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DRAFT FINAL
DOE DISPOSAL BOX AREA CLOSURE REPORT

for

Laboratory for Energy-Related Health Research (LEHR)
University of California at Davis, California

Submitted to:

Weiss Associates
5500 Shellmound Street
Emeryville, California 94608

Prepared by:

IT Corporation
4585 Pacheco Boulevard
Martinez, California 94553

LEHR
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Rev. 0

DOE Oakland Operations Office Contract DE-AC03-96SF20686

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United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 95612

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Approvals Page

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4585 Pacheco Boulevard
Martinez, California 94553

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Approved by: Gerhard E. Locke Date: 3/18/97
Gerhard Locke, Ph.D., P.E.
Project Manager
IT Corporation

Approved by: W. Schaal for W. Rankin Date: 3/18/97
William Rankin
Field Coordinator
IT Corporation

Approved by: Date: 3/18/97
Robert Swatek
Project Quality Assurance Specialist
IT Corporation

Concurrence by: Mary Stallard Date: 3/19/97
Mary Stallard, C.E.G.
Project Quality Assurance Manager
Weiss Associates

Concurrence by: Robert O. Devany Date: 3/19/97
Robert O. Devany, C.H.G.
Project Manager
Weiss Associates

Concurrence by: Michael D. Dresen Date: 3/20/97
Michael D. Dresen, C.H.G.
Program Manager
Weiss Associates

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LIST OF ACRONYMS

AA	Atomic Absorption
Bi	Bismuth
C	Centigrade
C-14	Carbon 14
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	Chain of Custody
Cs	Cesium
DOE	Department of Energy (United States)
DOT	Department of Transportation (United States)
EPA	Environmental Protection Agency (United States)
EM	Electro Magnetics
EML	Environmental Monitoring Laboratory
EMS	Environment Management Systems
EZ	Exclusion Zone
ft	foot or feet (form dependant upon usage)
ft^3	cubic feet
GM	Geiger müeller (detector)
GFAA	Graphite Furnace Atomic Absorption
GPR	Ground Penetrating Radar
H-3	Tritium
HDPE	High density polyethylene
HNO_3	Nitric Acid
HSP	Health and Safety Procedure
IATA	International Air Transport Association
ICAP	Inductively Coupled Argon Plasma
ID	Identification
IDW	Investigation derived wastes
in	Inch

IT	IT Corporation
K	Potassium
LEHR	Laboratory for Energy-Related Health Research
LAS	Lockheed Analytical Services
LSA	Low specific activity
MDA	Minimum detectable activity
MDL	Method Detection Limit
Ml	Milliliter
NPL	National Priorities List
OP	Operating Procedure
OSHA	Occupational Safety and Health Association
Pb	Lead
PCB	Polychlorinated biphenyl
PID	Photoionization Detector
PNL	Pacific Northwest Laboratories (Battelle)
PPE	Personal Protective Equipment
Ra	Radium
RCM	Radiological Control Manager
RCT	Radiation Control Technician
SOP	Standard Operating Procedure
SQP	Standard Quality Procedure
Sr	Strontium
TCLP	Toxic Characteristic Leaching Procedure
Th	Thorium
Tl	Thallium
U	Uranium
UCD	University of California at Davis
VOA	Volatile Organics Analysis
VOC	Volatile Organic Compounds
yd^3	cubic yards
WA	Weiss Associates
USA	Underground Service Alert

EXECUTIVE SUMMARY

The Laboratory for Energy-Related Health Research (LEHR) is located on a 15 acre parcel of land leased from the University of California, Davis. The facility was actively used from 1956 until 1988 to conduct research on animals using radionuclides, primarily strontium-90 and radium-226. In 1988 the Department of Energy discontinued further research and initiated activities to decontaminate and decommission the LEHR facility and return ownership to the University of California.

The Department of Energy had utilized a 40 x 12 x 10 foot trench (the "DOE Box Area") at the LEHR facility to dispose of approximately 55 cubic yards of low-level radioactive waste. A removal action was undertaken to mitigate the threat of further release of contaminants to the environment. This report describes the characterization of the waste matrix; the actions conducted to remove, separate and dispose of the waste matrix; and the results of sampling to confirm the removal of contamination.

A backhoe was used to excavate a series of trenches and locate the Department of Energy Box Area. Samples of the waste matrix and surrounding soils were taken and analyzed. Once the waste matrix was characterized, remedial actions resumed with the excavation of the waste matrix and over-excavation of approximately six inches into native soils. Excavated materials were sorted in a specially prepared work area and placed in metal B25 waste containers for shipment to the Department of Energy's low-level radioactive waste disposal site in Hanford, Washington. The excavation was backfilled with clean soil.

Analysis of samples collected adjacent to the excavation verified that the identified contaminants were successfully removed from the Department of Energy Box Area. The contaminant levels in the soil left in place in this area will be further evaluated during the Risk Assessment and, if necessary, the Engineering Evaluation/Cost Analysis to ensure they are below acceptable levels.

1. INTRODUCTION

The waste excavation, removal, segregation, and disposal reported in this document were performed to support the Department of Energy (DOE) decision to complete a time critical removal action at the Laboratory for Energy-Related Health Research (LEHR), University of California (UCD), Davis, California (Littlejohn, 1996). LEHR is on the National Priorities List (NPL) and the subject removal/disposal action is part of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) environmental restoration activities associated with LEHR.

LEHR is a 15 acre facility southeast of the main UCD campus (Figure 1). The facility consists of 15 buildings, including a main administration and office building, two animal hospitals, laboratory and support buildings, waste storage facilities, numerous animal pens, and trench burial areas (Figure 2). The facility was operated by UCD under contract to the DOE for about 30 years to perform research involving bone-seeking radionuclides. Radionuclides such as radium 226 (Ra-226) and strontium 90 (Sr-90) were injected and fed to dogs as part of the research.

Pursuant to the CERCLA Removal Action Memorandum (Littlejohn, 1996), the removal/disposal activities were planned to address approximately 55 cubic yards (yd^3) of low-level waste in a 40 x 12 x 10 foot (ft) onsite trench referred to as the DOE Box. The DOE Box was a repository used by the LEHR facility for the disposal of miscellaneous low-level wastes associated with research. Wastes were expected to consist of, and found to be, buried gravel and labware, including syringes, bottles, and vials. Laboratory testing performed prior to the removal action indicated the waste contained elevated levels of Ra-226 and Sr-90 (Mitchell, 1996). In accordance with the 1990 National Oil and Hazardous Substances Pollution Contingency Plan (Title 40, Part 300 of the Code of Federal Regulations [40 CFR 300]), and specifically with 40 CFR 300.415(b)(2), the removal action was undertaken to mitigate the threat of further release of contaminants to the environment.

This report was prepared by IT Corporation (IT), Martinez, California and reviewed by Weiss Associates (WA), Emeryville, California and Environmental Management Systems (EMS), Concord, California.

1.1 DOE Box Area Background

As part of a site investigation conducted in 1994, NORCAL Geophysical Consultants (NORCAL) identified several significant anomalies using Ground-Penetrating Radar (GPR), Electro Magnetics (EM), and a magnetometer in an area believed to be the burial site for the DOE Box

(NORCAL, 1994). This area is located on the west side of the asphalt road separating the two dog pen areas (Figure 2). A visual examination of the general area identified a ground surface depression suggestive of differential settlement in this area. The area had been previously disturbed as part of an investigation performed by Wahler Associates in February of 1988 (Wahler, 1988).

Also as part of the 1994 site investigation, five soil gas probes were placed in the general area of the depression. Analysis of recovered soil gas indicated that volatile organic compounds (VOCs) were not present above method detection limits (MDLs) (Dames and Moore, 1994).

2. FIELD ACTIVITIES CONDUCTED TO CHARACTERIZE THE WASTE MATRIX

Activities performed to characterize the waste matrix were conducted according to the Work Plan for DOE Disposal Box Excavation and Sampling (IT, 1995). These activities are described below.

2.1 Site Preparation

A geophysical investigation performed at LEHR by NORCAL Geophysical Consultants in 1994 indicated several strong anomalies in the general area believed to have been the site of the DOE Box burial. A preliminary field inspection identified signs of a depression indicative of differential settlement. The outline of this depression and the boundary of the proposed excavation were demarcated using wooden stakes and white paint. IT then performed a radiological surface survey of this general area. No detectable activity above background was found in the survey area.

