	46.9	62
Nitrate as N		12	18.4	10.7	45.9	10.6	9.4
Sulfate		100	119	108	109	109	100
PESTICIDES/PCBs (μg/L):							
beta-BHC		--	--	--	--	--	--
delta BHC		--	--	--	--	--	--
Endosulfan		--	--	--	--	--	--
Heptachlor		0.015 (J)	--	--	--	--	0.015 (J)
ACID HERBICIDES (μG/L):		NA	--	--	--	--	NA
ORGANOPHOSPHORUS PESTICIDES (μg/L):		NA	--	--	--	--	NA

* Reporting limits vary between sampling events. Caution should be exercized when comparing non-detects. See raw data tables in Appendices for data on PQLs and MDLs.
-- Not detected.
NA - Not analyzed.
B1 - Sample results are less than 5 times the amount detected in the method blank. Result is estimated.
M2 - Matrix spike recovery is low due to sample matrix effect. Sample result is estimated.
T - Sample results are less than 10 times the amount detected in the trip blank. Result is estimated.
J - Estimated quantity based on QC data.
JL - Estimated quantity; holding time exceeded.

PREPARED BY/DATE: DSK 4/12/95
CHECKED BY/DATE: MAB 4/12/95
APPROVED BY/DATE: SFW 4/12/95

APPENDIX D-2

GROUNDWATER POSITIVE RESULTS
BUILDING 354

TABLE D-2

COMPARISON OF NOVEMBER 1993 AND SEPTEMBER 1994
GROUNDWATER POSITIVE RESULTS
Building 354
Fort Riley, Kansas

Parameter / Date Collected	B35401 (TS029202) 11-4-93	B35401 (TS029202) 9-28-94	B35402 (TS029201) 11-4-93	B35402 (TS029201) 9-28-94
VOLATILE ORGANICS (μg/L):				
1,2-Dichloroethene	--	1.2 J	--	--
Acetone	--	36 J	--	--
Benzene	--	59	37	5.4
Carbon Tetrachloride	--	--	--	1.1 J
Chloroform	--	--	--	2.1
cis-1,2-Dichloroethene	--	5.4	--	--
Ethylbenzene	9.0	34	30	2.2 J
Methylene Chloride	--	7 J	--	--
Tetrachloroethane	--	--	13	130
Toluene	--	6.2	91	6.1
Trichloroethene	--	--	--	3.8 J
Xylenes, Total	5.2	23	90	7.8
DISSOLVED FURNACE METALS (μg/L):				
Arsenic	--	39	--	--
DISSOLVED ICP METALS (μg/L):				
Barium	NA	1,200	NA	63
Calcium	NA	170,000	NA	180,000
Iron	NA	1,300	NA	--
Magnesium	NA	35,000	NA	30,000
Manganese	NA	580	NA	83
Potassium	NA	11,000	NA	5,500
Sodium	NA	54,000	NA	42,000
TOTAL RECOVERABLE FURNANCE METALS (μg/L):				
Arsenic	--	39	--	--
Lead	9	--	0.11	--
Thallium	NA	2.6	NA	--
TOTAL RECOVERABLE ICP METALS (μg/L):				
Barium	NA	1,100	NA	59
Calcium	NA	150,000	NA	170,000
Cobalt	NA	--	NA	--
Iron	NA	12,000	NA	--
Magnesium	NA	32,000	NA	28,000
Manganese	NA	520	NA	79
Potassium	NA	10,000	NA	5,400
Sodium	NA	48,000	NA	39,000
Zinc	98	--	16 (B1)	--

TABLE D-2

COMPARISON OF NOVEMBER 1993 AND SEPTEMBER 1994
GROUNDWATER POSITIVE RESULTS
Building 354
Fort Riley, Kansas

Parameter Date Collected	B35401 (TS029202) 11-4-93	B35401 (TS029202) 9-28-94	B35402 (TS029201) 11-4-93	B35402 (TS029201) 9-28-94
<u>WET CHEMICAL INORGANICS (mg/L):</u>				
Inorganic Chloride	NA	100	NA	--
Nitrate	NA	--	NA	10
Sulfate	NA	--	NA	130
<u>PESTICIDES/PCBs (µg/L):</u>				
beta-BHC	--	--	--	0.02 (J)
delta-BHC	--	0.072 (J)	--	0.043 (J)
Endosulfon J	--	0.018 (J)	--	0.013 (J)
Heptachlor	--	0.22 (J)	--	--

-- Not detected.
NA – Not analyzed.
B1 – Sample results are less than 5 times the amount detected in the method blank. Result is estimated.
J – Estimated value based on QC data.
M2 – Matrix spike recovery is low due to sample matrix effect. Sample result is estimated.
T – Sample results are less than 10 times the amount detected in the trip blank. Result is estimated.

APPENDIX D-3

BACKGROUND SOIL ANALYTICAL RESULTS FOR THE REMOVAL ACTION

GREAT LAKES ANALYTICAL
1380 Busch Parkway • Buffalo Grove, Illinois 60089
(708) 808-7766 FAX (708) 808-7772

(Materials Corp.
Box 551
Findlay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480-BS T1
Lab Number: 402-0340

Sampled: Feb 7, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	85
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	8.4
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

EAT LAKES ANALYTICAL

Crystal Holloway

Kevin W. Keeley
Laboratory Director

GREAT LAKES ANALYTICAL 1380 Busch Parkway • Buffalo Grove, Illinois 60089 (708) 808-7766 FAX (708) 808-7772

O.H. Materials Corp.
Box 551
lay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480 BSA T2

Lab Number: 402-0328

Sampled: Feb 8, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	40
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	N.D.
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	3.9

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

Kevin W. Keeley
Laboratory Director

GREAT LAKES ANALYTICAL

1380 Busch Parkway • Buffalo Grove, Illinois 60089 (708) 808-7766 FAX (708) 808-7772

Materials Corp.	Client Project ID: 15480, Fort Riley	Sampled: Feb 7, 1994
Box 551	Sample Descript: Soil: 15480-BS T3	Received: Feb 10, 1994
Findlay, OH 45839-0551		Extracted: Feb 10, 1994
Attention: Phil Connor	Lab Number: 402-0343	Analyzed: Feb 10-17, 1994
		Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	48
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	N.D.
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

Crystal Pallasy

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Laboratory Director

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O.H. Materials Corp.
Box 551
ay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480 BSA T4
Lab Number: 402-0325

Sampled: Feb 8, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	60
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	5.4
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	3.4

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

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4020320.OHO <6>

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...aterials Corp.	Client Project ID: 15480, Fort Riley	Sampled:	Feb 8, 1994
P.O. Box 551	Sample Descript: Soil: 15480 BSA T5	Received:	Feb 10, 1994
...lay, OH 45839-0551		Extracted:	Feb 10, 1994
...tion: Phil Connor	Lab Number: 402-0322	Analyzed:	Feb 10-17, 1994
		Reported:	Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	70
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	8.3
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

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~~ I. Materials Corp.	Client Project ID: 15480, Fort Riley	Sampled: Feb 8, 1994
. Box 551	Sample Descript: Soil: 15480 BSB T5	Received: Feb 10, 1994
dlay, OH 45839-0551		Extracted: Feb 10, 1994
Attention: Phil Connor	Lab Number: 402-0323	Analyzed: Feb 10-17, 1994
		Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	2.7
Barium	3050/6010	25	75
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	8.1
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

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Materials Corp.	Client Project ID: 15480, Fort Riley	Sampled: Feb 8, 1994
Box 551	Sample Descript: Soil: 15480 BSA T6	Received: Feb 10, 1994
...dlay, OH 45839-0551		Extracted: Feb 10, 1994
Attention: Phil Connor	Lab Number: 402-0321	Analyzed: Feb 10-17, 1994
		Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	58
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	6.9
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

...EAT LAKES ANALYTICAL

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Laboratory Director

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Materials Corp.	Client Project ID:	15480, Fort Riley		Sampled:	Feb 7, 1994
Box 551	Sample Descript:	Soil: 15480-BS U5		Received:	Feb 10, 1994
lay, OH 45839-0551				Extracted:	Feb 10, 1994
Attention: Phil Connor	Lab Number:	402-0339		Analyzed:	Feb 10-17, 1994
				Reported:	Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	4.4
Barium	3050/6010	25	74
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	16
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

EAT LAKES ANALYTICAL

Kevin W. Keeley
Laboratory Director

4020335.OHO <5>

GREAT LAKES ANALYTICAL
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Materials Corp.	Client Project ID: 15480, Fort Riley	Sampled: Feb 7, 1994
Box 551	Sample Descript: Soil: 15480-BS A1	Received: Feb 10, 1994
Findlay, OH 45839-0551		Extracted: Feb 10, 1994
Attention: Phil Connor	Lab Number: 402-0341	Analyzed: Feb 10-17, 1994
		Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	94
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	7.9
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	1.1

Analytes reported as N.D. were not present above the stated limit of detection.

EAT LAKES ANALYTICAL

Kevin W. Keeley
Laboratory Director

GREAT
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Materials Corp.	Client Project ID: 15480, Fort Riley	Sampled:	Feb 7, 1994
Box 551	Sample Descript: Soil: 15480-BS A2	Received:	Feb 10, 1994
Findlay, OH 45839-0551		Extracted:	Feb 10, 1994
Attention: Phil Connor	Lab Number: 402-0342	Analyzed:	Feb 10-17, 1994
		Reported:	Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	81
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	5.4
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	1.7

Analytes reported as N.D. were not present above the stated limit of detection.

EAT LAKES ANALYTICAL

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Laboratory Director

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O.H. Materials Corp.
Box 551
ay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480 BSA A3

Lab Number: 402-0327

Sampled: Feb 8, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	7.1
Barium	3050/6010	25	200
Beryllium	3050/6010	0.50	0.59
Lead	3050/6010	5.0	16
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

Crystal Pallet

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Laboratory Director

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O.H. Materials Corp.	Client Project ID: 15480, Fort Riley	Sampled:	Feb 8, 1994
) Box 551	Sample Descript: Soil: 15480 BSA A3	Received:	Feb 10, 1994
dlay, OH 45839-0551		Extracted:	Feb 10, 1994
ention: Phil Connor	Lab Number: 402-0326	Analyzed:	Feb 10-17, 1994
		Reported:	Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	3.8
Barium	3050/6010	25	160
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	13
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

Crystal Pollock/

Kevin W. Keeley
Laboratory Director

4020320.OHO <7>

GREAT LAKES ANALYTICAL 1380 Busch Parkway • Buffalo Grove, Illinois 60089 (708) 808-7766 FAX (708) 808-7772

O.H. Materials Corp.
Box 551
lay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480 BSA A4
Lab Number: 402-0331

Sampled: Feb 8, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	3.4
Barium	3050/6010	25	98
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	9.0
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	5.8

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

Kevin W. Keeley
Laboratory Director

4020320.OHO <12>

GREAT LAKES ANALYTICAL
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O.H. Materials Corp.
F[illegible] Box 551
F[illegible]ay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480 BSA A5
Lab Number: 402-0333

Sampled: Feb 8, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	90
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	5.5
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

Kevin W. Keeley
Laboratory Director

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O.H. Materials Corp.
Box 551
ay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480 BSA A6

Lab Number: 402-0329

Sampled: Feb 8, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	3.3
Barium	3050/6010	25	100
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	10
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	2.6

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

Crystal Pollock

Kevin W. Keeley
Laboratory Director

4020320.OHO <10>

GREAT LAKES ANALYTICAL
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O-H Materials Corp.	Client Project ID: 15480, Fort Riley	Sampled:	Feb 8, 1994
[illegible] Box 551	Sample Descript: Soil: 15480 BSA A7	Received:	Feb 10, 1994
[illegible]ay, OH 45839-0551		Extracted:	Feb 10, 1994
Attention: Phil Connor	Lab Number: 402-0330	Analyzed:	Feb 10-17, 1994
		Reported:	Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	5.0
Barium	3050/6010	25	130
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	14
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

Kevin W. Keeley
Laboratory Director

4020320.OHO <11>

GREAT LAKES ANALYTICAL 1380 Busch Parkway • Buffalo Grove, Illinois 60089 (708) 808-7766 FAX (708) 808-7772

O.H. Materials Corp.
Box 551
lay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480 BSA A8
Lab Number: 402-0334

Sampled: Feb 8, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	80
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	5.5
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

Kevin W. Keeley
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4020320.OHO <15>

GREAT LAKES ANALYTICAL
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O.H. Materials Corp.
Box 551
lay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480 BSA A9
Lab Number: 402-0324

Sampled: Feb 8, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	5.7
Barium	3050/6010	25	130
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	9.0
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

Kevin W. Keeley
Laboratory Director

4020320.OHO <5>

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... Materials Corp.	Client Project ID: 15480, Fort Riley	Sampled:	Feb 8, 1994
Box 551	Sample Descript: Soil: 15480 BSA A10	Received:	Feb 10, 1994
...dlay, OH 45839-0551		Extracted:	Feb 10, 1994
Attention: Phil Connor	Lab Number: 402-0320	Analyzed:	Feb 10-17, 1994
		Reported:	Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	N.D.
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	12
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	1.8

Analytes reported as N.D. were not present above the stated limit of detection.

...EAT LAKES ANALYTICAL

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Laboratory Director

GREAT LAKES ANALYTICAL 1380 Busch Parkway • Buffalo Grove, Illinois 60089 (708) 808-7766 FAX (708) 808-7772

O.H. Materials Corp.	Client Project ID: 15480, Fort Riley	Sampled: Feb 8, 1994
[illegible] Box 551	Sample Descript: Soil: 15480 BSA A11	Received: Feb 10, 1994
H[illegible]y, OH 45839-0551		Extracted: Feb 10, 1994
Attention: Phil Connor	Lab Number: 402-0332	Analyzed: Feb 10-17, 1994
		Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	2.6
Barium	3050/6010	25	92
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	5.8
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

GREAT LAKES ANALYTICAL

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4020320.OHO <13>

GREAT LAKES ANALYTICAL
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) Materials Corp.
Box 551
Findlay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480-BS U1
Lab Number: 402-0335

Sampled: Feb 7, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	3.3
Barium	3050/6010	25	48
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	8.3
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	5.3

Analytes reported as N.D. were not present above the stated limit of detection.

:AT LAKES ANALYTICAL

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Laboratory Director

GREAT LAKES ANALYTICAL 1380 Busch Parkway • Buffalo Grove, Illinois 60089 (708) 808-7766 FAX (708) 808-7772

Materials Corp.
Box 551
Findlay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480-BS U2

Lab Number: 402-0336

Sampled: Feb 7, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	2.8
Barium	3050/6010	25	60
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	9.8
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	1.3

Analytes reported as N.D. were not present above the stated limit of detection.

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Materials Corp.
Box 551
Findlay, OH 45839-0551
Attention: Phil Connor

Client Project ID: 15480, Fort Riley
Sample Descript: Soil: 15480-BS U3
Lab Number: 402-0337

Sampled: Feb 7, 1994
Received: Feb 10, 1994
Extracted: Feb 10, 1994
Analyzed: Feb 10-17, 1994
Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	N.D.
Barium	3050/6010	25	81
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	39
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

EAT LAKES ANALYTICAL

Kevin W. Keeley
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4020335.OHO <3>

GREAT LAKES ANALYTICAL 1380 Busch Parkway • Buffalo Grove, Illinois 60089 (708) 808-7766 FAX (708) 808-7772

... Materials Corp. . Box 551 ...ndlay, OH 45839-0551 Attention: Phil Connor	Client Project ID: 15480, Fort Riley Sample Descript: Soil: 15480-BS U4 Lab Number: 402-0338	Sampled: Feb 7, 1994 Received: Feb 10, 1994 Extracted: Feb 10, 1994 Analyzed: Feb 10-17, 1994 Reported: Feb 18, 1994

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/kg	Sample Results mg/kg
Arsenic	3050/7060	2.5	2.8
Barium	3050/6010	25	45
Beryllium	3050/6010	0.50	N.D.
Lead	3050/6010	5.0	10
Thallium	3050/6010	25	N.D.
Nitrate	353.2	1.0	3.1

Analytes reported as N.D. were not present above the stated limit of detection.

...EAT LAKES ANALYTICAL

Crystal Pollock

Kevin W. Keeley
Laboratory Director

APPENDIX D-4

POSITIVE ANALYTICAL RESULTS/SURFACE WATER

TABLE D-4

POSITIVE ANALYTICAL RESULTS/SURFACE WATERS
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER	PSFSW01 4-2-92	SAMPLE PSFSW02 4-1-92	DUPLICATE PSFSW08 4-1-92	PSFSW03 4-1-92	PSFSW04 4-1-92	PSFSW06 3-31-92	PSFSW07 3-31-92
PESTICIDES/PCBs:	---	---	---	---	---	---	---
SEMI-VOLATILE ORGANICS:	---	---	---	---	---	---	---
VOLATILE ORGANICS:							
Methylene chloride, µg/L	---	---	---	---	---	30(T)	30(T)
TOTAL FURNACE METALS:							
Arsenic, µg/L	4.0	---	4.1	4.0	4.4	---	---
Lead, µg/L	---	---	---	4.2(M2)	---	---	---
TOTAL ICP METALS:							
Aluminum, µg/L	3900	5700	6700	8900	12000	600(B1)	620(B1)
Barium, µg/L	250	260	260	250	290	180	140
Cadmium, µg/L	---	---	4.5	---	---	---	---
Calcium, µg/L	110000	100000	100000	100000	110000	79000	70000
Chromium, µg/L	18	10	24	10	13	---	---
Copper, µg/L	10	7.2	10	12	13	6.4	8.0
Iron, µg/L	2800(M1)	4200(M1)	5100(M1)	6600(M1)	9400(M1)	410(M1)	410(M1)
Magnesium, µg/L	20000	22000	22000	22000	23000	14000	12000
Manganese, µg/L	100	92	110	120	190	110	63
Potassium, µg/L	9600	10000	10000	10000	11000	7300	6200
Sodium, µg/L	45000	49000	49000	47000	45000	42000	35000
Vanadium, µg/L	15	15	20	20	28	6.4	7.0
Zinc, µg/L	27	28	34	45	70	18	13
TOTAL MERCURY:	---	---	---	---	---	---	---
WET CHEMICAL INORGANICS:							
Inorganic Chloride, mg/l	71.30	65.40	65.40	65.00	61.10	50.00	37.60
Sulfate, mg/l	84.30	104.00	105.00	106.00	105.00	81.00	73.50
Bicarbonate, mg/l	310.00	240.00	248.00	234.00	292.00	194.00	172.00
ORGANOPHOSPHORUS PESTICIDES:	---	---	---	---	---	---	---
ACID HERBICIDES:	---	---	---	---	---	---	---

B1 – Sample results are less than 5 times the amount detected in method blank. Result is estimated.
M1 – Matrix spike recovery is high due to sample matrix effect. Sample result is a false positive or biased high.
M2 – Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
T – Sample result is less than 10 times the amount detected in the trip blank. Result is estimated.
--- Not detected

