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Rev. 0

Cleanup Status Report for the 116-KE-1 and 116-KW-1 Cribs

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Office of Environmental Restoration

Submitted by: Bechtel Hanford, Inc.

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Rev. 0

Cleanup Status Report for the 116-KE-1 and 116-KW-1 Cribs

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July 2004

EXECUTIVE SUMMARY

E1.0 INTRODUCTION

The purpose of this report is to document the current (2004) status of 116-KE-1 and 116-KW-1 site remediation to assist in future decision making for these sites.

The 116-KE-1 and 116-KW-1 Condensate Crib sites are located within the 100-KR-1 Operable Unit in the 100-K Area of the Hanford Site in southeastern Washington State. The 116-KE-1 site is located approximately 40 m (130 ft) northeast of the 105-KE Reactor Building. The 116-KW-1 site is located approximately 40 m (130 ft) northeast of the 105-KW Reactor Building. Both sites consisted of a gravel-filled crib fed by a 10-cm (4-in.)-diameter feed pipe. The cribs were constructed for disposal of condensate and other waste water from the 105-KE and 105-KW Reactor Gas Purification Systems. The cribs received effluent from approximately 1955 to 1971, at which time the 105-KE and 105-KW Reactors were shut down.

Remedial action objectives and goals for the 116-KE-1 and 116-KW-1 sites were established by the U.S. Environmental Protection Agency and the U.S. Department of Energy, Richland Operations Office, in concurrence with the Washington State Department of Ecology. These goals and objectives are documented in the *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units* (ROD Amendment) (EPA 1997) and the *Remedial Design Report/ Remedial Action Work Plan for the 100 Area* (DOE-RL 2002), and include objectives for direct exposure, groundwater protection, and protection of the Columbia River.

The remedial action selected by the ROD for the 116-KE-1 and 116-KW-1 sites included (1) excavation, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility in the 200 Area of the Hanford Site, and (3) backfilling with clean soil to average adjacent grade elevation.

Waste site contaminants of concern (COCs) identified through process knowledge are listed in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001). The COCs for these sites consist of the following:

- Carbon-14
- Cesium-137
- Cobalt-60
- Europium-154
- Strontium-90
- Tritium.

For the 116-KE-1 site, the SAP lists only carbon-14 as a COC. However, because the process history for the 116-KE-1 and 116-KW-1 sites are nearly identical, the COC list for the 116-KE-1 site has been revised to include the additional COCs identified for the 116-KW-1 site. In addition, tritium is not listed as a COC for the crib sites; however, during remediation tritium was identified in the soil and included as a COC for both sites.

E2.0 RESULTS

Because of the close proximity of adjacent buildings and the depth and magnitude of the more mobile contaminants (i.e., carbon-14 and tritium), the selected remedial action could not be fully implemented for the 116-KE-1 and 116-KW-1 sites. A large volume of contaminated soil and the crib structure and feed piping were excavated and removed. However, to avoid undermining adjacent building foundations and because of contamination depths beyond the approved excavation equipment capability, soil containing contaminant concentrations at levels exceeding the rural-residential remedial action objectives and goals remains in place.

Site excavation, to the extent that could be safely conducted in the vicinity of adjacent buildings and to the capability of the onsite excavation equipment, is complete. Excavated waste disposal is complete, and the exposed surfaces of the excavation have been sampled and analyzed to assess remaining contaminant concentrations. The excavations have been backfilled. At the completion of excavation, the excavation for the 116-KE-1 site was approximately 717 m^2 (7,713 ft^2) in area and the excavation for the 116-KW-1 site was approximately 759 m^2 (8,162 ft^2) in area. The bottom of the excavations for both sites were approximately 9.1 m (30 ft) below the surrounding grade. Approximately 224 bank cubic meters of material from the 116-KE-1 site and approximately 2,519 bank cubic meters of material from the 116-KW-1 site were disposed of at the Environmental Restoration Disposal Facility. The disposal volume difference between the two sites is because the overburden material associated with the 116-KE-1 Crib was not contaminated and the overburden material associated with the 116-KW-1 Crib was contaminated.

Disposition of these sites will be determined at a later date. Examples of future decisions that may affect the disposition of the residual contamination associated with these sites include remediation decisions for adjacent buildings (including the 105-KE and 105-KW Reactor Buildings), final ROD decisions, and ongoing and future 100 Area risk assessments.

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ACRONYMS AND ABBREVIATIONS

COC	contaminant of concern
DQA	data quality assessment
ERDF	Environmental Restoration Disposal Facility
GEA	gamma energy analysis
K_d	distribution coefficient
MDA	minimum detectable activity
MS	matrix spike
PARCC	precision, accuracy, representativeness, completeness, and comparability
PQL	practical quantitation limit
QA	quality assurance
QC	quality control
RAG	remedial action goal
RAO	remedial action objective
RDR/RAWP	remedial design report/remedial action work plan
RESRAD	RESidual RADioactivity (dose assessment model)
ROD	record of decision
RPD	relative percent difference
SAP	sampling and analysis plan
SDG	sample delivery group

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to document the current (2004) status of the 116-KE-1 and 116-KW-1 site remediations to assist in future decision making for these sites. Remediation was conducted under the *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units* (ROD Amendment) (EPA 1997). The ROD Amendment provides the U.S. Department of Energy, Richland Operations Office the authority, guidance, and objectives to conduct this remedial action. The preferred remedy specified in the ROD Amendment and conducted for the 116-KE-1 and 116-KW-1 sites was excavation and disposal of contaminated materials at the Environmental Restoration Disposal Facility (ERDF). However, for the 116-KE-1 and 116-KW-1 sites, because of adjacent buildings and the depth and magnitude of the more mobile contaminants (i.e., carbon-14 and tritium), the selected remedial action could not be fully implemented at this time.

1.2 DOCUMENT ORGANIZATION

- Section 2.0 Site Description and Supporting Information
- Section 3.0 Summary of Remedial Action Objectives and Goals
- Section 4.0 Remedial Action Field Activities
- Section 5.0 Data Evaluation
- Section 6.0 Conclusion.

The main text is supported by the following appendices:

- Appendix A Summary of Soil Sampling and Analytical Results
- Appendix B Data Quality Assessment
- Appendix C Sample Designs.

2.0 SITE DESCRIPTION AND SUPPORTING INFORMATION

2.1 SITE HISTORY

The 116-KE-1 and 116-KW-1 sites are located within the 100-KR-1 Operable Unit in the 100-K Area of the Hanford Site. The 116-KE-1 site is located approximately 40 m (130 ft) northeast of the 105-KE Reactor Building (Figure 1). The 116-KW-1 site is located approximately 40 m (130 ft) northeast of the 105-KW Reactor Building (Figure 2). Both sites consisted of a gravel-filled crib fed by a 10-cm (4-in.)-diameter pipe and 20-cm (8-in.)-diameter perforated piping. The perforated piping branched into two additional short pipe runs. The perforated piping was approximately 3.2 m (10.5 ft) long,

Figure 1. Hanford Site Map and 116-KE-1 Site Plan.

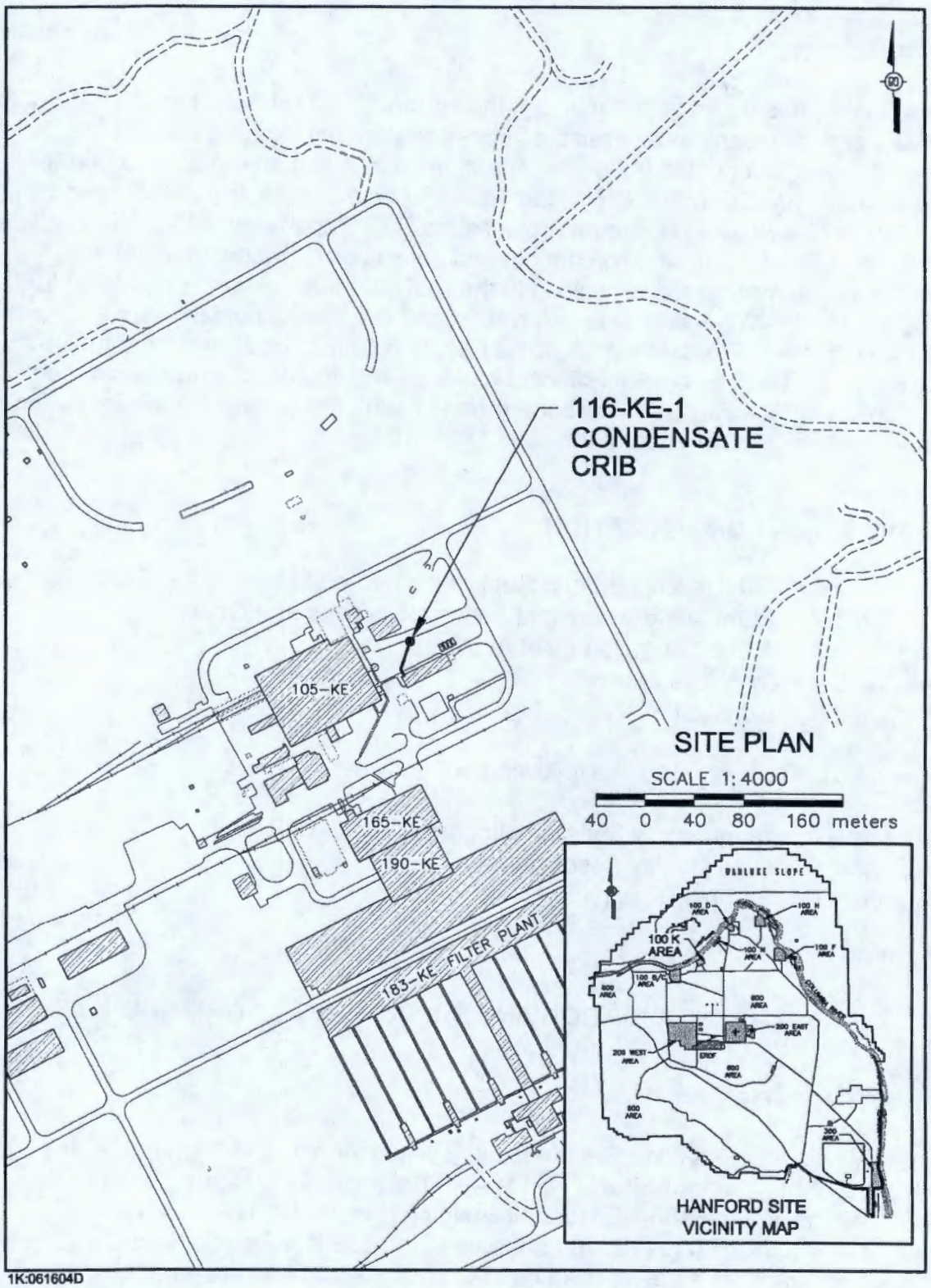

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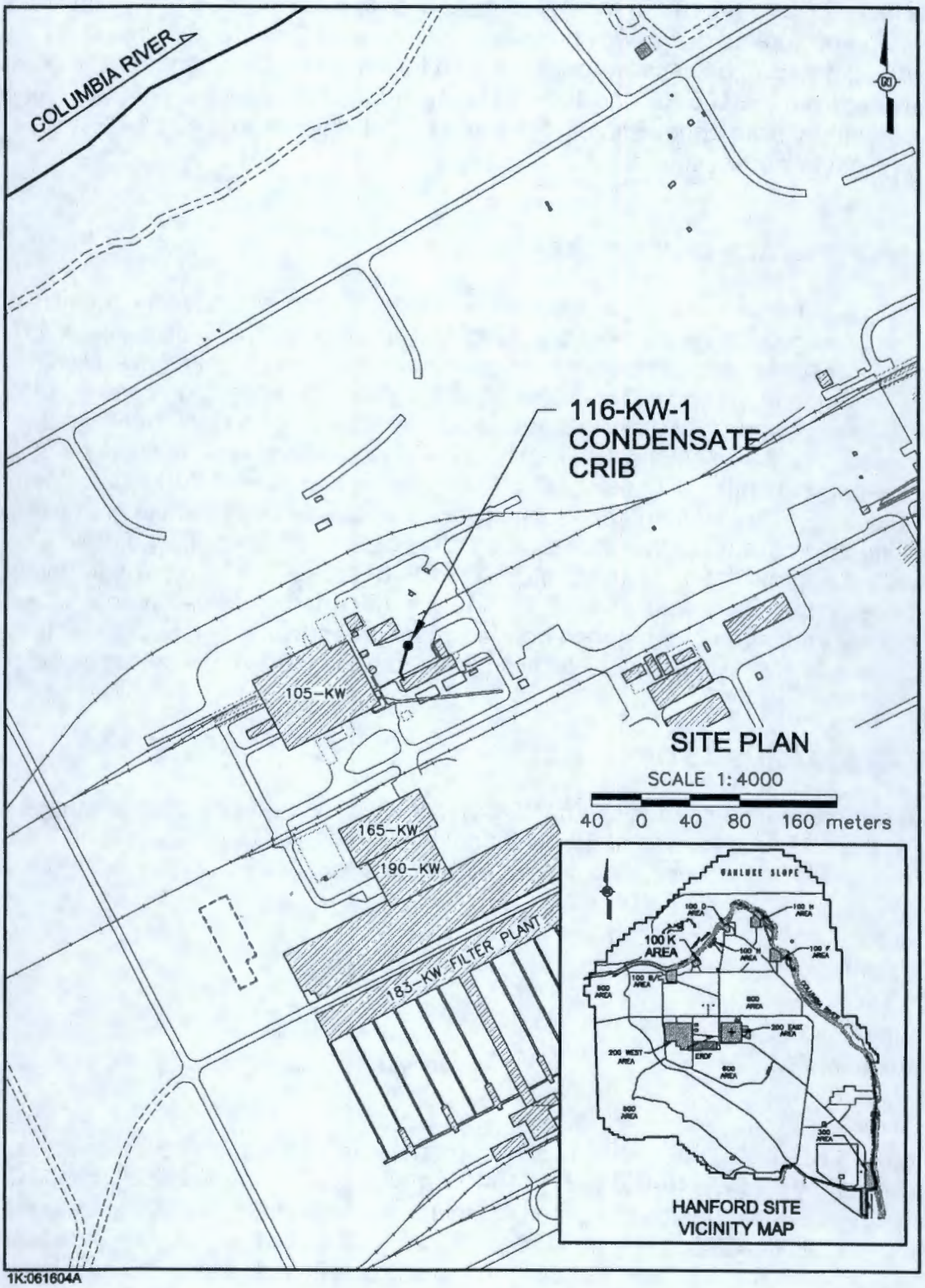
Figure 2. Hanford Site Map and 116-KW-1 Site Plan.