2.2 Utility Clearance and Permitting

Following the identification of the proposed excavation boundary, Underground Service Alert (USA), the UCD Building and Maintenance Department and the UCD Communication Department were contacted to determine the location of underground utilities in the general area. UCD issued a permit entitled "Location Map and Acceptance Form, Facilities Services" to authorize the excavation.

2.3 Trenching

Once the underground utilities had been located and permits obtained, a backhoe was used to excavate a series of trenches to determine the actual location of the DOE Box. Field activities were performed by the backhoe operator, the Lead man and a Radiological Controls Technician (RCT). Excavated soil was stockpiled on poly sheeting placed along the edge of the paved roadway (Figure 3). The trenching activities did not find any evidence of an actual box buried beneath the surface, but did locate gravel and labware in an area where such items were thought to have been disposed (Figure 4). The disposal area was approximately 36 feet long by 9 feet wide with the exterior boundary defined by metal runway matting placed end on end (Figure 5). The waste matrix was

encountered below 2 to 3 feet of gravel/soil overburden. Deteriorated plywood was found over and on the sides of the trench. Plywood was used routinely at the LEHR facility as shoring to keep disposal trench walls from collapsing.

2.4 Chemical and Radiological Monitoring

For worker safety, field activities were initiated in Level B personal protective equipment (PPE). Radiological and chemical exposure were continuously monitored during excavation activities. Field monitored parameters included perimeter and work zone airborne particulate radiation, radiological surface contamination, and VOCs. To monitor perimeter airborne particulate radiation a sample pump was operated continuously at the perimeter of the work zone throughout the day. The resultant filter sample was analyzed onsite for beta, gamma, and alpha activity prior to beginning work the next day. Work zone airborne particulate radiation was monitored by collecting two to three air filter samples from within the work zone and analyzing them onsite for beta, gamma, and alpha activity prior to beginning work the next day. Surface contamination monitoring for beta/gamma and alpha activity was performed in or on the work area, tools, recovered wastes, waste containers and related materials using field screening instrumentation. VOCs were monitored as wastes and related materials were uncovered during the excavation and periodically during waste segregation activities using a photoionization detector (PID) and colorimetric tubes.

None of the field monitored parameters were detected above background levels. Based on these monitoring results, PPE selection was downgraded to Level C for the remaining excavation and sampling activities.

2.5 Sampling Box Disposal Area Contents

Following radiological measurements of the Box Area contents, a total of 13 discrete and composite soil samples were collected. Four sample trenches were excavated within the disposal area to collect waste matrix composite samples at varying locations and depths. Additionally, two soil samples were collected from the surrounding soil outside the Box Area and two soil samples were collected from soil beneath the waste matrix. Sample collection locations are shown in Figure 6. Sample collection and identification procedures are detailed in Section 4.

2.6 Backfilling the Trenches

Following the sample collection described in Section 2.5, the trenches were backfilled to mitigate the potential hazards associated with an open excavation during sample analysis and analytical data review. Potential hazards associated with an open excavation at the DOE Box location included a trip or fall hazard to vehicular and foot traffic, exposure of humans and animals to waste materials, and leaching of contaminants by infiltrating precipitation.

Backfill material consisted of overburden previously removed from above the waste matrix. During backfill activities, segregated stockpiles of overburden were replaced at their original location and depth. A fence was erected around the limits of the excavation and was posted with warning signs to preclude entry of personnel and vehicles.

3. FIELD ACTIVITIES CONDUCTED TO REMOVE, SEPARATE AND DISPOSE OF THE WASTE MATRIX

Following characterization of the waste matrix, IT resumed remedial activities at the DOE Box Disposal Area. Field activities were conducted according to the Work Plan for DOE Disposal Box Area Excavation and Disposal (IT, 1996) in September and October 1996 and are described below.

3.1 Site Preparation

A Laydown Area, used to temporarily store the removed waste matrix, was established on the asphalt road east of the Disposal Area (Figure 7). A 16 ft x 40 ft Separation and Packaging Area was established south of the disposal area on both sides of the asphalt road. These two areas were connected by a Bobcat Travel Area (Figure 7). A Bobcat is a small front-end loader. All three areas were prepared by laying 6-mil poly sheeting over the ground surface and placing 4ft x 8ft x ½ inch (in) plywood sheets over it. The plywood sheets were point-fastened to the ground.

3.2 Excavation

Once the site was prepared, a backhoe was mobilized and positioned on the asphalt road adjacent to the site as shown on Figure 3. Based on previous chemical and radiological monitoring, field activities were performed in modified Level D PPE as described in Section 5.4. The first 2 to 3 feet (ft) of gravel overburden and uncontaminated soil from the top of the disposal area were removed, segregated and stored at the side of the Separation and Packaging Area.

The contaminated waste matrix (gravel and labware) extended from a depth of approximately three feet to a depth of ten feet (Figure 8). The backhoe bucket was used to bring the waste to the surface where it was placed in the Laydown Area. A small front-end loader was used to move the waste matrix to an unused portion of the Separation and Packing Area where it was manually spread and separated (Figure 9). Following removal of the waste matrix, the Box Area was over-excavated to remove approximately six inches of native soils from the bottom and the internal walls of the open trench to ensure that potentially contaminated materials were removed from the excavation.

3.3 Separating and Packaging the Waste Matrix

Field personnel used rakes to sort the waste gravel and labware into separate piles (Figure 9). Following separation, a small front-end loader was used to place the waste gravel into B-25 steel boxes. Labware was placed into 1 gallon screw top poly buckets which were subsequently placed inside a B-25 steel box. Once filled, the B-25 steel boxes were moved to a posted storage area alongside the Separation and Packaging Area to await disposal. Thirty-three B25 boxes, about 2970 cubic feet (ft^3), were filled with excavated material from this operation. Twenty of the boxes were filled with gravel. Five boxes were filled with gravel and steel runway matting. Two boxes were filled with gravel and plywood. Five boxes were filled with gravel, runway matting, and plywood. Two boxes were filled with gravel and labware.

All labware recovered from the excavation that contained liquid was found intact and sealed. This labware was retained onsite for future characterization. This included 72 bottles recovered from the north end of the excavation. These bottles appeared to be intact and did not show signs of leakage (Figure 10). No detectable activity above background was found when the exterior of the bottles were scanned with a Geiger müeller (GM) detector.

3.4 Collecting Soil Samples from the Limits of the Excavation

After the waste matrix and the metal runway matting had been removed from the excavation, nine soil samples were collected from the native soil along the sides and the bottom of the excavation. Grab samples were collected using the backhoe bucket at the appropriate location. Sample collection locations are shown in Figure 11. Sample collection and identification procedures are described in Section 4.

3.5 Backfilling the Excavation

Once the soil samples had been collected from the limits of the excavation, the excavation was lined with a 20 mil high density polyethylene (HDPE) liner and backfilled (Figure 12). The liner was placed within the excavation pending the results of the verification sampling.

All uncontaminated soil removed during the excavation process was replaced in the excavation. Additional backfill was obtained from soil stored in the Cobalt-60 Building yard (Figure 13). This soil was generated previously during trenching in Animal Hospitals No. 1 and 2 and had been stored in drums. Laboratory test results indicated that the soil was not contaminated (Dames and Moore, 1994). This soil had been tested for parameter suites that included radionuclides, metals, volatile organic compounds, semi-volatile organic compounds, pesticides, and nitrate.

The backfilled soil was compacted and mounded using the backhoe and small front-end loader to minimize the potential for settlement.

3.6 Decontamination of Heavy Equipment

The backhoe and small front-end loader were decontaminated according to the Work Plan during excavation activities and upon completion of trenching and loading operations. Over-excavation of the Box Area was terminated in native soil. The native soil was presumed not to be contaminated. This presumption was supported by field screening. Final decontamination of the heavy equipment involved removal of gross material from the backhoe and spraying it with a solution of detergent and water. Removed material and decontamination solution were discarded at the excavation site. Upon completion of the decontamination, equipment was radiologically surveyed to verify that it could be removed from the containment area.