APPENDIX D-5

POSITIVE ANALYTICAL RESULTS/SEDIMENT

TABLE D-5

POSITIVE ANALYTICAL RESULTS/SEDIMENTS
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSD01A (0-1') 4-2-92	PSFSD01B (1-2') 4-2-92	SAMPLE PSFSD02A (0-1') 4-1-92	DUPLICATE PSFSD06 (0-1') 4-1-92	PSFSD02B (1-2') 4-1-92	PSFSD04A (0-1') 4-1-92	PSFSD04B (1-2') 4-1-92
PESTICIDES/PCBs:							
4,4'-DDD, µg/Kg	--	--	8.7	--	--	91	13
4,4'-DDE, µg/Kg	--	--	--	--	--	21	--
4,4'-DDT, µg/Kg	11	--	--	--	--	16	--
Dieldrin, µg/Kg	--	--	--	--	--	20	--
alpha-Chlordane, µg/Kg	9.4	--	4.7	5.8	--	33	--
gamma-Chlordane, µg/Kg	14	--	7.0	7.6	--	37	--
SEMI-VOLATILE ORGANICS:							
Benzo[a]anthracene, µg/Kg	--	--	130	--	--	--	--
Chrysene, µg/Kg	--	--	170	--	--	120	--
Fluoranthene, µg/Kg	--	--	170	--	--	210	--
Phenanthrene, µg/Kg	--	--	--	--	--	--	--
Pyrene, µg/Kg	880	--	340	120	120	250	--
bis(2-Ethylhexyl)phthalate, µg/Kg	--	--	550	640	--	450	570
VOLATILE ORGANICS:							
1,1,2,2-Tetrachloroethane, µg/Kg	--	--	39(I)	--	--	--	--
1,2-Dichloropropane, µg/Kg	--	--	64	--	--	--	--
Carbon disulfide, µg/Kg	--	--	--	--	--	--	6.9
Methylene chloride, µg/Kg	49(B2)	47(B2)	55(B2)	55(B2)	66(B2)	38(B2)	77(B2)
Toluene, µg/Kg	6.0	6.7(I)	5.6(I)	9.8	7.1	13(I)	12(I2)
TOTAL FURNACE METALS:							
Arsenic, mg/Kg	2.2	1.4	1.1	1.5	0.8	0.9	2.7
Selenium, mg/Kg	0.2(M2)	--	--	--	--	--	--
TOTAL ICP METALS:							
Barium, mg/Kg	88	74	95	110	55	110	150
Cadmium, mg/Kg	2.1	--	1.3	0.9	--	1.2	--
Chromium, mg/Kg	13	7.6	19	16	4.2	25	14
Lead, mg/Kg	60	10	130	110	24	210	64
Silver, mg/Kg	--	--	--	--	--	0.8	--

TABLE D-5

POSITIVE ANALYTICAL RESULTS/SEDIMENTS
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSD01A (0-1') 4-2-92	PSFSD01B (1-2') 4-2-92	SAMPLE PSFSD02A (0-1') 4-1-92	DUPLICATE PSFSD06 (0-1') 4-1-92	PSFSD02B (1-2') 4-1-92	PSFSD04A (0-1') 4-1-92	PSFSD04B (1-2') 4-1-92
TOTAL MERCURY:							
Mercury, mg/kg	--	--	--	--	--	0.1(B1)	--
ORGANOPHOSPHORUS PESTICIDES:	--	--	--	--	--	--	--
ACID HERBICIDES:	--	--	--	--	--	--	--
DIOXIN:	NA	NA	NA	NA	NA	--	NA

B1 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
B2 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
M2 – Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
I – Low internal standard response. Result is an estimated quantitation.
I2 – Low internal standard response and high surrogate recovery. Result is biased high.
NA – Not analyzed

TABLE D-5

POSITIVE ANALYTICAL RESULTS/SEDIMENTS
Pesticide Storage Facility
Fort Riley, Kansas

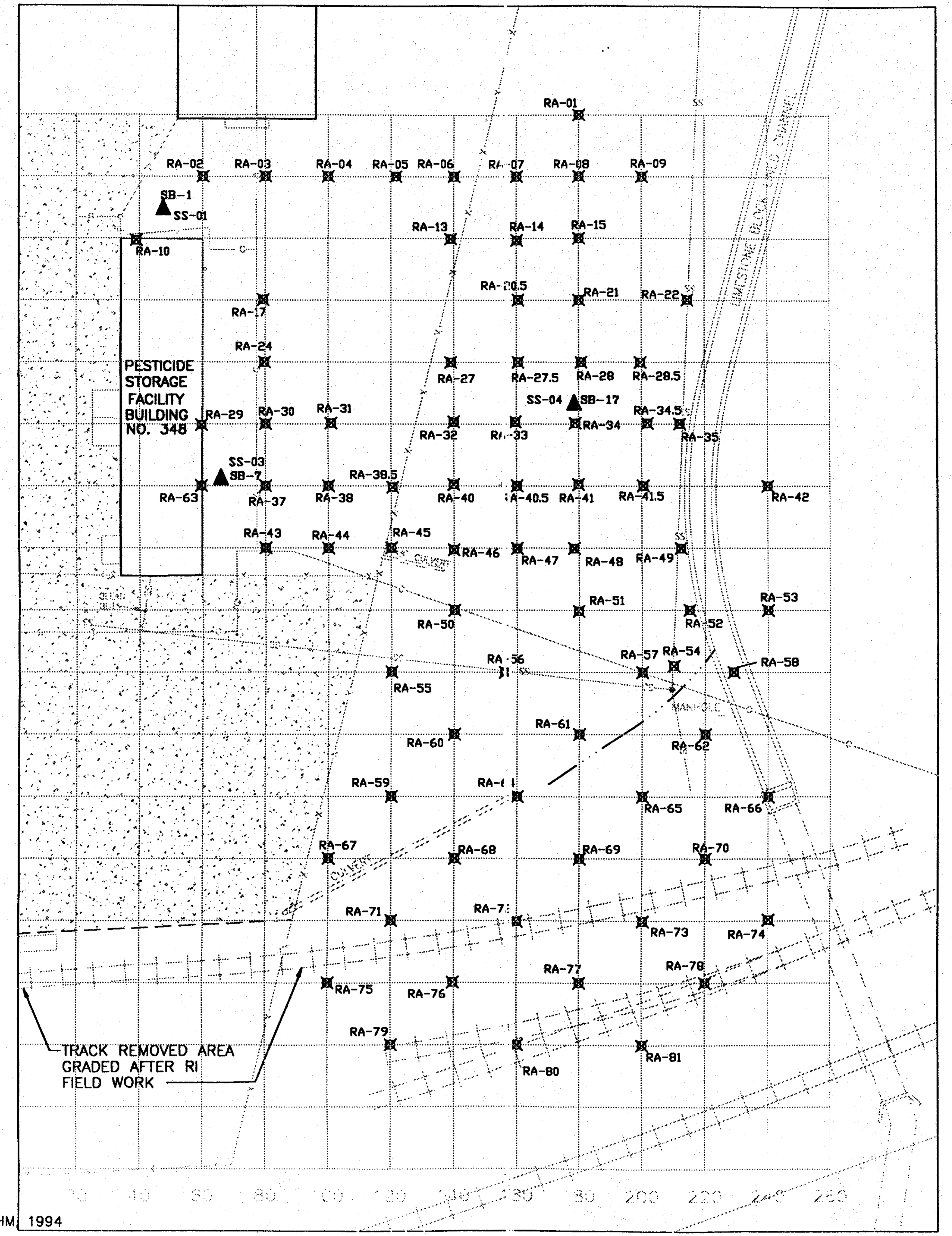
PARAMETER Sample Depth Date Collected	PSFSD05A (0–1') 4–1–92	PSFSD05B (1–2') 4–1–92	PSFSD06A (0–1') 3–31–92	PSFSD06B (1–2') 3–31–92	PSFSD07 (0–1') 3–31–92	PSFSD07B (1–2') 3–31–92	PSFSD09A (0–1') 7–16–92	PSFSD09B (1–2') 7–16–92
PESTICIDES/PCBs:								
4,4'–DDD, µg/Kg	100	--	15	31	24	--	--	--
4,4'–DDE, µg/Kg	280	46	--	--	11	--	--	--
4,4'–DDT, µg/Kg	460	37	--	--	17	8.6	40	17
Dieldrin, µg/Kg	56	--	--	--	--	--	--	--
alpha–Chlordane, µg/Kg	67	--	7.1	9.6	22	9.5	11	10
gamma–Chlordane, µg/Kg	65	--	8.5	12	28	12	24	21
SEMI–VOLATILE ORGANICS:								
Benzo[a]anthracene, µg/Kg	120	160	--	--	--	--	160	130
Chrysene, µg/Kg	160	160	--	--	120	120	240	130
Fluoranthene, µg/Kg	250	270	--	190	--	--	360	290
Phenanthrene, µg/Kg	--	200	--	--	--	--	360	210
Pyrene, µg/Kg	290	310	--	140	160	120	440	380
bis(2–Ethylhexyl)phthalate, µg/Kg	--	--	--	--	--	470	--	--
VOLATILE ORGANICS:								
1,1,2,2–Tetrachloroethane, µg/Kg	--	--	--	--	--	--	--	--
1,2–Dichloropropane, µg/Kg	--	--	--	--	--	--	--	--
Carbon disulfide, µg/Kg	--	--	--	--	--	--	--	--
Methylene chloride, µg/Kg	82(B2)	66	12(B2)(T)	30(B2)(T)	27(B2)(T)	21(B2)(T)	21(B2)	23(B2)
Toluene, µg/Kg	13(I)	7.4(I)	--	--	--	--	--	--
TOTAL FURNACE METALS:								
Arsenic, mg/Kg	3.4	3.8	1.7	1.6	1.4	1.4	2.6	2.5
Selenium, mg/Kg	--	--	0.3(M2)	--	--	--	0.2(M2)	0.3(M2)
TOTAL ICP METALS:								
Barium, mg/Kg	93	74	44	110	76	52	97	130
Cadmium, mg/Kg	--	--	1.3	--	--	--	1.9	3.3
Chromium, mg/Kg	10	8.0	7.7	6.4	9.4	6.1	14	17
Lead, mg/Kg	72	56	66	61	24	16	66	140
Silver, mg/Kg	--	--	--	--	--	--	--	--

TABLE D-5

POSITIVE ANALYTICAL RESULTS/SEDIMENTS
Pesticide Storage Facility
Fort Riley, Kansas

PARAMETER Sample Depth Date Collected	PSFSD05A (0-1') 4-1-92	PSFSD05B (1-2') 4-1-92	PSFSD06A (0-1') 3-31-92	PSFSD06B (1-2') 3-31-92	PSFSD07 (0-1') 3-31-92	PSFSD07B (1-2') 3-31-92	PSFSD09A (0-1') 7-16-92	PSFSD09B (1-2') 7-16-92
TOTAL MERCURY: Mercury, mg/kg	--	--	0.4(B1)	0.2(B1)	0.1(B1)	--	--	0.4
ORGANOPHOSPHORUS PESTICIDES:	--	--	--	--	--	--	--	--
ACID HERBICIDES:	--	--	--	--	--	--	--	--
DIOXIN:	NA	NA	NA	NA	NA	NA	NA	NA

B1 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
B2 – Sample results are less than 10 times the amount detected in method blank. Result is estimated.
M2 – Matrix spike recovery is low due to sample matrix effect. Sample result is biased low.
I – Low internal standard response. Result is an estimated quantitation.
T – Sample results are less than 10 times the amount detected in trip blank. Result is estimated.
NA – Not analyzed



MAP SOURCE: OHM, 1994

LEGEND:

- ▲ SURFACE SOIL SAMPLE LOCATION (1992 RI)
- ⊠ SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)
- ASPHALT
- RAILROAD
- GAS LINES
- FENCE
- SANITARY SEWER
- OVERHEAD POWERLINE

0 40 80

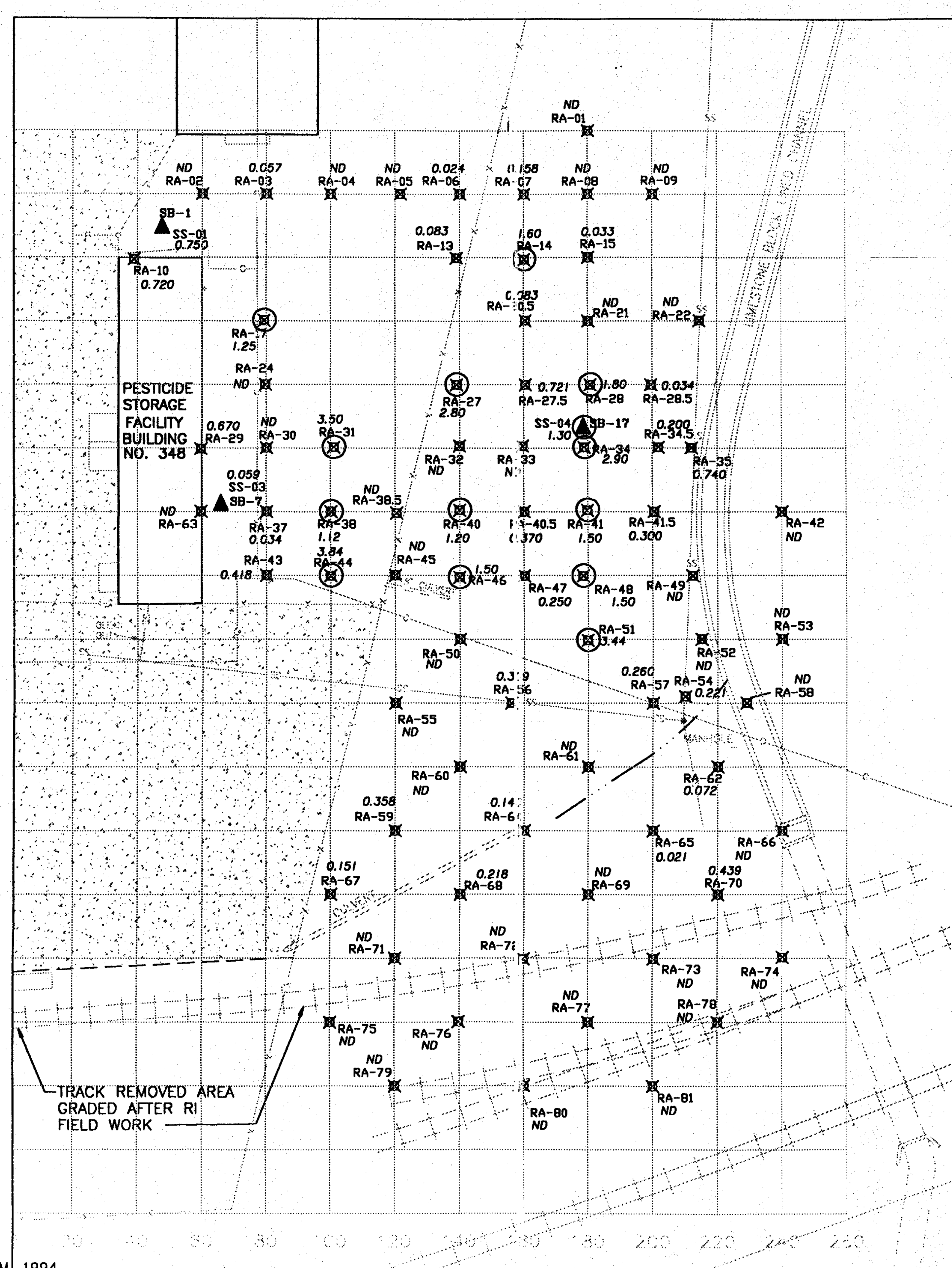
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

SURFACE SOIL LOCATIONS SAMPLED DURING THE RI AND REMOVAL ACTION

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:		FILE DATE:	21.OCTOBER.94
CHECKED BY/DATE:	EFW/5-95	D-1		PLOT DATE:	5-9-95
APPROVED BY/DATE:	KAH/5-95			FILE NAME:	RIREMOV.DWG



MAP SOURCE: OHM 1994

LEGEND:

- SURFACE SOIL SAMPLE EXCEEDING 1.0 mg/kg
- SURFACE SOIL SAMPLE LOCATION (1992 RI)
- SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)
- ASPHALT
- RAILROAD
- GAS LINES
- FENCE
- SANITARY SEWER
- OVERHEAD POWERLINE

NOTES

1. SURFACE SOILS ARE LESS THAN 2 FEET IN DEPTH
2. SB-1 IS ALSO SS-01 LOCATION
   SB-7 IS ALSO SS-03 LOCATION
   SB-17 IS ALSO SS-04 LOCATION

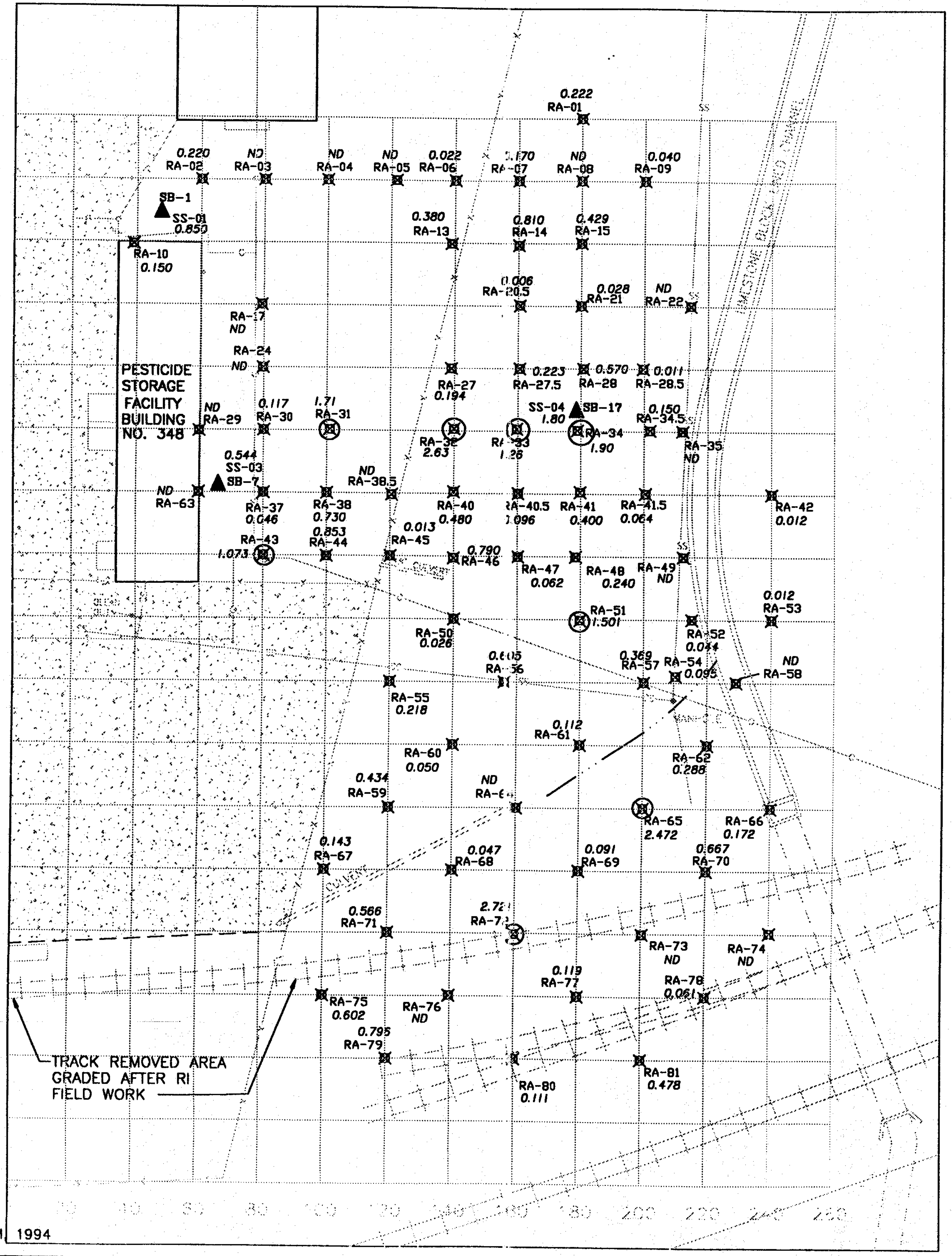
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SURFACE SOIL CONTAMINATION CHLORDANE

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:		FILE DATE:	21.OCTOBER.94
CHECKED BY/DATE: EFW/5-95	D-2		PLOT DATE:	5-2-95
APPROVED BY/DATE: KAH/5-95			FILE NAME:	SAMPE-NE.DWG



LEGEND:

- SURFACE SOIL SAMPLE EXCEEDING 1.0 mg/kg
- SURFACE SOIL SAMPLE LOCATION (1992 RI)
- SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)
- ASPHALT
- RAILROAD
- GAS LINES
- FENCE
- SANITARY SEWER
- OVERHEAD POWERLINE

NOTES

1. SURFACE SOILS ARE LESS THAN 2 FEET IN DEPTH
2. SB-1 IS ALSO SS-01 LOCATION
   SB-7 IS ALSO SS-03 LOCATION
   SB-17 IS ALSO SS-04 LOCATION
3. CONCENTRATIONS SHOWN ARE THE SUM OF DDT AND METABOLITES, WHEN ANALYZED SEPARATELY.