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and the two branches were approximately 2 m (6.5 ft) long and buried in an approximate 12.2-m (40-ft) top and 1.8-m (6-ft) bottom diameter hole filled with coarse gravel. The perforated piping was buried approximately 4.6 m (15 ft) below the surrounding grade. The cribs were constructed for disposal of condensate and other waste water from the 105-KE and 105-KW Reactor Gas Purification Systems. The cribs received effluent from approximately 1955 to 1971, at which time the 105-KE and 105-KW Reactors were shut down.

2.2 SUBSURFACE CONDITIONS

The soil column underlying the waste sites and extending to groundwater consists of materials belonging to the Hanford and Ringold Formations. The shallower Hanford formation consists predominantly of medium-dense to dense sand and gravel with varying amounts of silt and cobble. The underlying Ringold Formation consists of dense, well-cemented gravels with sand and silt interbeds. The Hanford/Ringold contact depth varies within the 100-K Area. The Ringold Formation is exposed at the surface along the banks of the Columbia River and up to 366 m (1,200 ft) away from the river. Elsewhere, the Hanford formation covers the Ringold Formation in gradually increasing thickness up to the southern boundary of the 100-K Area, where the formation is approximately 37 to 40 m (120 to 130 ft) thick. The long-term groundwater level beneath the sites is estimated at El. 119.2 m (391 ft) for analysis purposes, based on historical and current information from adjacent groundwater wells. The depth to groundwater is approximately 23.3 m (76 ft) beneath the grade level of these sites.

2.3 CONTAMINANTS OF CONCERN

Waste site contaminants of concern (COCs) identified through process knowledge are listed in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001). The COCs for these sites consist of the following:

- Carbon-14
- Cesium-137
- Cobalt-60
- Europium-154
- Strontium-90
- Tritium.

For the 116-KE-1 site, the SAP lists only carbon-14 as a COC. However, because the process history for the 116-KE-1 and 116-KW-1 sites are nearly identical, the COC list for the 116-KE-1 site has been revised to include the additional COCs identified for the 116-KW-1 site. In addition, tritium is not listed as a COC for the crib sites; however, during remediation tritium was identified in the soil and included as a COC for both sites.

3.0 SUMMARY OF REMEDIAL ACTION OBJECTIVES AND GOALS

3.1 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) for the 116-KE-1 and 116-KW-1 sites were established in the ROD Amendment (EPA 1997). The RAOs are qualitative statements defining the extent to which waste sites require cleanup to protect human health and the environment. For a detailed discussion of the RAOs, see the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2002) and the ROD Amendment.

3.2 REMEDIAL ACTION GOALS

Remedial action goals (RAGs) are the specific numeric goals against which the remedial action data are evaluated. The RAGs were developed to support an unrestricted land use (EPA 1997) as represented by a rural-residential exposure scenario. This scenario involves exposure to shallow zone soils (i.e., less than 4.6 m [15 ft] deep). The scenario assumes institutional controls against uncontrolled drilling or digging into deep zone soils (i.e., below 4.6 m [15 ft]). A detailed description of the rural-residential scenario, and how it is applied, is provided in the RDR/RAWP (DOE-RL 2002).

The contaminant-specific RAGs applicable to the 116-KE-1 and 116-KW-1 sites are listed in Table 1.

Table 1. Summary of Remedial Action Goals.

COCs	Direct Exposure RAG (pCi/g)		Groundwater Protection RAG (pCi/L)		Columbia River Protection RAG (pCi/L)	
Carbon-14	15 mrem/yr (cumulative)	5.16[a]	4 mrem/yr (cumulative)	2,000[b]	4 mrem/yr (cumulative)	2,000[b]
Cesium-137		6.2[a]		60[b]		60[b]
Cobalt-60		1.4[a]		100[b]		100[b]
Europium-154		3[a]		60[b]		60[b]
Strontium-90		4.5[a]		8[c]		8[c]
Tritium		510[a]		20,000[c]		20,000[c]

[a]Lookup values that correspond to the 15 mrem/yr dose rate are based on a generic site model from the RDR/RAWP (DOE-RL 2002).
[b]Individual constituent drinking water concentrations corresponding to a dose rate of 4 mrem/yr.
[c]Promulgated groundwater protection standards (40 *Code of Federal Regulations* 141). Strontium-90 and tritium also contribute to the 4 mrem/yr dose rate limit (cumulative) for groundwater and river protection.

3.2.1 Direct Exposure RAGs

Under the rural-residential scenario, direct exposure RAGs are applicable to soils that are less than 4.6 m (15 ft) below ground surface (shallow zone soils). Direct exposure RAGs are listed in Table 1. Only radionuclide COCs have been identified for the 116-KE-1 and 116-KW-1 sites. For radionuclide COCs in the shallow zone (all pathways) and in the deep zone (water-dependent pathways), the RAG is a total dose rate of 15 mrem/yr above background for a period of 1,000 years.

3.2.2 Groundwater and River Protection

Groundwater and river protection RAGs are applicable to all vadose zone soils (shallow and deep zone soils). For these sites, river protection and surface water protection are synonymous since the Columbia River is the only surface water in proximity to the Hanford Site. The term river protection is used throughout this report. The groundwater and river protection RAGs are listed in Table 1. Only beta- and gamma-emitting radionuclide COCs have been identified for the 116-KE-1 and 116-KW-1 sites. For these COCs, the RAO is to meet "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141.66) dose rate standards (4 mrem/yr total body or organ dose rate) for a period of 1,000 years starting from site cleanup. Drinking water concentrations corresponding to the 4 mrem/yr dose rate and additional promulgated standards are cited in Table 1.

4.0 REMEDIAL ACTION FIELD ACTIVITIES

4.1 EXCAVATION AND DISPOSAL

Remedial action at the 116-KE-1 and 116-KW-1 sites began in January 2004. Excavation of the 116-KE-1 and 116-KW-1 sites involved removing overburden materials, the crib structures, feed pipelines, and underlying contaminated soil. Contaminated materials were disposed of at ERDF.

Because of the depth and steep slope of the excavations, post-excavation topographical surveys could not be conducted. The pre-excavation topographic maps are shown in Figures 3 and 4 and the post-excavation site boundaries are shown in Figures 5 and 6. At the completion of excavation, the excavation for the 116-KE-1 site was approximately 717 m^2 (7,713 ft^2) in area and the excavation for the 116-KW-1 site was approximately 759 m^2 (8,162 ft^2) in area. The bottoms of the excavations for both sites were approximately 9.1 m (30 ft) below the surrounding grade. Approximately 224 bank cubic meters of material from the 116-KE-1 site and approximately 2,519 bank cubic meters of material from the 116-KW-1 site were disposed of at ERDF. The disposal volume difference between the two sites is because the overburden material associated with the 116-KE-1 site was not contaminated and the overburden material from the 116-KW-1 site was contaminated.

Figure 3. Pre-Excavation Topographic Map of the 116-KE-1 Crib.

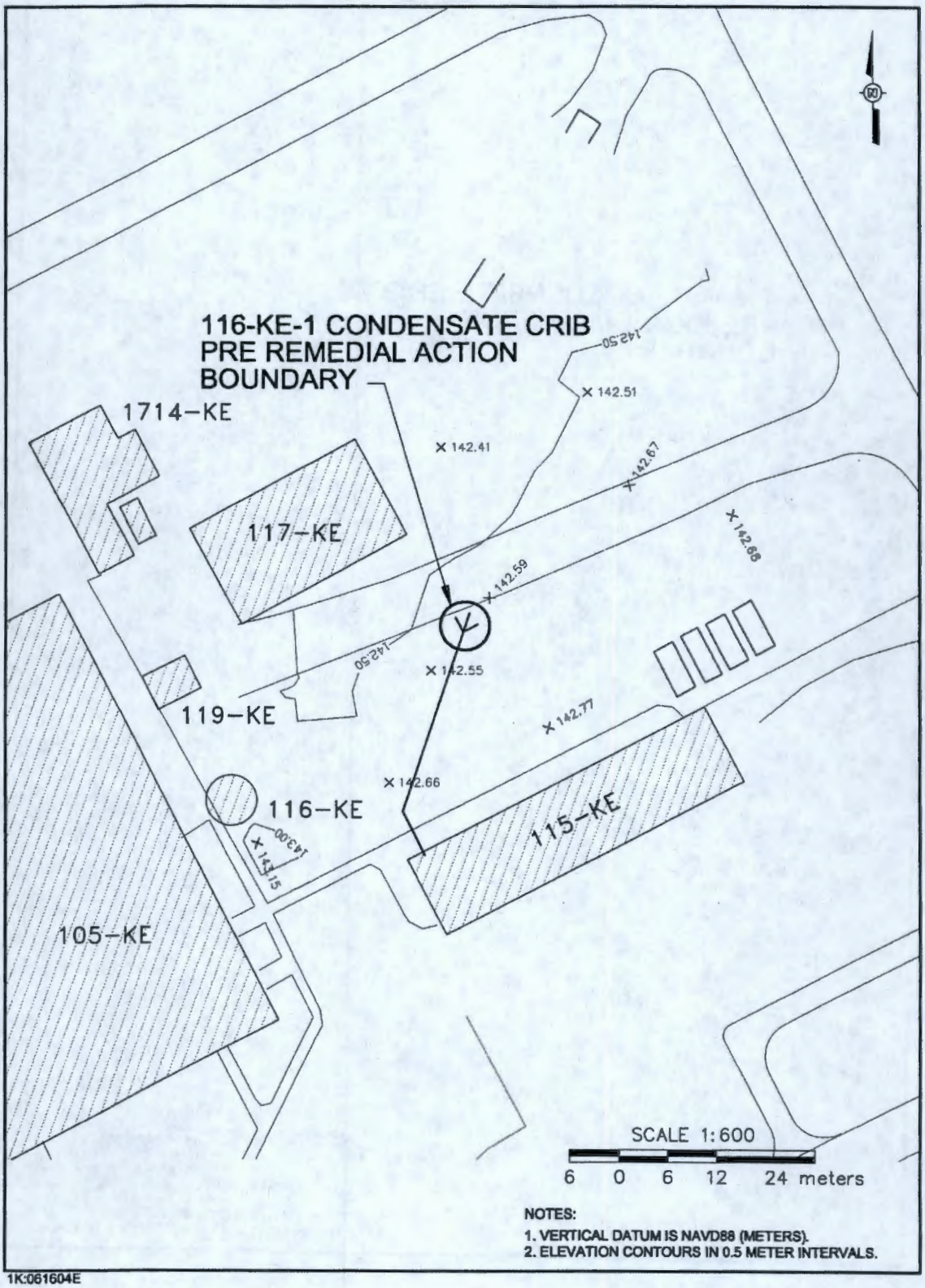

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Figure 4. Pre-Excavation Topographic Map of the 116-KW-1 Crib.