3.7 Shipping the Waste to an Off-Site Disposal Facility

Wastes transported for off-site disposal were manifested on a straight bill of lading as "radioactive material, low specific activity (LSA), UN 2912." A radiological survey of each waste container was performed according to Operating Procedure Two (OP-02) "Radiological Surveys and Instrumentation" in Appendix A of the Work Plan for the decontamination and decommissioning of the Imhoff Building (IT, 1993). Containers were packaged and shipped to DOE Hanford in Richland, Washington according to "Shippers General Requirements for Shipments and Packaging" (49 CFR 173); OP-11 "Waste Processing and Packaging" (Appendix A, IT, 1993); and OP-13 "Radioactive Waste Shipment" (Appendix A, IT, 1993).

4. SAMPLING ACTIVITIES AND LABORATORY ANALYTICAL RESULTS

This section describes the sampling procedures and laboratory analytical results obtained during the DOE Box remedial action.

4.1 Sample Identification

Each sample collected was labeled with a unique identification sequence. The first four letters indicate the site location, the next letter indicates whether the sample is a liquid or solid, and the last three numbers indicate the sequential order in which samples were taken. For instance, LEHR-S-301 indicates that the sample was collected at LEHR, was a soil sample, and was the three hundred and first sample collected at LEHR.

4.2 Sample Collection

A total of thirteen samples were collected from the waste matrix and surrounding soil. Sample locations from this initial sampling event are shown in Figure 6. Following removal of the waste matrix and over-excavation of approximately six inches of native soil from the bottom and sidewalls of the excavation, an additional nine soil samples were collected from the limits of the excavation (Figure 11).

4.3 Sample Documentation

To ensure sample integrity, complete chain-of-custody (COC) documentation was performed, and appropriate sample preservation techniques, holding times, and shipment methods were employed. COC forms were completed according to the requirements of SOP-3, "Chain-of-Custody," (Appendix A, IT, 1993).

4.4 Waste Matrix Laboratory Analyses Results

Samples collected from the waste matrix and surrounding soil were submitted to Lockheed Analytical Services (LAS) for analysis of the chemical and radiological constituents listed in Table 1. A detailed summary of the analytical results for these samples is included in Mitchell,

1996. This detailed summary reports that the only tested radionuclides above the natural soil background levels were radium-226 and strontium-90. Reported activities for radium-226 range from 0.29 to 9.7 picoCuries per gram (pCi/g). Reported activities for strontium-90 range from below the minimum detectable activity (MDA) of 0.67 to 36.7 pCi/g.

4.5 Limits of Excavation

Because analysis of the waste matrix did not detect the presence of hazardous chemicals (Mitchell, 1996), the nine soil samples collected from the limits of excavation were analyzed only for the radiological constituents listed in Table 2. Laboratory analytical results obtained for the samples are shown in Table 3.

As shown in Table 3, reported activities for actinium-228 range from below the MDA to 0.65 pCi/g. Excluding sample LEHR-S-508, which is the only sample from the suite with activity below the MDA, the activity range for actinium-228 is 0.51 to 0.65 pCi/g. Reported activities for bismuth-212 and radium-226 (Gamma Scan) do not exceed the sum of the MDA and the reported laboratory error (i.e., uncertainty). Reported activities for bismuth-214 range from 0.38 to 0.74 pCi/g. Reported activities for carbon-14, cesium-237, cobalt-60, lead-210, radium-223, strontium-90 and uranium-235 do not exceed the MDA. Reported activities for gross alpha range from below the MDA to 13.5 pCi/g. Reported activities for gross beta range from 10.6 to 16.2 pCi/g. Reported activities for lead-212 range from 0.59 to 0.72 pCi/g. Reported activities for lead-214 range from 0.49 to 0.75 pCi/g. Reported activities for potassium-40 range from 10.3 to 12.2 pCi/g. Reported activities for radium-226 range from below the sum of the MDA and the reported laboratory error to 1.13 pCi/g.

Excluding the samples LEHR-S-504 and LEHR-S-507, which are the only two samples from the suite with activities below the sum of the MDA and laboratory error, the activity range for radium-226 is 0.43 to 0.68 pCi/g. Reported activities for thallium-208 range from 0.16 to 0.22 pCi/g. Reported activities for thorium-234 do not exceed the MDA except for that in sample LEHR-S-511. Activity for this sample is reported to be 0.84 pCi/g. Reported activities for tritium do not exceed the MDA except for that in sample LEHR-S-511, which is 280 pCi/g.

These results document the successful removal of the identified contamination from the DOE Box Area. The radionuclide activities in the soil left in place in this area will be further evaluated during the Risk Assessment and, if necessary, the Engineering Evaluation/Cost Estimate (EE/CA) to ensure they are below acceptable levels.

5. HEALTH AND SAFETY CONSIDERATIONS

The Health and Safety Plan and Health and Safety Procedures contained in Appendices D and E of the Work Plan for the Decontamination and Decommissioning of the Imhoff Building (IT, 1993) were followed during field activities. All excavation work was performed in accordance with HSP-61, "Excavation and Trenching," in Appendix E of this reference.

5.1 Training

Personnel performing activities associated with the excavation of the DOE Disposal Area received training covering the Work Plans. All onsite project personnel had completed at least 40 hours of hazardous waste operations-related training, as required by OSHA and specified in 29 CFR 1910.120. Those personnel who completed the 40-hour training more than 12 months prior to the start of the field activities had completed an 8-hour refresher course within the past 12 months.

In addition, workers who entered radiological control zones had successfully completed Radiological Worker II training and site-specific Radworker training. All site workers received training covering the LEHR site Contingency Plan. Personnel performing activities within the contamination area received the training according to the requirements specified in Section 4.2 of SQP-02, "Indoctrination and Training," (Appendix C, IT, 1993) for the specific job assignments.

5.2 Radiological Exposure

General area air samples were continuously collected to monitor airborne radioactive contaminant levels. Filters were analyzed onsite using a gross alpha/beta scaler counter. Air monitoring was conducted according to procedures HSP-54, "Air Surveillance Program" and HSP-55, "Airborne Radioactivity Monitoring," (Appendix E, IT, 1993).

5.3 Chemical and Material Exposure

During field activities, grab samples, colorimetric tube monitoring, GM detectors and Scintillation Detectors were used to detect the presence of hazardous chemicals and materials. The levels of organic vapors in the work area were monitored using a PID. Throughout the remedial action, chemical instrumentation indicated field monitoring parameters were not detected, and radiological instrumentation indicated no detectable activity above background.

5.4 PPE

During excavation activities, workers initially wore Level B PPE in accordance with the PPE selection matrix in Appendix D, Section 5.4 (Health and Safety Plan), of the Work Plan for the DOE Disposal Box Excavation and Sampling (IT, 1995). The PPE was downgraded to Level C for waste matrix sampling activities based on results of chemical and radiological monitoring performed during field activities (Section 5.2 and 5.3). Finally, based on waste matrix laboratory analytical results and continuous air monitoring, PPE was reduced to modified Level D consisting of:

- Hard hat (ANSI approved),
- Coated Tyvek coveralls
- Two pair nitrile gloves,
- Steel-toed boots,
- Safety glasses, and
- Plastic and rubber overboots.

Level D PPE was worn during the removal, separation and disposal of the waste matrix.