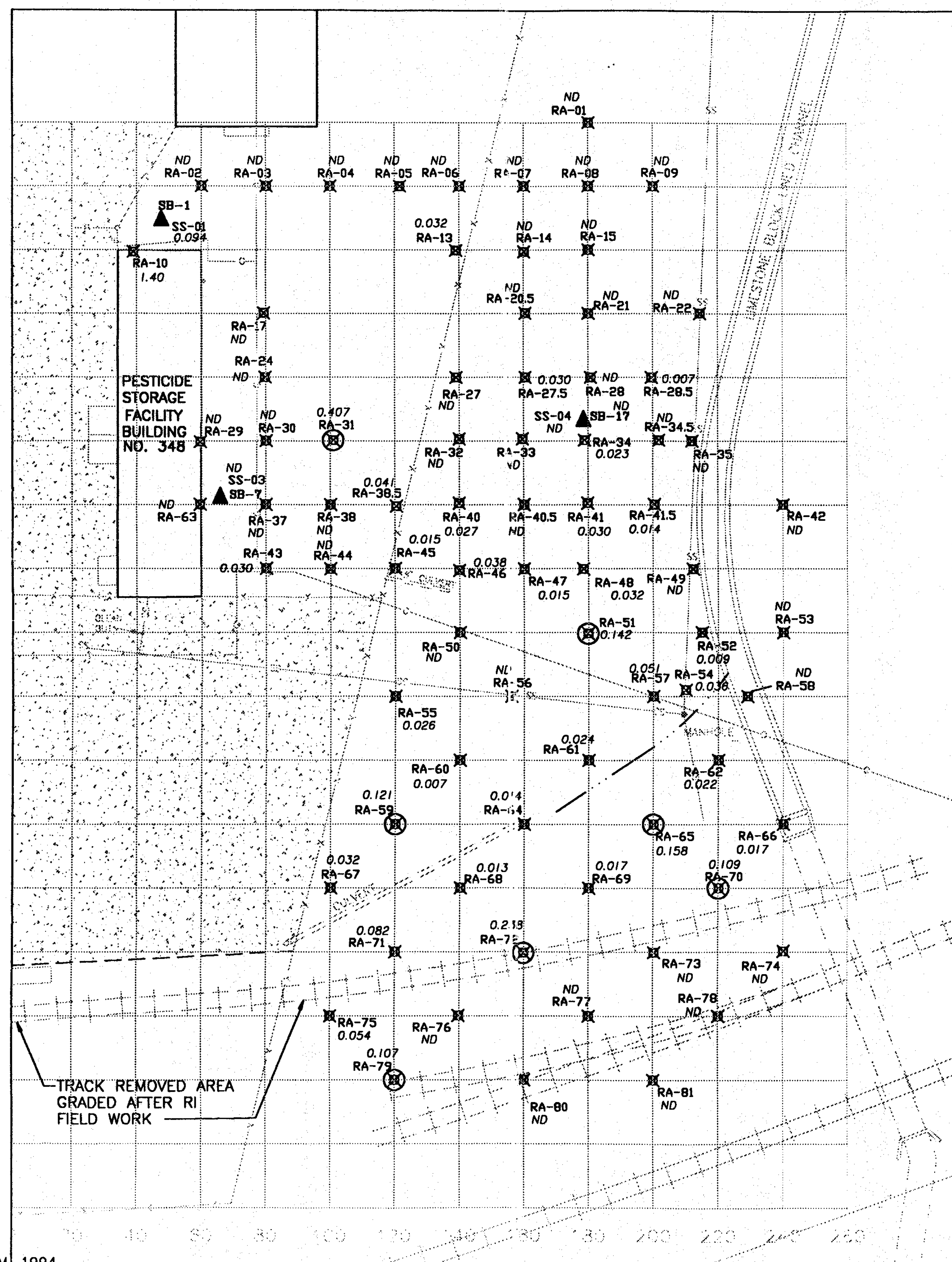
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SURFACE SOIL CONTAMINATION DDT & METABOLITES

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER: D-3	FILE DATE:	21.OCTOBER.94
CHECKED BY/DATE:	EFW/5-95		PLOT DATE:	5-2-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	SAMPE--NE.DWG



LEGEND:

- SURFACE SOIL SAMPLE EXCEEDING 0.10 mg/kg
- SURFACE SOIL SAMPLE LOCATION (1992 RI)
- SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)
- ASPHALT
- RAILROAD
- GAS LINES
- FENCE
- SANITARY SEWER
- OVERHEAD POWERLINE

NOTES

1. SURFACE SOILS ARE LESS THAN 2 FEET IN DEPTH
2. SB-1 IS ALSO SS-01 LOCATION
   SB-7 IS ALSO SS-03 LOCATION
   SB-17 IS ALSO SS-04 LOCATION

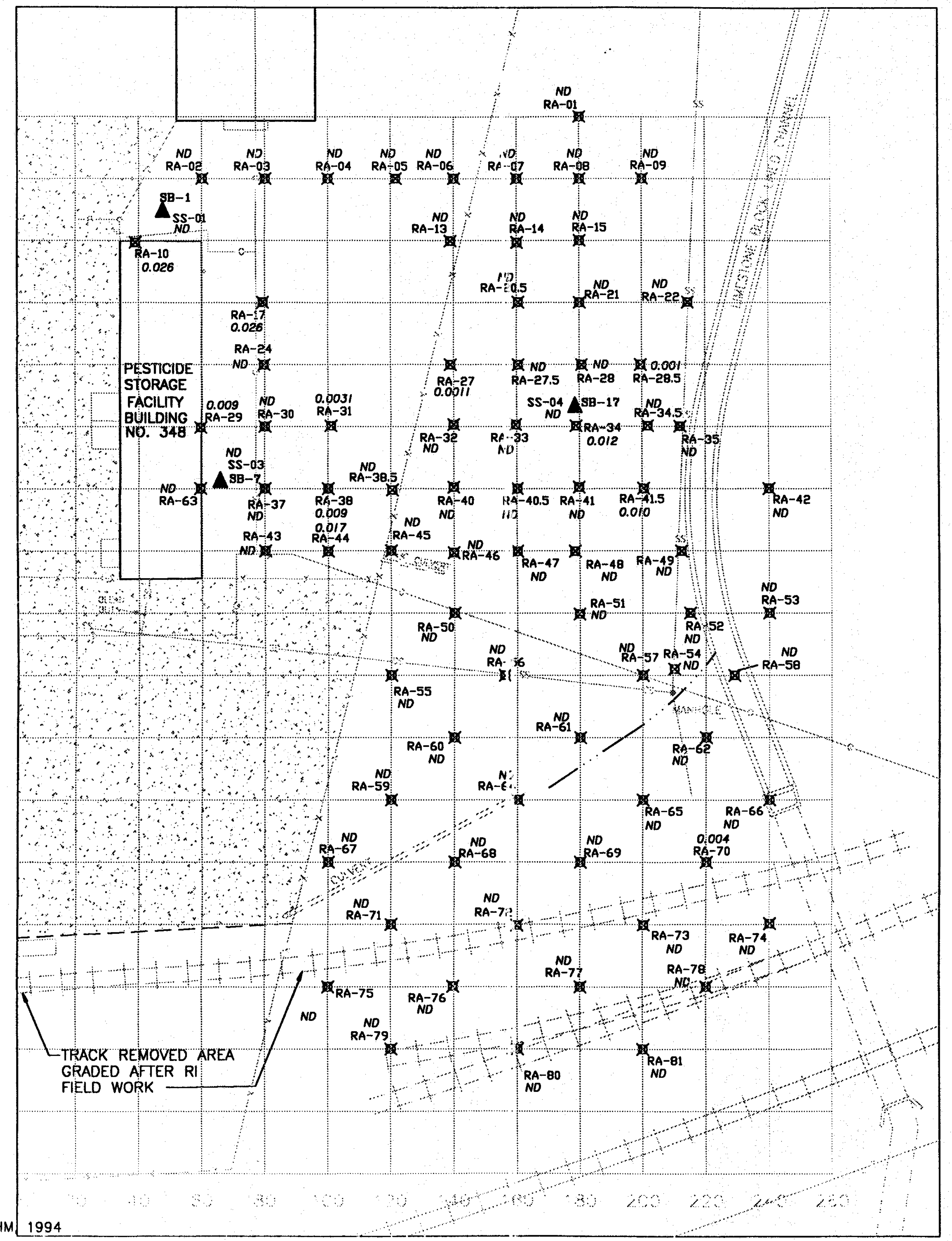
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SURFACE SOIL CONTAMINATION DIELDRIN

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	FILE DATE: 21.OCTOBER.94	
CHECKED BY/DATE: EFW/5-95	D-4	PLOT DATE: 5-2-95	
APPROVED BY/DATE: KAH/5-95		FILE NAME: SAMPE-NE.DWG	



MAP SOURCE: OHM 1994

LEGEND:

- ▲ SURFACE SOIL SAMPLE LOCATION (1992 RI)
- ⊠ SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)
- ASPHALT
- RAILROAD
- GAS LINES
- FENCE
- SANITARY SEWER
- OVERHEAD POWERLINE

0 40 80

SCALE IN FEET

UNITED STATES ARMY

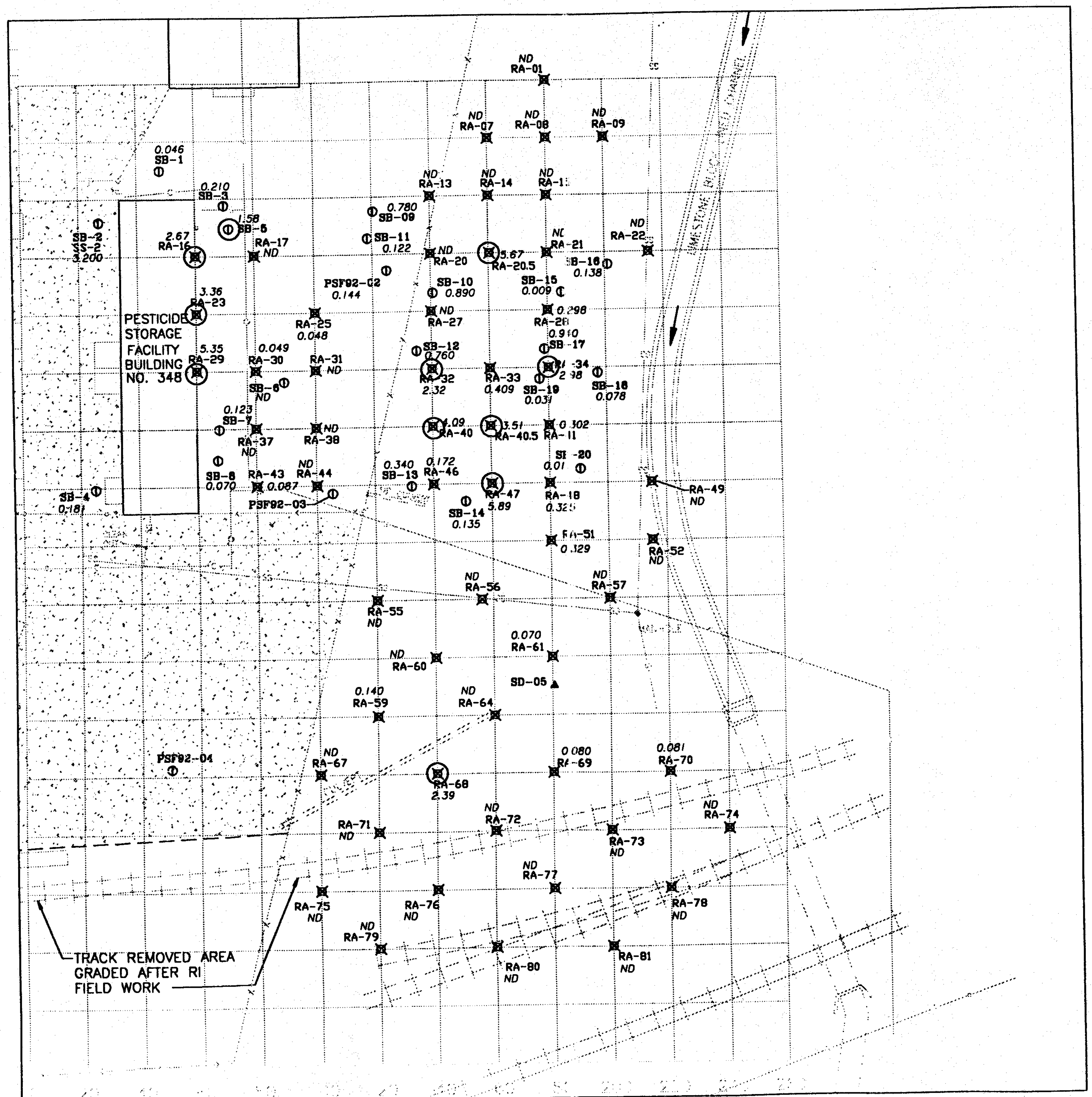
FORT RILEY

FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SURFACE SOIL CONTAMINATION HEPTACHLOR

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	FILE DATE: 21.OCTOBER.94	
CHECKED BY/DATE: EFW/5-95	D-5	PLOT DATE: 5-2-95	
APPROVED BY/DATE: KAH/5-95		FILE NAME: SAMPE-NE.DWG	



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80

SCALE IN FEET

MAP SOURCE: OHM, 1994

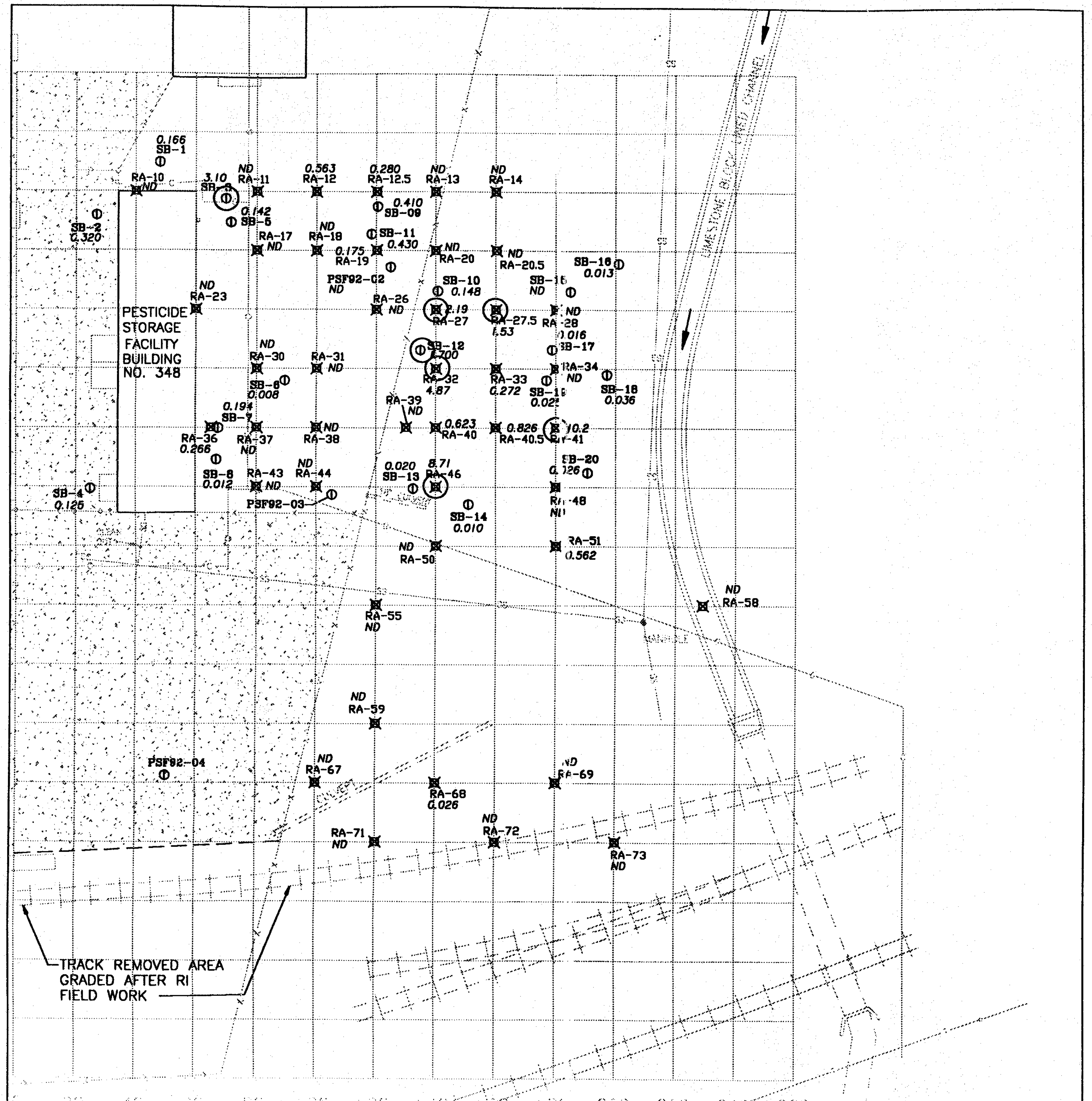
UNITED STATES ARMY

FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SUBSURFACE SOIL CONTAMINATION CHLORDANE 2'-3' DEPTH

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-6	PLOT DATE:	5-2-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	CHL01.DWG



