Final Status Survey Report
Volume I– Pond Parcel Excavation Bottom

Survey Units Kaiser – FSS – 001
Through Kaiser – FSS - 024

Prepared For:

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Thorium Remediation Project
Tulsa, Oklahoma Facility

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Executive Summary
Final Status Survey Report
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Penn Environmental & Remediation, Inc. (Penn E&R) has been retained by the Kaiser Aluminum & Chemical Corporation (Kaiser) to provide radiological final status survey technical support for the remediation of its Kaiser Aluminum Specialty Products facility (Tulsa, Oklahoma facility) located at 7311 East 41st Street in Tulsa, Oklahoma. The remediation of radiologically impacted portions of the Tulsa, Oklahoma facility has been authorized by the Nuclear Regulatory Commission (NRC) via approval of the site-specific Decommissioning Plan (DP) (June 2001, Rev. May 2003, September 2003, May 2005, and September 2005) and Decommissioning Plan Addendum (DPA) (May 2002, Rev. May 2003) for the facility. The DP and DPA were designed to address the remediation of thorium dross and contaminated soil known to be present at the Tulsa, Oklahoma facility (Thorium Remediation Project).

The DP addresses the remediation of the impacted portions of the 14-acre "Pond Parcel" at the Tulsa, Oklahoma facility and the DPA addresses the approximate 3.5-acre "Former Operational Area" (FOA). The remediation alternative chosen for the Pond Parcel requires excavating material with a net Th-232 activity concentration greater than the Derived Concentration Guideline Level ($DCGL_w$) of 3.0 pCi/g, based on a dose limit of 25 mrem/yr. Material with net Th-232 activity concentrations greater than the Derived Cutoff Concentration Level (DCCL) of 31.1 net pCi/g Th-232 is being segregated and disposed off site as exempt material at the U.S. Ecology Grand View, Idaho facility. Material with activity concentrations less than 31.1 net pCi/g Th-232 (Below Criteria Material or BCM) is being used as backfill in the Pond Parcel excavation. A layer of clean imported borrow material (minimum thickness of 10 feet) obtained from an off site source is being placed over the BCM and graded in a manner to direct drainage away from the site, after which the site will be revegetated. At the time of preparation of this report, approximately 93 percent of the impacted portion of the Pond Parcel has been remediated.

Remediation activities for the FOA were similar to those implemented for the Pond Parcel with the exception of the excavations being backfilled with clean imported borrow material. At the time of preparation of this **Final Status Survey Report**, the remediation of the impacted portions of the FOA had been completed.

Final status surveys for the Thorium Remediation Project consist of three distinct elements: (1) surveys of the "open land areas" of the site including the excavation bottom surface soils for the Pond Parcel and FOA; (2) surveys of BCM placed in the Pond Parcel excavations; and (3) surveys of structural surfaces. Final status surveys are completed

prior to the backfilling of any Pond Parcel or FOA remediation excavation and during/following the placement of BCM in the Pond Parcel. The survey unit acceptance criteria developed in the DP are applicable to the entire site. Thus, if each survey unit meets the acceptance criteria, the dose for the entire site will be less than the release criteria of 25 mrem/yr.

Pond Parcel Excavation Bottom and FOA Excavation Final Status Surveys

Final status surveys associated with the Pond Parcel and FOA excavation bottoms are conducted through a progression of Class 1 survey units. Survey units typically consist of excavation bottom surface soil and associated side walls, elevated soil areas (if left in-place), and embedded structures (if encountered and left in-place). The final status survey of excavation bottom survey units typically consists of a gross gamma scan of the exposed surface soil of the unit and systematic soil sampling. Additional scanning and soil sampling are included for each elevated measurement comparison (EMC) performed for elevated areas left in-place. Embedded structures (typically small pipes and concrete) are surveyed for total alpha contamination (when possible) and removable alpha contamination.

Compliance with survey unit acceptance criteria is demonstrated by comparison of the average residual contamination for each survey element (excavation bottom soil, elevated areas, and embedded structures) to the appropriate acceptance criteria value and a sum of fractions for each survey unit is also calculated. The sum of fractions is a very conservative assessment of the survey unit. Summing the fractions ensures the survey unit and the entire site will be a small fraction of 25 mrem/yr (the release criterion) when the actual as-left dose assessment is complete. Systematic final status survey data are also evaluated using the Wilcoxan Rank Sum Test procedure.

A total of 30 Pond Parcel excavation bottom survey units are anticipated for the Thorium Remediation Project. Final status surveying and reporting have been completed for 24 of the 30 Pond Parcel excavation bottom survey units. **Volume I** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSS-001 through Kaiser-FSS-024. One of the 24 excavation bottom survey units (Kaiser-FSS-001) consisted of an embedded structure encountered (a buried concrete spillway) during the removal of radiologically impacted soil. A summary of the final status survey results by survey unit is provided below in **Table 1.**

Of the 6 remaining open land area survey units for the pond parcel (Survey Units Kaiser-FSS-025 through Kaiser-FSS-030) it should be noted that remediation and final status survey sampling have been completed for 4 of those units (Kaiser-FSS-027 through Kaiser-FSS-030). Soil screening values and/or analytical laboratory results for all systematic soil samples for each survey unit were below the $DCGL_W$. In addition, no elevated areas were left in-place, therefore, no elevated measurement comparisons will be required for these units. Kaiser anticipates that the remediation and final status survey sampling results for Survey Units Kaiser-FSS-025 and Kaiser-FSS-026 will also meet the DP acceptance criteria. The results of the final status surveys for the remaining 6 Pond

Parcel excavation bottom survey units will be documented in an addendum to this **Final Status Survey Report** to be submitted at the end of the remediation project.

Table 1 – Pond Parcel Excavation Final Status Survey Summary by Survey Unit

Survey Unit	Surface Area (m^2)	No. of Systematic Samples Collected	Systematic Sample Exceedance of DCGL Value	WRS Test Criterion Met	Elevated Area(s) Present	Embedded Structure(s) Present	Total Sum of Fractions	Survey Unit Meets DP Acceptance Criteria
Kaiser-FSS-001*	84.5	36	YES	YES	YES	N/A	0.99	YES
Kaiser-FSS-002	126.5	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-003	80	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-004	107	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-005	35	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-006	2,670	12	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-007	1,182	16	NO	YES	NO	YES	0.04	YES
Kaiser-FSS-008	424	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-009	1,000	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-010	986	10	NO	YES	NO	YES	0.00	YES
Kaiser-FSS-011	2,400	12	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-012	2,460	12	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-013	1,320	10	NO	YES	YES	YES	0.38	YES
Kaiser-FSS-014	1,892	10	NO	YES	YES	YES	0.67	YES
Kaiser-FSS-015	1,997	10	NO	YES	NO	YES	0.18	YES
Kaiser-FSS-016	2,484	14	NO	YES	YES	NO	0.79	YES
Kaiser-FSS-017	2,230	17	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-018	1,582	10	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-019	1,582	10	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-020	1,570	9	NO	YES	YES	NO	0.19	YES
Kaiser-FSS-021	1,985	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-022	1,840	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-023	1,750	10	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-024	1,454	10	NO	YES	NO	NO	0.00	YES

* Survey Unit Kaiser- FSS-001 is the buried concrete spillway structure. The other pond parcel survey units are defined as open land areas.

Final status surveying and reporting have been completed for all 9 FOA excavation survey units. **Volume II** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSSFOA-001 through Kaiser-FSSFOA-009. Three of the nine FOA excavation survey units consisted only of embedded structures (retaining walls) that were encountered during the removal of radiologically impacted

soil located adjacent to the structures. A summary of the final status survey results by survey unit is provided below in **Table 2.**

Table 2 – FOA Excavation Final Status Survey Summary by Survey Unit

Survey Unit	Surface Area (m^2)	No. of Systematic Samples Collected	Systematic Sample Exceedance of DCGL Value	WRS Test Criterion Met	Elevated Area(s) Present	Embedded Structure(s) Present	Total Sum of Fractions	Survey Unit Meets DP Acceptance Criteria
Kaiser-FSSFOA-001	228	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSSFOA-002	49	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSSFOA-003*	35	21	NO	YES	NO	N/A	0.16	YES
Kaiser-FSSFOA-004	84	10	NO	YES	NO	YES	0.15	YES
Kaiser-FSSFOA-005	1,320	9	NO	YES	NO	YES	0.03	YES
Kaiser-FSSFOA-006	2,550	13	NO	YES	YES	YES	0.59	YES
Kaiser-FSSFOA-007*	81.5	18	NO	YES	NO	N/A	0.07	YES
Kaiser-FSSFOA-008*	9.3	14	NO	YES	NO	N/A	0.09	YES
Kaiser-FSSFOA-009	19.5	10	NO	YES	NO	NO	0.00	YES

* Survey unit consists of a structure (cinderblock or concrete retaining wall) encountered during the removal of radiologically impacted soil.

Pond Parcel Excavation Backfill Units (BCM) Final Status Surveys

As with the Pond Parcel excavation bottoms, final status surveys associated with the Pond Parcel excavation backfill units (BCM) are conducted through a progression of Class 1 survey units. Typically a unit of BCM is placed in a portion(s) of a pond parcel excavation bottom(s) associated with a defined excavation bottom final status survey unit(s). Backfill units are completed through the placement of typically four to eight continuous layers (2-foot compacted lift depth) of BCM in a defined area. The final status survey of excavation backfill units consists of a gross gamma scan of each placed 2-foot lift of BCM and systematic soil core sampling upon completion of the BCM unit. Compliance with survey unit acceptance criteria is demonstrated by comparison of the average residual contamination for the survey unit to the appropriate acceptance criteria value. Systematic soil core sampling data are also evaluated using the Wilcoxan Rank Sum Test procedure.

A total of 15 Pond Parcel excavation backfill survey units are anticipated for the Thorium Remediation Project. Final status surveying and reporting have been completed for 9 of the 15 Pond Parcel excavation backfill survey units. **Volume III** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSSB-001 through Kaiser-FSSB-009. A summary of the final status survey results by survey unit is provided below in **Table 3.**

Of the six remaining BCM survey units for the pond parcel (Survey Units Kaiser-FSSB-010 through Kaiser-FSSB-015), it should be noted that the placement of BCM and final status survey sampling have been completed for three of those units (Kaiser-FSSB-010 through Kaiser-FSS-012). Soil screening values and/or analytical laboratory results for all systematic core samples for each survey unit were below the DCCL. Kaiser anticipates that the final status survey sampling results for Survey Units Kaiser-FSSB-013 through Kaiser-FSSB-015 will also meet the DP acceptance criteria. The results of the final status surveys for the remaining six Pond Parcel backfill survey units will be documented in an addendum to this **Final Status Survey Report** to be submitted at the end of the remediation project.