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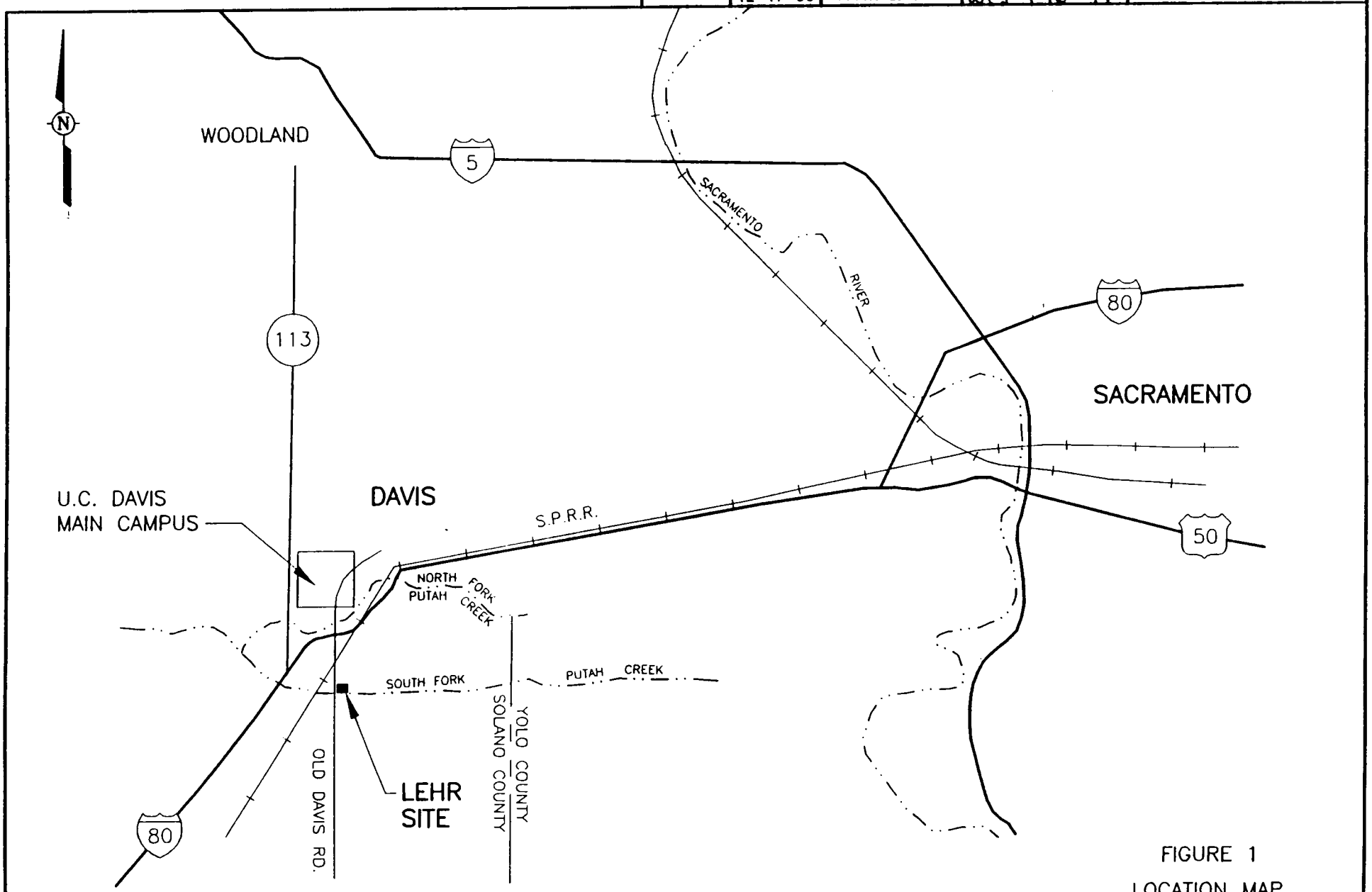

FIGURE 1

LOCATION MAP

PREPARED FOR

LEHR FACILITY

DAVIS, CALIFORNIA

NOT TO SCALE

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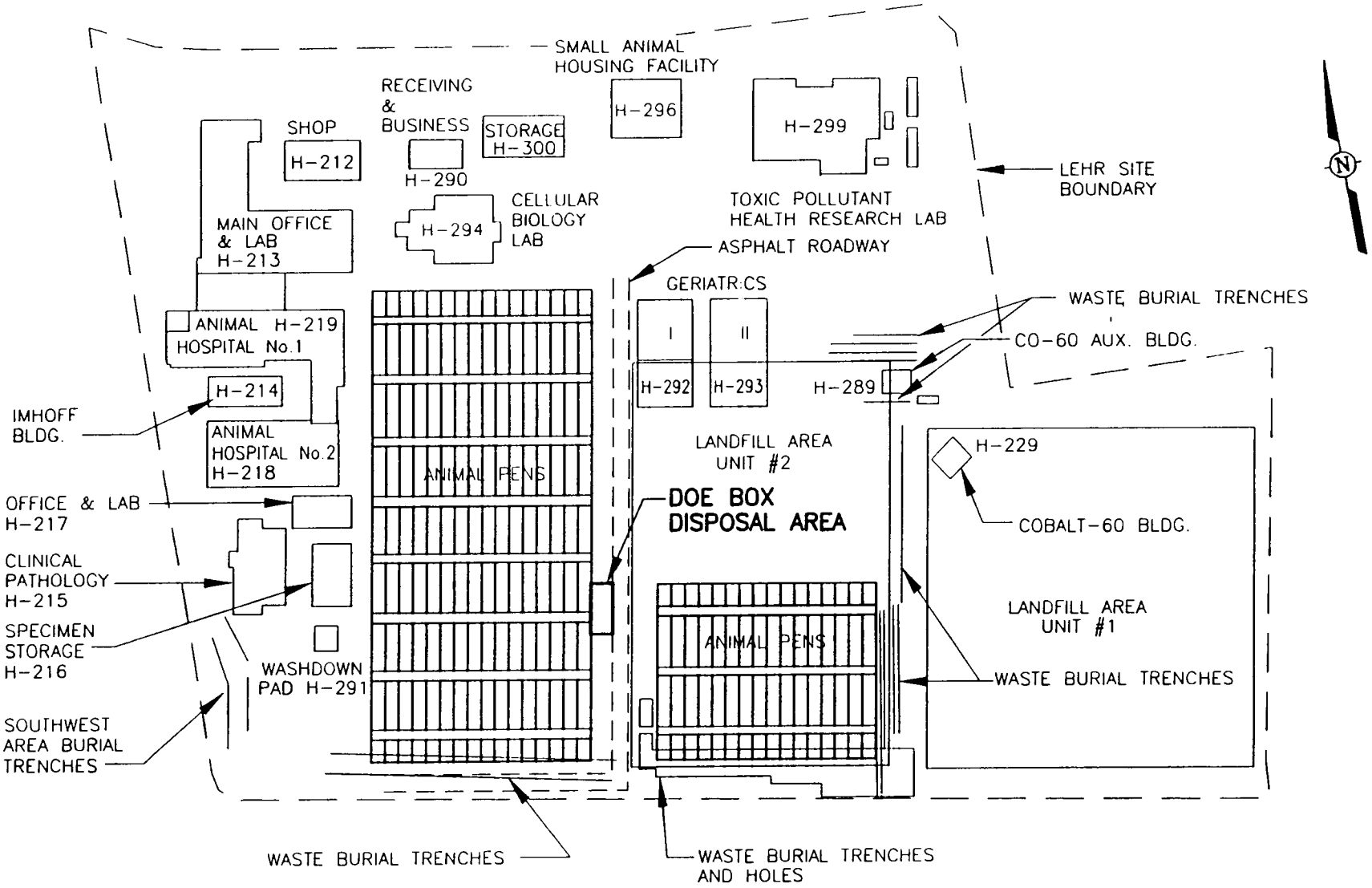

FIGURE 2

LOCATION OF DOE BOX AT THE LEHR FACILITY DAVIS, CALIFORNIA

LE-DBX2(LE5)

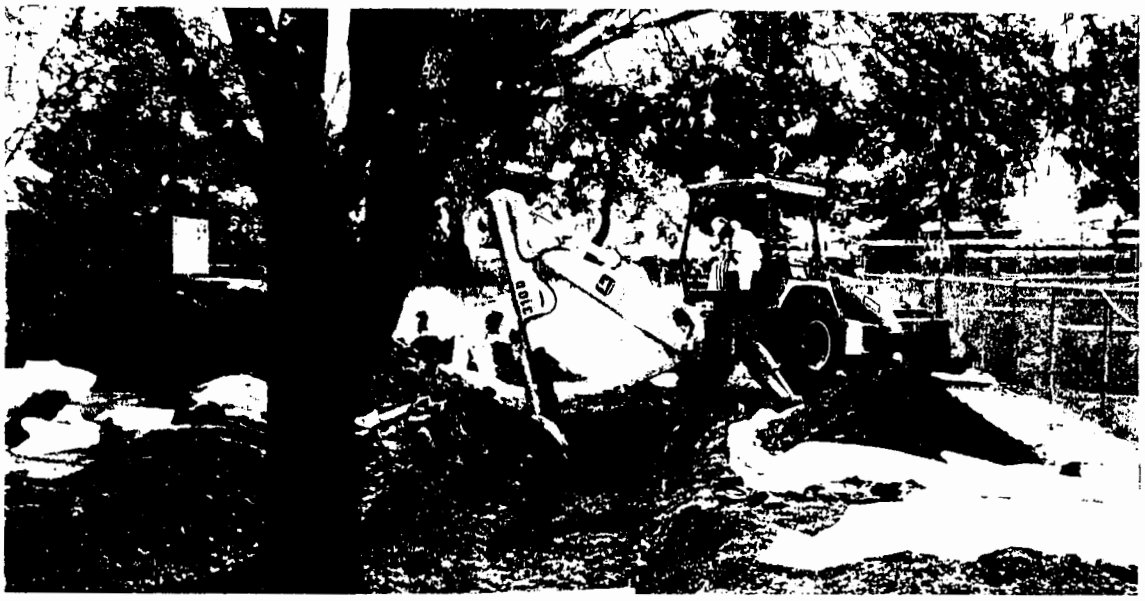

FIGURE 3. Excavation operation at the DOE Box Area. Soil is stockpiled on poly sheeting.