MAP SOURCE: OHM, 1994

LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

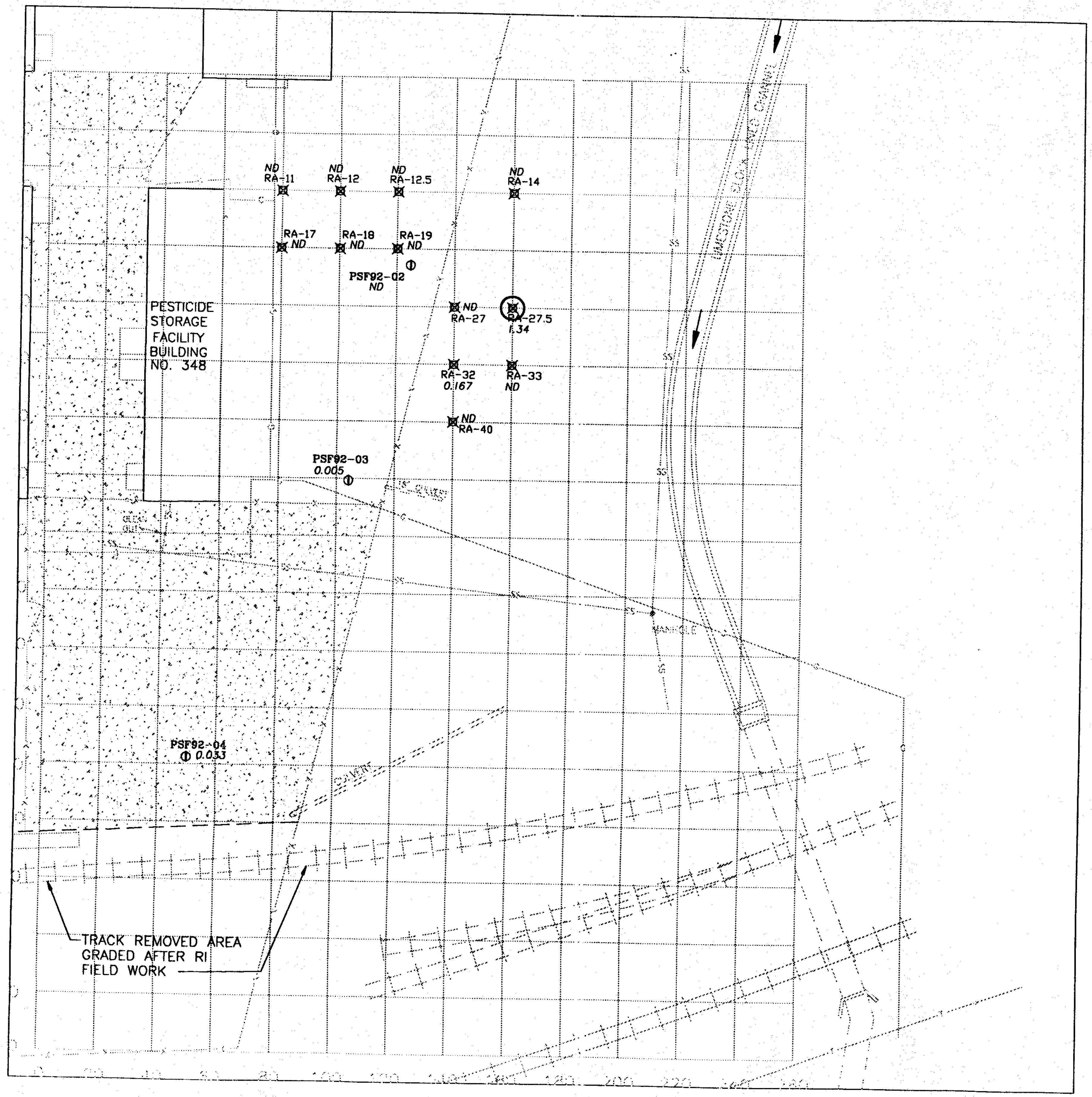
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SUBSURFACE SOIL CONTAMINATION CHLORDANE 4'-5' DEPTH

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE: EFW/5-95	D-7	PLOT DATE:	5-2-95
APPROVED BY/DATE: KAH/5-95		FILE NAME:	CHL02.DWG



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80

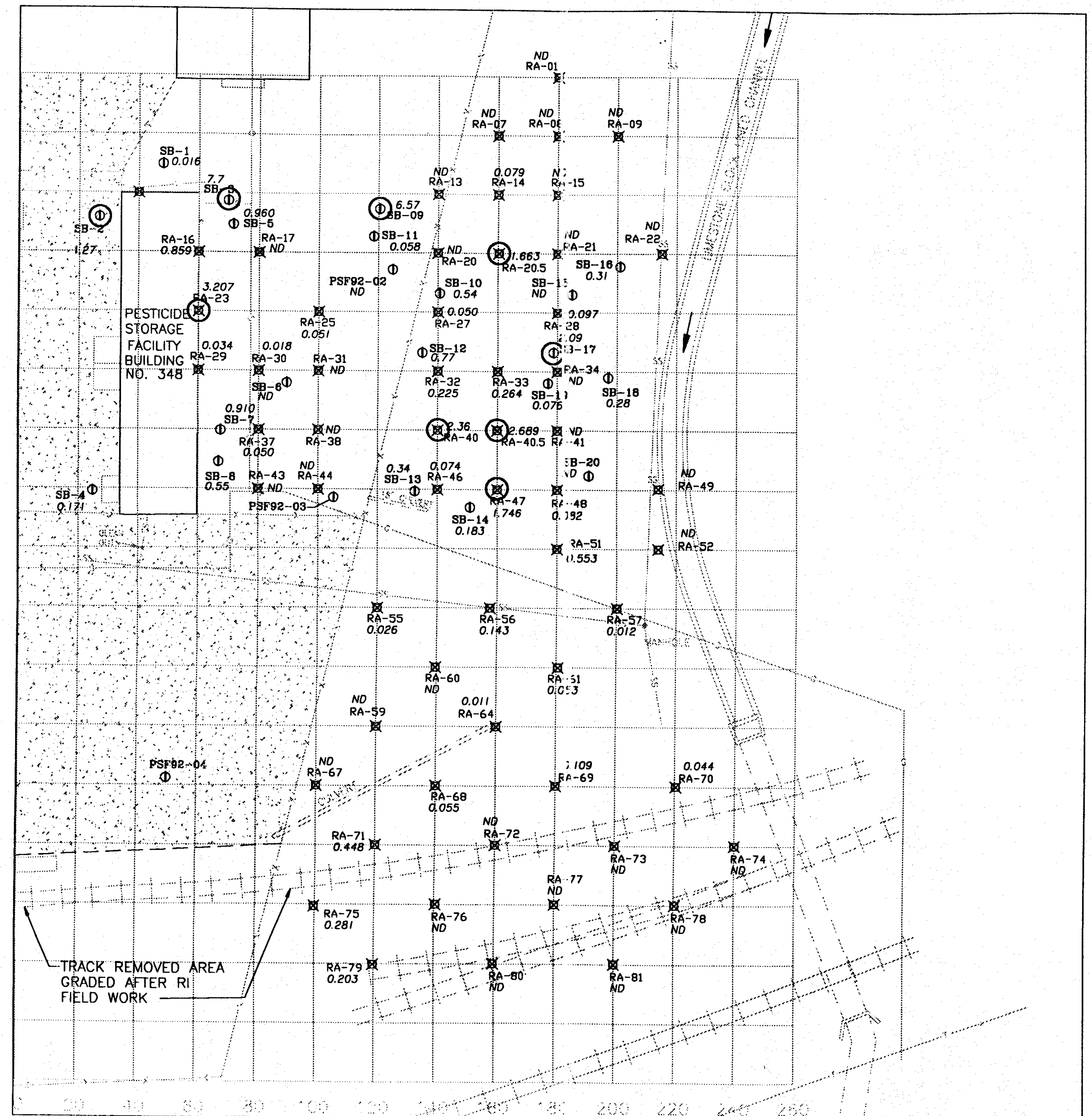
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SUBSURFACE SOIL CONTAMINATIONS CHLORDANE 6' AND GREATER

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-8	PLOT DATE:	5-2-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	CHL03.DWG



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80

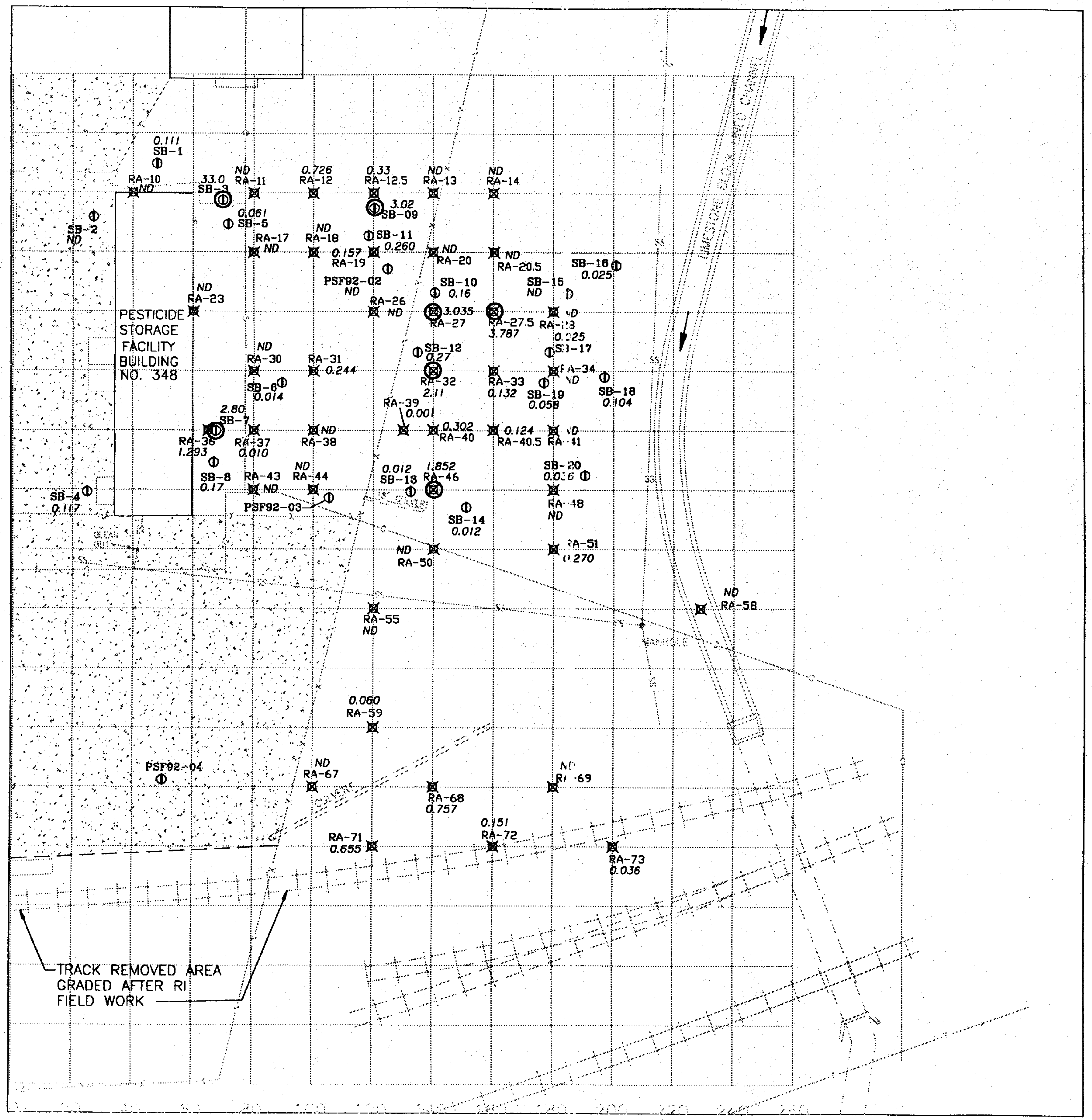
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SUBSURFACE SOIL CONTAMINATIONS DDT 2'-3' DEPTH

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-9	PLOT DATE:	5-3-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	DDT01.DWG



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80

SCALE IN FEET

UNITED STATES ARMY

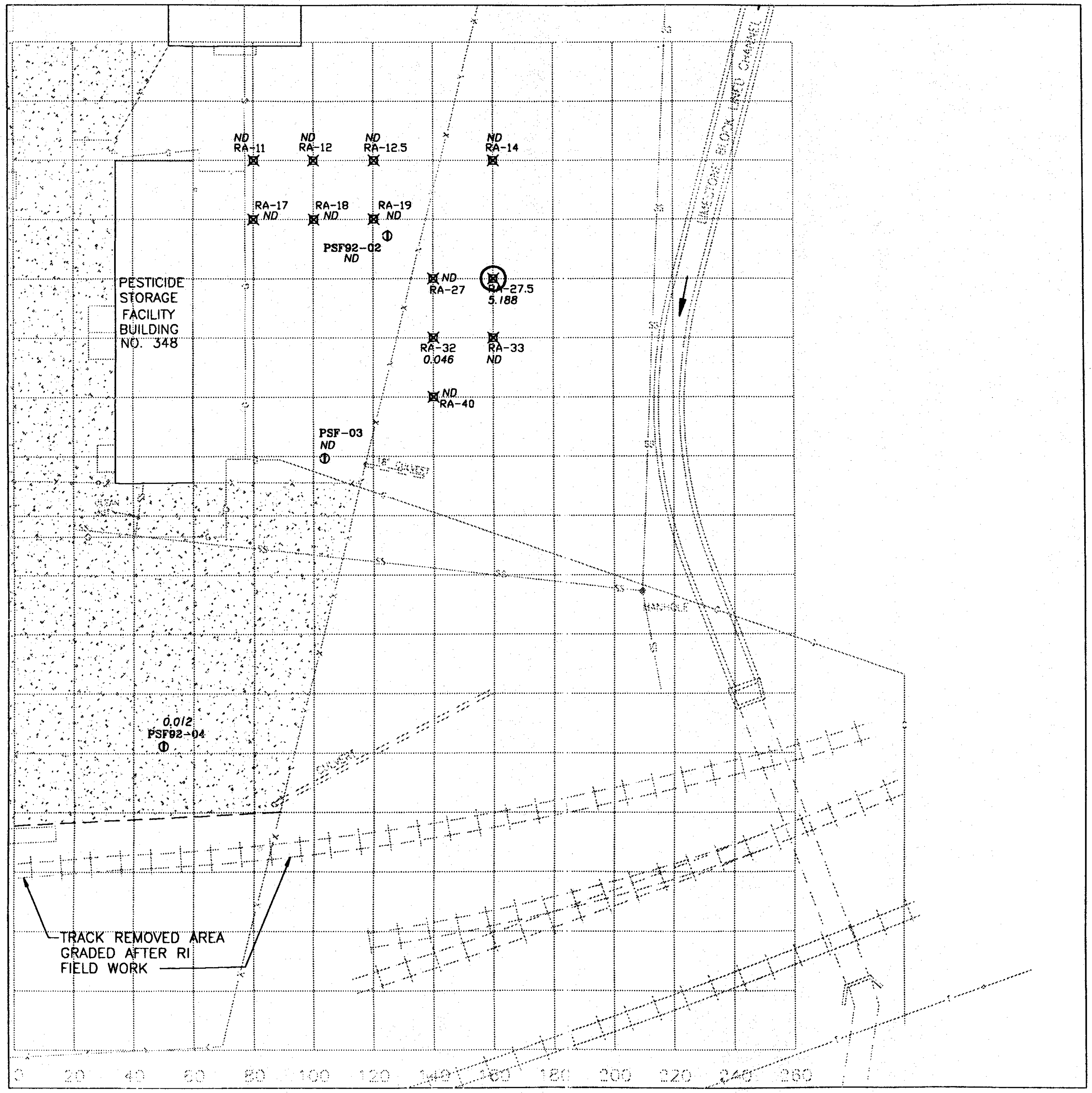
FORT RILEY

FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SUBSURFACE SOIL CONTAMINATIONS DDT 4'-5' DEPTH

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-10	PLOT DATE:	5-1-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	DDT02.DWG



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

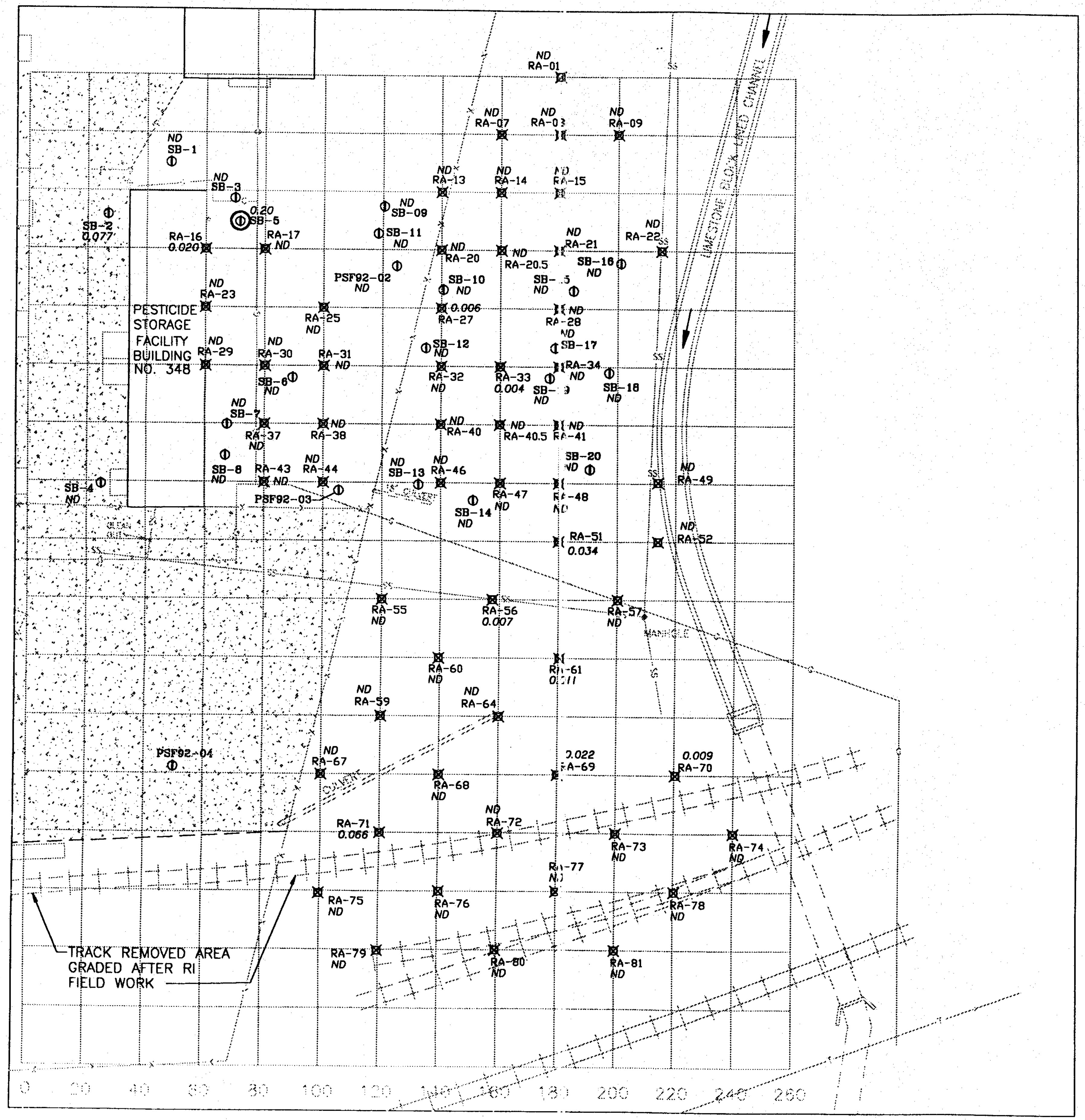
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SUBSURFACE SOIL CONTAMINATIONS DDT 6' AND GREATER