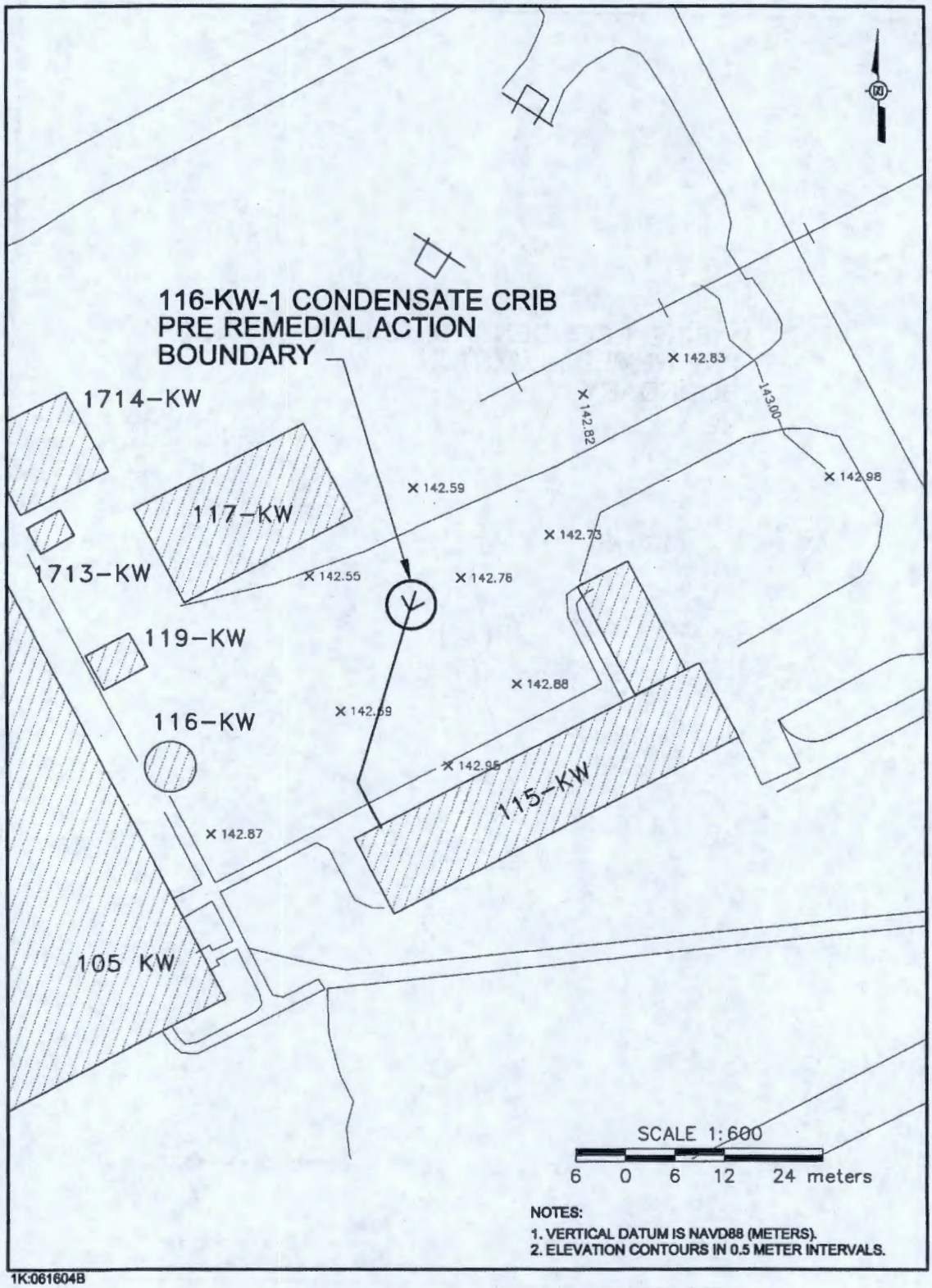

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Figure 5. Post-Excavation Site Boundary for the 116-KE-1 Crib.

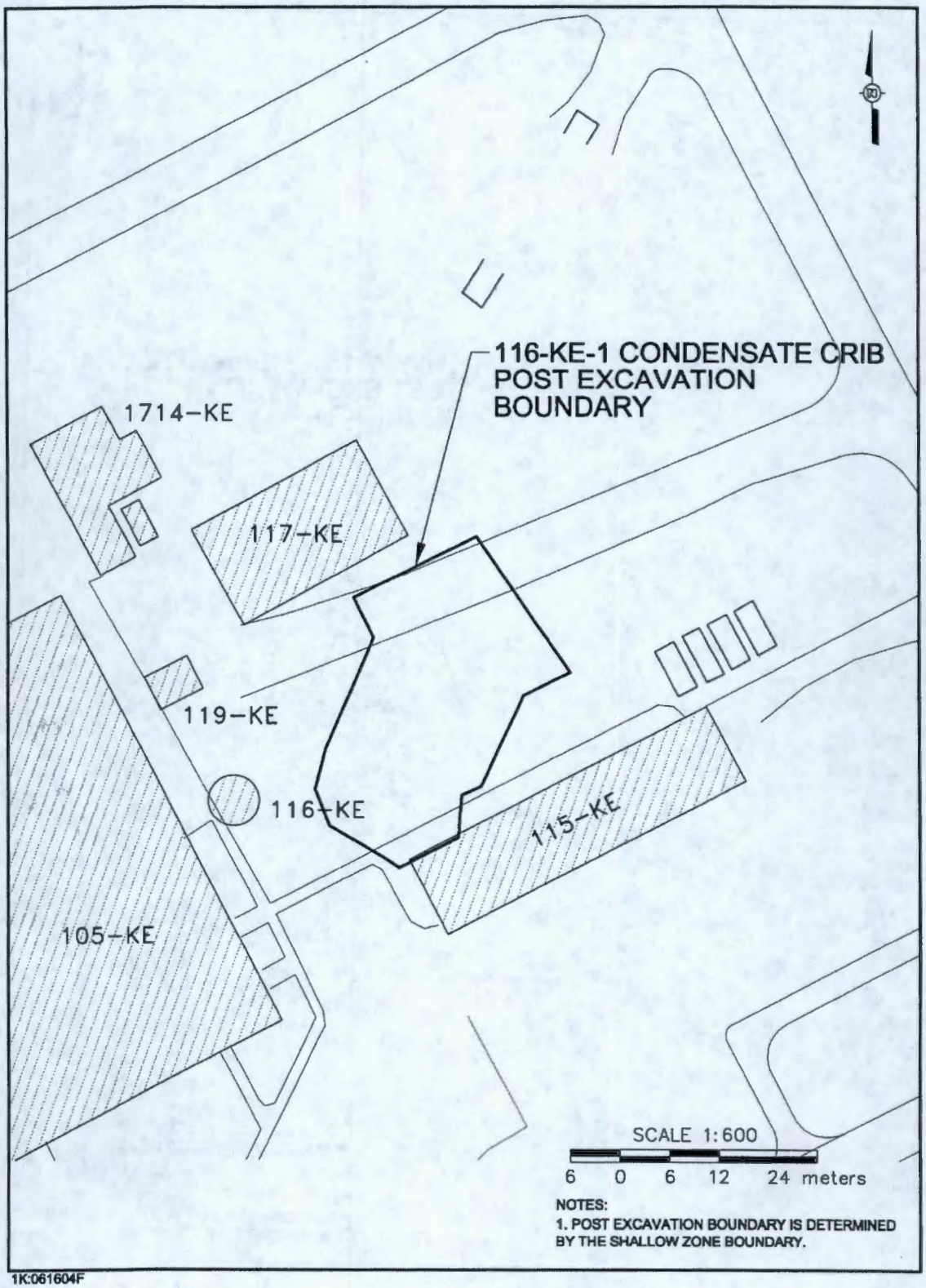

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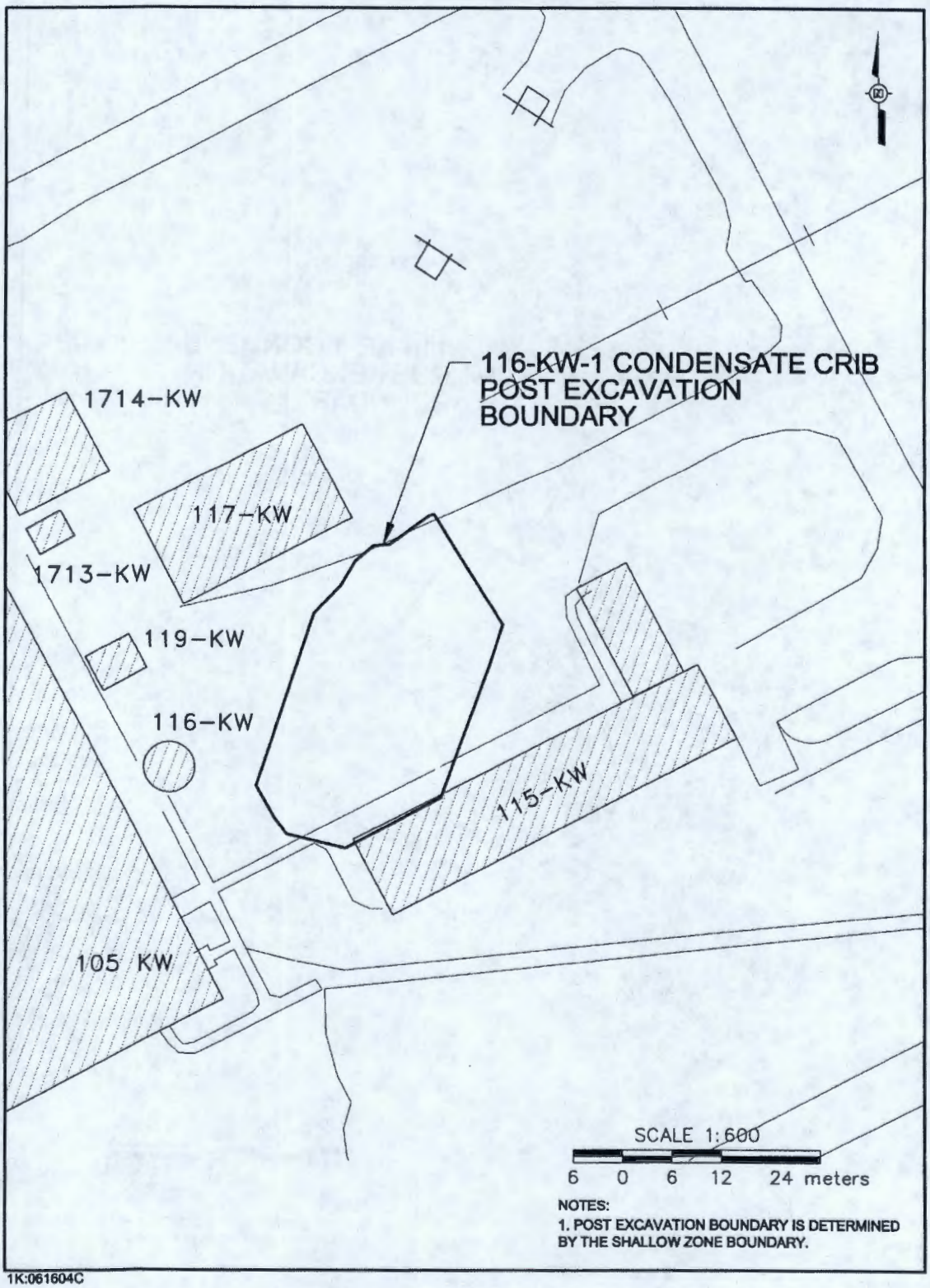
Figure 6. Post-Excavation Site Boundary for the 116-KW-1 Crib.



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4.2 EXCAVATION SAMPLING AND ANALYSIS

To assess the remedial excavations of the 116-KE-1 and 116-KW-1 sites, soil samples were collected from the excavation walls and floors in February 2004. Soil samples were also collected from the 116-KE-1 overburden pile in February 2004. The overburden material associated with the 116-KW-1 site was contaminated and disposed of and is, therefore, not included in this assessment. The samples collected from the remedial excavations and the 116-KE-1 overburden were collected using the sampling approach detailed in the SAP (DOE-RL 2001). The approach includes two phases of sampling typically referred to as variance sampling and verification sampling. Because of an accelerated schedule, the two sampling phases were conducted simultaneously.

The variance sampling consists of multiple discrete samples analyzed for a small subset of the site COC list. The results from the variance analysis are typically used to quantify the variability of residual contamination, and to determine the appropriate number of final cleanup verification samples. In the case of the 116-KE-1 and 116-KW-1 sites, the samples are used to assess the extent of remaining contamination. A variability calculation was not performed because the sites do not currently meet the RAGs. A total of 24 variance samples were collected from each of the sites shallow zones and analyzed for cesium-137, cobalt-60, and europium-154. A total of 48 variance samples were collected from the 116-KE-1 overburden pile and analyzed for the same analytes. Sample locations are shown in the sample design (Appendix C). Sample results are shown in Appendix A.

The second phase of sampling included the collection of composite samples. Composite samples were collected by combining soil from four randomly-selected nodes within each sampling area. The shallow zone of each site was divided into four sampling areas (A1-A4). The deep zone for each site was divided into three sampling areas (A1-A3). The 116-KE-1 overburden pile was divided into eight sample areas (A1-A4 and B5-B8). The sample design for these sites is shown in Appendix C.

All soil samples were submitted to offsite laboratories for analysis using U.S. Environmental Protection Agency-approved analytical methods as specified per the SAP (DOE-RL 2001).

The division of the site excavation into decision units (shallow zone and deep zone), as shown in the sample design figures in Appendix C, is a function of the applicable RAGs (Section 3.2, "Remedial Action Goals"). The direct exposure, groundwater protection, and river protection RAGs are applicable to soils within 4.6 m (15 ft) of the ground surface. This soil zone is referred to as the shallow zone. The 116-KE-1 overburden pile is a shallow zone decision unit. The groundwater protection and river protection RAGs are applicable to soils greater than 4.6 m (15 ft) below the ground surface. This soil zone is referred to as the deep zone.

Both sites consisted of shallow zone and deep zone decision units. Both crib sites were excavated to a depth greater than 4.6 m (15 ft) with the shallow zone consisting of the excavation sidewalls to a depth of 4.6 m (15 ft), and the deep zone consisting of the excavation sidewalls below 4.6 m (15 ft) together with the floor of the excavation. All deep zone samples were collected below 4.6 m (15 ft).

5.0 DATA EVALUATION

This section presents the evaluation of the 116-KE-1 and 116-KW-1 sample data for comparison with the data quality criteria and an assessment against cleanup criteria. A data quality assessment (DQA) was performed to compare the analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications. The DQA determined that the data are suitable for making the determination that the 116-KE-1 and 116-KW-1 sites do not currently (2004) meet the interim ROD Amendment (EPA 1997) RAOs.