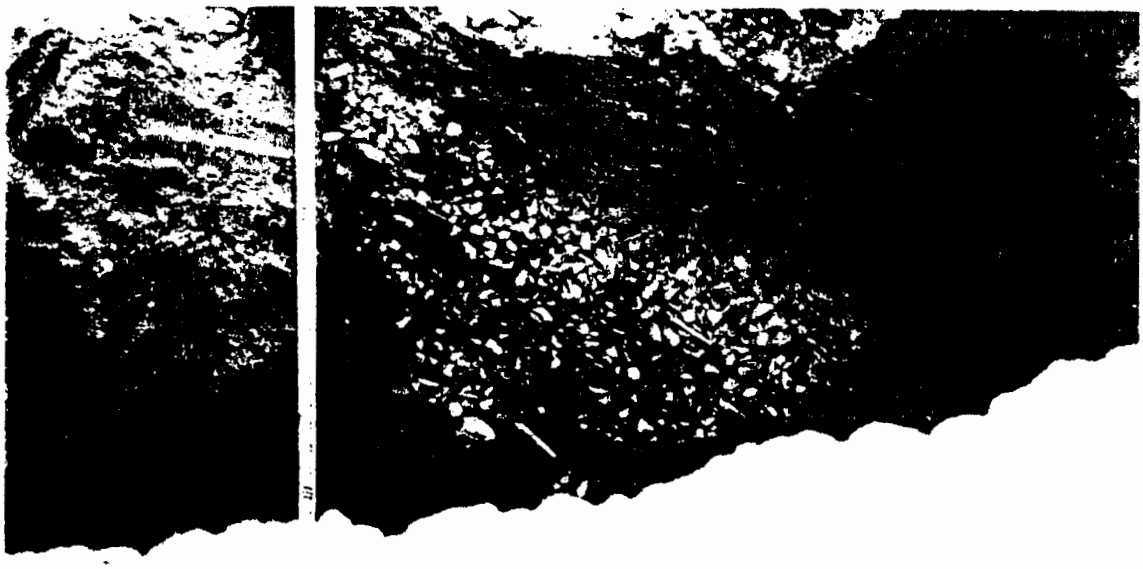

FIGURE 4. Disposed gravel, vials, and syringes exposed in open DOE Box Area trench.

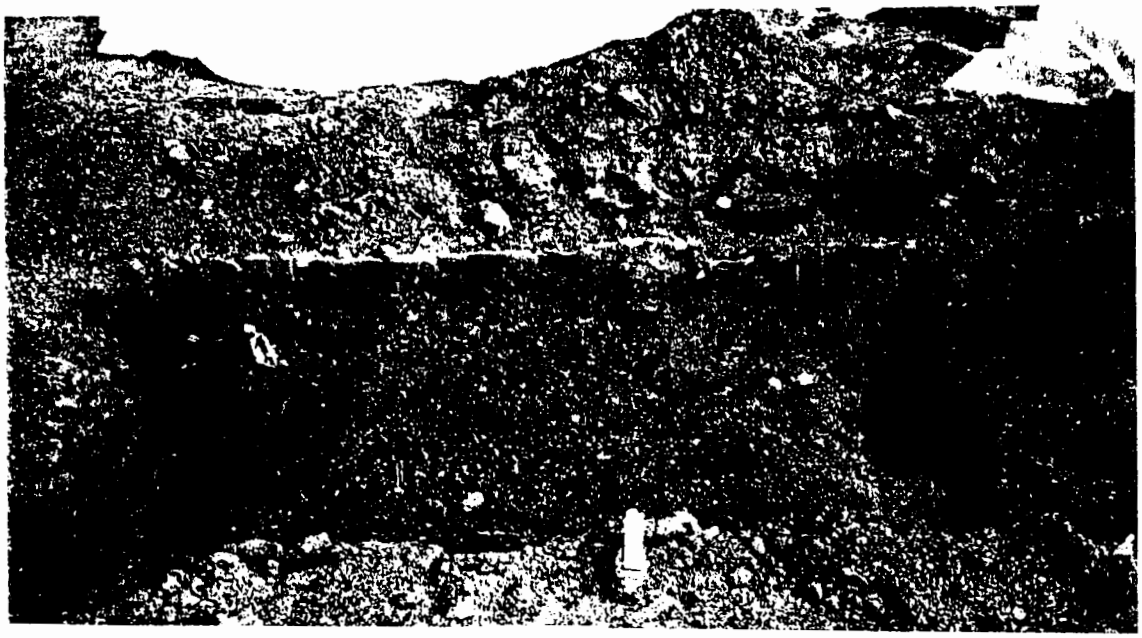

FIGURE 5. Exterior boundary of DOE Box disposal area defined by metal runway matting placed end on end.