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-11	PLOT DATE:	5-1-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	DD103.DWG



MAP SOURCE: OHM, 1994

LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE LOCATIONS EXCEEDING 0.10 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80

SCALE IN FEET

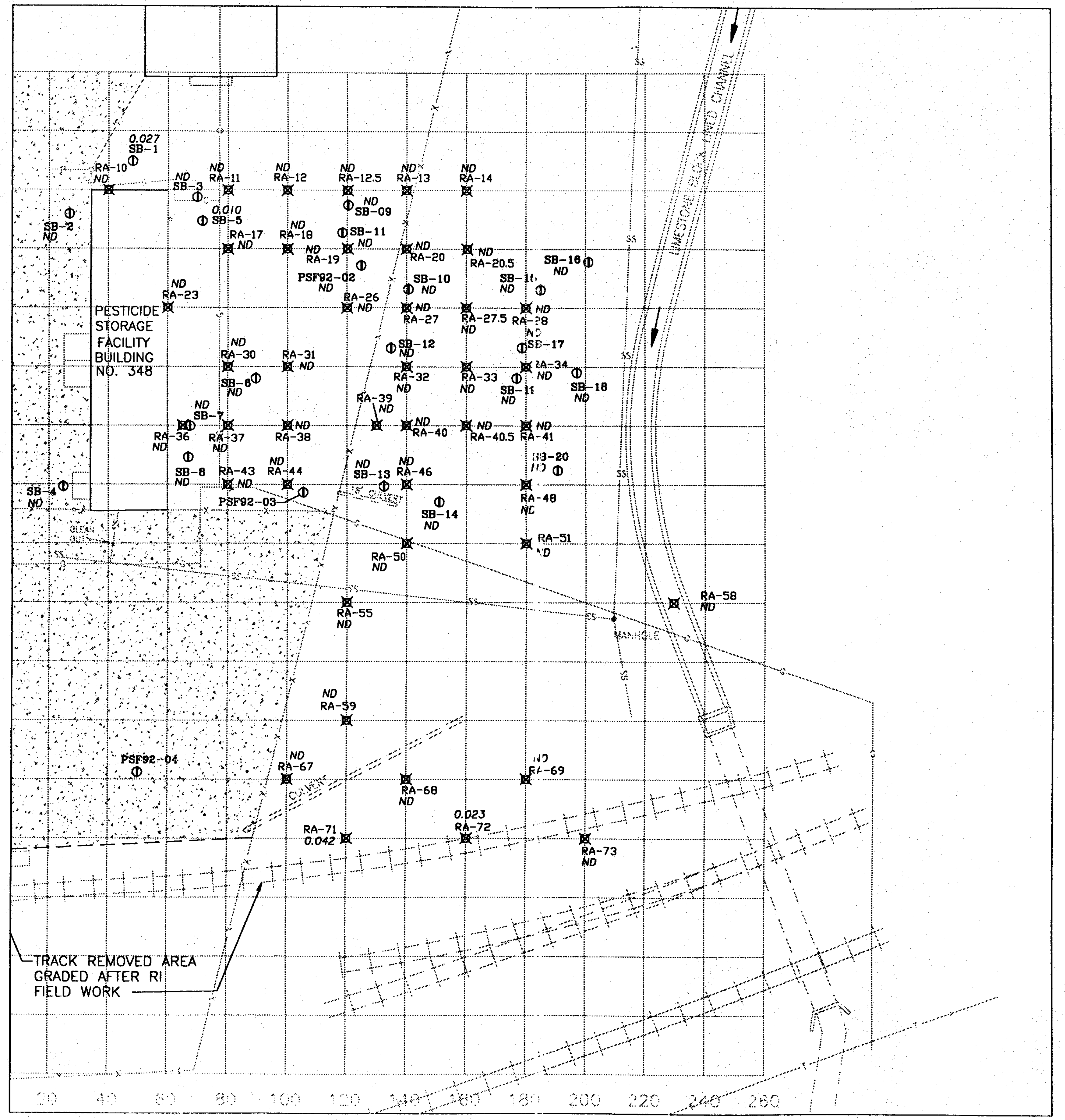
UNITED STATES ARMY

FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SUBSURFACE SOIL CONTAMINATIONS DIELDRIN 2'-3' DEPTH

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	D-12	FILE DATE:	12-5-94
CHECKED BY/DATE: EFW/5-95			PLOT DATE:	5-1-95
APPROVED BY/DATE: KAH/5-95			FILE NAME:	DLD01.DWG



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80
SCALE IN FEET

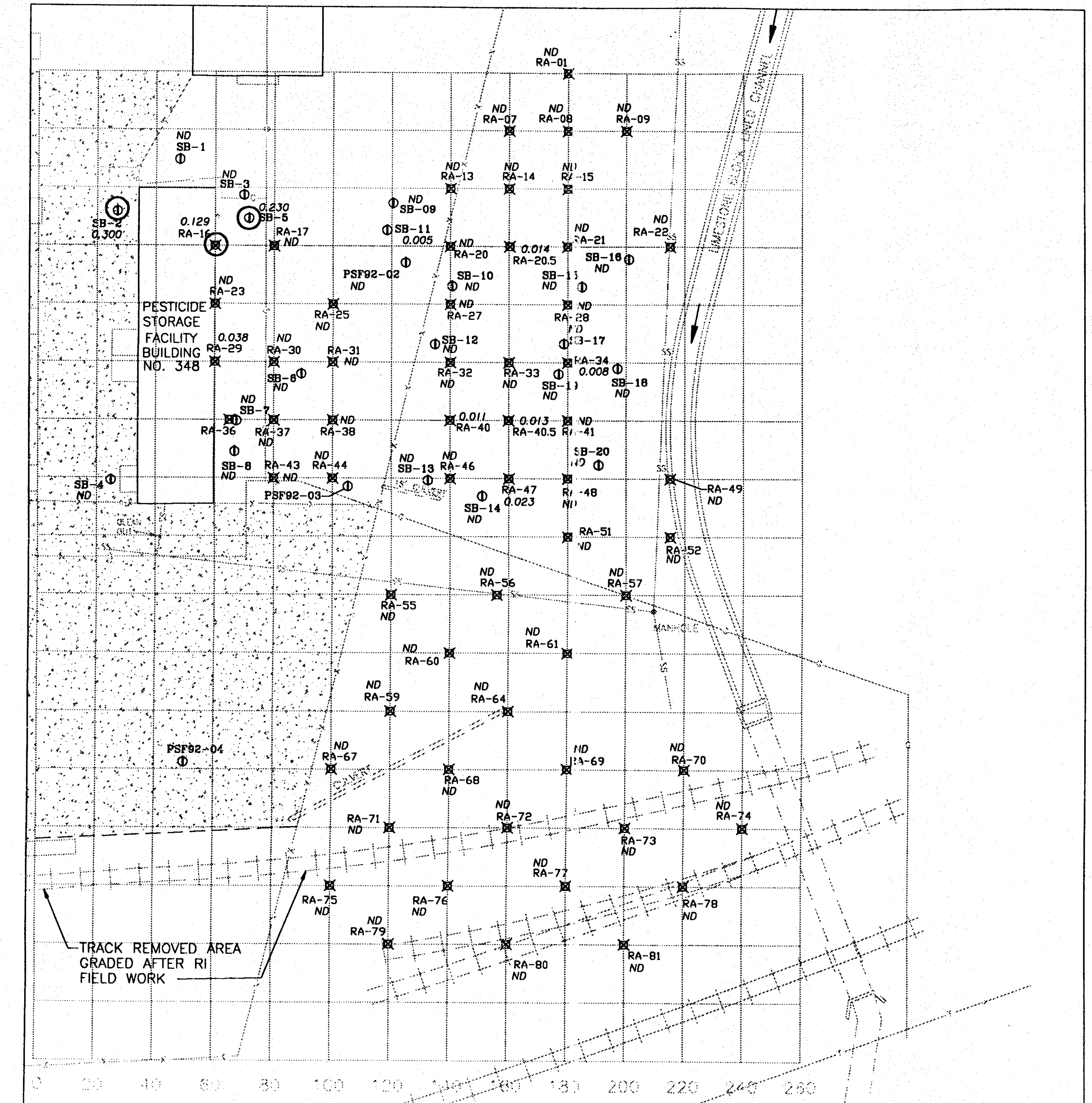
MAP SOURCE: OHM, 1994

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE–REMOVAL ACTION SUBSURFACE SOIL CONTAMINATIONS DIELDRIN 4'–5' DEPTH

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-13	PLOT DATE:	5-1-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	DLD02.DWG



MAP SOURCE: OHM, 1994

LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE LOCATIONS EXCEEDING 0.05 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80

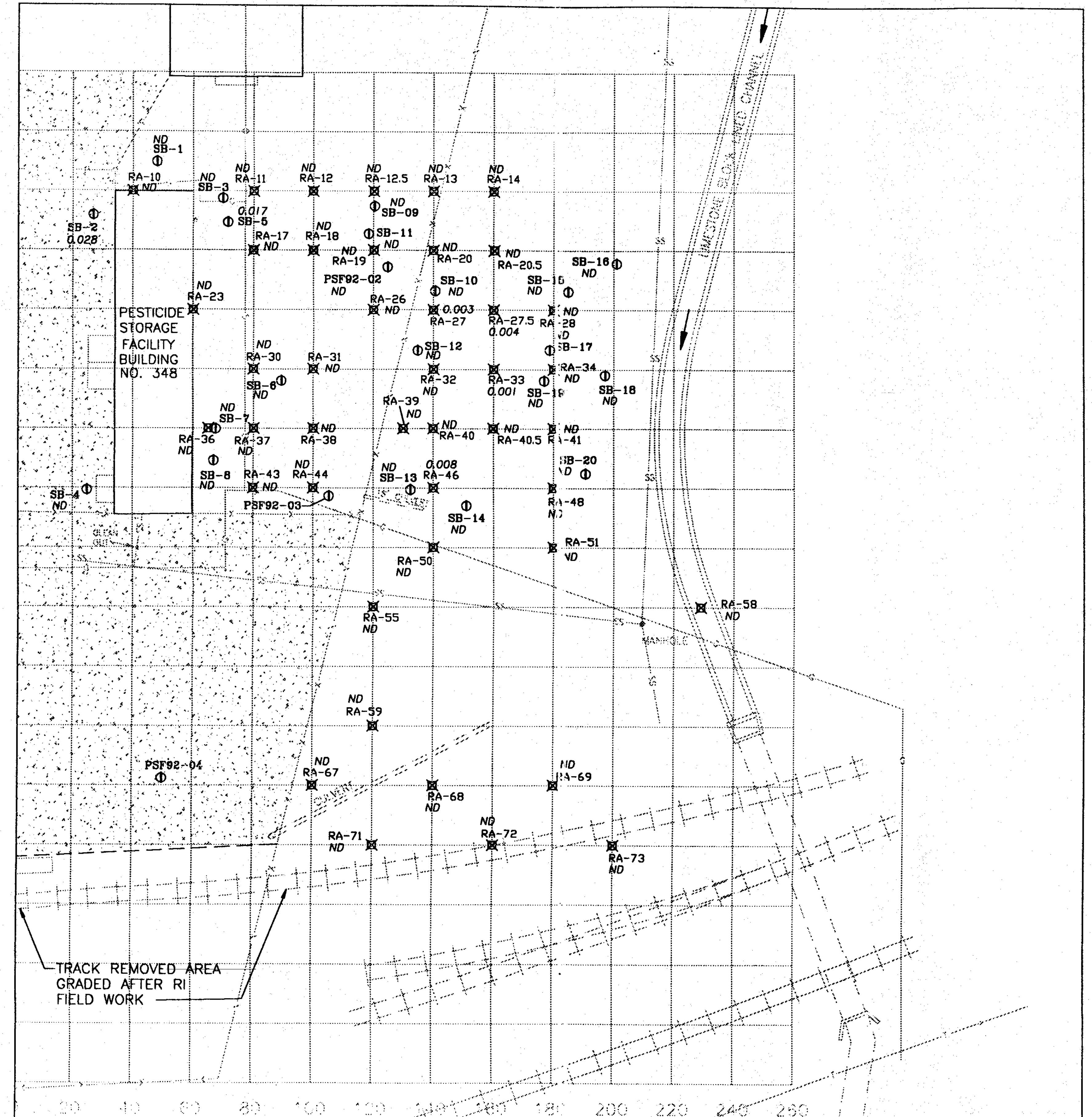
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SUBSURFACE SOIL CONTAMINATION HEPTACHLOR 2'-3' DEPTH

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER: D-14	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95		PLOT DATE:	5-1-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	HEPT01.DWG



MAP SOURCE: OHM, 1994

LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80

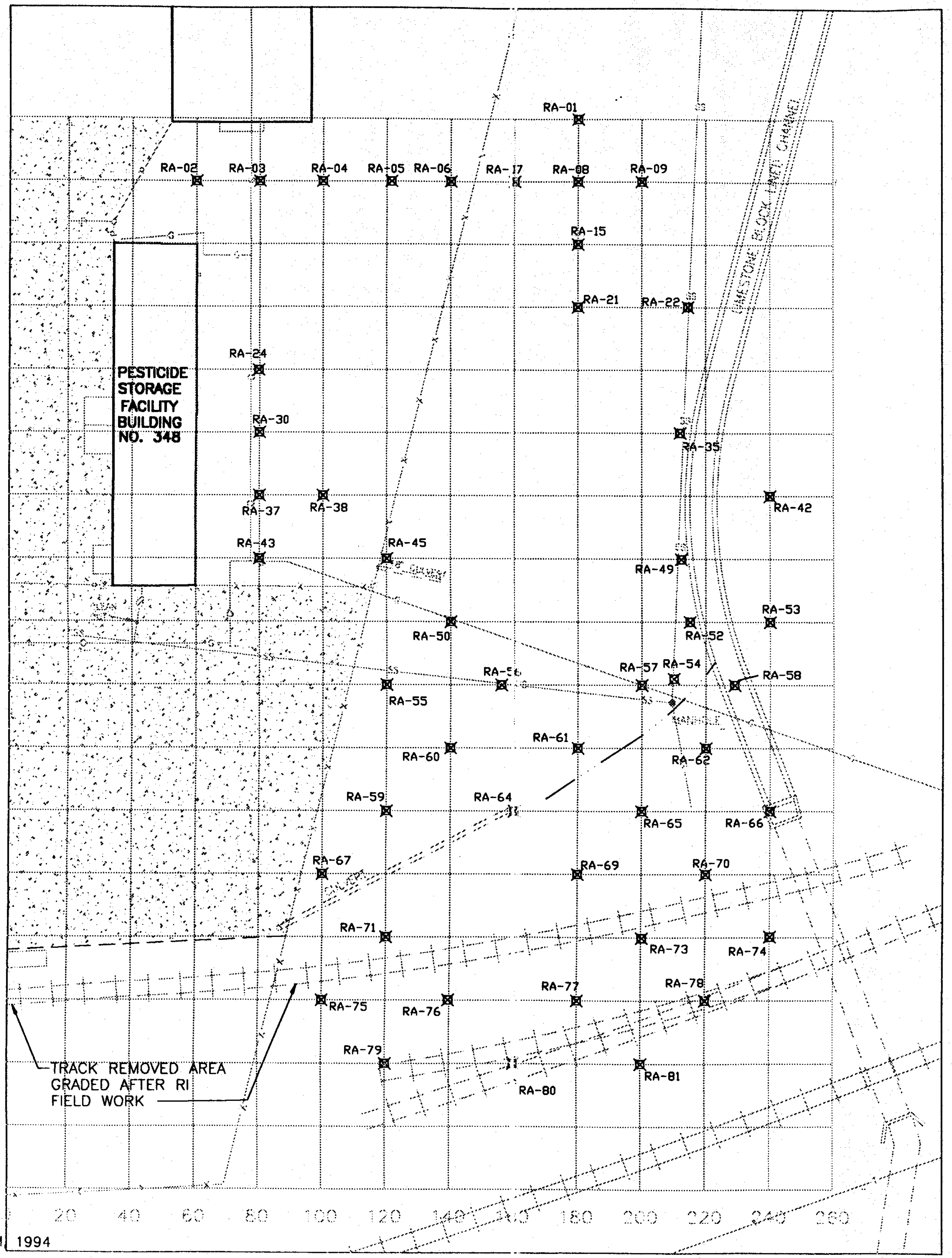
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

PRE-REMOVAL ACTION SUBSURFACE SOIL CONTAMINATION HEPTACHLOR 4'-5' DEPTH

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-15	PLOT DATE:	5-1-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	HEPT02.DWG



MAP SOURCE: OHM 1994

LEGEND:

- ▲ SURFACE SOIL SAMPLE LOCATION (1992 RI)
- ☒ SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)
- ASPHALT
- RAILROAD
- GAS LINES
- FENCE
- SANITARY SEWER
- OVERHEAD POWERLINE

0 40 80

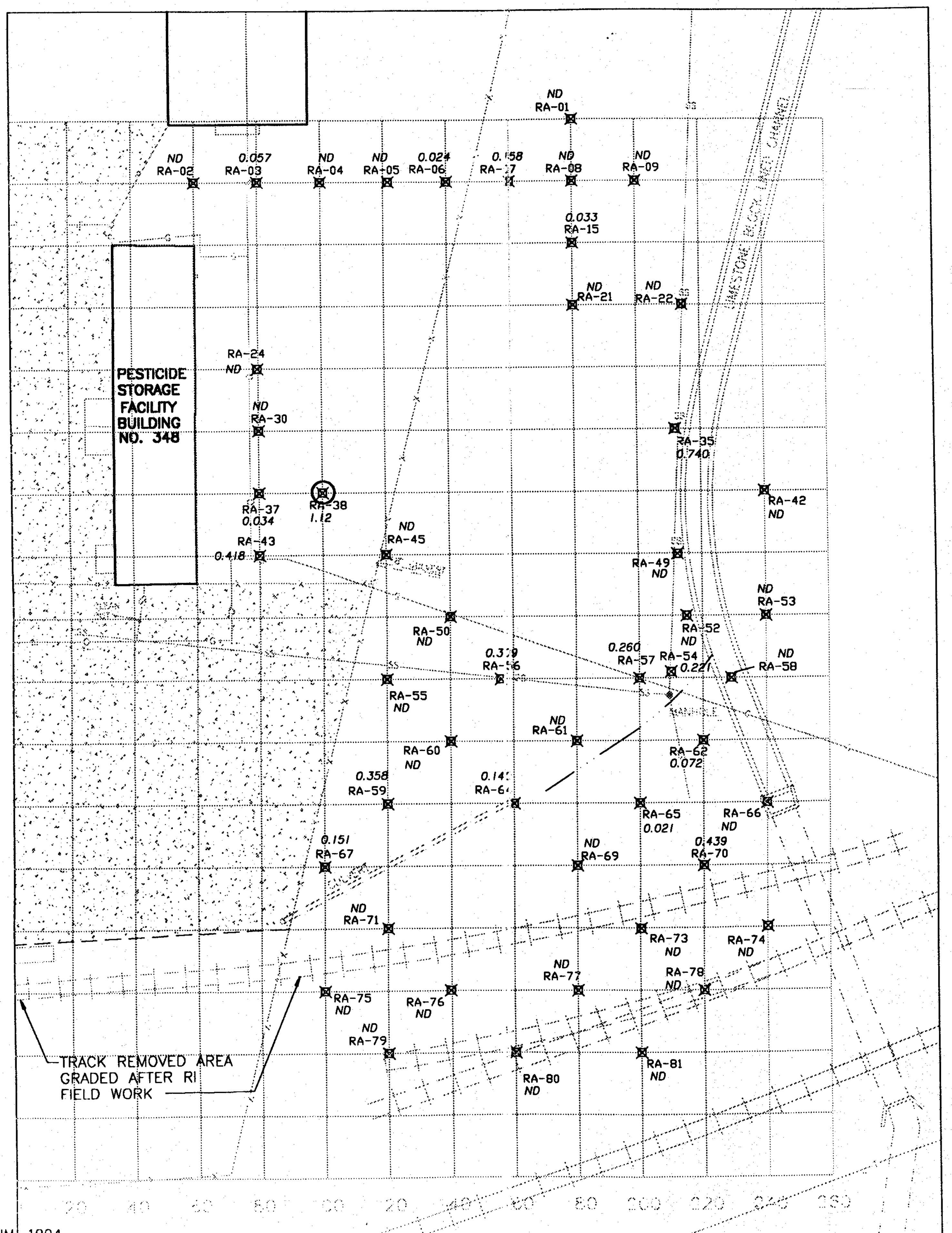
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SURFACE SOIL LOCATIONS SAMPLED DURING THE RI AND REMOVAL ACTION