Table 3 – Pond Parcel Excavation Backfill Final Status Survey Summary by Survey Unit

Survey Unit	Base Surface Area (m^2)	No. of Systematic Soil Cores	No. of Systematic Soil Core Composite Samples	Systematic Soil Core Sample Exceedance of DCCL Value	WRS Test Criterion Met	Elevated Area(s) Present	Survey Unit Meets DP Acceptance Criteria
Kaiser-FSSB-001	2,220	11	28	NO	YES	NO	YES
Kaiser-FSSB-002	2,405	12	17	NO	YES	NO	YES
Kaiser-FSSB-003	1,709	11	37	NO	YES	NO	YES
Kaiser-FSSB-004	1,647	9	33	NO	YES	NO	YES
Kaiser-FSSB-005	1,716	9	34	NO	YES	NO	YES
Kaiser-FSSB-006	2,177	12	44	NO	YES	NO	YES
Kaiser-FSSB-007	1,381	9	44	NO	YES	NO	YES
Kaiser-FSSB-008	1,431	9	45	NO	YES	NO	YES
Kaiser-FSSB-009	1,840	9	20	NO	YES	NO	YES

Bounding As-Left Condition Final Dose Assessment

A bounding as-left condition dose assessment based on the maximum activity concentration of the BCM and minimum clean soil cover requirement has been completed for the Thorium Remediation Project. The resulting maximum dose is 1.33 mrem/yr. At the conclusion of the Thorium Remediation Project, the actual activity concentrations and the actual dimensions of the cover could be used to reassess the final dose. Since the activity concentrations will be less than bounding values used and the dimensions of the cover will be at least what were used, the resulting dose would be less than 1.33 mrem/yr.

Final Status Survey Report
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1.0 ROAD MAP – VOLUMES I THROUGH III

Penn Environmental & Remediation, Inc. (Penn E&R) has been retained by the Kaiser Aluminum & Chemical Corporation (Kaiser) to provide radiological final status survey technical support for the remediation of its Kaiser Aluminum Specialty Products facility (Tulsa, Oklahoma facility) located at 7311 East 41st Street in Tulsa, Oklahoma (**Figure 1**). The remediation of radiologically impacted portions of the Tulsa, Oklahoma facility has been authorized by the Nuclear Regulatory Commission (NRC) via approval of the site-specific Decommissioning Plan (DP) (June 2001, Rev. May 2003, September 2003, May 2005, and September 2005) and Decommissioning Plan Addendum (DPA) (May 2002, Rev. May 2003) for the facility. The DP and DPA were designed to address the remediation of thorium dross and contaminated soil known to be present at the Tulsa, Oklahoma facility (Thorium Remediation Project). The DP and DPA specify the procedures to safely decommission the Tulsa, Oklahoma facility and meet the NRC requirements for unrestricted use: residual radioactivity distinguishable from background will not result in a total effective dose equivalent (TEDE) to an average member of a critical group (resident farmer) that exceeds 25 millirem per year (mrem/yr). Additionally, implementation of the DP and the DPA will reduce residual radioactivity to levels that are as low as reasonably achievable (ALARA).

The final status survey technical approach authorized by the NRC (Chapter 14.0 of the DP and DPA) includes the protocols and guidance provided in NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (USEPA, December 1997) to demonstrate compliance with the DP and DPA release criteria. A copy of the most recent version (September 2005) of Chapter 14.0 is presented as an appendix to the Final Status Survey Report.

This Road Map was written to provide the reader with relevant background information related to the DP and DPA, a historical operations perspective for the site, as well as an overview of current site remediation and associated final status survey activities.

1.1 Decommissioning Plan and Decommissioning Plan Addendum

The DP addresses the remediation of the impacted portions of the 14-acre "Pond Parcel" at the Tulsa, Oklahoma facility and the DPA addresses the approximate 3.5-acre "Former Operational Area". The Pond Parcel has been divided into three parts: the non-impacted former Freshwater Pond area to the west (approximately 4 acres); the impacted

Retention Pond/Reserve Pond area to the east (approximately 9 acres); and the impacted area adjacent to the Flux Building and paved area (approximately 1 acre) (**Figure 2**).

The Former Operational Area (FOA) is principally a triangular parcel of land north of 41st Street and south of the Union Pacific Railroad right-of-way, on which plant processes and operations occurred. None of the original buildings which housed magnesium-thorium alloy processing, existed on site at the onset of the Thorium Remediation Project. The Flux Building, located to the northeast of the triangular parcel, is part of the FOA (**Figure 2**).

1.2 Historical Operations Perspective

The Standard Magnesium Corporation (SMC) built the Tulsa, Oklahoma facility in Tulsa, Oklahoma in the early to mid-1950s to manufacture magnesium products. SMC received a source materials license (C-4012) from the Atomic Energy Commission in March 1958 to receive possession and title to magnesium-thorium alloy (a thorium metal) with up to 4 percent thorium content for processing. Historical operations at the facility included the smelting of scrap magnesium alloy for the production of anodes. Scrap magnesium-thorium alloy was smelted, along with other magnesium materials, to recover the magnesium. Thorium alloy material comprised a small fraction of the total magnesium refined on site. Licensed operations involving the recovery of magnesium-thorium alloy began in 1958 and continued through 1968. Kaiser purchased the facility in 1964. Magnesium refining operations continued at the facility until approximately 1985. Aluminum then replaced magnesium in smelting and anode manufacture, and the plant continued operating until the 1997-1998 time frame.

License C-4012 was superseded by License STB-472 in November 1961. License STB-472 was amended in June 1968 to add uranium to the list of authorized materials, but there is no record that uranium-bearing materials were ever received on site. The license was terminated in 1971 by the AEC at Kaiser's request. At that time, Kaiser stated that it had not processed magnesium-thorium alloy in the past year.

The scrap magnesium alloy refining process consisted of placing the material into large melting pots, heating the material until molten, and then siphoning off the pure magnesium. Impurities from the mixture, including thorium, separated from the magnesium. This residue material was removed, allowed to cool, and crushed. The crushed material was returned to the heating pots for a second recovery process. Once refined, the metallic dross residue material was crushed and disposed on site.

The quantity of licensed material SMC and later Kaiser were authorized to possess at one time was periodically amended, but generally was limited to 30,000 pounds of magnesium-thorium alloy containing no more than 4 percent thorium. Records documenting the quantity of licensed material present at the site are not available.

1.3 Site Remediation

The site has been divided into two remediation areas: the Pond Parcel area where the dross residues were stored and the FOA where the site structures were located. These two areas and the planned/completed remedial activities are described in the following sections.

1.3.1 Pond Parcel Description and Remediation

Extensive site characterization activities were conducted within the 14-acre land area of the facility known as the Pond Parcel. These characterization activities indicated the presence of residual radioactive material within a 10-acre portion of the Pond Parcel. The radioactive material identified within this portion of land was a thorium-bearing dross containing the isotopes thorium-232 (Th-232), thorium-230 (Th-230), and thorium-228 (Th-228). No elevated uranium was detected. Th-228 and Th-232 were determined to be in secular equilibrium. In addition, a ratio of Th-230-to-((Th-232+Th-228)/2) of 3.5 was calculated based on characterization data.

As previously mentioned, the impacted portion of the parcel contains the Retention Pond and former Reserve Pond area. The non-impacted portion of the Pond Parcel contains the former Freshwater Pond area. The DP was written to address the remediation of the Pond Parcel land area. The impacted Pond Parcel land area is bounded by the south fence line, the former Freshwater Pond embankment on the west, Fulton Creek ditch on the north, and the east fence line. A central feature of this area is the Retention Pond and associated embankments.

Thorium-bearing dross was also present on land adjacent to current Kaiser Property along the east and south fence lines and represented the margins of the impacted material. Per an NRC-approved remediation plan, Kaiser remediated this "adjacent land" by excavation and storing impacted soil within the Pond Parcel. Kaiser conducted the adjacent land remediation project (ALRP) during the period of October 2000 through May 2001. Impacted soil generated during the ALRP was considered part of the on-site decommissioning. In a letter dated March 7, 2002, the NRC provided Kaiser with a determination that the remediated adjacent properties met the criteria for unrestricted release.

The remediation alternative chosen for the Pond Parcel requires excavating material with a net Th-232 activity concentration greater than the Derived Concentration Guideline Level ($DCGL_w$) of 3.0 pCi/g, based on a dose limit of 25 mrem/yr. Material with net Th-232 activity concentrations greater than the Derived Cutoff Concentration Level (DCCL) of 31.1 net pCi/g Th-232 is being segregated and disposed off site as exempt material at the U.S. Ecology Grand View Idaho facility. Material with activity concentrations less than 31.1 net pCi/g Th-232 (Below Criteria Material or BCM) is

over the BCM and graded in a manner to direct drainage away from the site, after which the site will be revegetated.

At the time of preparation of this report, approximately 93 percent of the impacted portion of the Pond Parcel has been remediated. The remediated portion of the Pond Parcel has been excavated to depths up to 15 to 20 feet and to an average depth estimated at 14 feet across most of the Retention and Reserve ponds. At the end of the Thorium Remediation Project, approximately 4,000,000 cubic feet (ft^3) of clean off-site soil will have been used to backfill the Pond Parcel excavations.

1.3.2 Former Operational Area (FOA) Description and Remediation

The DP identified the potential for radioactive material beneath several paved areas and building floor surfaces of the FOA. This determination was based upon an interpretation of historical data and/or observations made during the ALRP. As a result, a limited Additional Site Characterization Activities (ASCA) effort was conducted in the FOA during mid-2001. The objective of the ASCA was to determine if thorium-bearing dross/radioactive material was present beneath these areas of concern. Soil data obtained during the ASCA indicated the presence of residual radioactive material beneath several concrete-paved surfaces at relatively shallow depths. The presence of this material beneath the surfaces was most likely the result of historical grading activities.

A Historical Site Assessment (HSA) was then performed during late 2001 for the FOA. The HSA was conducted as the first step toward decommissioning the FOA at the Tulsa, Oklahoma facility. The objective of the HSA was to compile as much historical information as possible for the facility and, using the MARSSIM guidelines, categorize the land areas and structures of the FOA of the facility as either impacted or non-impacted. None of the original buildings which housed magnesium-thorium alloy processing existed on site at the time of the HSA. With the exception of the Flux Building, there were no buildings in the FOA of the facility classified as impacted in the HSA. The Flux Building was initially classified as an impacted structure due to past and current uses of the building to house and process soil core and surface samples. Land areas initially classified as impacted included the land areas beneath the Maintenance Building, the Crusher Building, the Crusher Addition Building, the North Extrusion Building, the Warehouse Building, and the former Smelter Building, as well as concrete paved areas completed post-1958 (**Figure 2**).