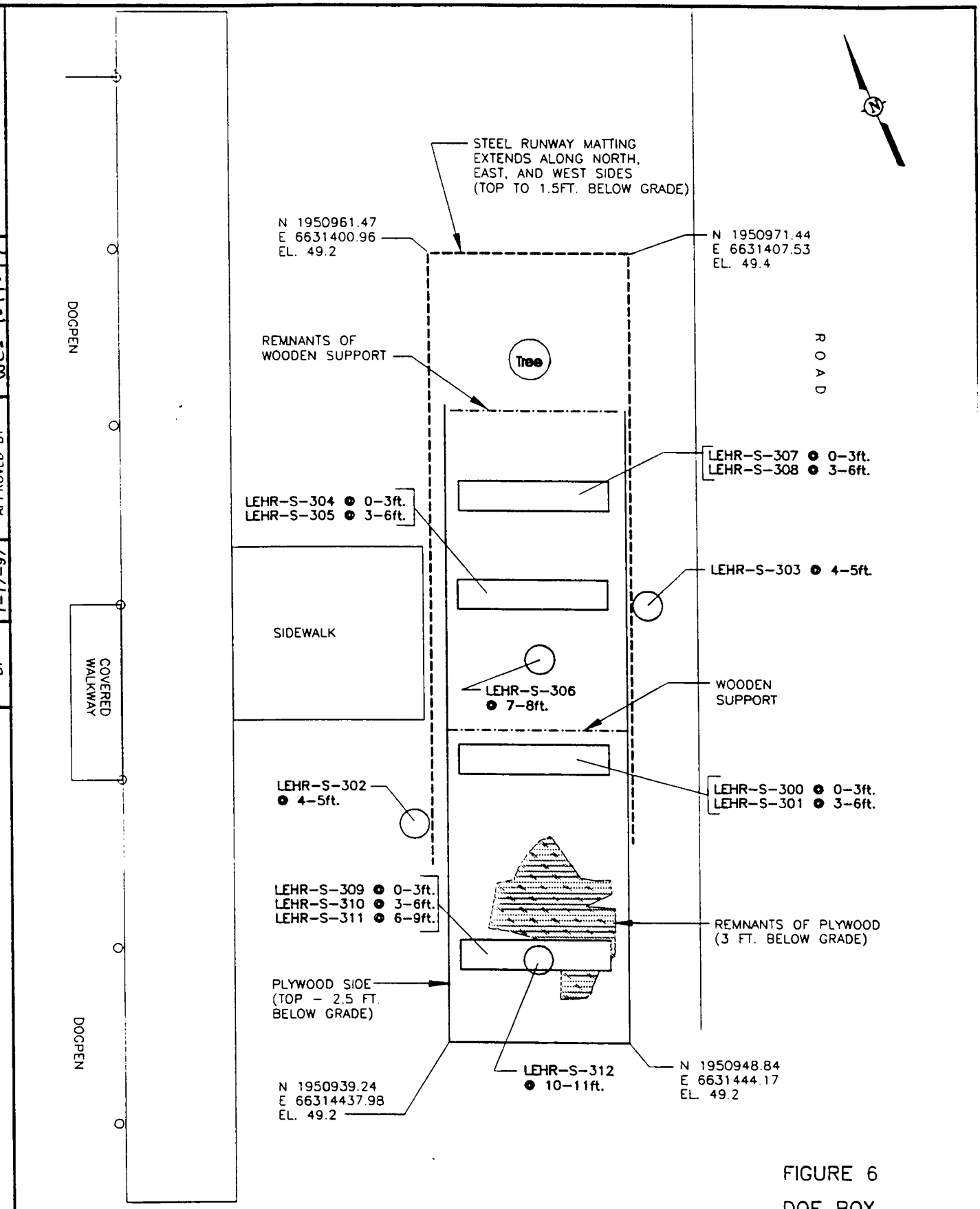

FIGURE 6

DOE BOX WASTE MATRIX SAMPLE LOCATIONS AT THE LEHR FACILITY DAVIS, CALIFORNIA

LE-DGBX(LE5)

DRAWN BY	SJZ 1-17-97	CHECKED BY	JM 1-17-97	DRAWING NUMBER	769375-A4
		APPROVED BY	WCS 1-17-97		

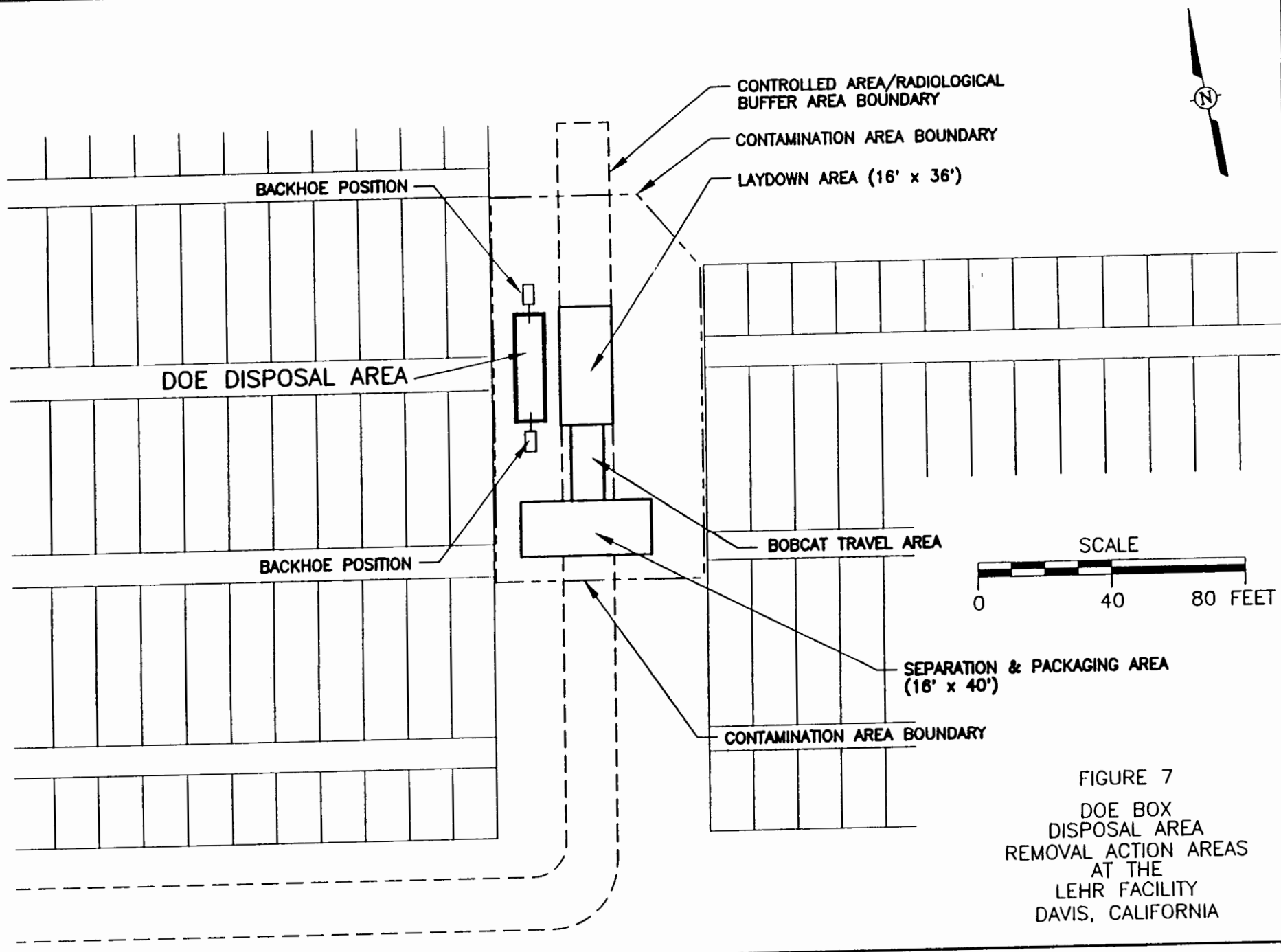

FIGURE 7

DOE BOX DISPOSAL AREA REMOVAL ACTION AREAS AT THE LEHR FACILITY DAVIS, CALIFORNIA

LE DAR2(LE5)

FIGURE 8. Contaminated waste matrix recovered from the DOE Box Area excavation was comprised of gravel and labware located approximately between three and ten feet below ground surface.

FIGURE 9. Waste matrix recovered from the DOE Box Area excavation was manually spread and sorted on the Separation and Packing Area.

FIGURE 10. Portion of the 72 bottles recovered from the north end of the DOE Box Area Excavation.