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	FILE DATE: 21.OCTOBER.94	
CHECKED BY/DATE: EFW/5-95	D-16	PLOT DATE: 5-2-95	
APPROVED BY/DATE: KAH/5-95		FILE NAME: RIREM01.DWG	



MAP SOURCE: OHM 1994

LEGEND:

- SURFACE SOIL SAMPLE EXCEEDING 1.0 mg/kg
- SURFACE SOIL SAMPLE LOCATION (1992 RI)
- SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)
- ASPHALT
- RAILROAD
- GAS LINES
- FENCE
- SANITARY SEWER
- OVERHEAD POWERLINE

NOTES

1. SURFACE SOILS ARE LESS THAN 2 FEET IN DEPTH
2. SB-1 IS ALSO SS-01 LOCATION
   SB-7 IS ALSO SS-03 LOCATION
   SB-17 IS ALSO SS-04 LOCATION

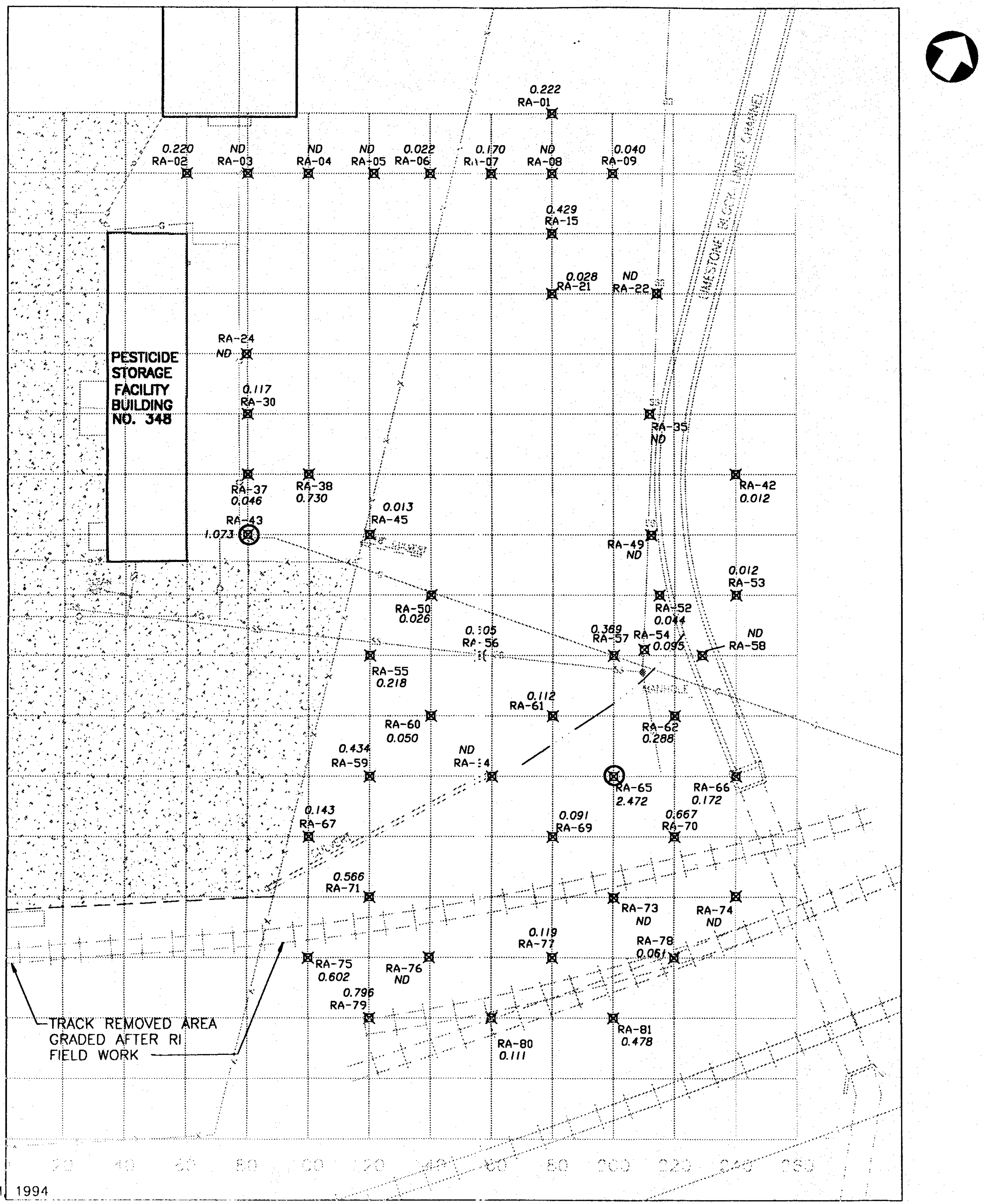
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SURFACE SOIL CONTAMINATION CHLORDANE

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	FILE DATE:	21.OCTOBER.94
CHECKED BY/DATE: EFW/5-95	D-17	PLOT DATE:	5-2-95
APPROVED BY/DATE: KAH/5-95		FILE NAME:	SAMP01.DWG



MAP SOURCE: OHM 1994

LEGEND:

- SURFACE SOIL SAMPLE EXCEEDING 1.0 mg/kg
- SURFACE SOIL SAMPLE LOCATION (1992 RI)
- SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)
- ASPHALT
- RAILROAD
- GAS LINES
- FENCE
- SANITARY SEWER
- OVERHEAD POWERLINE

NOTES

1. SURFACE SOILS ARE LESS THAN 2 FEET IN DEPTH
2. SB-1 IS ALSO SS-01 LOCATION
   SB-7 IS ALSO SS-03 LOCATION
   SB-17 IS ALSO SS-04 LOCATION
3. CONCENTRATIONS SHOWN ARE THE SUM OF DDT AND METABOLITES, WHEN ANALYZED SEPARATELY.

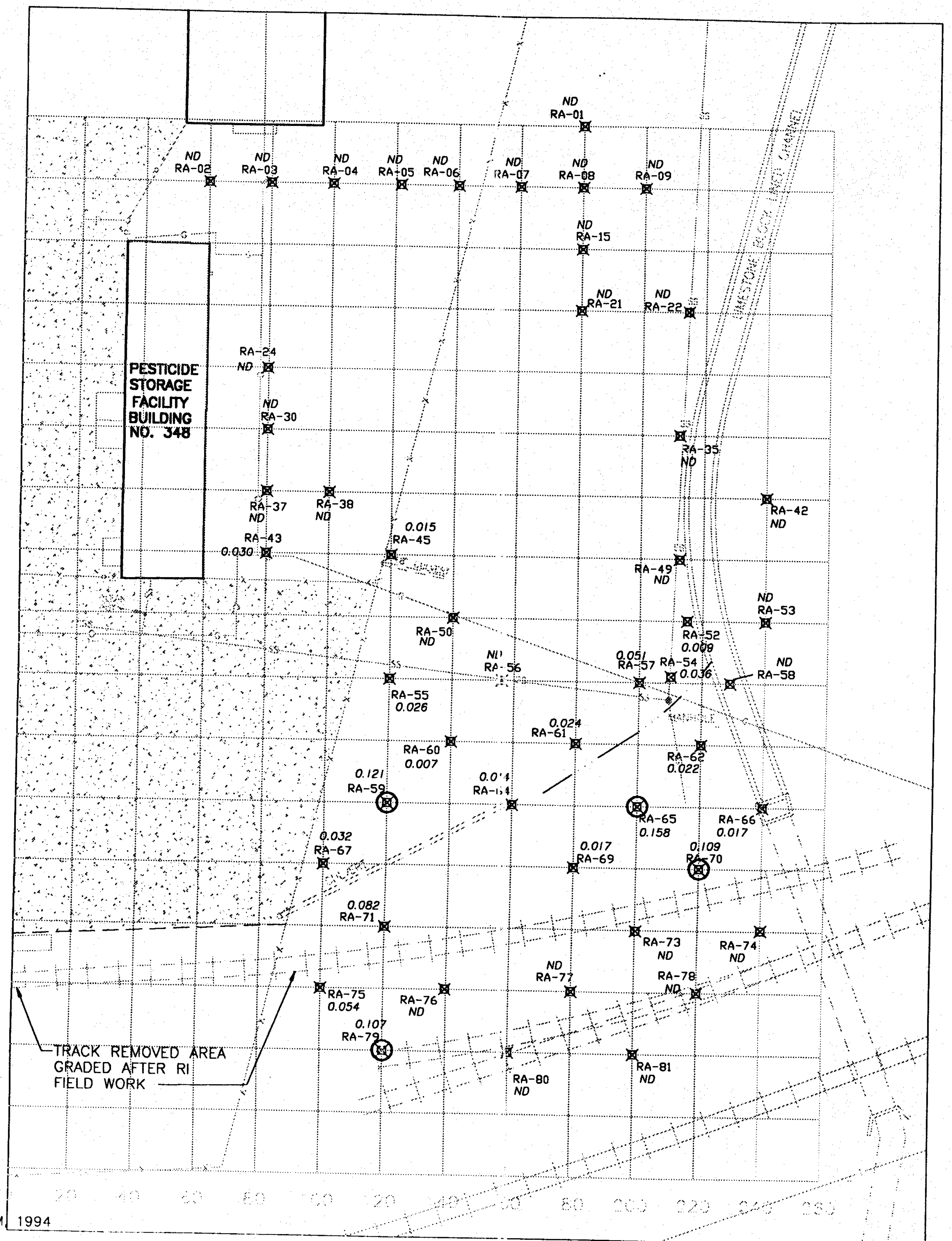
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SURFACE SOIL CONTAMINATION DDT & METABOLITES

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	21.OCTOBER.94
CHECKED BY/DATE:	EFW/5-95	D-18	PLOT DATE:	5-2-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	SAMP01.DWG



MAP SOURCE: OHM, 1994

LEGEND:

- SURFACE SOIL SAMPLE EXCEEDING 0.1 mg/kg
- ▲ SURFACE SOIL SAMPLE LOCATION (1992 RI)
- SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)
- ASPHALT
- RAILROAD
- GAS LINES
- FENCE
- SANITARY SEWER
- OVERHEAD POWERLINE

NOTES

1. SURFACE SOILS ARE LESS THAN 2 FEET IN DEPTH
2. SB-1 IS ALSO SS-01 LOCATION
   SB-7 IS ALSO SS-03 LOCATION
   SB-17 IS ALSO SS-04 LOCATION

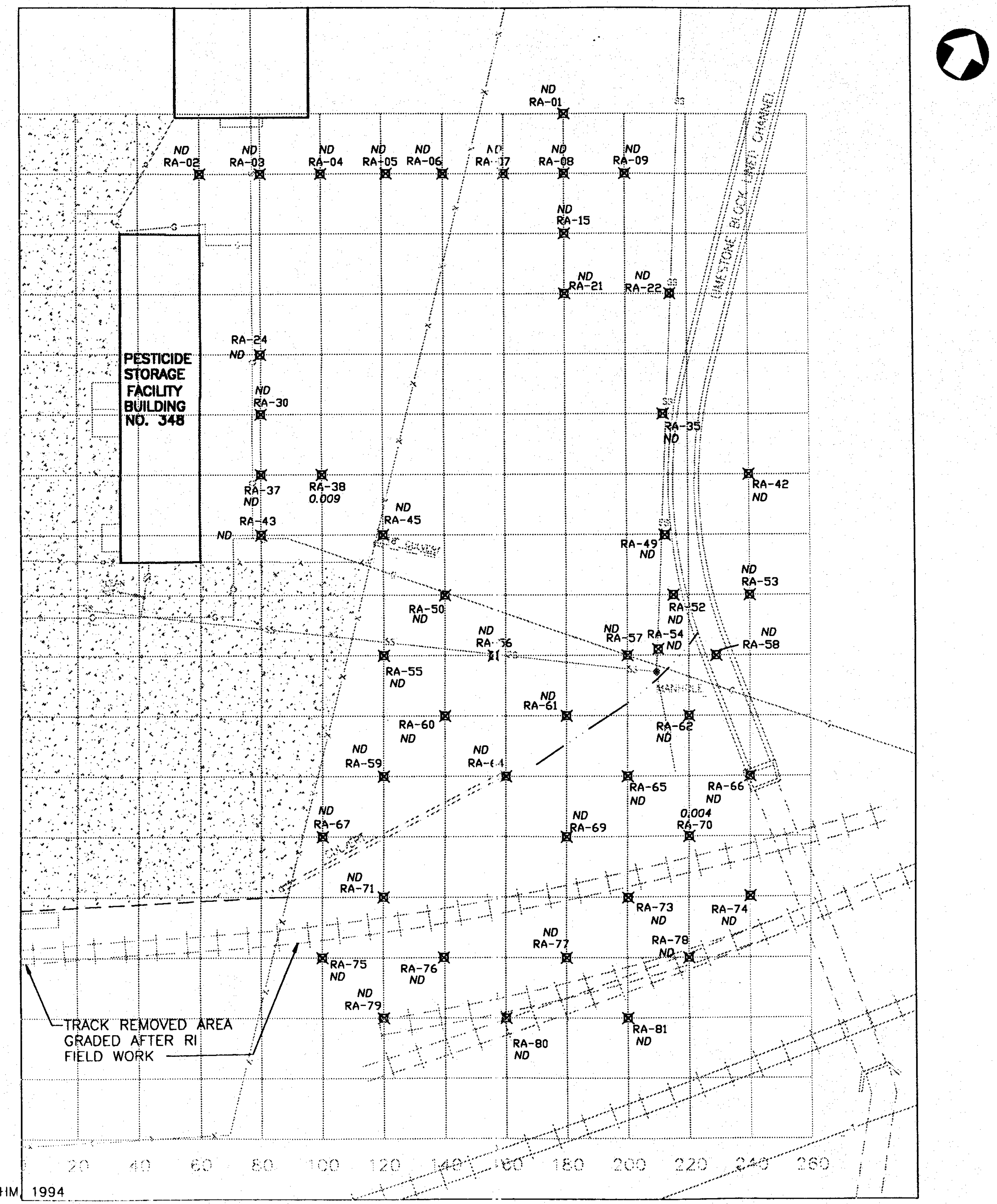
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SURFACE SOIL CONTAMINATION DIELDRIN

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER: D-19	FILE DATE: 21.OCTOBER.94
CHECKED BY/DATE: EFW/5-95		PLOT DATE: 5-2-95
APPROVED BY/DATE: KAH/5-95		FILE NAME: SAMP01.DWG



MAP SOURCE: OHM 1994

LEGEND:

- ▲ SURFACE SOIL SAMPLE LOCATION (1992 RI)
- ⊠ SURFACE SOIL SAMPLE LOCATIONS (1994 REMOVAL ACTION)
- ASPHALT
- RAILROAD
- GAS LINES
- FENCE
- SANITARY SEWER
- OVERHEAD POWERLINE

0 40 80

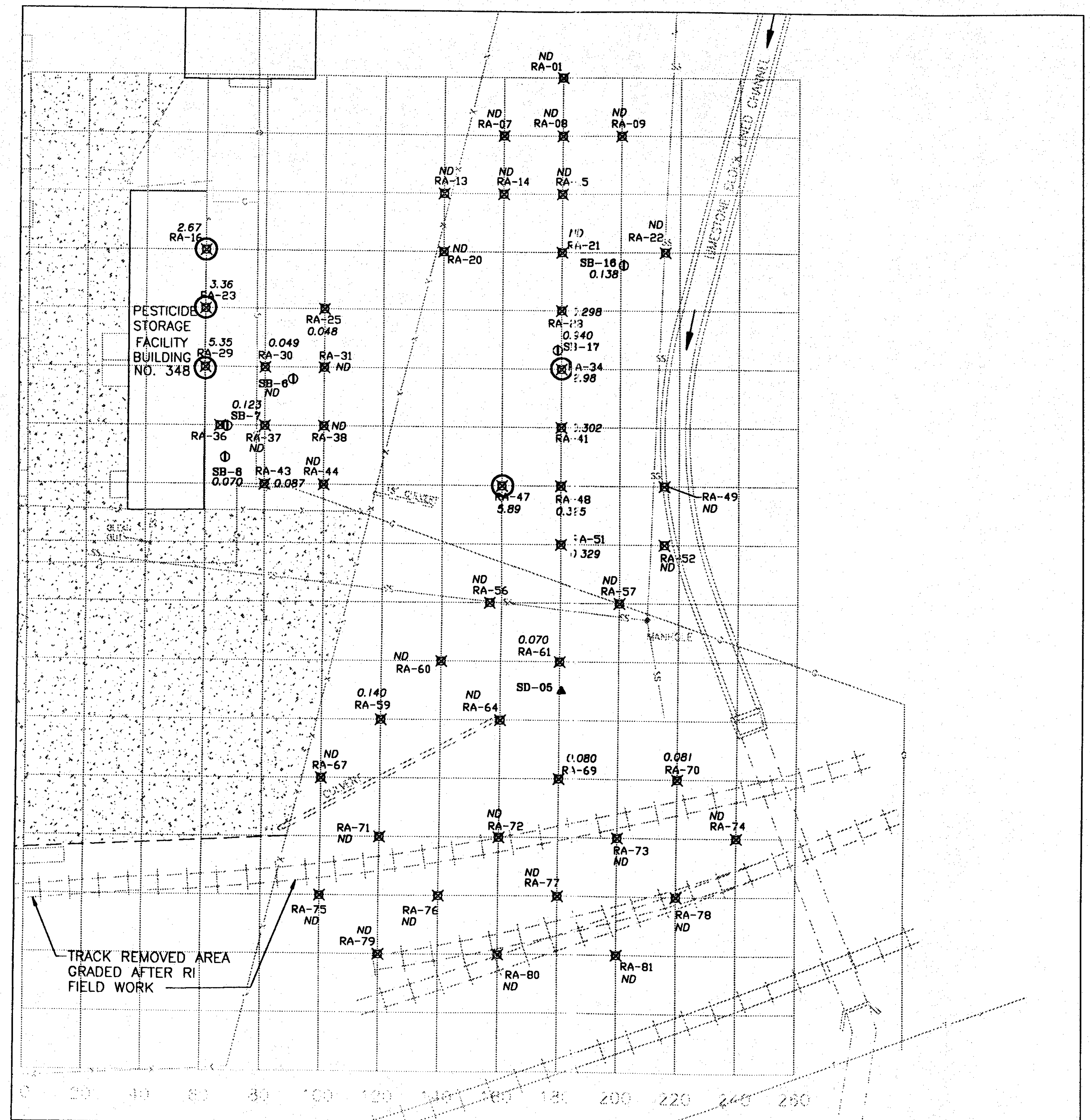
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SURFACE SOIL CONTAMINATION HEPTACHLOR