5.1 116-KE-1 REMEDIAL ACTION ASSESSMENT

The 116-KE-1 shallow zone sample data (Tables A-1 and A-2) and overburden sample data (Tables A-4 and A-5) indicate that the dose rate from the 116-KE-1 shallow zone soil is less than the 15 mrem/yr direct exposure RAG. However, the shallow zone split sample (J017F1), which is generally only used for assessing data quality, indicates elevated concentrations of cesium-137 (46.5 pCi/g) and cobalt-60 (3.71 pCi/g). Cesium-137 and cobalt-60 were not detected in the main sample (J017D6) and duplicate sample (J017F0) at concentrations above the minimum detectable activity. The main, duplicate, and split samples were composite samples collected from the same sample area. The discrete sample data (Table A-2) from the same area (sample area A1) is consistent with the main and duplicate sample results. The discrepancy between the main-duplicate (J017D6-J017F0) and the split (J017F1) would likely require additional data collection if a decision for interim closure were made. However, because these sites do not currently meet the interim RAOs (Section 6.0), site closure has been deferred pending future site, adjacent site, and building decisions. The 116-KE-1 and 116-KW-1 sites will be reassessed for potential additional data needs pending future closure or additional remedial action decisions. Additional discussion regarding the main-duplicate and split difference is included in the DQA in Appendix B.

With the exceptions of tritium and potentially carbon-14 in the deep zone, residual concentrations at the 116-KE-1 Crib site (including overburden) indicate that the remediated site is protective of groundwater and the river. Tritium was detected in deep zone soils beneath the 116-KE-1 site at concentrations ranging from 465 pCi/g to 851 pCi/g. Based on screening level RESidual RADioactivity (RESRAD) (ANL 2002) modeling and an RDR/RAWP-specified tritium distribution coefficient (K_d) of 0 mL/g, the residual tritium concentrations are predicted to impact groundwater at levels exceeding

the drinking water standard of 20,000 pCi/L under the rural-residential land-use scenario. Carbon-14 was detected in deep zone soil at concentrations ranging from 1,880 pCi/g to 7,600 pCi/g. Using the current carbon-14 K_d identified in the RDR/RAWP (DOE-RL 2002) of 200 mL/g, a screening level RESRAD run indicated that the residual carbon-14 concentrations are protective of groundwater and the river. However, the carbon-14 K_d in the RDR/RAWP is based on leach testing of soils from the 100-F Area, and was conducted on lower concentration soil samples than those detected at the crib sites. The lower-level concentrations of carbon-14 in the 100-F Area are thought to be from different processes than the higher carbon-14 concentrations associated with the two 100-K Area crib sites. As a result, additional leach testing to establish a 100-K Area-specific carbon-14 K_d is tentatively planned. Pending potential carbon-14 leach testing and K_d determination, the residual carbon-14 concentrations at the 116-KE-1 Crib site may or may not be protective of groundwater and the river under the rural-residential scenario.

5.2 116-KW-1 REMEDIAL ACTION ASSESSMENT

The sample data indicate that the dose rate from the 116-KW-1 shallow zone soil is greater than the 15 mrem/yr dose rate direct exposure RAG, and is primarily from carbon-14. Carbon-14 was detected in the shallow zone soil at concentrations of up to 77 pCi/g. The carbon-14 concentration from Table 1 that corresponds to 15 mrem/yr is 5.16 pCi/g.

Similar to the 116-KE-1 site, residual concentrations of the COCs at the 116-KW-1 Crib site indicate that the remediated site is protective of groundwater and the river with the exceptions of tritium and potentially carbon-14 in deep zone soil. Tritium was detected in deep zone soils beneath the 116-KW-1 site at concentrations ranging from 35.5 pCi/g to 162 pCi/g. Based on a screening level RESRAD modeling and an RDR/RAWP-specified tritium K_d of 0 mL/g, the residual tritium concentrations are predicted to impact groundwater at levels exceeding the drinking water standard of 20,000 pCi/L. Carbon 14 was detected in deep zone soil at concentrations ranging from 427 pCi/g to 45,000 pCi/g. Using the current carbon-14 K_d identified in the RDR/RAWP of 200 mL/g, a screening level RESRAD run indicates that the residual carbon-14 concentrations are protective of groundwater and the river. However, the carbon-14 K_d in the RDR/RAWP is based on leach testing of soils from the 100-F Area, and was conducted on lower concentration soil samples as compared to the crib concentrations. The lower level concentrations of carbon-14 in the 100-F Area are thought to be from different processes than the higher carbon-14 concentrations associated with the two 100-K Area crib sites. Because of this, additional leach testing to establish a 100-K Area-specific carbon-14 K_d is tentatively planned. Pending potential carbon-14 leach testing and K_d determination, the residual carbon-14 concentrations at the 116-KW-1 Crib site may or may not be protective of groundwater and the river under the rural-residential scenario.

6.0 CONCLUSION

The structures associated with the 116-KE-1 and 116-KW-1 Crib sites have been removed and disposed of at ERDF. A large volume of contaminated soil in the vicinity of the former cribs was excavated and disposed of at ERDF. However, to avoid impacting adjacent building foundations and because of the depth of residual contamination, impacted soils that currently do not meet the RAOs and RAGs of the interim ROD Amendment (EPA 1997) remain in place. Disposition of these sites will be determined at a later date. Examples of future decisions that may affect the disposition of the residual contamination associated with these sites include remediation decisions for adjacent buildings (including the 105-KE and 105-KW Reactor Buildings), final ROD decisions, and ongoing and future 100 Area risk assessments.

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APPENDIX A

SUMMARY OF SOIL SAMPLING ANALYTICAL RESULTS

Table A-1. Shallow Zone 116-KE-1 Composite Sample Data (February 18, 2003).

Sample Area	HEIS No.	Carbon-14			Cesium-137			Cobalt-60			Europium-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J017D6	2.67E+00	U	5.60E+00	4.20E-02	U	4.20E-02	4.70E-02	U	4.70E-02	1.90E-01	U	1.90E-01
Duplicate of J017D6	J017F0	1.19E+00	U	5.60E+00	5.90E-02	U	5.90E-02	6.20E-02	U	6.20E-02	1.90E-01	U	1.90E-01
Split of J017D6	J017F1	1.05E+00		3.13E-01	4.65E+01		3.58E-02	3.71E+00		2.00E-02	3.62E-02	U	6.70E-02
A2	J017D7	-9.10E-01	U	5.70E+00	1.00E-01	U	1.00E-01	1.10E-01	U	1.10E-01	3.20E-01	U	3.20E-01
A3	J017D8	1.27E+00	U	5.60E+00	8.20E-02	U	8.20E-02	7.90E-02	U	7.90E-02	2.60E-01	U	2.60E-01
A4	J017D9	2.95E+00	U	5.30E+00	3.80E-02	U	3.80E-02	4.10E-02	U	4.10E-02	1.40E-01	U	1.40E-01
Equipment blank	J017D5	-4.42E-01	U	5.60E+00	1.10E-01	U	1.10E-01	1.10E-01	U	1.10E-01	3.30E-01	U	3.30E-01
Conc. corresponding to 15 mrem/yr.		5.16			6.2			1.4			3		

Sample Area	HEIS No.	Strontium-90			Tritium		
		pCi/g	Q	MDA	mg/kg	Q	PQL
A1	J017D6	-5.60E-02	U	2.80E-01	-6.40E-02	U	8.80E-01
Duplicate of J017D6	J017F0	-1.20E-01	U	2.90E-01	-2.86E-01	U	6.80E-01
Split of J017D6	J017F1	9.81E-02	U	1.92E-01	6.23E-02		3.14E-02
A2	J017D7	-7.20E-02	U	2.70E-01	-8.30E-02	U	6.50E-01
A3	J017D8	6.10E-02	U	2.70E-01	3.02E-01	U	6.90E-01
A4	J017D9	4.90E-02	U	3.10E-01	-2.10E-02	U	5.80E-01
Equipment blank	J017D5	5.00E-03	U	3.00E-01	-1.45E-01	U	6.10E-01
Conc. corresponding to 15 mrem/yr		4.5			510		

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
PQL = practical quantitation limit
U = Analyte is below detection limits of the method and instruments used (not detected).

Table A-2. Shallow Zone 116-KE-1 Discrete Sample Data (February 18, 2003).

Sample Area and Node	HEIS No.	Cesium-137			Cobalt-60			Europium-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1-2	J017W5	5.90E-02	U	5.90E-02	6.00E-02	U	6.00E-02	2.40E-01	U	2.40E-01
A1-3	J017W6	2.90E-02	U	2.90E-02	3.60E-02	U	3.60E-02	1.00E-01	U	1.00E-01
A1-4	J017W7	3.90E-02	U	3.90E-02	4.50E-02	U	4.50E-02	1.80E-01	U	1.80E-01
A1-10	J017W8	5.40E-02	U	5.40E-02	5.70E-02	U	5.70E-02	1.80E-01	U	1.80E-01
A1-13	J017W9	6.20E-02	U	6.20E-02	5.80E-02	U	5.80E-02	2.40E-01	U	2.40E-01
A1-16	J017X0	3.90E-02	U	3.90E-02	4.40E-02	U	4.40E-02	1.60E-01	U	1.60E-01
A2-3	J017X1	4.90E-02	U	4.90E-02	4.70E-02	U	4.70E-02	1.90E-01	U	1.90E-01
A2-6	J017X2	6.10E-02	U	6.10E-02	6.10E-02	U	6.10E-02	1.80E-01	U	1.80E-01
A2-7	J017X3	7.70E-02	U	7.70E-02	7.50E-02	U	7.50E-02	3.50E-01	U	3.50E-01
A2-10	J017X4	3.70E-02	U	3.70E-02	5.00E-02	U	5.00E-02	1.60E-01	U	1.60E-01
A2-14	J017X5	5.10E-02	U	5.10E-02	5.70E-02	U	5.70E-02	2.10E-01	U	2.10E-01
A2-15	J017X6	5.30E-02	U	5.30E-02	5.90E-02	U	5.90E-02	1.90E-01	U	1.90E-01
A3-1	J017X7	5.60E-02	U	5.60E-02	5.00E-02	U	5.00E-02	2.20E-01	U	2.20E-01
A3-2	J017X8	3.90E-02	U	3.90E-02	4.60E-02	U	4.60E-02	1.60E-01	U	1.60E-01
A3-4	J017X9	4.90E-02	U	4.90E-02	5.00E-02	U	5.00E-02	1.50E-01	U	1.50E-01
A3-5	J017Y0	6.20E-02	U	6.20E-02	6.20E-02	U	6.20E-02	2.10E-01	U	2.10E-01
A3-9	J017Y1	5.40E-02	U	5.40E-02	6.60E-02	U	6.60E-02	2.40E-01	U	2.40E-01
A3-11	J017Y2	3.50E-02	U	3.50E-02	3.60E-02	U	3.60E-02	1.30E-01	U	1.30E-01
A4-3	J017Y3	4.10E-02	U	4.10E-02	4.20E-02	U	4.20E-02	1.50E-01	U	1.50E-01
A4-4	J017Y4	5.60E-02	U	5.60E-02	5.80E-02	U	5.80E-02	1.70E-01	U	1.70E-01
A4-7	J017Y5	6.60E-02	U	6.60E-02	7.30E-02	U	7.30E-02	2.20E-01	U	2.20E-01
A4-9	J017Y6	4.50E-02	U	4.50E-02	4.30E-02	U	4.30E-02	1.50E-01	U	1.50E-01
A4-12	J017Y7	6.30E-02	U	6.30E-02	5.60E-02	U	5.60E-02	1.50E-01	U	1.50E-01
A4-13	J017Y8	6.90E-02	U	6.90E-02	6.30E-02	U	6.30E-02	2.30E-01	U	2.30E-01
Conc. corresponding to 15 mrem/yr		6.2			1.4			3		

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
U = Analyte is below detection limits of the method and instruments used (not detected).

Table A-3. Deep Zone 116-KE-1 Data (February 23, 2004).

Sample Area	HEIS No.	Carbon-14			Cesium-137			Cobalt-60			Europium-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J017F2	7.60E+03		9.40E+00	6.19E+00		5.20E-02	2.42E-01		4.10E-02	1.10E-01	U	1.10E-01
Duplicate of J017F2	J017F5	5.58E+03		7.70E+00	5.44E+00		9.70E-02	2.29E-01		9.00E-02	2.00E-01	U	2.00E-01
Split of J017F2	J017F6	3.67E+03		5.03E-01	8.69E+00		2.35E-02	3.76E-01		1.74E-02	7.45E-03	U	5.67E-02
A2	J017F3	1.88E+03		5.40E+00	3.56E+00		8.70E-02	1.30E-01	U	1.30E-01	2.50E-01	U	2.50E-01
A3	J017F4	5.25E+00	U	5.50E+00	4.40E-02	U	4.40E-02	3.35E-01		4.80E-02	1.40E-01	U	1.40E-01

Sample Area	HEIS No.	Strontium-90			Tritium		
		pCi/g	Q	MDA	mg/kg	Q	PQL
A1	J017F2	4.40E-01		1.80E-01	8.51E+02		6.90E-01
Duplicate of J017F2	J017F5	3.28E-01		1.70E-01	7.37E+02		7.00E-01
Split of J017F2	J017F6	9.46E-01		9.05E-01	6.41E+02		3.31E-02
A2	J017F3	1.55E-01	U	2.10E-01	8.45E+02		6.70E-01
A3	J017F4	-4.50E-02	U	1.60E-01	4.65E+02		5.00E-01

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
PQL = practical quantitation limit
U = Analyte is below detection limits of the method and instruments used (not detected).