The results of the HSA (Appendix A of the DPA) were used to design radiological survey efforts for the structures and land areas of the FOA. The recommended radiological extended scoping (non-impacted structures) and characterization (impacted land areas) survey efforts were described in a work plan prepared by Earth Sciences Consultants, Inc. (December 2001). The primary objective of the extended scoping survey of the six existing site structures were to verify their initial classification as non-impacted in the HSA. The primary objectives of the characterization survey of the impacted land areas were to determine the nature and extent of residual radioactive materials within the FOA and collect sufficient data to support evaluation of remedial alternatives and technologies

for the impacted land areas of the FOA. The radiological survey efforts were completed during the months of January and February 2002. Results of the radiological surveys are presented in Chapter 4.0 of the DPA.

Based on the results of the survey effort, select land areas of the FOA were identified for remediation. These areas include the following:

- A portion of the land area beneath the former Warehouse Building (Survey Unit Kaiser-FSSFOA-005).
- A portion of the land area beneath the former Crusher Building (Survey Unit Kaiser-FSSFOA-006).
- The land area beneath a "built-up" dock area located immediately west of the former Crusher Building (Survey Unit Kaiser-FSSFOA-005).
- The land area beneath a built-up dock area located immediately west of the former Maintenance Building (Survey Unit Kaiser-FSSFOA-004).
- A portion of the land area beneath a paved concrete surface situated northwest of the former Maintenance Building, northeast of the former North Extrusion Building, and south of the Union Pacific Railroad right-of-way (Survey Unit Kaiser-FSSFOA-001).
- A portion of the land area along a concrete retaining wall situated at the southeastern corner of the former Maintenance Building (Survey Unit Kaiser-FSSFOA-002).
- A portion of the land area beneath a paved concrete surface situated to the north of the former Warehouse Building (Survey Unit Kaiser-FSSFOA-005).
- A portion of the land area beneath a paved concrete surface situated north of 41st Street and the former Crusher Building, south of the UPRR right-of-way, and west of the areas remediated during the ALRP (Survey Unit Kaiser-FSSFOA-006).

Kaiser completed select pre-decommissioning activities prior to undertaking the Thorium Remediation Project. The most significant pre-decommissioning activity was the demolition of several of the non-impacted FOA structures to facilitate the excavation of impacted material located beneath floor slabs. Non-impacted structures that were demolished included the Warehouse Building, the Crusher Building, and Crusher Addition Building. The Flux Building was demolished during the Thorium Remediation Project following the completion of a final status survey of the structure and NRC approval (August 1, 2005 NRC letter from John T. Buckley to Bill Vinzant). The demolished materials were disposed as construction debris off-site at a local permitted facility. The concrete floor slabs and paved surface concrete were removed in sections. The underside of each section of concrete was mechanically cleaned to remove loose soil and clearance surveyed based on the guidance of NRC FC 83-23. In addition, relative to the disposal of the cleared concrete slabs in a local permitted facility, the State of Oklahoma specified that contamination levels shall not be different than background.

At the time of preparation of this Final Status Survey report, the remediation of the impacted portions of the FOA had been completed. Remediation activities for the FOA consisted of the excavation of material with a net Th-232 activity concentration greater than the $DCGL_w$ of 3.0 pCi/g and the backfill of the excavations with clean imported borrow material. The excavated material was transported to the Pond Parcel where material with net Th-232 activity concentrations greater than the DCCL of 31.1 pCi/g was segregated on site and disposed off site as exempt material at the U.S. Ecology Grand View Idaho facility. BCM (material with net activity concentrations below 31.1 pCi/g Th-232) was placed in the Pond Parcel excavation as backfill. At the end of the decommissioning project, the backfilled excavations located within the FOA will be final graded and vegetated to minimize soil erosion and promote positive site drainage.

1.4 Final Status Surveys and Reporting

Final status surveys for the Thorium Remediation Project consists of three distinct elements: (1) surveys of the "open land areas" of the site including the excavation bottom surface soils for the Pond Parcel and FOA; (2) surveys of BCM placed in the Pond Parcel excavations; and (3) surveys of structural surfaces. Final status surveys are completed prior to the backfilling of any Pond Parcel or FOA remediation excavation and during/following the placement of BCM in the Pond Parcel. The survey unit acceptance criteria developed in the DP are applicable to the entire site. Thus, if each survey unit meets the acceptance criteria, the dose for the entire site will be less than the release criteria of 25 mrem/yr.

The Final Status Survey Report is being submitted to NRC to address the survey units completed to date for the Thorium Remediation Project. The layout of this submittal is as follows:

- Volume I – Pond Parcel Excavation Bottom Survey Units
- Volume II – Former Operational Area Excavation Survey Units
- Volume III – Pond Parcel Backfill (BCM) Survey Units

Each volume of the Final Status Survey Report contains individual sub-reports that provide final status survey results for a particular survey unit. Each volume also contains independent chapters describing the specific type and/or area of survey, applicable acceptance criteria and survey protocols, and a summary of survey results as well as supporting figures, tables, and attachments.

1.4.1 Pond Parcel and FOA Excavation Bottom Surveys and Reporting

Final status surveys associated with the Pond Parcel and FOA excavation bottoms are conducted through a progression of Class 1 survey units. Survey units typically consist of excavation bottom surface soil and associated side walls, elevated soil areas (if left in-place), and embedded structures (if encountered and left in-place). The final status survey of excavation bottom survey units typically consists of a gross gamma scan of the exposed surface soil of the unit and systematic soil sampling. Additional scanning and

soil sampling are included for each elevated measurement comparison (EMC) performed for elevated areas left in-place. Embedded structures (typically small pipes and concrete) are surveyed for total alpha contamination (when possible) and removable alpha contamination.

Compliance with survey unit acceptance criteria is demonstrated by comparison of the average residual contamination for each survey element (excavation bottom soil, elevated areas, and embedded structures) to the appropriate acceptance criteria value and a sum of fractions for each survey unit is also calculated. The sum of fractions is a very conservative assessment of the survey unit. Summing the fractions ensures the survey unit and the entire site will be a small fraction of 25 mrem/yr (the release criterion) when the actual as-left dose assessment is complete. Systematic final status survey data are also evaluated using the Wilcoxan Rank Sum Test procedure.

A total of 30 Pond Parcel excavation bottom survey units are anticipated for the Thorium Remediation Project. Final status surveying and reporting have been completed for 24 of the 30 Pond Parcel excavation bottom survey units. **Volume I of this Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSS-001 through Kaiser-FSS-024. One of the 24 excavation bottom survey units (Kaiser-FSS-001) consisted of an embedded structure encountered (a buried concrete spillway) during the removal of radiologically impacted soil. A discussion of the appropriate survey unit acceptance criteria and surveying protocol for the Pond Parcel excavation bottom survey units is also presented in **Volume I of this Final Status Survey Report.** The results of the final status surveys for the remaining 6 Pond Parcel excavation bottom survey units will be documented in an addendum to this Final Status Survey Report to be submitted at the end of the remediation project.

Final status surveying and reporting have been completed for all 9 FOA excavation survey units. **Volume II of this Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSSFOA-001 through Kaiser-FSSFOA-009. Three of the 9 FOA excavation survey units consisted only of embedded structures (retaining walls) that were encountered during the removal of radiologically impacted soil located adjacent to the structures. A discussion of the appropriate survey unit acceptance criteria and surveying protocol for the FOA excavation survey units is also presented in **Volume II of this Final Status Survey Report.**

1.4.2 Pond Parcel Excavation Backfill Units (BCM) Surveys and Reporting

As with the Pond Parcel excavation bottoms, final status surveys associated with the Pond Parcel excavation backfill units (BCM) are conducted through a progression of Class 1 survey units. Typically a unit of BCM is placed in a portion(s) of a pond parcel excavation bottom(s) associated with a defined excavation bottom final status survey unit(s). Backfill units are completed through the placement of typically four to eight continuous layers (2-foot compacted lift depth) of BCM in a defined area. The final status survey of excavation backfill units consists of a gross gamma scan of each placed 2-foot lift of BCM and systematic soil core sampling upon completion of the BCM unit.

Compliance with survey unit acceptance criteria is demonstrated by comparison of the average residual contamination for the survey unit to the appropriate acceptance criteria value. Systematic soil core sampling data are also evaluated using the Wilcoxan Rank Sum Test procedure.

A total of 15 Pond Parcel excavation backfill survey units are anticipated for the Thorium Remediation Project. Final status surveying and reporting have been completed for 9 of the 15 Pond Parcel excavation backfill survey units. **Volume III** of this **Final Status Survey Report** documents the final status survey results for Survey Units Kaiser-FSSB-001 through Kaiser-FSSB-009. A discussion of the appropriate survey unit acceptance criteria and surveying protocol for the Pond Parcel excavation backfill units is presented in **Volume III** of this **Final Status Survey Report.** The results of the final status surveys for the remaining 6 Pond Parcel excavation backfill survey units will be documented in an addendum to this **Final Status Survey Report** to be submitted at the end of the remediation project.

1.4.3 Final Status Survey QA Program

The final status survey QA program implemented for the Thorium Remediation Project includes QA functions that cover aspects of data collection, including both field radiation instrument surveys, and soil and smear sampling for laboratory analysis, through the preparation of the documentation of the results. Applicable field radiation instrument final status survey QA data for each survey unit is provided in **Appendix A to Volumes I through III of this Final Status Survey Report.** Analytical QA data for the final status surveys will be documented in an addendum to this Final Status Survey Report to be submitted at the end of the remediation project.

1.4.4 Documentation of As-Left Condition and the Completion of a Final Dose Assessment

A bounding dose assessment based on the maximum activity concentration and minimum soil cover requirement has been completed and is presented in **Appendix E** of **Volume III** of this **Final Status Survey Report.** The resulting maximum dose is 1.33 mrem/yr. At the conclusion of the Thorium Remediation Project, the actual activity concentrations and the actual dimensions of the cover could be used to reassess the final dose. Since the activity concentrations will be less than bounding values used and the dimensions of the cover will be at least what were used, the resulting dose would be less than 1.33 mrem/yr.

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Survey Units Kaiser-FSS-001 through Kaiser-FSS-024
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

2.0 INTRODUCTION

This volume of the Final Status Survey Report presents the results of Pond Parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Final status surveys associated with the Pond Parcel excavation bottom are being conducted through a progression of Class 1 survey units. Survey units typically consist of excavation bottom surface soil and associated side walls, elevated soil areas (if left in-place), and embedded structures (if encountered and left in-place). The final status survey of excavation bottom survey units typically consist of a gross gamma scan of the exposed surface soil of the unit and systematic soil sampling. Additional scanning and soil sampling are included for each elevated measurement comparison (EMC) performed for elevated areas left in-place. Embedded structures (if encountered and left in-place) are surveyed for total alpha contamination (when possible) and removable alpha contamination.