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	21.OCTOBER.94
CHECKED BY/DATE:	EFW/5-95	**D-20**	PLOT DATE:	5-2-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	HEPT05.DWG



MAP SOURCE: OHM, 1994

LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80

SCALE IN FEET

UNITED STATES ARMY

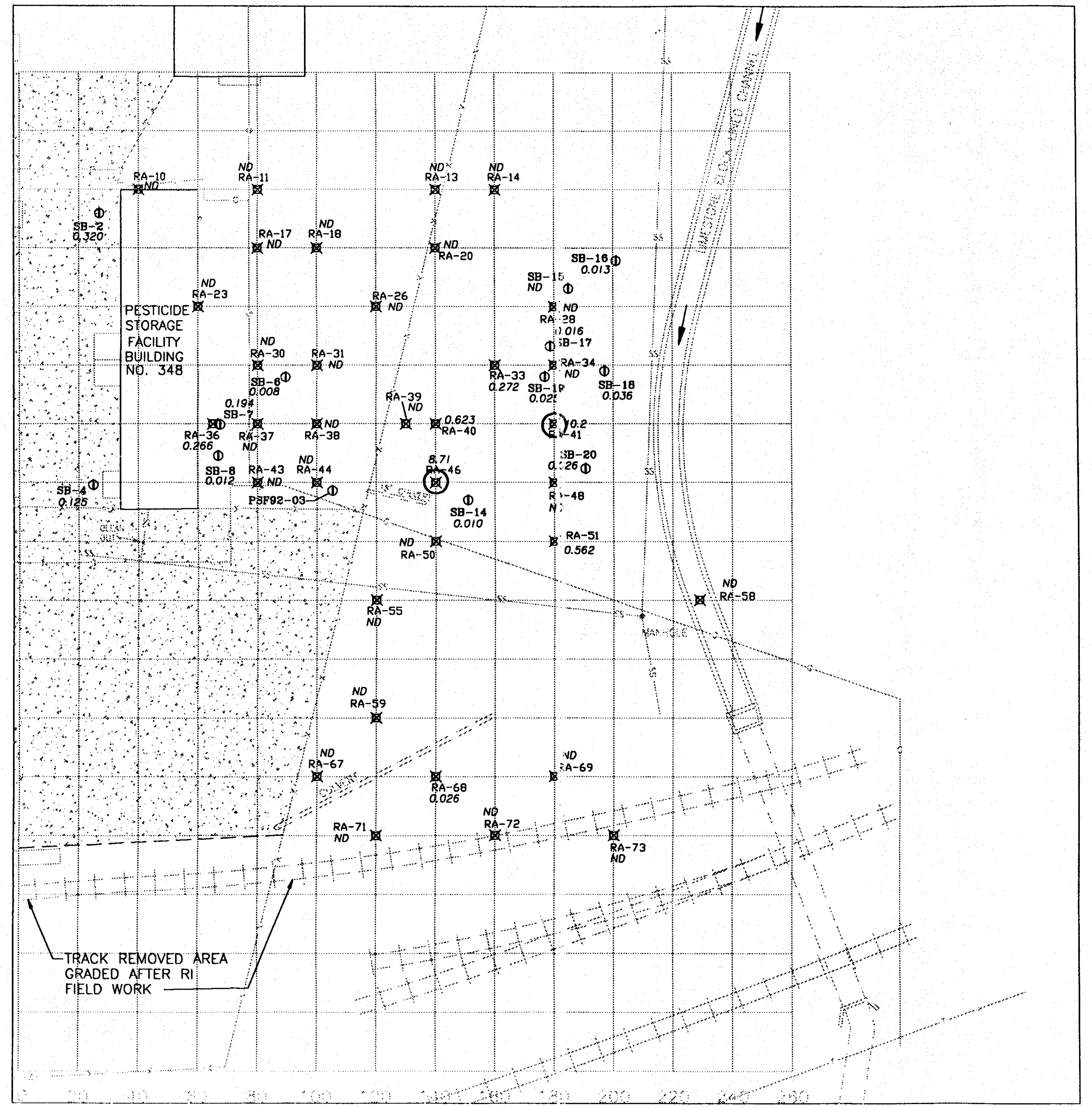
FORT RILEY

FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SUBSURFACE SOIL CONTAMINATION CHLORDANE 2'–3' DEPTH

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	FILE DATE: 12-5-94
CHECKED BY/DATE: EFW/5-95	D-21	PLOT DATE: 5-2-95
APPROVED BY/DATE: KAH/5-95		FILE NAME: CHL04.DWG



MAP SOURCE: OHM, 1994

LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

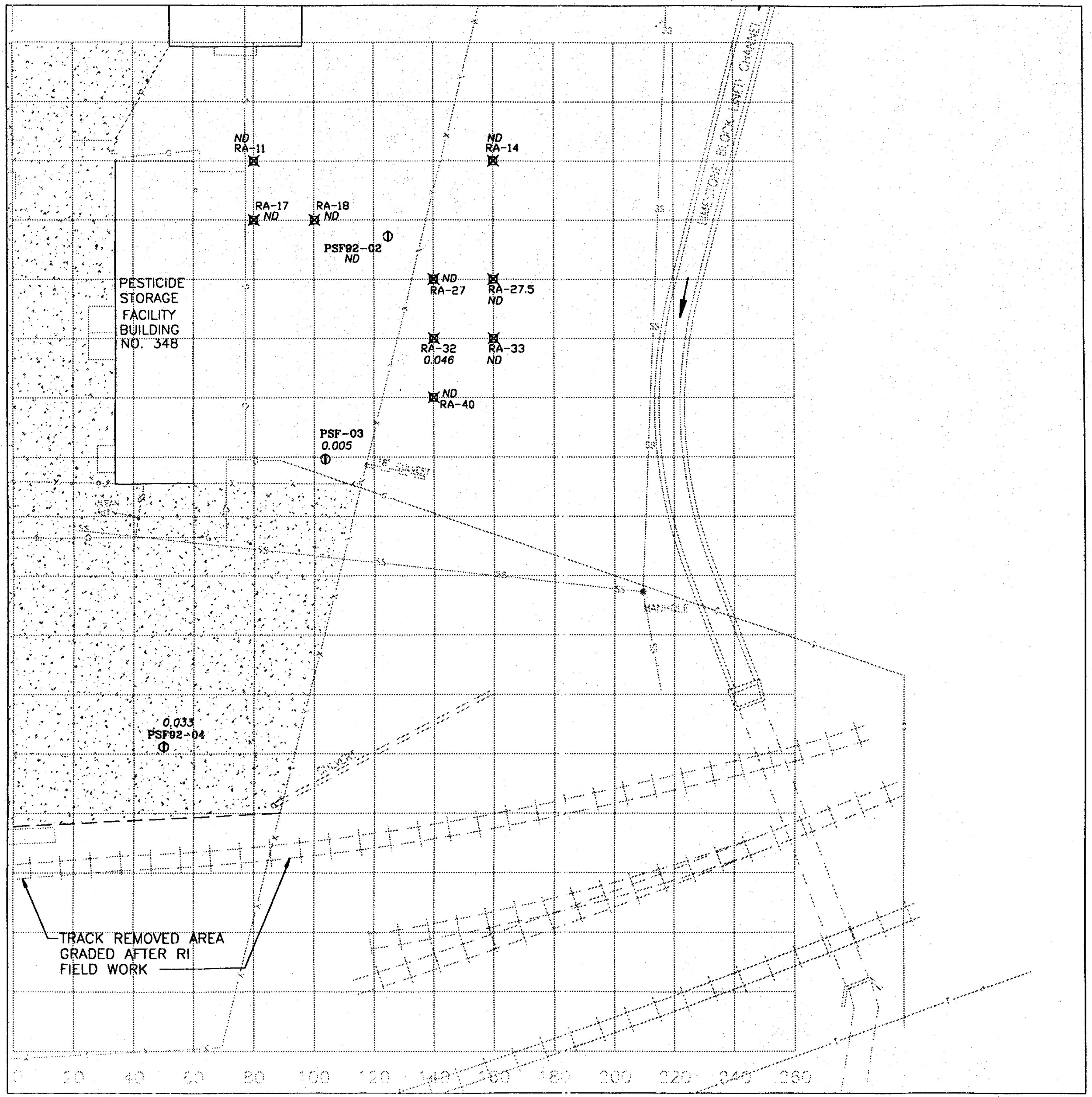
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SUBSURFACE SOIL CONTAMINATION CHLORDANE 4'–5' DEPTH

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	FILE DATE: 12-5-94
CHECKED BY/DATE: EFW/5-95	D-22	PLOT DATE: 5-2-95
APPROVED BY/DATE: KAH/5-95		FILE NAME: CHL05.DWG



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

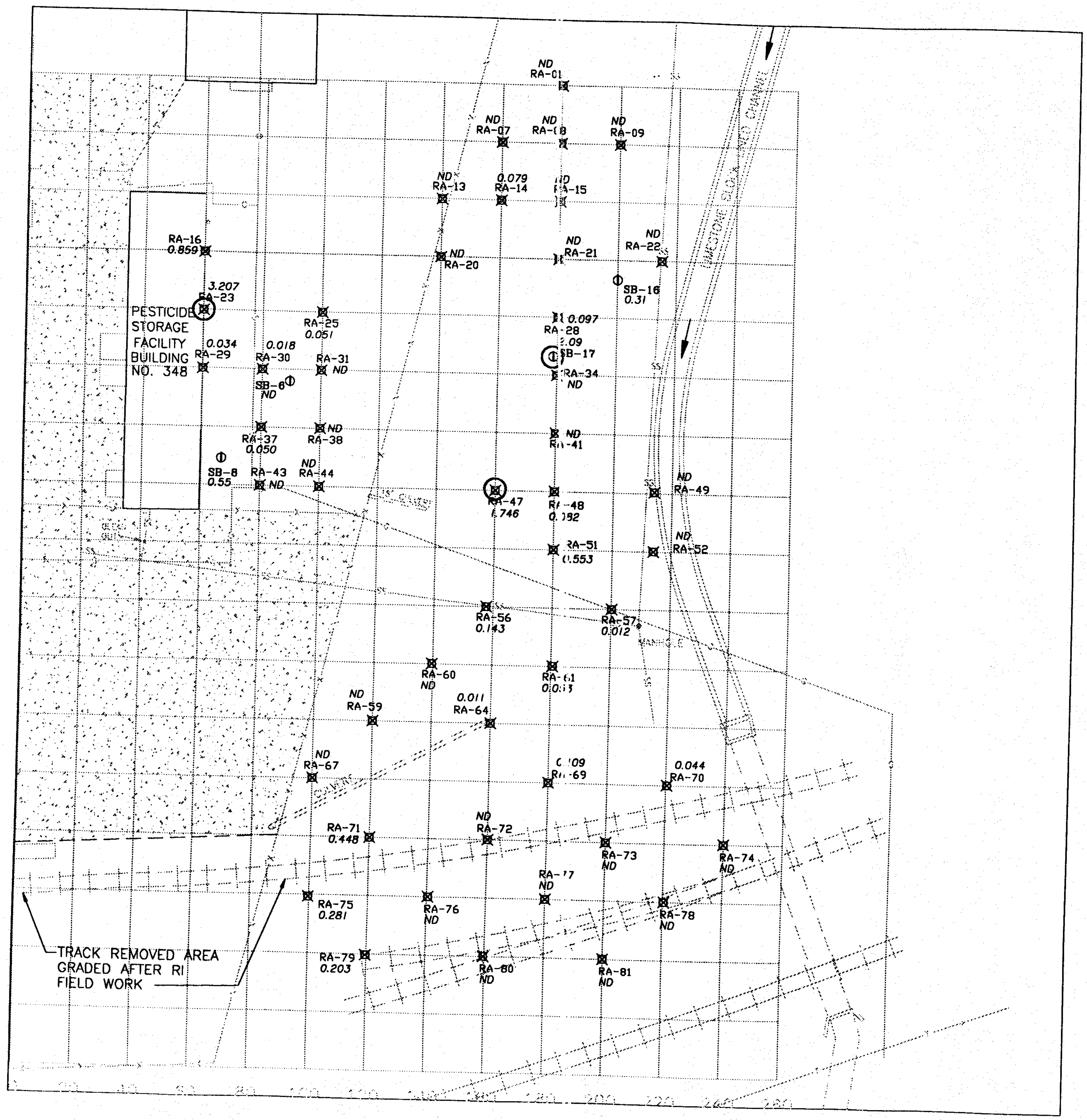
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SUBSURFACE SOIL CONTAMINATIONS DDT 6' AND GREATER

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	FILE DATE: 12-5-94
CHECKED BY/DATE: EFW/5-95	D-23	PLOT DATE: 5-1-95
APPROVED BY/DATE: KAH/5-95		FILE NAME: DDT04.DWG



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

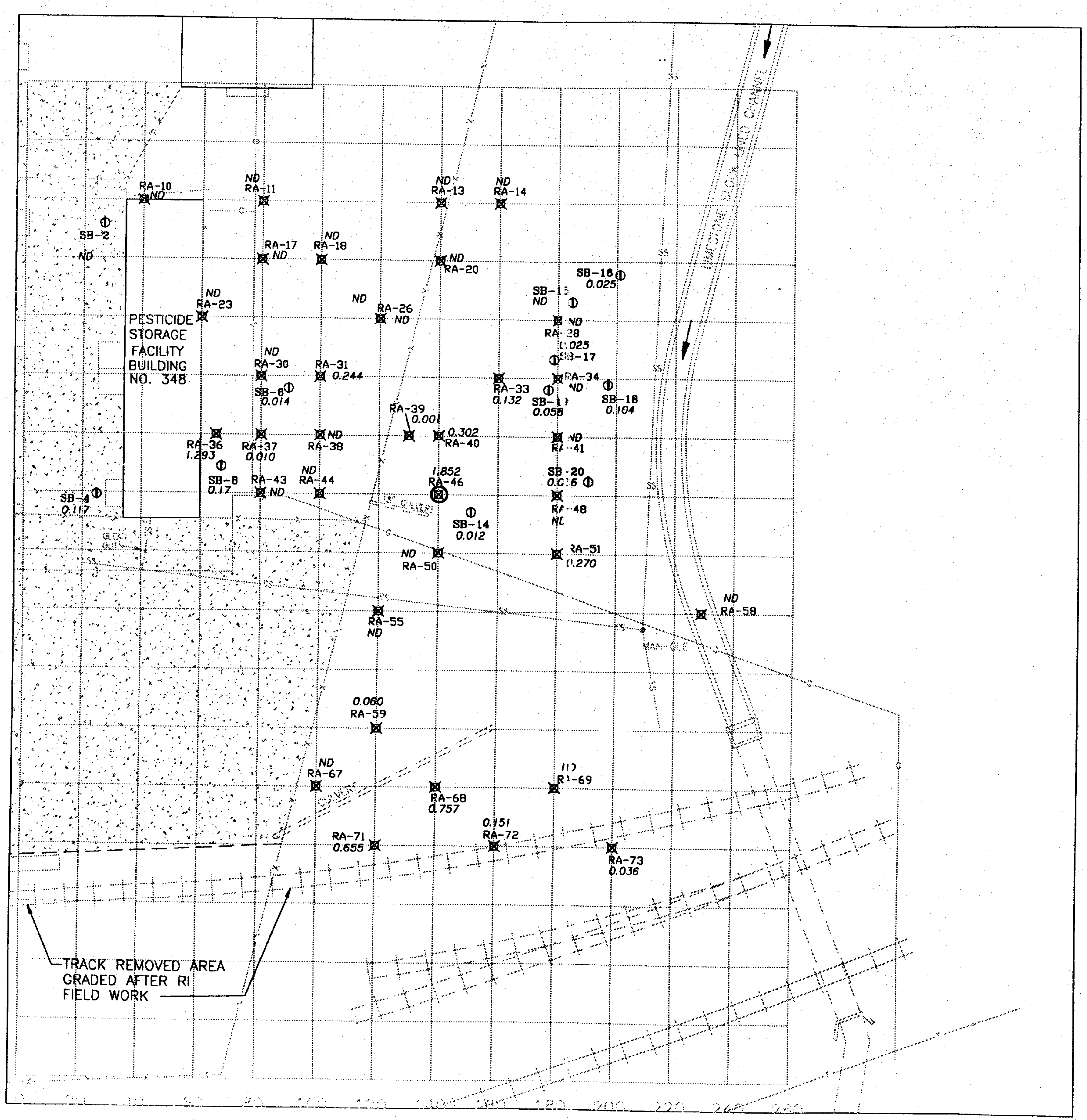
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SUBSURFACE SOIL CONTAMINATIONS DDT 2'–3' DEPTH

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-24	PLOT DATE:	5-3-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	DDT05.DWG



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80

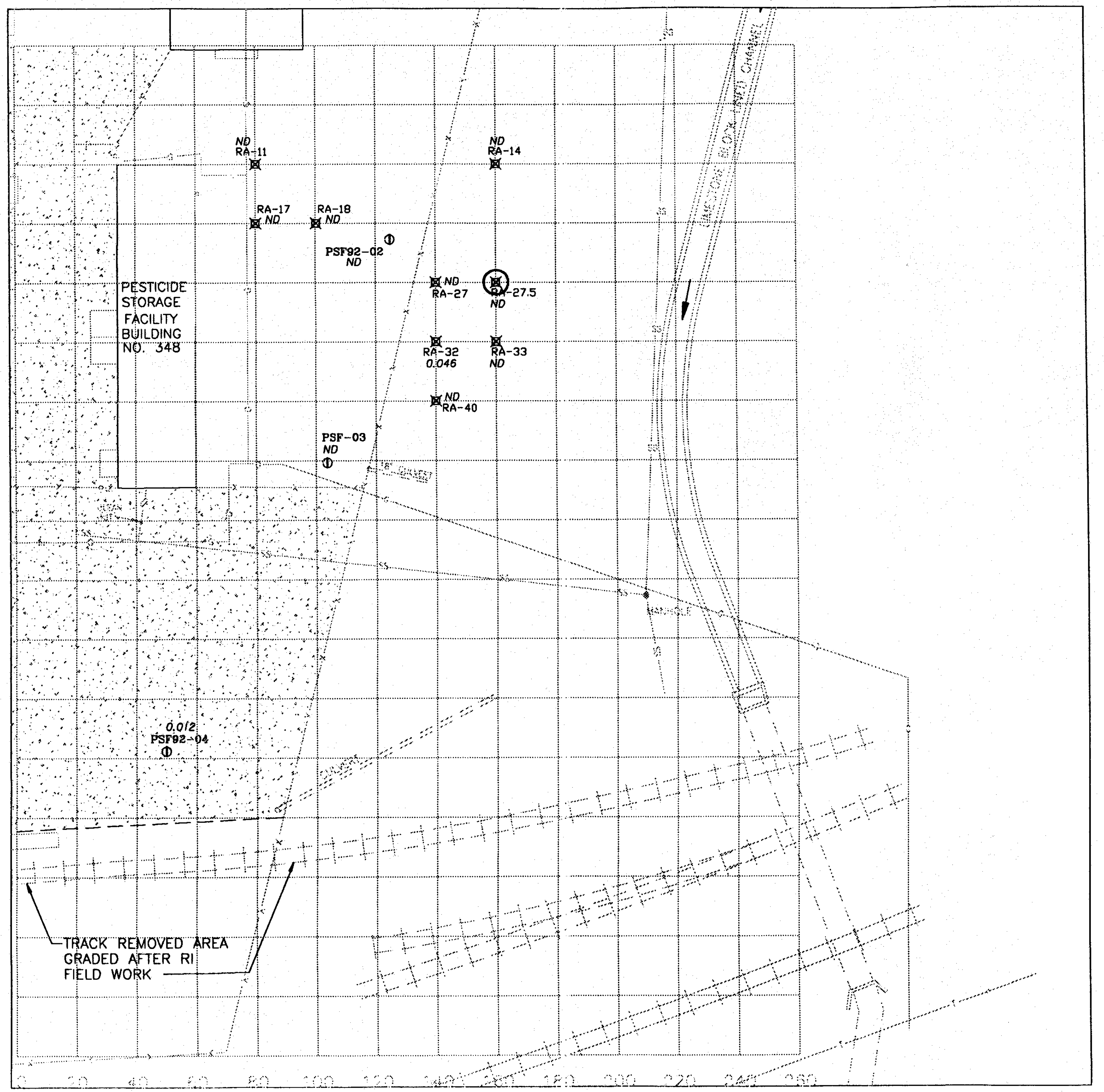
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SUBSURFACE SOIL CONTAMINATIONS DDT 4'–5' DEPTH