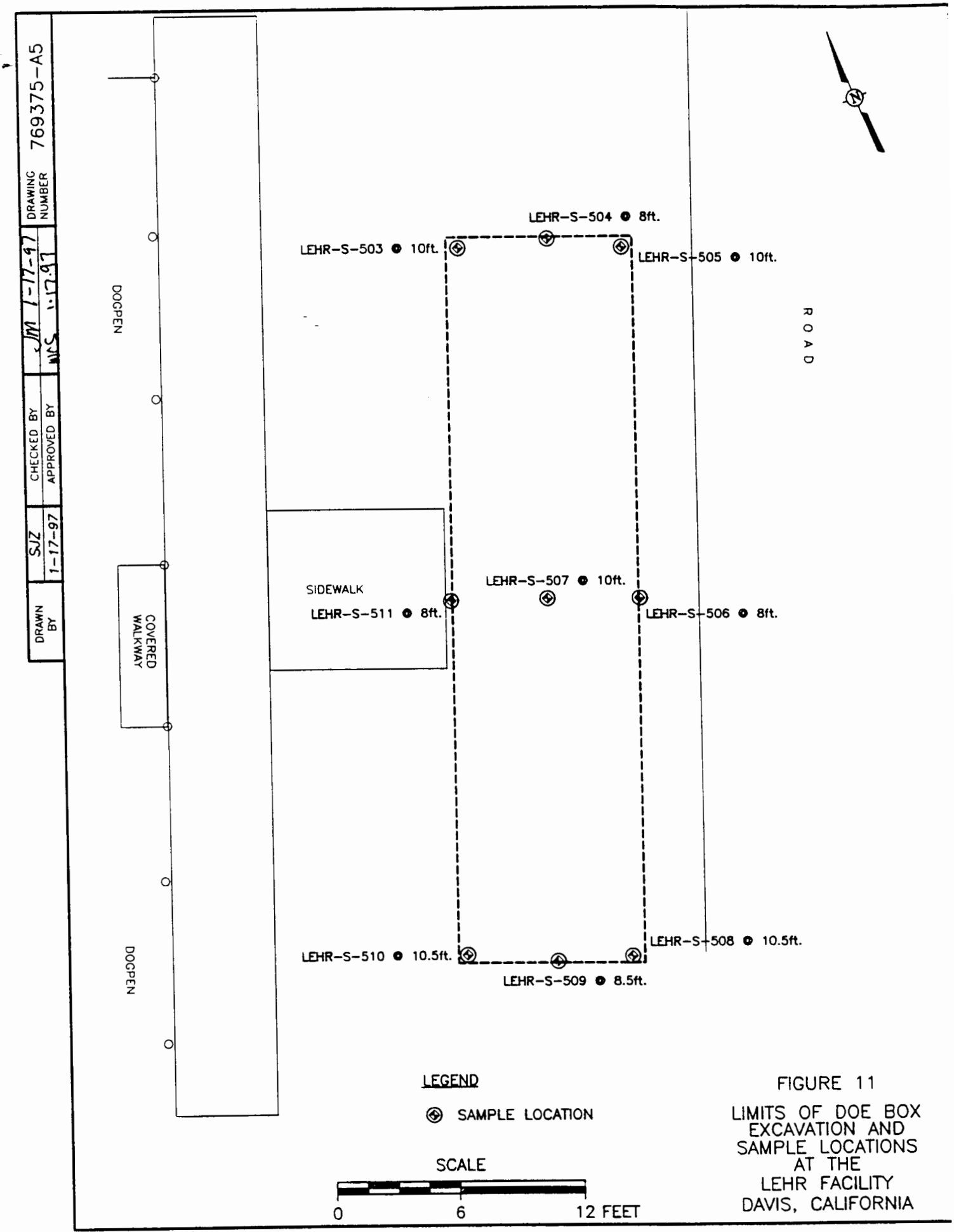

FIGURE 11

LIMITS OF DOE BOX EXCAVATION AND SAMPLE LOCATIONS AT THE LEHR FACILITY DAVIS, CALIFORNIA

LE-DGLM(LE5)

FIGURE 12. A high density polyethylene liner was placed in the DOE Box Area excavation prior to backfill.

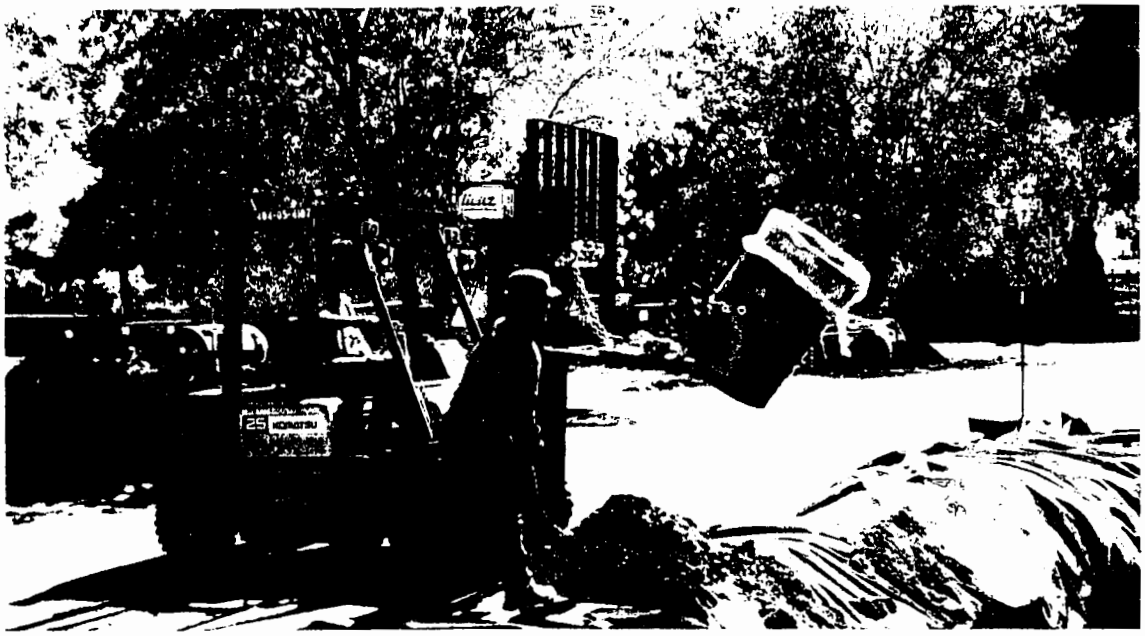

FIGURE 13. Additional soil required to backfill the DOE Box Area excavation was obtained from drummed soil stored in the Co-60 Building yard.

TABLE 1
LABORATORY ANALYTICAL METHODS for LEHR DOE BOX WASTE MATRIX SAMPLES
(IT, 1995)

Analytical Parameter	Analytical Technique	Sample Volume	Sample Container	Preservation Method	Holding Time
TCLP Volatiles	EPA Method 8240	40 ml.	40 ml. glass, septum lined with Teflon	Cool ≤4°C	14 Days
TCLP Semivolatiles	EPA Method 8270	1 Liter	1 liter amber glass, with Teflon lid	Cool ≤4°C	14 Days
TCLP Metals	EPA Method 7470	1 Liter	1 liter Polyethylene	HNO_3 pH ≤2.0	28 Days
TCLP Pesticides/PCB	EPA Method 8080	8 oz.	8 oz. wide mouth amber glass, with Teflon lid	Cool ≤4°C	14 Days
TCLP Inorganics	EPA Method 6010, ICAP, GFAA, Flame AA	1 Liter	1 liter polyethylene	HNO_3 pH ≤2.0	180 Days
TCLP Herbicides	EPA Method 8150	8 oz.	8 oz. wide mouth amber glass, with Teflon lid	Cool ≤4°C	14 Days
Corrosivity	EPA 150.1	50 ml.	100 ml. glass	None	Upon receipt of sample
Ignitability	EPA Method 1010	60 ml.	100 ml. glass	None	None
H-3 / C-14 / Ra-226 / Sr-90	LAS Procedures Manual	8 oz.	8 oz. wide mouth with Teflon lid	None	6 Months
Gamma Spec	LAS Procedures Manual	8 oz.	8 oz. wide mouth with Teflon lid	None	6 Months
Gross Alpha & Gross Beta	EPA Method 9310	8 oz.	8 oz. wide mouth with Teflon lid	None	6 Months

TABLE 2
LABORATORY ANALYTICAL METHODS for LEHR DOE BOX SOIL SAMPLING
(IT, 1996)

Analytical Parameter	Analytical Technique	Sample Volume	Sample Container	Preservation Method	Holding Time
H-3 / C-14 / Ra-226 / Sr-90	LAS Procedures Manual	8 oz.	8 oz. wide mouth with Teflon lid	None	6 Months
Gamma Spectrum	LAS Procedures Manual	8 oz.	8 oz. wide mouth with Teflon lid	None	6 Months
Gross Alpha & Gross Beta	EPA Method 9310	8 oz.	8 oz. wide mouth with Teflon lid	None	6 Months