A total of 30 Pond Parcel excavation bottom survey units are anticipated for the Thorium Remediation Project. Final status surveying and reporting have been completed for 24 of the 30 Pond Parcel excavation bottom survey units. This volume of the Final Status Survey Report documents the final status survey results for Survey Units Kaiser-FSS-001 through Kaiser-FSS-024 (**Figure 3**). The results of the final status surveys for the remaining 6 Pond Parcel excavation bottom survey units will be documented in an addendum to this Final Status Survey Report to be submitted at the end of the remediation project.

This volume of the Final Status Survey Report contains 24 individual sub-reports (EB-001 through EB-024), each documenting the final status survey results for a particular survey unit. Sub-Report EB-001 documents the final status survey results for Survey Unit Kaiser-FSS-001, an embedded structure encountered (a buried concrete spillway) during the removal of radiologically impacted soil from the southwestern corner of the Retention Pond area. Survey Unit Kaiser-FSS-001 is unique in that the structural surface was large, constituted the entire survey unit and as such was systematically scanned and sampled per the final status survey protocol for structures. All additional embedded structures are included as part of the open land area survey unit sub-reports. Sub-Reports EB-002 (Survey Unit Kaiser-FSS-002) through EB-024 (Survey Unit Kaiser-FSS-024) document the final status survey results for open land areas (pond parcel excavation bottom surface soil) resulting from the removal of radiologically impacted soil from impacted portions of the Pond Parcel. These open land area survey units are considered Class 1 survey units with surface areas generally less than 2,000 m^2.

The remaining chapters of this volume presents the site release criteria for the Tulsa, Oklahoma facility and the acceptance criteria to be used to clear survey units (**Chapter 3.0**), an overview of the surveying protocol for the Pond Parcel excavation bottom survey units (**Chapter 4.0**), and a

summary of findings relative to the final status survey of Pond Parcel excavation bottom Survey Units Kaiser-FSS-001 through Kaiser-FSS-024 **(Chapter 5.0)**. Supporting appendices to this volume of the Final Status Survey Report include the following:

- **Appendix A** – Survey Instrument Quality Assurance/Quality Control (QA/QC) Documentation
- **Appendix B** – Chapter 14.0 of the Decommissioning Plan (September 2005 Revision)
- **Appendix C** – Evaluation of Survey Unit Analytical Results, Wilcoxon Rank Sum Test
- **Appendix D** – Onsite Cave Counter Calibration and Soil Sample Results

3.0 FINAL STATUS SURVEY ACCEPTANCE CRITERIA

3.1 Site Release Criteria and Survey Unit Acceptance Criteria

The **site release criteria** for the Kaiser Tulsa, Oklahoma facility, as presented in the DP are:

"The site will be remediated in accordance with decommissioning criteria of Subpart E, Radiological Criteria for License Termination of 10 CFR Part 20, Standards of Protection Against Radiation. Specifically, Subpart E, 10 CFR 20.1402, Radiological Criteria for Unrestricted Use, allows release of a site for unrestricted use if the residual radioactivity distinguishable from background results in a TEDE to an average member of the critical group that does not exceed 25 mrem/yr and the residual radioactivity has been reduced to levels that are ALARA."

In regards to **acceptance criteria** to be used to clear survey units the DP continues:

"Dose modeling is used to estimate the TEDE to the average member of the critical group (that group reasonably expected to receive the greatest exposure to residual radioactivity for any applicable circumstances). The concentration of residual radioactivity (per radionuclide) distinguishable from background that, if distributed uniformly throughout a survey unit, results in a TEDE of 25 mrem in 1 year to an average member of the critical group is the single-radionuclide $DCGL_W$."

Two factors complicate the application of $DCGL_W$ acceptance criteria at the Kaiser Tulsa, Oklahoma facility. The first is the presence of multiple radionuclides, specifically, Th-232, Th-228 and Ra-228 from the thorium decay series and Th-230, Ra-226 and Pb-210 from the uranium decay series. Each radionuclide has a $DCGL_W$ value corresponding to the 25 mrem TEDE criteria. When multiple radionuclides are present, compliance may be demonstrated by a sum of fractions calculation over the entire series of radionuclides or the use of a surrogate value to represent 25 mrem TEDE for the entire mix of radionuclides presents. The activity concentration of Th-232 in units of pCi/g has been established as the surrogate acceptance criteria for surveys of soil and soil-like material. Use of Th-232 as a surrogate for soil surveys is detailed in the DP. Likewise gross alpha activity has been established as the surrogate acceptance criteria for surveys of structural surfaces. The use of gross alpha as a surrogate for structure surveys is detailed in the Technical Addendum to the Decommissioning Plan and Addendum, Revised Structural Surface Acceptance Criteria (May 2005).

The second factor is the presence of three distinct survey elements onsite. In addition to the exposed surface soil of the excavated open land areas and surfaces of structures remaining onsite, a third survey element is present as a result of the remedy provided in the DP. In developing the remedial action plan, a derived cutoff concentration level (DCCL) of 31.1 net pCi/g Th-232 has been determined. This value represents the dividing line concentration between material which must be exported to an off-site disposal facility and material which can remain onsite under an unrestricted release scenario. The dose assessment presented in Chapter 5.0 of the DP demonstrates that unrestricted release dose levels can be achieved when material below the DCCL are returned to the excavation. The average concentration of BCM

remaining on site is termed in the DP as the Average Derived Concentration Level ($ADCL_W$). Dose-based criteria have been established for the Kaiser Tulsa, Oklahoma facility for three distinct survey elements: (1) surveys of the open land areas of the site including the FOA and the Pond Parcel excavation bottoms; (2) surveys of the Pond Parcel excavation backfill (BCM) units; and (3) surveys of structural surfaces.

Finally, for each survey element acceptance criteria there are additional criteria provided to address small areas of elevated activity calculated from area factors (AF) provided in the DP and the technical addendum to the DP. The elevated measurement comparison (EMC) criteria are referred to as $DCGL_{EMC}$ values.

The inputs and assumptions used to derive element specific acceptance criteria are not the same, but rather are conservative for the specific survey element. The stand-alone acceptance criteria and key inputs/assumptions are:

- **Excavation Bottom Surface Soil $DCGL_W$** – 3.0 net pCi/g of Th-232 over the entire survey unit. Inputs/assumptions include 6-inch contaminated zone thickness and no cover.
- **Excavation Bottom Surface Soil $DCGL_{EMC}$** – 37.5 net pCi/g of Th-232 over 1 m^2. Additional values are provided for increasing survey areas. Inputs/assumptions are the same as excavation bottom surface soil except for area.
- **Below Criteria Material (BCM) DCCL** – 31.1 net pCi/g of Th-232 over the entire survey unit. Inputs/assumptions include a 3.31-meter contaminated zone thickness and minimum 3.05-meter (10 feet) clean layer of import borrow (soil) material.
- **Below Criteria Material (BCM) $ADCL_{EMC}$** – 87.5 net pCi/g of Th-232 over 1 m^2. Additional values are provided for increasing survey areas. Inputs/assumptions are the same as BCM except for area.
- **Structure Surface Total Contamination GA-DCGL** – 944 net dpm/100cm^2 gross alpha over 100 m^2. Inputs/assumptions include 100 m^2 of surface area and a removable fraction of 0.1.
- **Structure Surface Removable Contamination GA-DCGL** – 94.4 net dpm/100cm^2 gross alpha over 100 m^2. Inputs/assumptions are the same as structure surface total contamination.
- **Structure Surface Total Contamination GA-$DCGL_{EMC}$** – 92,700 net dpm/100cm^2 gross alpha over 1 m^2. Inputs/assumptions are the same as structure surface total contamination except for area.
- **Structure Surface Removable Contamination GA-$DCGL_{EMC}$** – 9,270 net dpm/100cm^2 gross alpha over 1 m^2. Additional values are provided for increasing survey areas. Inputs/assumptions are the same as structure surface total contamination except for area.

3.2 Open Land Area Acceptance Criteria

For surveys of the open land surface (excavation bottom and side walls) remaining after excavation of radiologically impacted material from the Pond Parcel and FOA, a surrogate net Th-232 activity concentration of 3.0 pCi/g is the applicable $DCGL_W$ value. **Table 3-1** presents area factors (based upon MARSSIM guidance) to be used for elevated measurement comparisons

(EMC) and to determine sampling requirements in situations where the scan instrument's minimum detectable concentration (MDC) is greater than the $DCGL_W$. The $DCGL_{EMC}$ values applicable to the open land areas of the site area are calculated by multiplying the $DCGL_W$ by the area factors presented in **Table 3-1**. $DCGL_{EMC}$ values are presented in **Table 3-2.**

$$DCGL_{EMC} = \text{Area Factor} * DCGL_W$$

Table 3-1 – Open Land Areas Area Factors

Area Factors									
Radio-nuclide	1 m^2 (11 ft^2)	3 m^2 (32 ft^2)	10 m^2 (108 ft^2)	30 m^2 (323 ft^2)	100 m^2 (1,076 ft^2)	300 m^2 (3,229 ft^2)	1,000 m^2 (10,764 ft^2)	3,000 m^2 (32,292 ft^2)	10,000 m^2 (107,639 ft^2)
Th-232	12.5	6.2	3.2	2.3	1.8	1.5	1.1	1.0	1.0

Table 3-2 - $DCGL_{EMC}$ Values for Open Land Areas

$DCGL_{EMC}$ (pCi/g)									
Radio-nuclide	1 m^2 (11 ft^2)	3 m^2 (32 ft^2)	10 m^2 (108 ft^2)	30 m^2 (323 ft^2)	100 m^2 (1,076 ft^2)	300 m^2 (3,229 ft^2)	1,000 m^2 (10,764 ft^2)	3,000 m^2 (32,292 ft^2)	10,000 m^2 (107,639 ft^2)
Th-232	37.5	18.6	9.6	6.9	5.4	4.5	3.3	3.0	3.0

3.3 Below Criteria Material (BCM) Acceptance Criteria

For surveys of the BCM placed in Pond Parcel excavations, a surrogate net Th-232 activity concentration of 31.1 pCi/g is the DCCL value. **Table 3-1** presents area factors (based upon MARSSIM guidance) to be used for EMCs of open land areas and to determine sampling requirements in situations where the scan instrument's MDC is greater than the DCCL. (The use of the open land area areas factors is conservative for surveys of the BCM.) For the BCM used as Pond Parcel backfill, the ADCL value was multiplied by the area factors presented in **Table 3-1** and the results are presented in **Table 3-3.**

$$ADCL_{EMC} = \text{Area Factor} * ADCL$$

However, since the BCM can be as high as 31.1 net pCi/g Th-232, the EMC is only applicable to concentrations exceeding 31.1 pCi/g Th-232 above background. The ADCL value of 7 pCi/g of Th-232 was conservatively used to establish elevated measurement criteria for BCM greater than 31.1 pCi/g Th-232 above background, to maintain the average concentration of the backfill material ALARA.