Table A-4. 116-KE-1 Overburden Composite Sample Data (February 25, 2003).

Sample Area	HEIS No.	Carbon-14			Cesium-137			Cobalt-60			Europium-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J01873	4.26E+00	U	5.40E+00	8.80E-02	U	8.80E-02	9.60E-02	U	9.60E-02	3.30E-01	U	3.30E-01
Duplicate of J01873	J01881	-1.10E+00	U	5.40E+00	6.30E-02	U	6.30E-02	7.00E-02	U	7.00E-02	1.90E-01	U	1.90E-01
Split of J01873	J01882	3.43E-01		3.23E-01	-3.09E-03	U	1.57E-02	-3.59E-03	U	1.47E-02	3.64E-02	U	5.16E-02
A2	J01874	-1.74E-01	U	6.40E+00	7.80E-02	U	7.80E-02	1.10E-01	U	1.10E-01	2.90E-01	U	2.90E-01
A3	J01875	-1.50E+00	U	5.90E+00	9.00E-02	U	9.00E-02	9.80E-02	U	9.80E-02	3.80E-01	U	3.80E-01
A4	J01876	-6.71E-01	U	5.50E+00	5.50E-02	U	5.50E-02	6.10E-02	U	6.10E-02	1.40E-01	U	1.40E-01
B5	J01877	1.38E+00	U	5.40E+00	6.60E-02	U	6.60E-02	6.30E-02	U	6.30E-02	2.20E-01	U	2.20E-01
B6	J01878	5.55E-01	U	5.90E+00	8.60E-02	U	8.60E-02	1.30E-01	U	1.30E-01	3.60E-01	U	3.60E-01
B7	J01879	1.08E+00	U	5.70E+00	4.40E-02	U	4.40E-02	4.90E-02	U	4.90E-02	1.70E-01	U	1.70E-01
B8	J01880	2.06E+00	U	5.90E+00	7.30E-02	U	7.30E-02	1.00E-01	U	1.00E-01	2.80E-01	U	2.80E-01
Conc. corresponding to 15 mrem/yr.		5.16			6.2			1.4			3		

Sample Area	HEIS No.	Strontium-90			Tritium		
		pCi/g	Q	MDA	mg/kg	Q	PQL
A1	J01873	7.90E-02	U	2.80E-01	-1.83E-01	U	5.80E-01
Duplicate of J01873	J01881	5.40E-02	U	2.40E-01	1.72E-01	U	7.70E-01
Split of J01873	J01882	1.01E-01	U	1.59E-01	2.93E-02	U	3.00E-02
A2	J01874	5.80E-02	U	3.10E-01	2.60E-02	U	5.80E-01
A3	J01875	9.80E-02	U	3.00E-01	9.90E-02	U	5.50E-01
A4	J01876	-4.00E-02	U	2.80E-01	-1.21E-01	U	6.00E-01
B5	J01877	4.10E-02	U	2.70E-01	3.47E-01	U	6.00E-01
B6	J01878	-1.20E-02	U	1.50E-01	5.00E-02	U	7.40E-01
B7	J01879	-7.00E-03	U	1.50E-01	3.90E-02	U	5.70E-01
B8	J01880	1.60E-02	U	2.50E-01	1.50E-01	U	5.60E-01
Conc. corresponding to 15 mrem/yr		4.5			510		

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
PQL = practical quantitation limit
U = Analyte is below detection limits of the method and instruments used (not detected).

Table A-5. 116-KE-1 Overburden Discrete Sample Data (February 25, 2003).

Sample Area and Node	HEIS No.	Cesium-137			Cobalt-60			Europium-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1-2	J01614	6.60E-02	U	6.60E-02	9.70E-02	U	9.70E-02	2.90E-01	U	2.90E-01
A1-3	J01615	4.60E-02	U	4.60E-02	5.00E-02	U	5.00E-02	1.50E-01	U	1.50E-01
A1-4	J01616	7.30E-02	U	7.30E-02	6.90E-02	U	6.90E-02	2.60E-01	U	2.60E-01
A1-10	J01617	6.90E-02	U	6.90E-02	5.90E-02	U	5.90E-02	2.10E-01	U	2.10E-01
A1-13	J01618	5.50E-02	U	5.50E-02	9.20E-02	U	9.20E-02	2.00E-01	U	2.00E-01
A1-16	J01619	4.60E-02	U	4.60E-02	4.00E-02	U	4.00E-02	1.60E-01	U	1.60E-01
A2-3	J01620	9.90E-02	U	9.90E-02	6.50E-02	U	6.50E-02	2.40E-01	U	2.40E-01
A2-6	J01621	7.20E-02	U	7.20E-02	6.30E-02	U	6.30E-02	2.30E-01	U	2.30E-01
A2-7	J01622	6.30E-02	U	6.30E-02	7.70E-02	U	7.70E-02	2.40E-01	U	2.40E-01
A2-10	J01623	4.30E-02	U	4.30E-02	5.40E-02	U	5.40E-02	1.50E-01	U	1.50E-01
A2-14	J01624	6.40E-02	U	6.40E-02	5.70E-02	U	5.70E-02	1.90E-01	U	1.90E-01
A2-15	J01625	6.10E-02	U	6.10E-02	6.10E-02	U	6.10E-02	2.10E-01	U	2.10E-01
A3-1	J01626	6.50E-02	U	6.50E-02	9.60E-02	U	9.60E-02	2.60E-01	U	2.60E-01
A3-2	J01627	4.00E-02	U	4.00E-02	4.50E-02	U	4.50E-02	1.60E-01	U	1.60E-01
A3-4	J01628	6.40E-02	U	6.40E-02	5.90E-02	U	5.90E-02	2.50E-01	U	2.50E-01
A3-5	J01629	6.50E-02	U	6.50E-02	6.20E-02	U	6.20E-02	1.80E-01	U	1.80E-01
A3-9	J01630	6.00E-02	U	6.00E-02	7.40E-02	U	7.40E-02	2.70E-01	U	2.70E-01
A3-11	J01631	3.80E-02	U	3.80E-02	4.00E-02	U	4.00E-02	1.30E-01	U	1.30E-01
A4-3	J01632	6.50E-02	U	6.50E-02	6.40E-02	U	6.40E-02	2.00E-01	U	2.00E-01
A4-4	J01633	7.20E-02	U	7.20E-02	8.60E-02	U	8.60E-02	2.40E-01	U	2.40E-01
A4-7	J01634	3.80E-02	U	3.80E-02	3.90E-02	U	3.90E-02	1.40E-01	U	1.40E-01
A4-9	J01635	7.30E-02	U	7.30E-02	6.90E-02	U	6.90E-02	2.40E-01	U	2.40E-01
A4-12	J01636	5.80E-02	U	5.80E-02	6.40E-02	U	6.40E-02	1.80E-01	U	1.80E-01
A4-13	J01637	5.10E-02	U	5.10E-02	5.70E-02	U	5.70E-02	1.60E-01	U	1.60E-01
B5-1	J01849	4.00E-02	U	4.00E-02	3.80E-02	U	3.80E-02	1.40E-01	U	1.40E-01
B5-2	J01850	5.90E-02	U	5.90E-02	6.10E-02	U	6.10E-02	1.90E-01	U	1.90E-01
B5-5	J01851	6.00E-02	U	6.00E-02	6.20E-02	U	6.20E-02	2.10E-01	U	2.10E-01
B5-7	J01852	5.10E-02	U	5.10E-02	4.60E-02	U	4.60E-02	1.50E-01	U	1.50E-01
B5-13	J01853	6.00E-02	U	6.00E-02	5.80E-02	U	5.80E-02	1.90E-01	U	1.90E-01
B5-15	J01854	5.10E-02	U	5.10E-02	7.40E-02	U	7.40E-02	2.30E-01	U	2.30E-01
B6-1	J01855	7.30E-02	U	7.30E-02	7.30E-02	U	7.30E-02	2.70E-01	U	2.70E-01
B6-10	J01856	4.60E-02	U	4.60E-02	5.00E-02	U	5.00E-02	1.80E-01	U	1.80E-01
B6-12	J01857	4.40E-02	U	4.40E-02	4.60E-02	U	4.60E-02	1.70E-01	U	1.70E-01
B6-13	J01858	4.30E-02	U	4.30E-02	3.50E-02	U	3.50E-02	1.30E-01	U	1.30E-01
B6-15	J01859	5.00E-02	U	5.00E-02	4.90E-02	U	4.90E-02	1.60E-01	U	1.60E-01
B6-16	J01860	3.70E-02	U	3.70E-02	3.90E-02	U	3.90E-02	1.50E-01	U	1.50E-01
B7-1	J01861	4.30E-02	U	4.30E-02	5.00E-02	U	5.00E-02	1.20E-01	U	1.20E-01
B7-3	J01862	5.60E-02	U	5.60E-02	6.20E-02	U	6.20E-02	1.90E-01	U	1.90E-01
B7-4	J01863	7.10E-02	U	7.10E-02	6.10E-02	U	6.10E-02	2.30E-01	U	2.30E-01
B7-5	J01864	7.00E-02	U	7.00E-02	6.60E-02	U	6.60E-02	1.90E-01	U	1.90E-01
B7-8	J01865	6.80E-02	U	6.80E-02	7.00E-02	U	7.00E-02	2.20E-01	U	2.20E-01
B7-11	J01866	4.90E-02	U	4.90E-02	6.60E-02	U	6.60E-02	2.10E-01	U	2.10E-01
B8-2	J01867	5.70E-02	U	5.70E-02	6.00E-02	U	6.00E-02	1.80E-01	U	1.80E-01
B8-3	J01868	4.90E-02	U	4.90E-02	5.00E-02	U	5.00E-02	1.60E-01	U	1.60E-01
B8-4	J01869	6.30E-02	U	6.30E-02	5.90E-02	U	5.90E-02	1.90E-01	U	1.90E-01
B8-8	J01870	4.10E-02	U	4.10E-02	4.10E-02	U	4.10E-02	1.50E-01	U	1.50E-01
B8-12	J01871	7.10E-02	U	7.10E-02	1.10E-01	U	1.10E-01	3.20E-01	U	3.20E-01
B8-13	J01872	4.10E-02	U	4.10E-02	3.90E-02	U	3.90E-02	1.20E-01	U	1.20E-01
Conc. corresponding to 15 mrem/yr		6.2			1.4			3		

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
U = Analyte is below detection limits of the method and instruments used (not detected).

Table A-6. Shallow Zone 116-KW-1 Data (February 5, 2004).

Sample Area	HEIS No.	Carbon-14			Cesium-137			Cobalt-60			Europium-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J01788	7.70E+01		2.20E+00	2.90E-02	U	2.90E-02	3.30E-02	U	3.30E-02	1.20E-01	U	1.20E-01
Duplicate of J01788	J01792	7.39E+01		2.20E+00	5.10E-02	U	5.10E-02	5.10E-02	U	5.10E-02	1.80E-01	U	1.80E-01
Split of J01788	J01793	3.91E+01		7.76E-01	2.67E-03	U	1.69E-02	7.02E-03	U	1.63E-02	-1.32E-03	U	5.21E-02
A2	J01789	2.70E+01		2.10E+00	4.30E-02	U	4.30E-02	4.20E-02	U	4.20E-02	1.40E-01	U	1.40E-01
A3	J01790	1.28E+01		2.20E+00	2.60E-02	U	2.60E-02	2.60E-02	U	2.60E-02	8.20E-02	U	8.20E-02
A4	J01791	9.72E+00		2.60E+00	3.20E-02	U	3.20E-02	3.70E-02	U	3.70E-02	1.40E-01	U	1.40E-01
Equipment blank	J01787	1.37E+00	U	6.00E+00	2.80E-02	U	2.80E-02	2.80E-02	U	2.80E-02	8.40E-02	U	8.40E-02
Conc. corresponding to 15 mrem/yr.		5.16			6.2			1.4			3		

Sample Area	HEIS No.	Strontium-90			Tritium		
		pCi/g	Q	MDA	mg/kg	Q	PQL
A1	J01788	3.30E-02	U	1.90E-01	5.07E+00		2.30E-01
Duplicate of J01788	J01792	1.00E-02	U	1.70E-01	5.37E+00		2.30E-01
Split of J01788	J01793	8.66E-02	U	3.61E-01	4.07E+00		2.88E-02
A2	J01789	-2.00E-03	U	1.80E-01	1.90E-01	U	2.20E-01
A3	J01790	7.20E-02	U	2.00E-01	2.68E-01		2.00E-01
A4	J01791	1.80E-02	U	1.80E-01	2.33E-01		2.30E-01
Equipment blank	J01787	-7.90E-02	U	1.80E-01	6.00E-03	U	2.10E-01
Conc. corresponding to 15 mrem/yr		4.5			510		

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
PQL = practical quantitation limit
U = Analyte is below detection limits of the method and instruments used (not detected).

Table A-7. Shallow Zone 116-KW-1 Discrete Sample Data (February 5, 2004).