TABLE 3

LABORATORY ANALYTICAL RESULTS FOR LEHR DOE BOX SOIL SAMPLING

Radionuclide	Units	LEHR-S-503				LEHR-S-504				LEHR-S-505				LEHR-S-506			
		Value		Uncert	MDA	Value		Uncert	MDA	Value		Uncert	MDA	Value		Uncert	MDA
Actinium-228*	pCi/g	0.61	I	0.128	0.15	0.58	I	0.11	0.12	0.57	I	0.11	0.12	0.65	I	0.17	0.2
Bismuth-212*	pCi/g	0.16	I	0.2	0.27	0.34	I	0.18	0.2	0.32	I	0.2	0.24	0.25	I	0.3	0.39
Bismuth-214*	pCi/g	0.522	I	0.091	0.079	0.424	I	0.076	0.072	0.384	I	0.077	0.075	0.74	I	0.13	0.11
Carbon-14	pCi/g	-0.39	I	0.553	1.1	-0.25	I	2.56	1.1	-0.61	I	0.53	1.1	0.27	I	0.65	1.1
Cesium-137*	pCi/g	-0.007	I	0.014	0.035	0.014	I	0.023	0.031	0.008	I	0.021	0.028	-0.04	I	0.028	0.068
Cobalt-60*	pCi/g	-0.006	I	0.011	0.034	-0.001	I	0.013	0.03	0.001	I	0.016	0.033	0.011	I	0.026	0.051
Gross Alpha	pCi/g	13.5	IC	6.2	6.8	5.4	IC	4.4	6.3	5.4	IC	5.17	6.4	8.7	IC	5.1	6.4
Gross Beta	pCi/g	14.4	I	4.2	5.7	13.1	I	[illegible]	5.6	10.6	I	4.02	5.6	14	I	3.9	5.3
Lead-210*	pCi/g	2.4	I	8	11	1.8	I	2.5	3.4	0.6	I	2.6	3.7	1.11	I	0.9	1.3
Lead-212*	pCi/g	0.535	I	0.083	0.063	0.532	I	0.078	0.053	0.527	I	0.079	0.06	0.7	I	0.11	0.079
Lead-214*	pCi/g	0.494	I	0.074	0.073	0.471	I	0.068	0.062	0.576	I	0.075	0.061	0.75	I	0.11	0.098
Potassium-40*	pCi/g	11.2	I	1.4	0.52	11	I	1.4	0.39	10.7	I	1.3	0.37	12.1	I	1.7	0.61
Radium-223*	pCi/g	-0.1	I	0.18	0.61	-0.15	I	0.12	0.53	-0.03	I	0.18	0.57	-0.11	I	0.21	0.94
Radium-226	pCi/g	0.68	I	0.24	0.24	0.36	I	0.283	0.29	0.65	I	0.26	0.22	0.51	I	0.2	0.13
Radium-226*	pCi/g	1.1	I	0.53	0.69	0.53	I	0.47	0.66	0.69	I	0.48	0.66	1.41	I	0.7	0.93
Strontium-90	pCi/g	0.28	I	0.33	0.59	-0.09	I	1.66	0.62	0.28	I	0.34	0.57	-0.09	I	0.3	0.54
Thallium-208*	pCi/g	0.16	I	0.04	0.04	0.174	I	0.039	0.036	0.173	I	0.039	0.035	0.224	I	0.059	0.057
Thorium-234*	pCi/g	0.32	I	0.39	1.1	0.4	I	0.41	1.3	0.18	I	0.41	1.3	0.91	I	0.43	1.2
Tritium	pCi/L	90	I	135	200	40	I	110	200	50	I	110	200	70	I	120	200
Uranium-235*	pCi/g	-0.096	I	0.086	0.22	0.06	I	0.12	0.18	0.04	I	0.12	0.19	-0.08	I	0.13	0.24

Notes:
- Uncert = Uncertainty or Error
- MDA = Minimum Detectable Activity
- pCi/g = pico Curies per gram
- C = The minimum detectable activity exceeded the Reporting Detection Limit due to the residue weight limitations forcing a volume reduction.
- * = Gamma scan

TABLE 3

LABORATORY ANALYTICAL RESULTS FOR LEHR DOE BOX SOIL SAMPLING

Radionuclide	Units	LEHR-S-507				LEHR-S-508				LEHR-S-509				LEHR-S-510			
		Value		Uncert	MDA	Value		Uncert	MDA	Value		Uncert	MDA	Value		Uncert	MDA
Actinium-228*	pCi/g	0.59	I	0.17	0.2	0.7	I	0.18	0.21	0.57	I	0.12	0.13	0.56	I	0.18	0.25
Bismuth-212*	pCi/g	0.27	I	0.24	0.37	0.15	I	0.28	0.37	0.37	I	0.2	0.23	0.57	I	0.28	0.37
Bismuth-214*	pCi/g	0.57	I	0.12	0.1	0.41	I	0.11	0.11	0.402	I	0.079	0.073	0.42	I	0.11	0.11
Carbon-14	pCi/g	0.16	I	0.59	1	0.03	I	0.56	1	0.09	I	0.58	1	0.0	I	0.56	1
Cesium-137*	pCi/g	0.006	I	0.036	0.05	-0.032	I	0.023	0.063	-0.006	I	0.013	0.033	-0.007	I	0.022	0.056
Cobalt-60*	pCi/g	0.002	I	0.024	0.054	0.01	I	0.027	0.055	0.008	I	0.015	0.027	-0.011	I	0.02	0.056
Gross Alpha	pCi/g	5	IC	5.1	8	11.6	IC	5.7	6.5	7.4	IC	4.9	6.5	6.2	IC	4.6	6.3
Gross Beta	pCi/g	16.2	I	4.2	5.5	17.8	I	4.3	5.5	15.3	I	4.2	5.6	13.7	I	4	5.5
Lead-210*	pCi/g	0.97	I	0.86	1.2	0.79	I	0.93	1.4	-0.9	I	2.5	3.6	0.71	I	0.86	1.3
Lead-212*	pCi/g	0.76	I	0.12	0.087	0.68	I	0.11	0.086	0.59	I	0.085	0.06	0.72	I	0.12	0.092
Lead-214*	pCi/g	0.66	I	0.11	0.11	0.594	I	0.1	0.1	0.568	I	0.077	0.067	0.56	I	0.11	0.12
Potassium-40*	pCi/g	11.3	I	1.7	0.52	11.4	I	1.7	0.59	12.2	I	1.5	0.41	11.6	I	1.7	0.44
Radium-223*	pCi/g	-0.2	I	0.26	1	-0.11	I	0.24	0.95	-0.06	I	0.23	0.58	-0.3	I	0.33	1
Radium-226	pCi/g	0.3	I	0.18	0.22	0.43	I	0.2	0.2	1.13	I	0.34	0.26	0.56	I	0.23	0.23
Radium-226*	pCi/g	1.3	I	0.76	1	0.24	I	0.73	0.99	0.16	I	0.49	0.65	0.46	I	0.73	0.99
Strontium-90	pCi/g	0.0	I	0.26	0.45	-0.02	I	0.33	0.58	0.27	I	0.37	0.62	0.11	I	0.35	0.61
Thallium-208*	pCi/g	0.199	I	0.057	0.055	0.18	I	0.059	0.063	0.206	I	0.042	0.034	0.189	I	0.059	0.061
Thorium-234*	pCi/g	0.66	I	0.44	1.2	0.85	I	0.47	1.4	0.51	I	0.43	1.4	0.83	I	0.45	1.2
Tritium	pCi/L	80	I	120	200	-20	I	100	200	130	I	130	200	90	I	120	200
Uranium-235*	pCi/g	-0.03	I	0.14	0.26	0.04	I	0.16	0.25	0.08	I	0.13	0.19	0.04	I	0.16	0.24

Notes:
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MDA = Minimum Detectable Activity
pCi/g = pico Curies per gram
C = The minimum detectable activity exceeded the Reporting Detection Limit due to the residue weight limitations forcing a volume reduction.
* = Gamma scan

TABLE 3

LABORATORY ANALYTICAL RESULTS FOR LEHR DOE BOX SOIL SAMPLING

Radionuclide	Units	LEHR-S-511			
		Value		Uncert	MDA
Actinium-228*	pCi/g	0.51	I	0.16	0.16
Bismuth-212*	pCi/g	0.2	I	0.28	0.28
Bismuth-214*	pCi/g	0.425	I	0.1	0.1
Carbon-14	pCi/g	-0.57	I	0.5	0.5
Cesium-137*	pCi/g	0.007	I	0.031	0.031
Cobalt-60*	pCi/g	-0.004	I	0.018	0.018
Gross Alpha	pCi/g	7.7	IC	5.2	5.2
Gross Beta	pCi/g	13	I	3.9	3.9
Lead-210*	pCi/g	0.6	I	0.77	0.77
Lead-212*	pCi/g	0.626	I	0.096	0.096
Lead-214*	pCi/g	0.493	I	0.087	0.087
Potassium-40*	pCi/g	11.3	I	1.6	1.6
Radium-223*	pCi/g	-0.11	I	0.21	0.21
Radium-226	pCi/g	0.48	I	0.2	0.2
Radium-226*	pCi/g	0.94	I	0.62	0.62
Strontium-90	pCi/g	-0.02	I	0.35	0.35
Thallium-208*	pCi/g	0.152	I	0.048	0.048
Thorium-234*	pCi/g	0.84	I	0.39	0.39
Tritium	pCi/L	280	I	150	150
Uranium-235*	pCi/g	0.12	I	0.14	0.14

Notes:
Uncert = Uncertainty or Error
MDA = Minimum Detectable Activity
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