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-25	PLOT DATE:	5-1-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	DDT06.DWG



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE EXCEEDING 1.0 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80

SCALE IN FEET

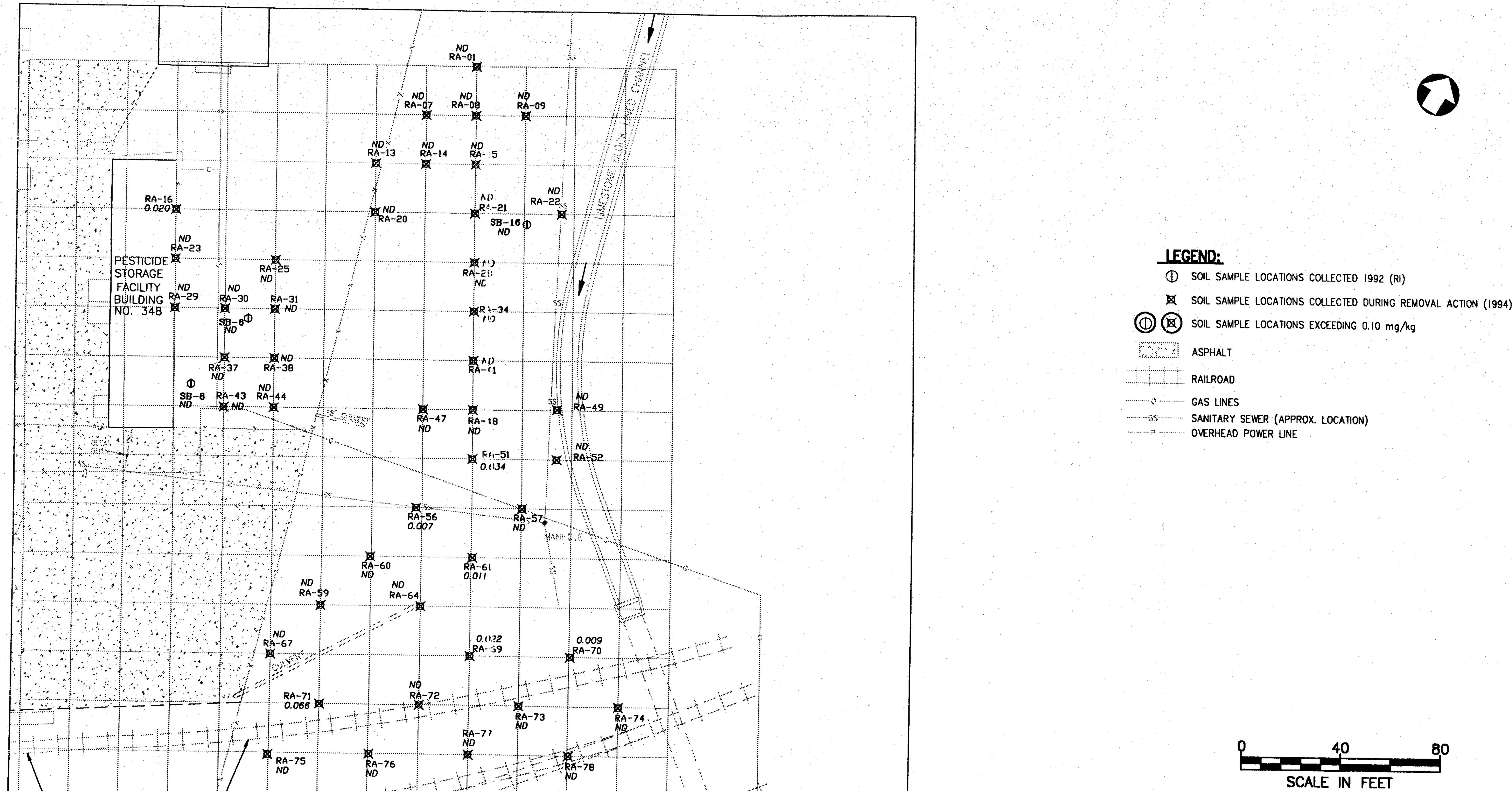
UNITED STATES ARMY

FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SUBSURFACE SOIL CONTAMINATIONS DDT 6' AND GREATER

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE: EFW/5-95	D-26	PLOT DATE:	5-1-95
APPROVED BY/DATE: KAH/5-95		FILE NAME:	DDT07.DWG



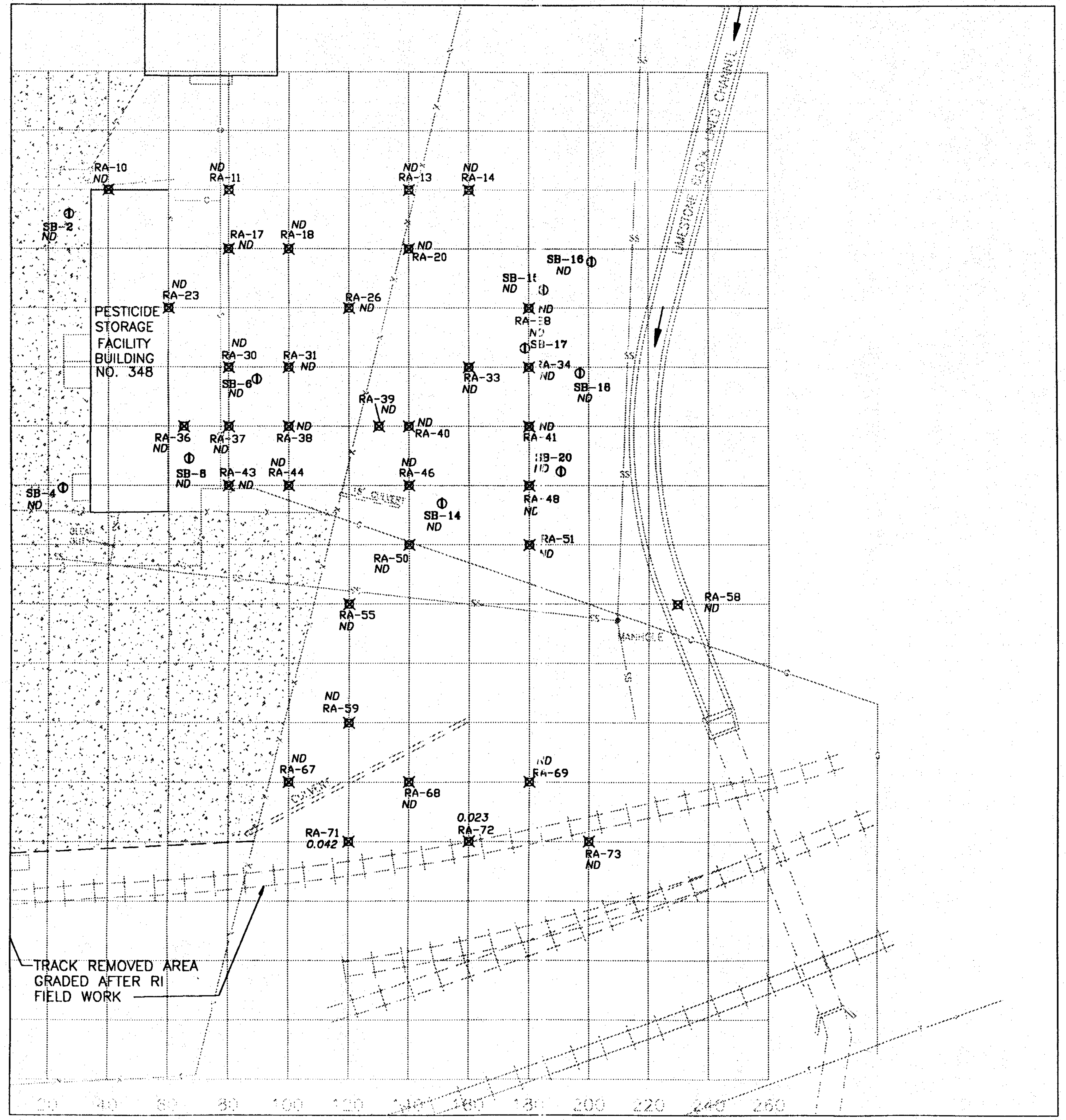
MAP SOURCE: OHM, 1994

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SUBSURFACE SOIL CONTAMINATIONS DIELDRIN 2'–3' DEPTH

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-27	PLOT DATE:	5-1-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	DLD03.DWG



LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80
SCALE IN FEET

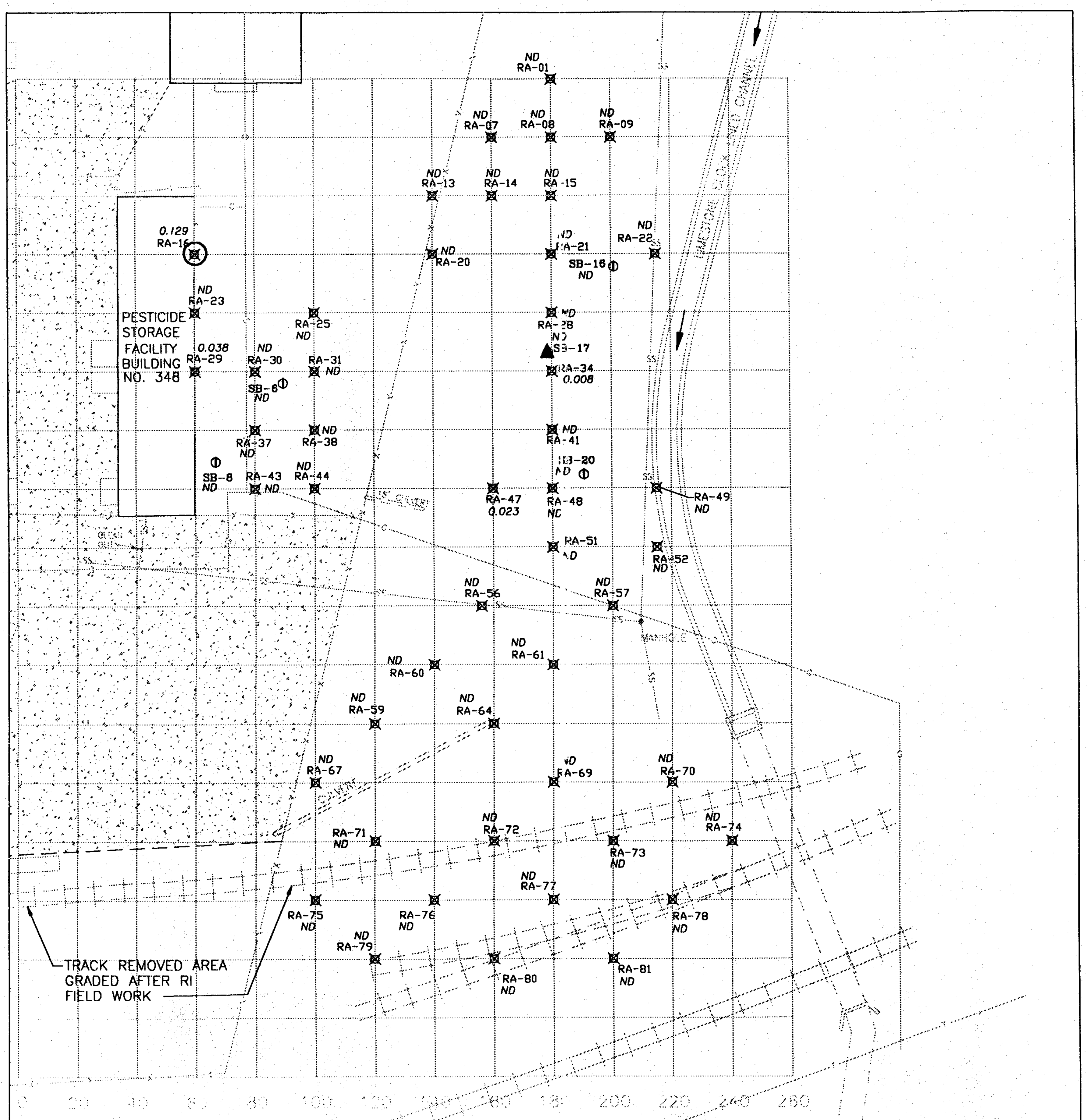
MAP SOURCE: OHM, 1994

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SUBSURFACE SOIL CONTAMINATIONS DIELDRIN 4'–5' DEPTH

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-28	PLOT DATE:	5-1-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	DLD04.DWG



MAP SOURCE: OHM, 1994

LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- SOIL SAMPLE LOCATIONS EXCEEDING 0.05 mg/kg
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

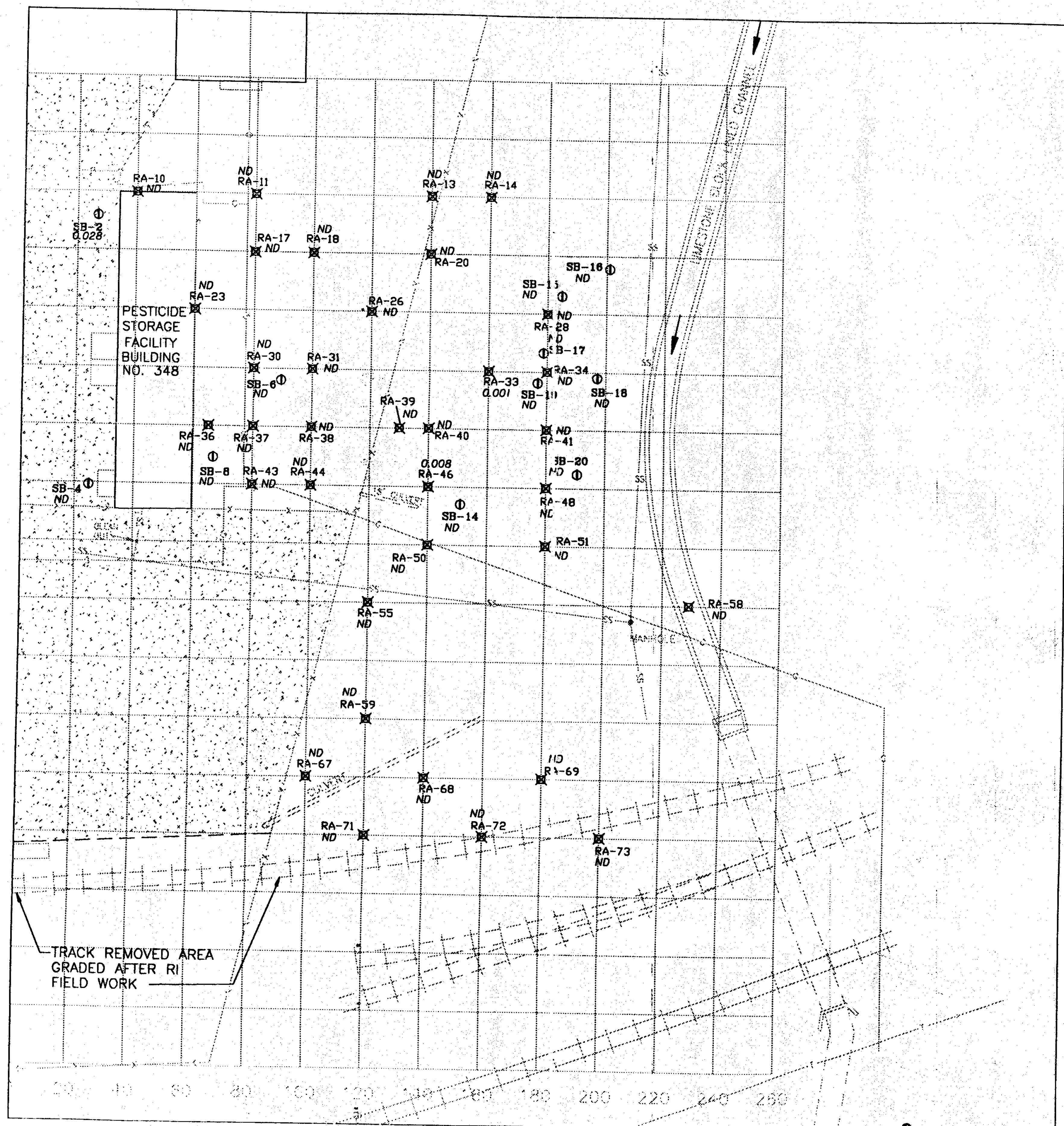
0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SUBSURFACE SOIL CONTAMINATION HEPTACHLOR 2'–3' DEPTH

PREPARED BY/DATE: SEG/5-95	FIGURE NUMBER:	FILE DATE: 12-5-94
CHECKED BY/DATE: EFW/5-95	D-29	PLOT DATE: 5-1-95
APPROVED BY/DATE: KAH/5-95		FILE NAME: HEPT03.DWG



MAP SOURCE: OHM, 1994

LEGEND:

- SOIL SAMPLE LOCATIONS COLLECTED 1992 (RI)
- SOIL SAMPLE LOCATIONS COLLECTED DURING REMOVAL ACTION (1994)
- ASPHALT
- RAILROAD
- GAS LINES
- SANITARY SEWER (APPROX. LOCATION)
- OVERHEAD POWER LINE

0 40 80
SCALE IN FEET

UNITED STATES ARMY
FORT RILEY
FORT RILEY, KANSAS

PESTICIDE STORAGE FACILITY

EXISTING SUBSURFACE SOIL CONTAMINATION HEPTACHLOR 4'-5' DEPTH

PREPARED BY/DATE:	SEG/5-95	FIGURE NUMBER:	FILE DATE:	12-5-94
CHECKED BY/DATE:	EFW/5-95	D-30	PLOT DATE:	5-1-95
APPROVED BY/DATE:	KAH/5-95		FILE NAME:	HEPT04.DWG