Sample Area and Node	HEIS No.	Cesium-137			Cobalt-60			Europium-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1-2	J015Y0	5.90E-02	U	5.90E-02	6.30E-02	U	6.30E-02	2.30E-01	U	2.30E-01
A1-3	J015Y1	3.00E-02	U	3.00E-02	2.90E-02	U	2.90E-02	1.10E-01	U	1.10E-01
A1-4	J015Y2	3.10E-02	U	3.10E-02	3.90E-02	U	3.90E-02	1.30E-01	U	1.30E-01
A1-10	J015Y3	4.30E-02	U	4.30E-02	4.20E-02	U	4.20E-02	1.30E-01	U	1.30E-01
A1-13	J015Y4	6.80E-02	U	6.80E-02	8.30E-02	U	8.30E-02	2.60E-01	U	2.60E-01
A1-16	J015Y5	3.60E-02	U	3.60E-02	4.80E-02	U	4.80E-02	1.40E-01	U	1.40E-01
A2-3	J015Y6	5.80E-02	U	5.80E-02	6.80E-02	U	6.80E-02	2.20E-01	U	2.20E-01
A2-6	J015Y7	7.20E-02	U	7.20E-02	6.30E-02	U	6.30E-02	2.10E-01	U	2.10E-01
A2-7	J015Y8	6.50E-02	U	6.50E-02	7.10E-02	U	7.10E-02	2.30E-01	U	2.30E-01
A2-10	J015Y9	3.70E-02	U	3.70E-02	3.70E-02	U	3.70E-02	1.50E-01	U	1.50E-01
A2-14	J01600	4.60E-02	U	4.60E-02	5.70E-02	U	5.70E-02	2.00E-01	U	2.00E-01
A2-15	J01601	6.60E-02	U	6.60E-02	6.50E-02	U	6.50E-02	2.30E-01	U	2.30E-01
A3-1	J01602	6.30E-02	U	6.30E-02	7.40E-02	U	7.40E-02	2.20E-01	U	2.20E-01
A3-2	J01603	3.90E-02	U	3.90E-02	3.90E-02	U	3.90E-02	1.10E-01	U	1.10E-01
A3-4	J01604	5.30E-02	U	5.30E-02	5.30E-02	U	5.30E-02	1.80E-01	U	1.80E-01
A3-5	J01605	6.00E-02	U	6.00E-02	6.40E-02	U	6.40E-02	2.10E-01	U	2.10E-01
A3-9	J01606	7.00E-02	U	7.00E-02	8.40E-02	U	8.40E-02	2.80E-01	U	2.80E-01
A3-11	J01607	3.90E-02	U	3.90E-02	4.90E-02	U	4.90E-02	1.40E-01	U	1.40E-01
A4-3	J01608	4.10E-02	U	4.10E-02	5.00E-02	U	5.00E-02	2.00E-01	U	2.00E-01
A4-4	J01609	6.30E-02	U	6.30E-02	6.40E-02	U	6.40E-02	2.00E-01	U	2.00E-01
A4-7	J01610	7.00E-02	U	7.00E-02	6.60E-02	U	6.60E-02	2.50E-01	U	2.50E-01
A4-9	J01611	3.60E-02	U	3.60E-02	4.40E-02	U	4.40E-02	1.30E-01	U	1.30E-01
A4-12	J01612	5.60E-02	U	5.60E-02	6.20E-02	U	6.20E-02	1.90E-01	U	1.90E-01
A4-13	J01613	6.80E-02	U	6.80E-02	6.60E-02	U	6.60E-02	1.90E-01	U	1.90E-01

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
U = Analyte is below detection limits of the method and instruments used (not detected).

Table A-8. Deep Zone 116-KW-1 Data (February 11, 2004).

Sample Area	HEIS No.	Carbon-14			Cesium-137			Cobalt-60			Europium-154		
		pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
A1	J01794	4.50E+04		5.80E+01	3.18E+01		1.80E-01	2.26E+00		1.20E-01	4.10E-01	U	4.10E-01
Duplicate of J01794	J01797	3.81E+04		4.60E+01	3.68E+01		2.30E-01	2.11E+00		1.50E-01	4.30E-01	U	4.30E-01
Split of J01794	J01798	1.83E+04		6.05E+00	-9.50E-05	U	1.60E-02	-6.96E-03	U	1.52E-02	1.84E-02	U	5.19E-02
A2	J01795	1.98E+03		9.50E+00	2.30E+01		1.10E-01	6.40E-02	U	6.40E-02	1.70E-01	U	1.70E-01
A3	J01796	4.27E+02		6.80E+00	3.40E-01		3.90E-02	4.40E-02	U	4.40E-02	1.10E-01	U	1.10E-01

Sample Area	HEIS No.	Strontium-90			Tritium		
		pCi/g	Q	MDA	mg/kg	Q	PQL
A1	J01794	5.61E+00		2.10E-01	4.71E+01		2.20E-01
Duplicate of J01794	J01797	4.22E+00		2.00E-01	3.55E+01		2.20E-01
Split of J01794	J01798	2.26E+00		2.01E+00	1.24E+02		3.24E-02
A2	J01795	1.89E+00		2.00E-01	1.62E+02		3.30E-01
A3	J01796	1.17E+00		2.60E-01	1.45E+02		3.10E-01

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
PQL = practical quantitation limit
U = Analyte is below detection limits of the method and instruments used (not detected).

APPENDIX B

DATA QUALITY ASSESSMENT

B1.0 DATA QUALITY ASSESSMENT FOR THE 116-KE-1 AND 116-KW-1 SITES

B1.1 OVERVIEW

This data quality assessment (DQA) was performed to compare the analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

This DQA was performed in accordance with BHI-EE-01, *Environmental Investigations Procedures.* Specific data quality objectives for the site are found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001). The DQA is based on the guidelines presented in *Guidance for Data Quality Assessment* (EPA 2000). Data tests used in this DQA were performed as specified in the SAP and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2002).

All of the analytical data are evaluated for compliance with quality assurance (QA) project plan requirements (DOE-RL 2001). Data evaluation is performed to determine if the laboratory carried out all steps required by the SAP and the laboratory contract governing the conduct of analysis and reporting of the data. This evaluation also examines the available laboratory data to determine if an analyte is present or absent in a sample, and the degree of overall uncertainty associated with that determination.

The DQA for the 116-KE-1 and 116-KW-1 sites determined that the data are of the right type, quality, and quantity to support remedial excavation characterization activities, and to support a decision that the crib sites do not meet the objectives of the *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units* (EPA 1997). Additional quality requirements of the QA project plan included data acquisition requirements. The sample analytical data are stored in the Hanford Environmental Information System and are summarized in Appendix A. Sample collection is documented in the *100-K Remedial Sampling Field Logbook* (EL-1572-1).

The following subsections describe the DQA results for the 116-KE-1 and 116-KW-1 sites.

B1.2 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL ANALYSIS

All samples are subject to laboratory-specific QA requirements, including instrument procurement, maintenance, calibration, and operation. Additional laboratory requirements for internal quality control (QC) checks are performed, as appropriate, for the analytical method at a rate of 1 per sample delivery group (SDG), or 1 in 20, whichever is more frequent. Laboratory internal QC checks include the following:

- Laboratory Contamination. Each analytical batch contains a laboratory (method) blank (material of similar composition as the samples with known/minimal contamination of the analytes of interest) carried through the complete analytical

process. The method blank is used to evaluate false-positive results in samples due to contamination during handling at the laboratory.

- Analytical Accuracy. For most analyses, a known quantity of representative analytes of interest (matrix spike [MS]) is added to a separate aliquot of a sample from the analytical batch. The recovery percentage of the added MS is used to evaluate analytical accuracy. For analyses not amenable to MS techniques (e.g., gamma energy analysis [GEA]) or where analytical recovery is corrected via internal standards (e.g., alpha spectral analyses), accuracy is evaluated from recovery of the QC reference sample (e.g., laboratory control spike or blank spike sample).

- Analytical Precision. Separate aliquots removed from the same sample container (replicate samples) are analyzed for each analytical batch. The replicate sample results (evaluated as relative percent differences [RPDs]) are used to assess analytical precision.

- QC Reference Samples. A QC reference sample is prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples provide an independent check on analytical technique and methodology.

The laboratories are also subject to periodic and random assessments of the laboratory performance, systems, and overall program. These assessments are performed by the Bechtel Hanford, Inc. QA group to ensure that the laboratories are performing to meet laboratory contract requirements.

B1.3 LABORATORY QUALIFIERS

Data flagged as estimated (i.e., "J") indicate that the associated concentration is an estimate but that the data may be used for decision-making purposes. Data flagged as below detection limits (i.e., "U") indicate the contaminant was analyzed for but not detected, and the concentration is below the minimum detectable activity (MDA) for radionuclides or the practical quantitation limit (PQL) (i.e., reporting limit) for nonradionuclides. For nonradionuclides, nondetects are generally reported as the PQL. For radionuclides, nondetects report the actual value obtained from analysis (positive or negative but less than the MDA) except for limited analyses where no value can be calculated. In these cases, the MDA is reported. This situation is applicable for sample results that are below detection limits. All other results are considered to be accurate within the standard errors associated with the methods.

B1.4 DATA EVALUATION

To ensure adequate data quality, DQA investigators reviewed the study objectives in the SAP (DOE-RL 2001) to determine the context for assessing the data. The context for assessing the data includes evaluating the sample data using the methodology of

the SAP and a comparison of analytical results to the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters as specified in the SAP. This section summarizes the results of the PARCC parameter comparison and presents an evaluation of the affected data.

For this evaluation, the following items were reviewed, as appropriate, for each analytical method:

- Method blanks
- MS recovery
- Surrogate recovery
- MS/matrix spike duplicate results
- Sample replicates
- Associated batch laboratory control sample results
- Data package completeness
- Achievement of specified (or contractual) detection limits.

Detection Limit Comparison: Reported analytical detection levels for nondetected analytes were compared to the detection limits specified in the SAP (DOE-RL 2001). When detected results are obtained, evaluation of detection limits is not performed. The data evaluation noted any analyses in which the detection limit (MDA or PQL) was above the SAP-specified detection limits for nondetected analytes.

The reported MDA was above the specified detection limit for two cesium-137 and a number of cobalt-60 and europium-154 analyses; however, the reported MDAs are sufficiently low for characterization and assessment of the remaining soil at the remedial excavations. Data quality is not affected.

Precision and Accuracy Evaluation: Analytical accuracy and precision were evaluated by examination of the laboratory-reported results for the main and laboratory duplicate samples, MS, MS duplicates, method blanks, and laboratory control samples.

All laboratory duplicates were within acceptable limits. All MS and MS duplicate percent recoveries and RPDs were within acceptable limits. However, for some of the tritium samples MSs were not analyzed because the elevated concentrations of tritium in soil would swamp the spike. All method blanks and laboratory control samples were within acceptable limits. The data is suitable for the intended purpose of characterization and assessment of the remaining soil at the remedial excavations.

B1.5 FIELD QUALITY ASSURANCE/QUALITY CONTROL

Field QA/QC measures were used to assess potential sources of error and cross-contamination of soil samples that could bias results. Field QA/QC samples included equipment blanks (samples J017D5 and J01787), five field duplicates (samples J017F0, J017F5, J01792, J01797, and J01881), and five field splits (samples J017F1, J017F6,

J01793, J01798, and J01882). The duplicates and splits are duplicates or splits of shallow zone samples J017D6 and J01788, deep zone samples J017F2 and J01794, and overburden sample J01873. The main and QA/QC sample results are presented in Appendix A.

B1.5.1 Equipment Blank Samples

Two equipment blank samples (J017D5 and J01787) were collected as part of the QA/QC measures. The blank sample results were less than detection for all contaminants of concern (COCs), indicating no field handling and laboratory introduction of COCs through cross contamination.

B1.5.2 Field Duplicate Samples

Duplicate samples were collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicate is evaluated by computing the RPD of the duplicate samples for each COC. Only analytes with values above five times the detection limits for both the main and duplicate samples are compared.

All calculated duplicate RPDs were within control limits.

B1.5.3 Field Split Samples

Split samples were collected to provide a relative measure of the degree of variability in the sampling, sample handling, and analytical techniques used by commercial laboratories. A different laboratory from the main laboratory is used to analyze the split samples. The field main and split samples are evaluated by computing the RPDs of the split samples for each COC to assess the usability of the data. The U.S. Environmental Protection Agency Contract Laboratory Program duplicate sample comparison methodology, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994), is used as an initial test of the data from the splits. Only analytes that had values above five times the specified detection limits or contract required detection limit for both the main and split sample were compared.

With the exceptions of the cesium-137 and cobalt-60 split analyses for the 116-KE-1 shallow zone and the 116-KW-1 deep zone splits, and the carbon-14 split analyses for the 116-KE-1 deep zone split and the 116-KW-1 shallow zone and deep zone splits, and the tritium split analysis for the 116-KW-1 deep zone split, all calculated split RPDs were within control limits. In the case of the carbon-14 and tritium respective RPDs of 70%, 65%, 84%, and 90%, the out-of-limit RPDs are likely due to sample heterogeneity and are not indicative of laboratory quality problems. In the cases of the out-of-limit cesium-137 and cobalt-60 RPDs there is a relatively large disparity. For the 116-KE-1 main-split sample pair (J017D6-J017F1), cesium-137 was not detected in the main sample with an MDA of 0.042 pCi/g but was detected in the split sample at a concentration of 46.5 pCi/g. Similarly for the 116-KE-1 shallow zone split, cobalt-60

was not detected in the main sample with an MDA of 0.062 pCi/g but was detected in the split sample at a concentration of 3.71 pCi/g. For the 116-KW-1 main-split sample pair (J01794-J01798), cesium-137 was detected in the main sample at a concentration of 31.8 pCi/g but was not detected in the split sample with an MDA of 0.016 pCi/g. Similarly for the 116-KW-1 deep zone split, cobalt-60 was detected in the main sample at a concentration of 2.26 pCi/g but was not detected in the split sample with an MDA of 0.015 pCi/g. Other GEA main-split data (J017F2-J017F6 and J01788-J01793) are within acceptable limits.