Table 3-3 - $ADCL_{EMC}$ Values for Pond Parcel BCM Units

	$ADCL_{EMC}$ (pCi/g)								
Radio-nuclide	1 m^2 (11 ft^2)	3 m^2 (32 ft^2)	10 m^2 (108 ft^2)	30 m^2 (323 ft^2)	100 m^2 (1,076 ft^2)	300 m^2 (3,229 ft^2)	1,000 m^2 (10,764 ft^2)	3,000 m^2 (32,292 ft^2)	10,000 m^2 (107,639 ft^2)
Th-232	87.5	43.4	22.4	16.1	12.6	10.5	7.7	7.0	7.0

3.4 Structures Acceptance Criteria

For surveys of structures remaining onsite, 944 dpm/100cm^2 of total alpha contamination is the applicable GA-DCGL value. **Table 3-4** presents area factors (based on MARSSIM guidance) to be used for elevated measurement comparisons and to determine sampling requirements in situations where the scan instrument's MDC is greater than the GA-DCGL. The appropriate $GA\text{-}DCGL_{EMC}$ values are calculated by multiplying the GA-DCGL by the area factors presented in **Table 3-4** and the results are presented in **Table 3-5**.

$$GA\text{-}DCGL_{EMC} = \text{Area Factor} * GA\text{-}DCGL$$

Table 3-4 Structures Area Factors

	Area Factors								
GA-DCGL	1 m^2	2 m^2	3 m^2	4 m^2	5 m^2	10 m^2	20 m^2	30 m^2	100 m^2
	98.2	49.2	32.9	24.7	19.8	9.91	4.97	3.32	1.00

Table 3-5 $GA\text{-}DCGL_{EMC}$ Values Structures

	$DCGL_{EMC}$ (dpm/100cm^2)								
GA-DCGL	1 m^2	2 m^2	3 m^2	4 m^2	5 m^2	10 m^2	20 m^2	30 m^2	100 m^2
	9.27E+04	4.64e+04	3.10E+04	2.33E+04	1.87E+04	9.36E+03	4.69E+03	3.13E+03	9.44E+02

The criteria for total alpha contamination corresponds to 25 mrem/yr TEDE based on the assumption of less than 10% of the total contamination is removable. Compliance for structures is also demonstrated by taking smear samples of 100 cm^2 of surface area and comparison of the gross alpha count result to 10% of the applicable total contamination GA-DCGL.

3.5 Interim Sum of Fractions for Pond Parcel Excavation Bottom and FOA Excavation Surveys

The inputs and assumptions used to derive the DCCL value for BCM reflect the projected as-left condition of the site. This configuration is very conservative for all of the other survey elements since the DCGL derivation was based on no soil cover. When the layers of BCM and a minimum 10 foot clean cover are placed on top of the excavation surface soil and embedded structures, the dose from these survey elements are reduced to 0 mrem, since the great majority of exposure from these elements depends on direct contact or proximity to the element. Once the

final as-left configuration of the site has been determined through final status and land surveys, a final as-left dose assessment will be completed to demonstrate compliance with the DP release criteria of 25 mrem/yr TEDE.

Survey unit compliance is demonstrated by comparison of the average residual contamination for each survey element present to the appropriate acceptance criteria value and a sum of fractions for each survey unit is calculated. The sum of fractions is a very conservative assessment of the survey unit. Summing the fractions ensures the survey unit will be a small fraction of 25 mrem/yr (the release criteria) when the actual as-left dose assessment is complete. A bounding as-left condition dose assessment is included in **Volume III, Appendix E** of this Final Status Survey Report.

4.0 FINAL STATUS SURVEY PROTOCOL

4.1 Generic Survey Protocol

Survey units for the Thorium Remediation Project are evaluated to determine whether the average residual radioactivity concentration in a particular survey unit as a whole is below the applicable acceptance criterion concentration, i.e., the $DCGL_W$, GA-DCGL or DCCL. The final survey protocol uses both systematic grid sampling to determine this average radionuclide concentration in a survey unit in conjunction with scans to identify elevated areas of residual radioactivity. At least the minimum number of samples (N/2) is taken in each survey unit. Since the radionuclides of interest at the Tulsa, Oklahoma facility also occur naturally in background, survey unit final status survey data are compared to data from a reference area under what is known as a "two-sample test," or the Wilcoxon Rank Sum (WRS) Test. Application of the WRS Test procedure is described in **Appendix C** of this volume of the Final Status Survey Report.

When using the WRS Test, the minimum number of samples (N/2) is the number of samples required in the survey unit and in the reference background area. Hence "N" is the total number of samples required to complete the WRS Test. (Please note: N is often used to represent the number of samples in the survey unit or in the reference area also.) Paramount to determining the minimum number of samples is the determination of the relative shift, delta over sigma (Δ/σ). Delta is equal to the DCGL minus the lower-bound gray region (LBGR) value. The LBGR value is arbitrarily set at one-half the DCGL value to start the determination. Sigma is an estimate of the variability in a set of sample analysis results from a survey unit.

A random-start triangular pattern, or grid, is used in Class 1 and Class 2 survey units to locate the sample points. For Class 3 survey units, the samples are located randomly or at the discretion of the Data Manager. The distance between each sampling grid node, L, is determined by the following equation:

$$L = \sqrt{\frac{A}{0.866N}}$$

In the above equation, A is the survey unit area to be covered by the grid pattern and N (equal to N/2 for WRS testing) is the number of samples required for that survey unit. The random start point (X and Y coordinates) is selected using a random number generator ("RAND") function in the Microsoft computer application *Excel*©. Sample points are identified in the field by flags or other means using a global positioning system (or equivalent locating tool) to locate each grid node.

The routine method (of determining N) described above presumes that the actual scan MDC is less than or equal to the required scan MDC, i.e., there is sufficient scan sensitivity available to detect small areas of elevated activity. (The derivation of various scan MDCs is presented in **Section 4.2.**) For the infrequent situations where the actual scan MDC exceeds the required scan MDC (acceptance criteria for the survey unit), the alternate method for calculating the required number of samples N may be used. This alternate method is described in Section 5.5.2.4 of

MARSSIM and involves the calculation of an area factor corresponding to the actual scan MDC as follows:

$$AreaFactor = \frac{ScanMDC(actual)}{DCGL_W}$$

(Depending on the survey unit, *DCCL* or *GA-DCGL* is substituted for $DCGL_W$ in the above equation.) The size of an area of elevated radioactivity corresponding to this area factor is interpolated from the appropriate area factor tables contained in **Chapter 3.0** and divided into the survey unit area to determine the alternate number of sample locations N_1. If N_1 exceeds the value assigned to N, an alternate spacing L_1 for the systematic sampling grid is calculated using the equation:

$$L_1 = \sqrt{\frac{A}{0.866N_1}}$$

The corresponding height (h) of the equilateral triangle with side length equal to L (or L_1) is calculated using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$.

4.2 Final Status Survey Instrumentation

4.2.1 Soil Survey Instrumentation

The MARSSIM framework for determining the MDC for field instrument scanning activities is based on the premise that there are two stages of scanning. That is, surveyors do not make decisions on the basis of a single indication; rather, upon noting an increased number of counts, they pause briefly and then decide whether to move on or take further measurements. Thus, scanning consists of two components: continuous monitoring and stationary sampling. Accordingly, field instrument surveyor scan MDCs, $MDCR_S$, are calculated to control the occurrence of Type I (false negative) and Type II (false positive) errors using the following MARSSIM equation:

$$MDCR_S = \frac{MDCR}{\sqrt{p\varepsilon}}$$

where *MDCR* is the minimum detectable count rate (cpm), p is the surveyor efficiency (estimated in MARSSIM to be between 0.5 and 0.75; the value of 0.5 results in a more conservative $MDCR_S$ calculation and, therefore, will be used), and ε is the instrument efficiency (cpm per µR/hr; Table 6.4 of NUREG-1507). In addition:

$$MDCR = s_i\left(\frac{60}{i}\right)$$

$$s_i = d'\sqrt{b_i}$$

where s_i (counts) is the minimal number of net source counts required for a specified level of performance for the counting interval i (seconds); d' is the index of sensitivity; and b_i is the number of background counts in the interval. Index of sensitivity d' values are listed in MARSSIM Table 6.5 based on the proportions for required true positive and tolerable false positive occurrence rates. The index of sensitivity value selected for initial use at the Kaiser, Tulsa facility is 1.38, corresponding to a true positive proportion of 0.95 and a false positive proportion of 0.60.

Typical calculated Th-232 scan MDCs for a survey instrument equipped with 2-inch x 2-inch NaI (2x2) detector using this MARSSIM two-stage scanning framework are summarized below in **Table 4-1** for increasing background count rates.

Table 4-1 Typical Soil Scan MDCs for Th-232 Detection Using a 2 × 2 NaI Detector[a]

Bkg (cpm)	i (sec)	P -	ε (cpm per µR/hr)	D' -	s_i (counts)	$MDCR$ (ncpm)	$MDCR_S$ (ncpm)	CF[b]	*Scan MDC*[c]	
									µR/hr	pCi/g
5,000	1	0.5	830	1.38	13	756	1069	0.99	1.29	1.3
10,000					18	1069	1512		1.82	1.8

a. Th-232 in equilibrium with progeny uniformly distributed in a source thickness of 6 inches.

b. Conversion factor (pCi/g per µR/hr) taken from NUREG-1507, modeled using *MicroShield*. CF = Scan MDC (pCi/g) / Scan MDC (µR/hr)

c. *Scan MDC* (µR/hr) = $MDCR_S/\varepsilon$ and *Scan MDC* (pCi/g) = $(MDCR_S/\varepsilon)CF$

When scanning soil, the detector is held close to the ground (1 to 2 inches) and moved in a serpentine pattern. A scan rate of approximately 0.5 m per second is used reflecting the natural pace of the technician walking with the equipment swinging the detector a width of 1 meter in a serpentine pattern. Estimates of scan speed are provided for each soil survey unit for which the GPS/data logger system was used. The scan speed is estimated by dividing the total area surveyed by the number of 1 or 2 second interval gross gamma results recorded.

4.2.2 Structure Survey Instrumentation

Measurements of alpha activity are used to show compliance with the structural surface total and removable contamination acceptance criteria in units of dpm/100 cm^2. Scanning for gross alpha activity is used as part of final status surveys of structural surfaces to ensure elevated areas of activity are identified. In addition, static counts at predetermined sample points are used to assess total alpha contamination of structural surfaces. The following instrument is being used for the Thorium Remediation Project to survey structural surfaces:

Meter Manufacturer and Model	Detector Manufacturer and Model	Detector Type	Use
Ludlum 2221	Ludlum 43-68 Gas Proportional	Gas Proportional	Final status survey scans and static counts for total alpha contamination measurements

Structure survey instruments are evaluated and controlled to verify that MDCs of less than the $DCGL_w$ for direct measurements and/or scanning measurements are routinely achieved. Field instrument scan MDCs are calculated to control the occurrence of Type I (false negative) and Type II (false positive) as discussed in the following subsections.

4.2.2.1 Alpha Scan

For a typical alpha background level of less than 3 cpm, the probability of detecting a single count while passing over the contaminated area is:

$$P(n \geq 1) = 1 - e^{\frac{-GEd}{60v}}$$

where:

$P(n \geq 1)$ = probability of observing a single count,
G = activity (dpm),
E = 4π detector efficiency (cpd),
d = width of detector in direction of scan (cm), and
v = scan speed (cm/s).

The value of G is increased until the corresponding probability equaled the desired confidence level, e.g., 95 percent. **Table 4-2** summarizes the calculation of alpha scan MDCs for the 4π detector alpha efficiencies of the instruments used. The resulting values of G (dpm) are significantly below the GA-DCGL value of 944 dpm/100cm^2.

Table 4-2 Typical Structure Scan MDCs for Gross Alpha Detection

G (dpm)	d (cm)	E (cpm)	v (cm/s)	P (-)
380	11.7	0.1618	3.90	0.95
550	11.7	0.1618	5.9	0.95
720	11.7	0.1618	7.80	0.95
1080	11.7	0.1618	11.7	0.95

4.2.2.2 Alpha Static Counts

Minimum counting times for static counts of total and removable contamination will be chosen to provide an MDC that is a fraction (25 to 75 percent) of the survey unit-specific acceptance criteria. MARSSIM equations have been modified to convert to units of dpm/100 cm^2. Count times are determined using the following equation. Static counting MDCs at a 95 percent confidence level are calculated using the following equation which is an expansion of NUREG-1507, Equation 6-7 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E_{tot} \cdot \frac{A}{100}}$$

where:

MDC_{static}= minimum detectable concentration level in dpm/100 cm^2,
B_R = background count rate in counts per minute,
t_B = background count time in minutes,
t_S = sample count time in minutes,
A = detector probe physical (active) area in cm^2, and
E_{tot} = total detector efficiency for radionuclide emission of
= $E_i \times E_s$,
where:
E_i = 2π instrument efficiency in counts per disintegration (cpd) and
E_s = source (or surface contamination) efficiency.

Note: E_s values can be determined or the default values provided in NUREG-1507 can be used as follows: 0.25 for all alpha energies and beta maximum energies between 0.15 and 0.4 MeV, 0.5 for all beta maximum energies greater than 0.4 MeV.

Table 4-3 contains example static alpha MDC calculation results for structural surfaces.

Table 4-3 Structural Surface Alpha Static MDC

Background Gross Alpha Count Rate (cpm)	Background Count Time (min)	Static Measurement Count Time (min)	Total Detector Efficiency	Detector Probe Area (cm^2)	Static MDC (dpm/100cm^2)
0.5	1	1	0.040	126	123
1.0	1	1	0.040	126	150
1.0	5	5	0.040	126	52.6
2.0	5	5	0.040	126	69.5

4.3 Laboratory Analysis

Final status survey analytical laboratory services for the Thorium Remediation Project are being provided by Outreach Laboratory (Outreach) of Broken Arrow, Oklahoma. Final status survey samples consist of soil media samples and smear samples of removable alpha contamination.

Final status survey soil samples are analyzed for Th-232 activity concentration in units of pCi/g via gamma spectroscopy. The samples are counted by the laboratory as received, i.e., they are not dried and/or ground. The MDC value required for each gamma spectroscopy analysis is 25 percent of the release criteria for Th-232. Characterization survey results confirm that Th-232 is in secular equilibrium with its short-lived progeny Ac-228 and Th-228. Outreach infers Th-232 activity from the high energy/high yield gamma emitted by progeny of the thorium decay series, e.g., Actinium-228 (secular equilibrium progeny) high energy gamma line (911 keV). The Th-228 activity is calculated by multiplying the Th-232 activity by 1. The Th-230 activity is calculated by multiplying the Th-232 activity by 3.5.

The laboratory's analytical results are reported to include the activity, the 95 percent confidence level uncertainty (2-sigma error), and the MDC all in the same units of the sample analyzed.

To exclude the bias introduced when grouping analytical results containing "less than" values, the laboratory has been instructed to report observed counting data when reporting results that are below the critical level L_C (and thus "not detected") established for each analysis.

4.4 Open Land Area Survey Protocol

4.4.1 Minimum Number of Samples Determination

The estimate of sigma used for the Thorium Remediation Project is based on the standard deviation of the Th-232 activity measured in survey units during the ALRP final status survey (0.42). Using the $DGCL_w$ value of 3.0 pCi/g of Th-232, Δ is equal to 3.0 - 1.5, or 1.5. Delta divided by the sigma of 0.42 results in a relative shift of 3.57 which is rounded to 3.5 for the purpose of determining the required number of samples. The corresponding minimum number of samples looked up in Table 5.3 of MARSSIM is 9.

4.4.2 Open Land Area Gross Gamma Scan Survey

Portable survey meters consisting of 2-inch by 2-inch sodium iodide (NaI) detectors (Ludlum Model 44-10) coupled with scaler instruments (Ludlum Model 2221) are used to perform gross gamma scans (to identify elevated areas). Typically, the portable survey meters are also coupled to a Global Positioning System (GPS) unit and a data logger to provide electronic downloads of coordinates and associated gross gamma count rates in units of counts per minute (cpm).

Per Section 5.3.3 of MARSSIM, scanning is used to identify locations within the survey unit that exceed the investigation level. For Class 1 survey units, the investigation level is the derived concentration guideline elevated measurement criteria ($DCGL_{EMC}$) value for the area scanned. The $DCGL_{EMC}$ values applicable to the open land areas of the site are calculated by multiplying

the $DCGL_W$ by the area factors presented in **Chapter 3.0.** $DCGL_{EMC}$ values are also presented in **Chapter 3.0.**

The scan MDC and the scanning thresholds in measurement units of net counts per minute (ncpm) are calculated in accordance with MARSSIM and NUREG-1507. These values are summarized below in **Table 4-5** for a maximum background of 50,000 cpm and increasing survey areas (A). The first line (A = 0.25 m^2) is the default area used to demonstrate the calculation of scan MDC and the derivation of the conversion factor (CF in units of pCi/g or μR/h) in NUREG-1507. However, surveys of an area this small are not applicable to final status, open land area surveys. The increasing areas presented in the table correspond to the approved area factors (DP) and result in scan thresholds for detection of both elevated areas (Fail $DCGL_{EMC}$) and complete survey units with activity concentration greater than the $DCGL_W$ (Fail $DCGL_W$). The CF's for increasing areas were derived using the identical inputs of the NUREG-1507 derivation changing only the area.

In addition to the derived scan thresholds, scan data are evaluated against empirical data gathered in the field. For example, soil samples are collected at biased locations (highest scan count rate) and screened on site for Th-232 activity concentration corresponding to the high count rate. All of these factors (derived thresholds, empirical thresholds, and biased samples) are used to identify elevated areas and to release the survey unit for final sampling. The threshold values provided are theoretical, depend on counting geometry and other factors that cannot be controlled in the field, and are used to aid identifying elevated areas that may require additional remediation or application of the elevated measurement comparison.

Table 4-5 – Open Land Areas Scan MDC and Threshold Values

A Area (m^2)	$DCGL_{EMC}$ (pCi/g)	B (cpm)	CF (pCi/g / μR/h)	Scan MDC (pCi/g)	Fail $DCGL_{EMC}$ (ncpm)	Fail $DCGL_W$ (ncpm)
0.25	N/A	50,000	0.99	4.0	N/A	2,515
1	37.5	50,000	0.62	2.5	50,578	4,046
3	18.6	50,000	0.51	2.1	30,212	4,873
10	9.6	50,000	0.46	1.9	17,227	5,383
30	6.9	50,000	0.45	1.8	12,851	5,588
100	5.4	50,000	0.44	1.8	10,250	5,695
300	4.5	50,000	0.43	1.8	8,624	5,749
1000	3.3	50,000	0.43	1.8	6,360	5,782
3000	3.0	50,000	0.43	1.7	5,799	5,799

4.4.3 Open Land Area Soil Sampling

4.4.3.1 Systematic Final Status Survey Soil Sampling

Systematic soil samples are collected at locations determined through the use of a random start point and an equal-distant triangular grid in accordance with MARSSIM and the DP. Soil sample locations are demarcated in the field (using a GPS unit) and soil samples are collected at

the surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel.

4.4.3.2 Additional Biased and EMC Evaluation Soil Sampling

In addition to the systematic samples used to determine the average Th-232 activity concentration in the survey unit, other soil samples may be taken within a survey unit to help demonstrate compliance. At the discretion of the surveyor, biased samples are taken at high scan rate locations to help determine scan survey results. In addition, if small areas of elevated activity are identified, additional soil samples are taken at biased locations to aid in the elevated measurement comparison for the area.

4.4.3.3 Use of the On Site Cave Counter

Certain soil samples, e.g., biased and/or EMC samples collected as part of the final status survey process are screened for Th-232 activity concentration using an on site cave counter. The on site cave counter for the Thorium Remediation Project consists of a 2-inch by 2-inch NaI Ludlum Model 44-10 detector coupled with a Ludlum Model 2221 Scaler/Ratemeter instrument, mounted inside a shielded box with room for a standard soil sample container to be placed on the face (bottom, non-wire connecting end) of the detector. Two detectors (numbered NaI # 4 and NaI #8) have been used as part of the counter. The detectors were calibrated annually off-site by a qualified vendor to verify their response to high energy photons. The detectors, including their use as part of the counter, are utilized to obtain gross gamma readings from soil samples in units of counts per minute (cpm). The detector response is checked daily when in use to a Cs-137 source. Documentation of the on site cave counter calibration and the calculation of Th-232 activity concentration, 95% confidence level uncertainty, and the MDC, are presented in **Appendix D** of this volume of the Final Status Survey Report.

4.5 Structure Survey Protocol

Permanent structures (destined to remain on site) encountered during the implementation of the Thorium Remediation Project can be classified by type. The first type is termed "embedded structures" and consists of small pipes and remnants of previous structures uncovered during excavation activities. These structures consist of very small surface areas (< 1 or 2 m^2) and will be buried with BCM and/or clean fill based on the final site configuration. Measurements of total alpha contamination and smear samples of removable alpha contamination are taken on these structures and reported with the open land area survey unit for which they reside. The second type of structure is the large surface area (approaching 100 m^2) structure such as a concrete retaining wall. This type of structure constitutes a separate survey unit and is surveyed as such.