At first glance, it appears that the GEA split samples from the 116-KE-1 shallow zone and the 116-KW-1 deep zone may have been inadvertently switched. However, the samples were collected from different sites on different days and were shipped to the laboratory on different days using different SDG designations. There are no indications other than the detected concentrations that would suggest that the samples were inadvertently switched. The anomalies of the split sample results can not be explained through sample heterogeneity. The discrete sample results (Tables A-2 and A7) from the same areas indicate that the concentrations shown by the main and duplicate samples are the representative concentrations. The discrepancy between the shallow zone main-duplicate (J017D6-J017F0) and the split (J017F1) would likely require additional data collection if a decision for interim closure were made. However, because these sites do not currently meet the interim remedial action objectives, site closure has been deferred pending future site, adjacent site, and building decisions. The 116-KE-1 and 116-KW-1 sites will be reassessed for potential additional data needs pending future closure or additional remedial action decisions.

B1.6 SUITABILITY OF DATA

The conclusion of the DQA is that the data are of the right type, quality, and quantity to support the intended use. Detection limits, precision, accuracy, and SDG completeness were analyzed to determine if any analytical results should be rejected as a result of QA/QC deficiencies. With the possible exception of the differences between the GEAs between the main and split laboratory (discussed above), all COC analytical data were found to be acceptable.

B2.0 REFERENCES

BHI-EE-01, *Environmental Investigations Procedures*, Bechtel Hanford, Inc., Richland, Washington.

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EL-1572-1, *100-K Remedial Sampling Field Logbook,* Bechtel Hanford, Inc., Richland, Washington.

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EPA, 2000, *Guidance for Data Quality Assessment*, EPA QA/G-9, QA00 Update, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

APPENDIX C

SAMPLE DESIGNS

SCALE 1:250

2.5 0 2.5 5 10 meters

NOTES

1. SHALLOW ZONE NODE AREAS ARE APPROXIMATELY 9.74 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE SHALLOW ZONE CONSISTS OF SAMPLING AREAS A1, A2, A3 AND A4 WITHIN DECISION SUBUNIT 1.

LEGEND

(8) VARIANCE/VERIFICATION SAMPLING NODE

◇8 VARIANCE SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	S-A1-2	146475.14	568707.47
		S-A1-3	146472.17	568706.38
		S-A1-4	146469.15	568705.35
		S-A1-10	146483.30	568716.40
		S-A1-13	146473.87	568712.86
		S-A1-16	146466.91	568710.41
	A2	S-A2-3	146458.81	568701.71
		S-A2-6	146460.76	568704.92
		S-A2-7	146456.70	568703.51
		S-A2-10	146459.64	568706.85
		S-A2-14	146458.94	568708.87
		S-A2-15	146454.88	568707.55
	A3	S-A3-1	146484.93	568720.72
		S-A3-2	146481.74	568718.95
		S-A3-4	146480.76	568721.58
		S-A3-5	146478.23	568723.76
		S-A3-9	146471.69	568720.06
		S-A3-11	146471.48	568722.41
	A4	S-A4-3	146463.01	568719.20
		S-A4-4	146458.66	568717.86
		S-A4-7	146461.79	568723.39
		S-A4-9	146455.99	568716.01
		S-A4-12	146451.36	568708.61
		S-A4-13	146453.87	568719.76

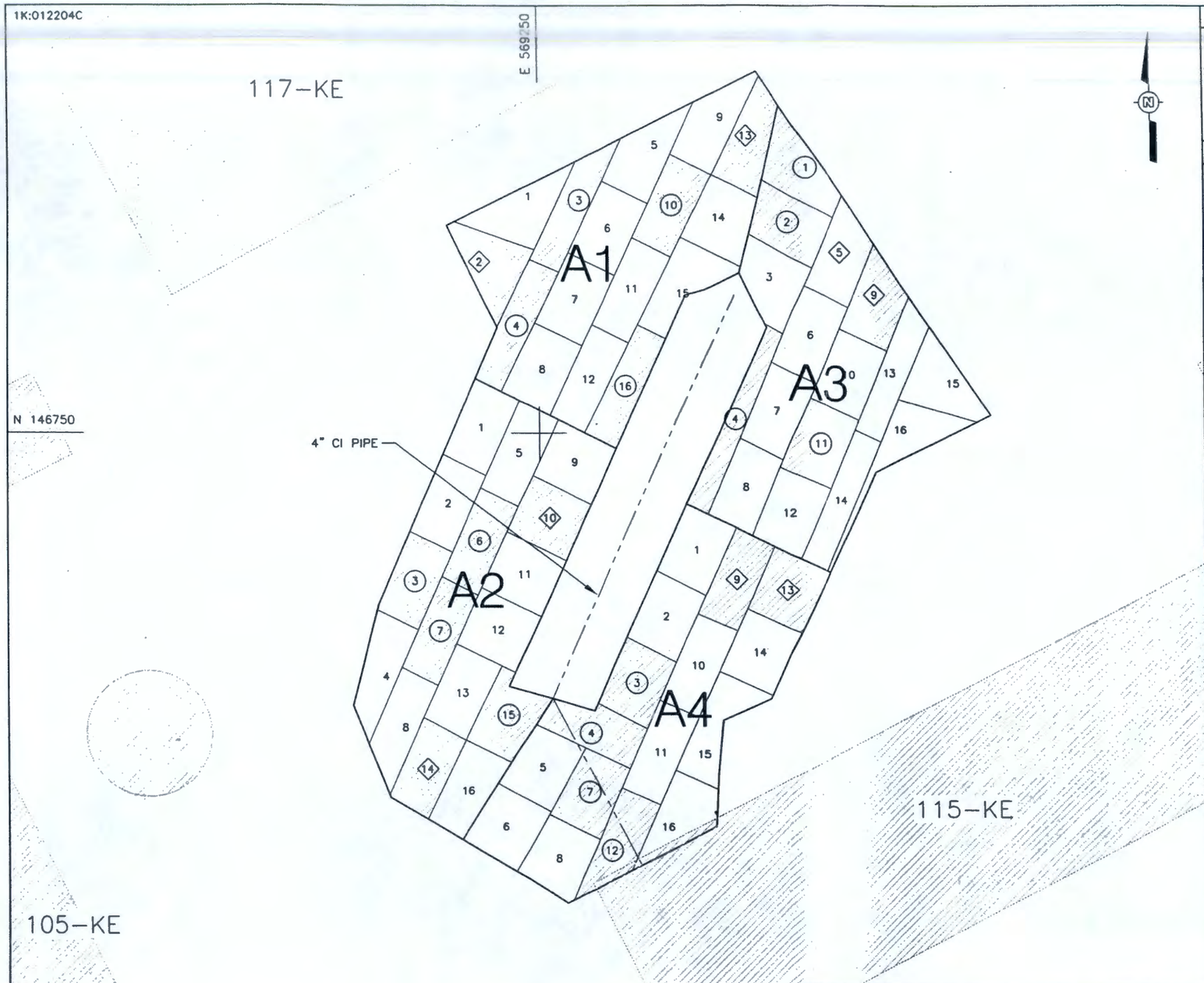
Attachment 3
Originator G. CRUC
Chk'd By AB
Calc. No. 0100K-CA-V0030
Sheet No. 1 of 4
Date 11/26/04
Date 11/26/04
Rev. No. 0

ATTACHMENT 3

U.S DEPARTMENT OF ENERGY
DOE FIELD OFFICE, RICHLAND
HANFORD ENVIRONMENTAL RESTORATION PROGRAM

100 K AREA
116-KW-1 CONDENSATE CRIB
SHALLOW ZONE SAMPLING PLAN

1K:012204C



SCALE 1:200

2 0 2 4 8 meters

NOTES

1. SHALLOW ZONE NODE AREAS ARE APPROXIMATELY 9.73 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE SHALLOW ZONE CONSISTS OF SAMPLING AREAS A1, A2, A3 AND A4 WITHIN DECISION SUBUNIT 1.

LEGEND

VARIANCE/VERIFICATION SAMPLING NODE

VARIANCE SAMPLING NODE

SAMPLE LOCATION TABLE

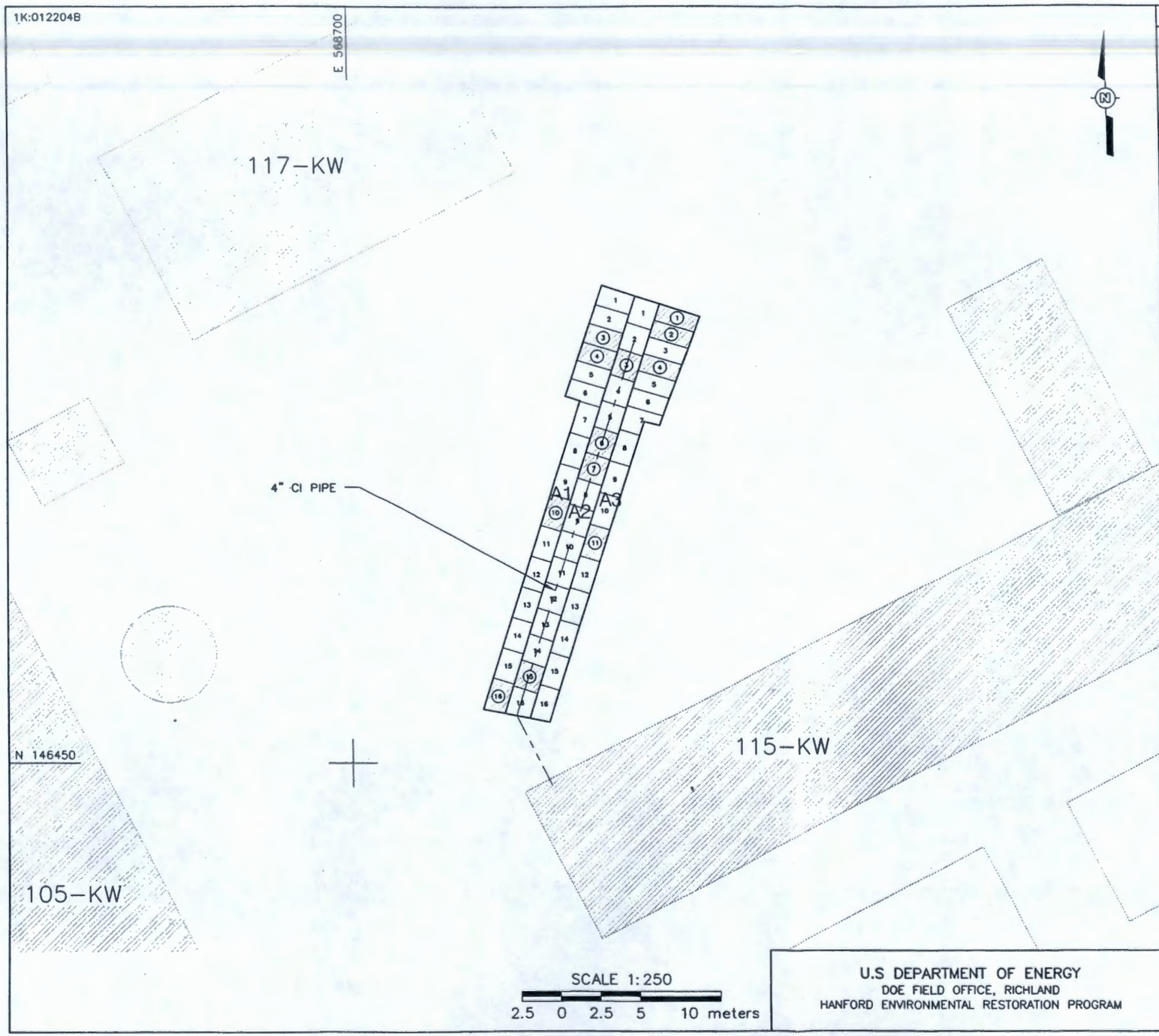
DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	S-A1-2	146758.42	569247.13
		S-A1-3	146761.43	569251.97
		S-A1-4	146755.30	569248.94
		S-A1-10	146761.20	569256.51
		S-A1-13	146764.59	569260.15
		S-A1-16	146752.33	569254.24
	A2	S-A2-3	146742.66	569243.87
		S-A2-6	146744.66	569247.08
		S-A2-7	146740.19	569245.09
		S-A2-10	146745.79	569250.46
		S-A2-14	146733.39	569244.42
		S-A2-15	146736.06	569248.43
	A3	S-A3-1	146763.07	569263.05
		S-A3-2	146760.40	569262.21
		S-A3-4	146750.71	569259.59
		S-A3-5	146758.92	569264.68
		S-A3-9	146756.85	569266.41
		S-A3-11	146749.50	569263.71
	A4	S-A4-3	146737.65	569254.71
		S-A4-4	146735.18	569252.41
		S-A4-7	146732.29	569252.32
		S-A4-9	146742.77	569259.61
		S-A4-12	146729.45	569253.40
		S-A4-13	146742.24	569262.13

Attachment 3 — Sheet No. 2 of 4
Designator G. CRUZ — Date 1/26/04
Checked By DB — Date 1/26/04
Job No. 01CCK-CA-V0030 — Rev. No. 1 0 1

ATTACHMENT 3

U.S DEPARTMENT OF ENERGY
DOE FIELD OFFICE, RICHLAND
HANFORD ENVIRONMENTAL RESTORATION PROGRAM

100 K AREA
116-KE-1 CONDENSATE CRIB
SHALLOW ZONE SAMPLING PLAN



NOTES

1. DEEP ZONE NODE AREAS ARE APPROXIMATELY 2.81 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE DEEP ZONE CONSISTS OF SAMPLING AREAS A1, A2, AND A3 WITHIN DECISION SUBUNIT 1.