4.5.1 Minimum Number of Samples Determination

The estimate of sigma used for the Thorium Remediation Project is based on the standard deviation of a set of total alpha contamination results from the final status survey of the Flux Building (Survey Unit FB-001 Floor Surface: 45.9). Since the gross alpha activity concentration

of 944 dpm/100cm2 will be used as the DGCL-GA, Δ is equal to 944 - 472, or 472. Delta divided by the sigma of 45.9 results in a relative shift of 10.3. The minimum number of samples (looked up in Table 5.3 of MARSSIM) corresponding to alpha and beta error rates of 0.05 and a relative shift of 10.3 is 9.

4.5.2 Structure Surfaces Gross Alpha Scan Survey

Portable survey meters consisting of gas proportional detectors (Ludlum Model 43-68) coupled to alpha/beta scaler instruments (Ludlum Model 2360) are used wherever possible to perform scans (to identify elevated areas of alpha activity). Whenever the structure is too small or inaccessible for a gas proportional detector, surveys of gross gamma activity are performed using a 2-inch by 2-inch sodium iodide (NaI) detector (Ludlum Model 44-10) coupled with a scaler instrument (Ludlum Model 2221)

4.5.3 Systematic Measurements of Total and Removable Alpha Contamination

Systematic sample points are marked at locations determined through the use of a random start point and an equal-distant triangular grid in accordance with MARSSIM and the DP. Static measurements are taken at each sample point location to determine the total alpha contamination (in units of dpm/100cm^2). Smear samples representing 100cm^2 areas are also collected at the same sample point location to assess removable alpha contamination (in units of dpm/100cm^2). The smear samples are sent to Outreach for laboratory analysis.

For small embedded structures, static counts are taken to determine total alpha contamination (in units of dpm/100cm^2) at biased locations (highest scan result) when possible. Smear samples representing 100 cm^2 areas are also collected at the same sample locations and counted for removable alpha contamination by Outreach. In areas such as the interiors of small diameter piping, the gas proportional detectors typically can not be used for static measurements; therefore, only smear samples are taken to assess the removable alpha contamination.

4.6 BCM Unit Survey Protocol

4.6.1 Minimum Number of Samples Determination

The estimate of sigma used for the Thorium Remediation Project is based on an estimate of the variance of Th-232 activity concentrations of core composite samples of 4.4. Using the DCCL value of 31.1 pCi/g of Th-232, and a LBGR of 31.1/2, Δ is equal to 31.1 - 15.55, or 15.55. Delta divided by the sigma of 4.4 results in a relative shift of 3.5. The corresponding minimum number of samples looked up in Table 5.3 of MARSSIM is 9.

4.6.2 BCM Unit Gross Gamma Scan Survey

Portable survey meters consisting of 2-inch by 2-inch sodium iodide (NaI) detectors (Ludlum Model 44-10) coupled with scaler instruments (Ludlum Model 2221) are used to perform gross gamma scans (to identify elevated areas) for each 2-foot lift of placed BCM. Typically, the portable survey meters are also coupled to a GPS unit and a data logger to provide electronic

downloads of coordinates and associated gross gamma count rates in units of counts per minute (cpm).

Per Section 5.3.3 of MARSSIM, scanning is used to identify locations within the survey unit that exceed the investigation level. For Class 1 survey units, the investigation level is the derived concentration guideline elevated measurement criteria ($DCGL_{EMC}$) value for the area scanned. The $DCGL_{EMC}$ values applicable to the BCM survey units are calculated by multiplying the ADCL by the area factors presented in **Chapter 3.0.** $ADCL_{EMC}$ values are also presented in **Chapter 3.0.**

The scan MDC and the scanning thresholds in measurement units of net counts per minute (ncpm) are calculated in accordance with MARSSIM and NUREG-1507. These values are summarized below in **Table 4-6** for a maximum background of 50,000 cpm and increasing survey areas (A). The first line (A = 0.25 m^2) is the default area used to demonstrate the calculation of scan MDC and the derivation of the conversion factor (CF in units of pCi/g or μR/h) in NUREG-1507. However, surveys of an area this small are not applicable to final status, open land area surveys. The increasing areas presented in the table correspond to the approved area factors (DP) and result in scan thresholds for detection of both elevated areas (Fail $DCGL_{EMC}$) and complete surveys units with activity concentration greater than the $DCGL_W$ (Fail $DCGL_W$). The CFs for increasing areas were derived using the identical inputs of the NUREG-1507 derivation changing only the area.

In addition to the derived scan thresholds, scan data are evaluated against empirical data gathered in the field. For example, soil samples are collected at biased locations (highest scan count rate) and screened on site for Th-232 activity concentration corresponding to the high count rate. All of these factors (derived thresholds, empirical thresholds, and biased samples) are used to identify elevated areas and to release the survey unit for final sampling. The threshold values provided are theoretical, depend on counting geometry and other factors that cannot be controlled in the field, and are used to aid identifying elevated areas that may require additional remediation or application of the elevated measurement comparison.

Table 4-6 – BCM Scan MDC and Threshold Values

A Area (m^2)	$ADCL_{EMC}$ (pCi/g)	B (cpm)	CF (pCi/g / mR/h)	Scan MDC (pCi/g)	Fail $ADCL_{EMC}$ (ncpm)	Fail DCCL (ncpm)
0.25	N/A	150,000	0.99	7.0	N/A	26,074
1	87.5	150,000	0.62	4.3	118,016	41,946
3	43.4	150,000	0.51	3.6	70,495	50,516
10	31.1	150,000	0.46	3.3	55,808	55,808
30	31.1	150,000	0.45	3.1	57,924	57,924
100	31.1	150,000	0.44	3.1	59,034	59,034
300	31.1	150,000	0.43	3.1	59,602	59,602
1000	31.1	150,000	0.43	3.0	59,938	59,938
3000	31.1	150,000	0.43	3.0	60,118	60,118

4.6.3 BCM Unit Systematic Soil Core Sampling

Upon completion of the placement of a BCM unit, systematic soil core samples are collected at locations determined through the use of a random start point and an equal-distant triangular grid in accordance with MARSSIM and the DP. Soil core sample locations are demarcated in the field using a GPS unit. Soil core samples are collected through the entire layer of placed BCM. It should be noted that the entire length of each soil core from a BCM survey unit may not equal the total depth of the placed BCM due to the following:

- The bottom surface (grade) of each excavation bottom unit may not be level when a BCM unit is placed.
- The top surface of BCM in a unit may not be level based upon the site's final grade plan relative to maintaining the minimum 10 feet of clean cover soil.
- BCM units are placed in 2 foot lifts with sloping side walls. As a result, succeeding lifts become smaller in surface area (a core sample point may fall on the unit's sloped side walls).

Core segments of BCM (typically 3 feet in length) are scanned in the field in 1-foot increments. Each one foot increment is also characterized by a 1-minute static count of gross gamma activity. A composite sample representing each core segment is then prepared by combining each set of three 1-foot increments in a bucket and breaking up the cores. The final segment of core may be less than or greater than 3 feet depending on the point at which virgin material is encountered. A sample (usually between 500 and 800 grams) is taken from each composite and forwarded to Outreach for analysis of Th-232 activity concentration.

5.0 SUMMARY OF FINDINGS

This chapter of Volume I of the Final Status Survey Report presents a summary of the final status survey findings and an overall summation of fractions for each Pond Parcel excavation bottom survey unit.

5.1 Structural Surfaces - Survey Unit Kaiser-FSS-001

Final status survey activities for Survey Unit Kaiser-FSS-001, an "embedded" structure (buried concrete spillway), consisted of a gross gamma scan of the exposed concrete surface of the survey unit and systematic measurements of total and removable alpha contamination. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan of the concrete surface did not indicate the presence of small areas of elevated activity (greater than the scan MDC).
- Nine of the 36 systematic measurements of total alpha contamination were greater than the DCGL-GA of 944 dpm/100cm^2. A spatial independence review of the data revealed the presence of 2 elevated areas of total alpha contamination; therefore, two elevated measurement comparisons were required for this unit.
- All 36 smear sample results were below the DCGL-GA of 94.4 dpm/100cm^2 for removable alpha contamination.
- The total alpha contamination results meet the DP statistical criterion based on the third statistical evaluation of the data (WRS Test procedure).

A summary of the final status survey results by survey unit is provided below in Table 1.

5.2 Open Land Areas - Survey Units Kaiser-FSS-002 through Kaiser-FSS-024

Final status survey activities for open land areas Survey Units Kaiser-FSS-002 through Kaiser-FSS-024 consisted of a gross gamma scan of the exposed surface soil of each survey unit (excavation bottom and side walls, if present) and systematic soil sampling. The results of the final status survey activities were as follows:

- With the exception of Survey Units Kaiser-FSS-013, Kaiser-FSS-014, Kaiser-FSS-016, and Kaiser-FSS-020, the 100 percent coverage gamma scan (final as-left condition) for each survey unit did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- The systematic soil sample analytical results (net) for each survey unit were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The systematic soil sample analytical results for each survey met the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- Elevated areas were left in-place for Survey Units Kaiser-FSS-013, Kaiser-FSS-014, Kaiser-FSS-016, and Kaiser-FSS-020; therefore, elevated measurement comparisons were required for these units.
- Embedded structures were encountered and left in-place for Survey Units Kaiser-FSS-007, Kaiser-FSS-010, Kaiser-FSS-013, Kaiser-FSS-014, and Kaiser-FSS-015.

A summary of the final status survey results by survey unit is provided below in **Table 1.**

Of the 6 remaining open land area survey units for the pond parcel (Survey Units Kaiser-FSS-025 through Kaiser-FSS-030) it should be noted that remediation and final status survey sampling have been completed for 4 of those units (Kaiser-FSS-027 through Kaiser-FSS-030). Soil screening values and/or analytical laboratory results for all systematic soil samples for each survey unit were below the $DCGL_W$. In addition, no elevated areas were left in-place, therefore, no elevated measurement comparisons will be required for these units. Kaiser anticipates that the remediation and final status survey sampling results for Survey Units Kaiser-FSS-025 and Kaiser-FSS-026 will also meet the DP acceptance criteria. The results of the final status surveys for the remaining 6 Pond Parcel excavation bottom survey units will be documented in an addendum to this **Final Status Survey Report** to be submitted at the end of the remediation project.

5.3 Sum of Fractions

To evaluate the status of each survey unit prior to backfill with either BCM or clean import borrow material, as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the each survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 1** by survey unit. The sum of fractions is a very conservative assessment of the survey unit. Summing the fractions ensures the survey unit will be a small fraction of 25 mrem/yr (the release criteria) when the actual as-left dose assessment is complete. The results of the Sum of Fractions assessment show that Survey Units Kaiser-FSS-001 through Kaiser-FSS-0024 meet the DP acceptance criteria. Kaiser anticipates that the Sum of Fractions assessment will also show that Survey Units Kaiser-FSS-025 through Kaiser-FSS-030 meet the DP acceptance criteria.