LEGEND

- VARIANCE/VERIFICATION SAMPLING NODE
- VARIANCE SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	D-A1-3	146477.30	568716.12
		D-A1-4	146476.12	568715.74
		D-A1-10	146466.04	568713.02
		D-A1-16	146454.25	568709.22
	A2	D-A2-3	146475.54	568717.59
		D-A2-6	146470.53	568716.00
		D-A2-7	146468.86	568715.47
		D-A2-15	146455.50	568711.23
	A3	D-A3-1	146478.56	568720.76
		D-A3-2	146477.52	568720.40
		D-A3-4	146475.39	568719.68
		D-A3-11	146464.11	568715.49

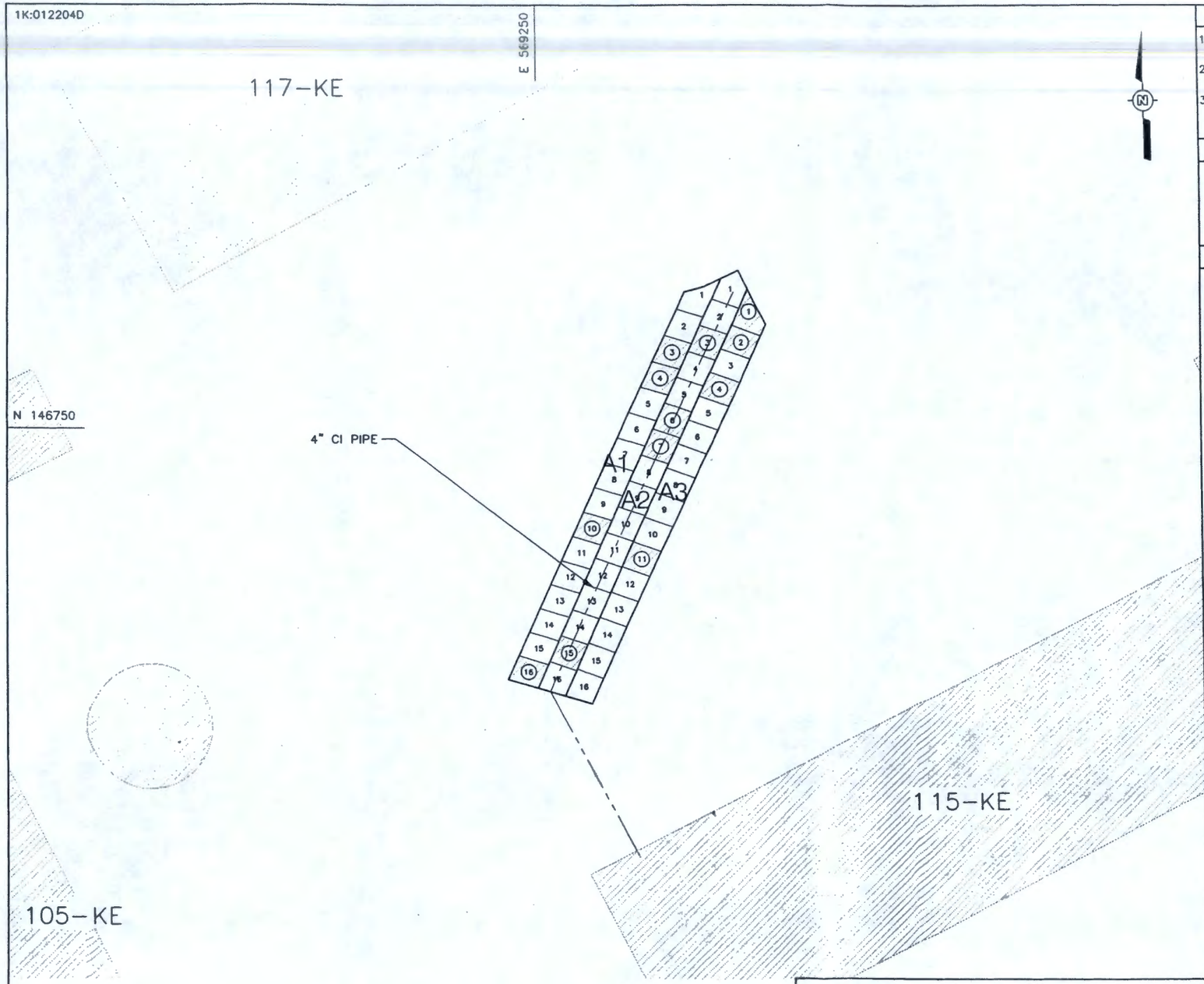
Attachment 3 — Sheet No. 3 of 4
Originator G. CRUZ — Date 1/24/04
Chk'd By [illegible] — Date 1/24/04
Calc. No. 0100K-CA-V0030 — Rev. No. 0

ATTACHMENT 3

U.S DEPARTMENT OF ENERGY
DOE FIELD OFFICE, RICHLAND
HANFORD ENVIRONMENTAL RESTORATION PROGRAM

100 K AREA
116-KW-1 CONDENSATE CRIB
DEEP ZONE SAMPLING PLAN

1K:012204D



SCALE 1:200

2 0 2 4 8 meters

NOTES

1. DEEP ZONE NODE AREAS ARE APPROXIMATELY 1.95 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE DEEP ZONE CONSISTS OF SAMPLING AREAS A1, A2, AND A3 WITHIN DECISION SUBUNIT 1.

LEGEND

(8) VARIANCE/VERIFICATION SAMPLING NODE

◇8 VARIANCE SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	D-A1-3	146753.83	569256.59
		D-A1-4	146752.54	569256.02
		D-A1-10	146745.02	569252.66
		D-A1-16	146737.85	569249.46
	A2	D-A2-3	146754.32	569258.32
		D-A2-6	146750.43	569256.60
		D-A2-7	146749.14	569256.03
		D-A2-15	146738.79	569251.46
	A3	D-A3-1	146755.87	569260.30
		D-A3-2	146754.34	569259.92
		D-A3-4	146751.99	569258.87
		D-A3-11	146743.49	569255.08

Attachment 3 Sheet No. 4 of 4
Originator G.C.Bill Date 1/26/04
Chk'd By [illegible] Date 1/26/04
Calc. No. 0100K-CA-V0032 Rev. No. 0

ATTACHMENT 3

U.S DEPARTMENT OF ENERGY
DOE FIELD OFFICE, RICHLAND
HANFORD ENVIRONMENTAL RESTORATION PROGRAM

100 K AREA
116-KE-1 CONDENSATE CRIB
DEEP ZONE SAMPLING PLAN

100-K Area
100-KE Overburden
Sample Coordinate Design Table

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	O-A1-2	146993.44	569294.36
		O-A1-3	146995.09	569297.65
		O-A1-4	146996.77	569300.97
		O-A1-10	146986.23	569294.55
		O-A1-13	146980.10	569289.63
		O-A1-16	146988.23	569304.14
	A2	O-A2-3	146983.03	569299.44
		O-A2-6	146978.05	569295.12
		O-A2-7	146981.11	569300.60
		O-A2-10	146975.82	569295.62
		O-A2-14	146974.02	569296.90
		O-A2-15	146976.90	569302.14
	A3	O-A3-1	146967.12	569291.40
		O-A3-2	146968.55	569294.03
		O-A3-4	146971.41	569299.29
		O-A3-5	146972.84	569301.93
		O-A3-9	146963.79	569293.75
		O-A3-11	146967.44	569300.54
	A4	O-A4-3	146964.12	569302.05
		O-A4-4	146965.90	569305.36
		O-A4-7	146971.24	569315.28
		O-A4-9	146957.41	569297.17
		O-A4-12	146962.75	569307.20
		O-A4-13	146964.52	569310.50
2	B5	O-B5-1	146954.07	569298.85
		O-B5-2	146955.80	569302.07
		O-B5-5	146961.07	569311.85
		O-B5-7	146964.66	569318.52
		O-B5-13	146958.18	569314.23
		O-B5-15	146961.60	569320.64
	B6	O-B6-1	146947.67	569302.28
		O-B6-10	146946.27	569307.53
		O-B6-12	146949.77	569314.17
		O-B6-13	146951.50	569317.44
		O-B6-15	146954.93	569323.93
		O-B6-16	146956.63	569327.15
	B7	O-B7-1	146941.17	569305.83
		O-B7-3	146944.59	569312.32
		O-B7-4	146946.31	569315.57
		O-B7-5	146948.04	569318.85
		O-B7-8	146953.26	569328.80
		O-B7-11	146941.45	569314.32
	B8	O-B8-2	146936.23	569312.52
		O-B8-3	146937.92	569315.68
		O-B8-4	146939.62	569318.89
		O-B8-8	146946.67	569332.14
		O-B8-12	146936.54	569321.05
		O-B8-13	146938.27	569324.28

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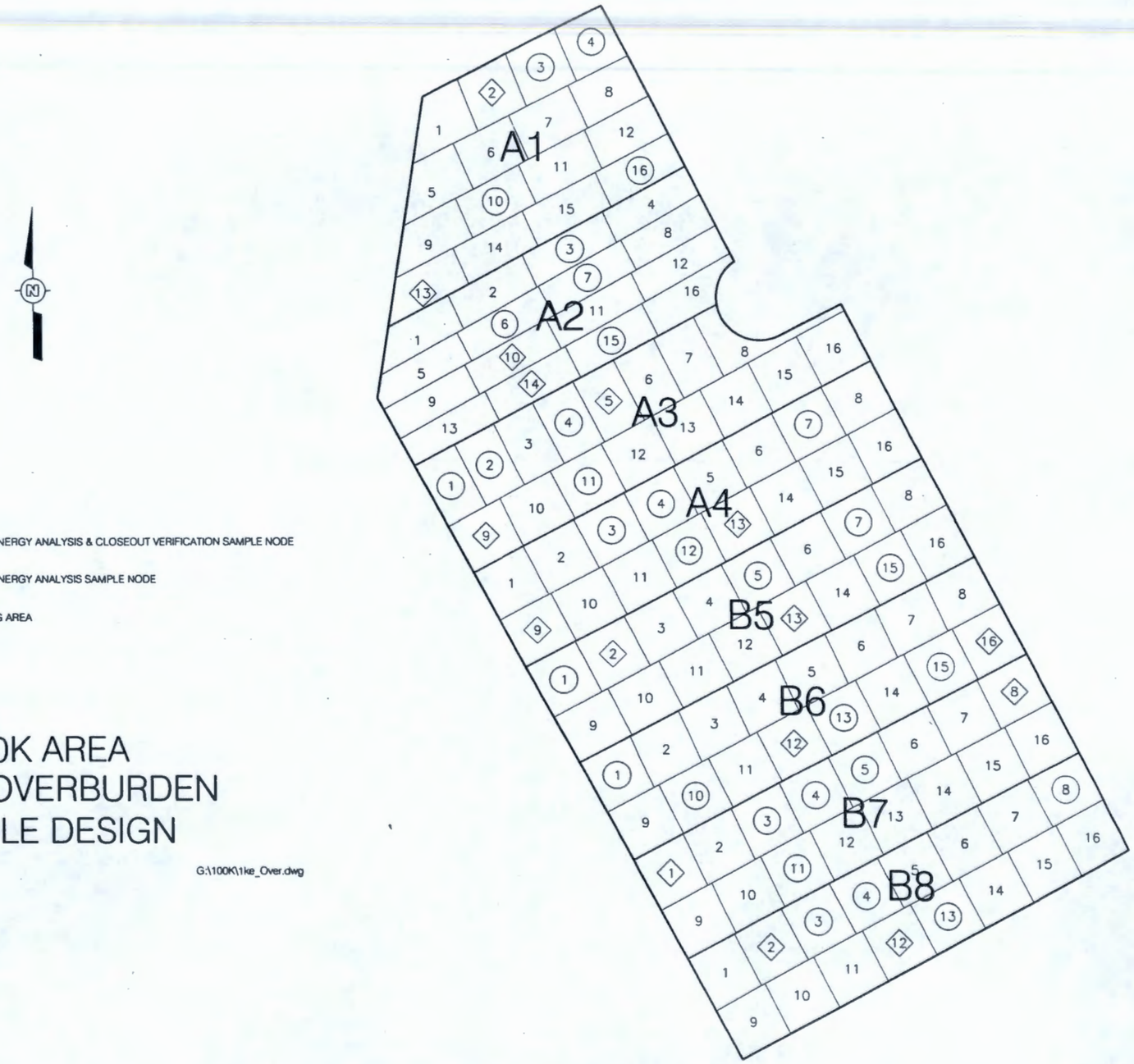

LEGEND

(11) GAMMA ENERGY ANALYSIS & CLOSEOUT VERIFICATION SAMPLE NODE

◇2 GAMMA ENERGY ANALYSIS SAMPLE NODE

A1 SAMPLING AREA

100K AREA
100-KE OVERBURDEN
SAMPLE DESIGN

G:\100K\1ke_Over.dwg

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