Table 1 – Pond Parcel Excavation Final Status Survey Summary by Survey Unit

Survey Unit	Surface Area (m^2)	No. of Systematic Samples Collected	Systematic Sample Exceedance of DCGL Value	WRS Test Criterion Met	Elevated Area(s) Present	Embedded Structure(s) Present	Total Sum of Fractions	Survey Unit Meets DP Acceptance Criteria
Kaiser-FSS-001*	84.5	36	YES	YES	YES	N/A	0.99	YES
Kaiser-FSS-002	126.5	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-003	80	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-004	107	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-005	35	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-006	2,670	12	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-007	1,182	16	NO	YES	NO	YES	0.04	YES
Kaiser-FSS-008	424	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-009	1,000	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-010	986	10	NO	YES	NO	YES	0.00	YES
Kaiser-FSS-011	2,400	12	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-012	2,460	12	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-013	1,320	10	NO	YES	YES	YES	0.38	YES
Kaiser-FSS-014	1,892	10	NO	YES	YES	YES	0.67	YES
Kaiser-FSS-015	1,997	10	NO	YES	NO	YES	0.18	YES
Kaiser-FSS-016	2,484	14	NO	YES	YES	NO	0.79	YES
Kaiser-FSS-017	2,230	17	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-018	1,582	10	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-019	1,582	10	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-020	1,570	9	NO	YES	YES	NO	0.19	YES
Kaiser-FSS-021	1,985	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-022	1,840	9	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-023	1,750	10	NO	YES	NO	NO	0.00	YES
Kaiser-FSS-024	1,454	10	NO	YES	NO	NO	0.00	YES

* Survey Unit Kaiser- FSS-001 is the buried concrete spillway structure. The other pond parcel survey units are defined as open land areas.

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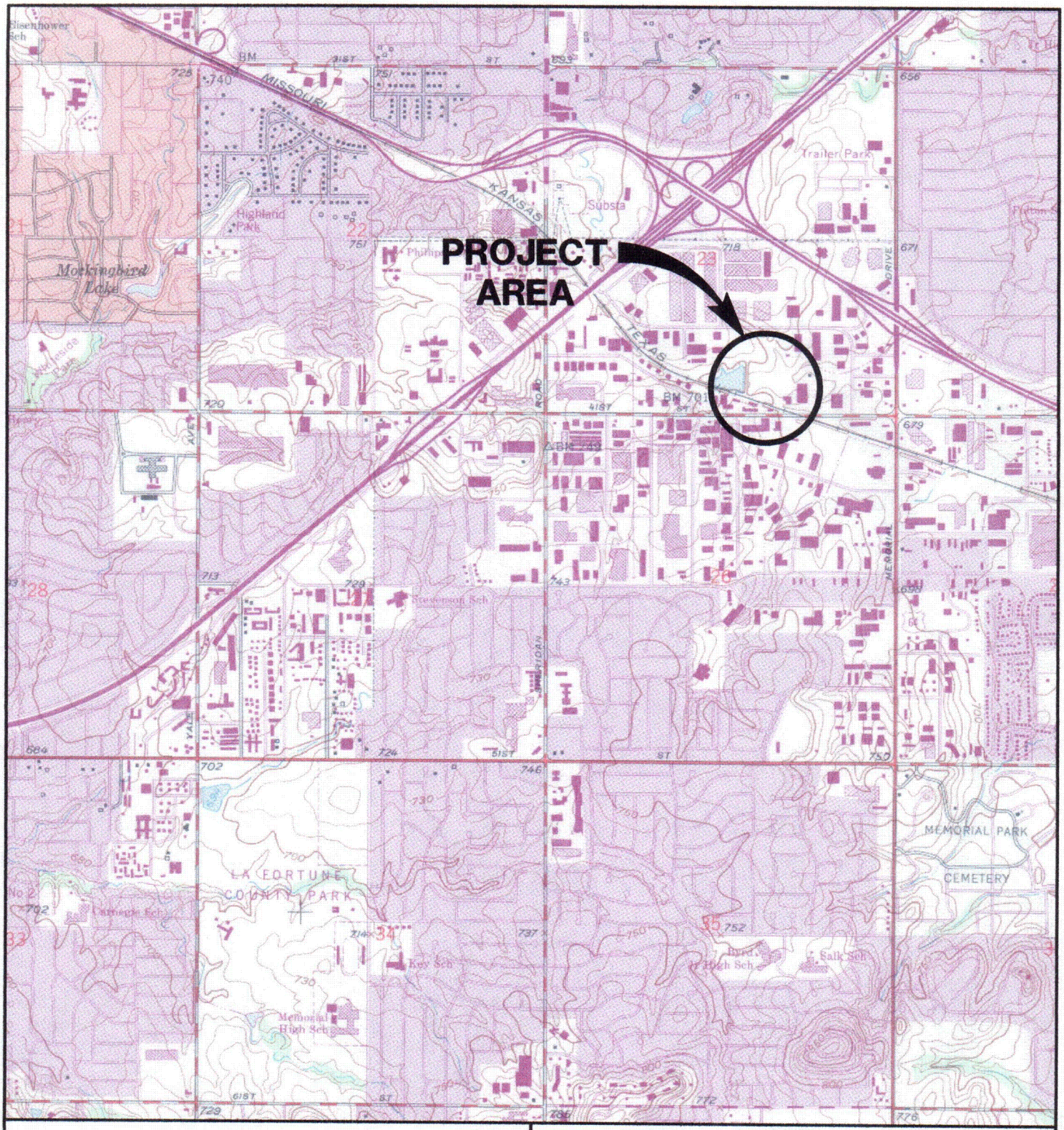

N

SCALE – FEET

0 2000

REFERENCE
USGS 7.5-MIN TOPOGRAPHIC QUADRANGLE
JENKS, OK
DATED 1952, PHOTOREVISED 1982
SCALE 1:24000.

FIGURE 1
SITE LOCATION MAP

THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	RFD 3-3-06
CHECKED	RFD 3-3-06
DRAWN	DEB 8/17/05
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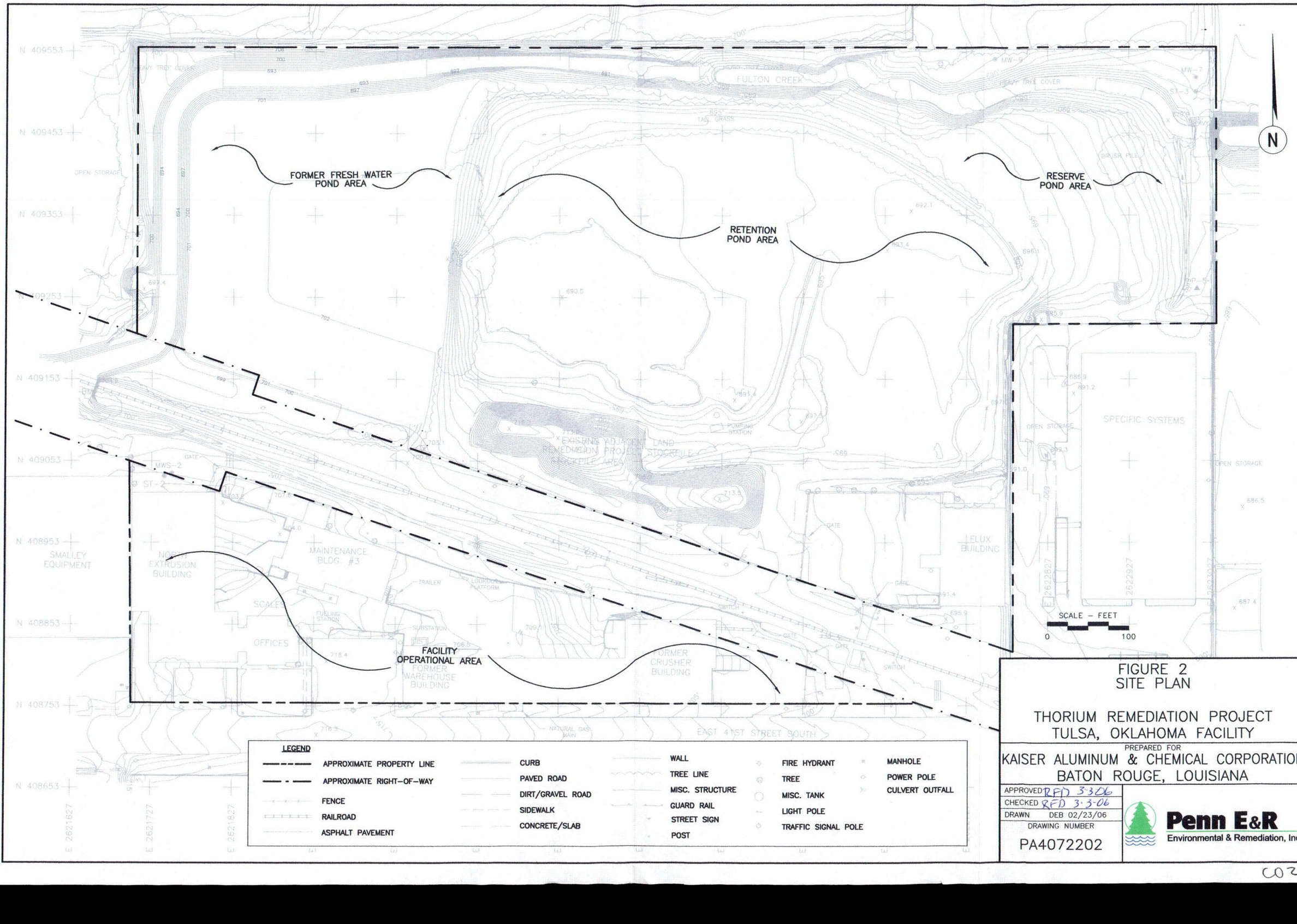
Penn E&R
Environmental & Remediation, Inc.

C01



LEGEND

- APPROXIMATE PROPERTY LINE
- APPROXIMATE RIGHT-OF-WAY
- FENCE
- RAILROAD
- ASPHALT PAVEMENT
- CURB
- PAVED ROAD
- DIRT/GRAVEL ROAD
- SIDEWALK
- CONCRETE/SLAB
- WALL
- TREE LINE
- MISC. STRUCTURE
- GUARD RAIL
- STREET SIGN
- POST
- FIRE HYDRANT
- TREE
- MISC. TANK
- LIGHT POLE
- TRAFFIC SIGNAL POLE
- MANHOLE
- POWER POLE
- CULVERT OUTFALL

FIGURE 2
SITE PLAN

THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	RFD 3-3-06
CHECKED	RFD 3-3-06
DRAWN	DEB 02/23/06
DRAWING NUMBER	PA4072202

Penn E&R
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C02

FSS-006
FSSB-002
FSS-022
FSS-021
FSSB-009
FSS-017
FSSB-006
FSS-015
FSSB-004
FSS-024
FSSB-011
FSS-023
FSSB-010
FSSB-003
FSS-014
FSS-018
FSS-016
FSS-011
FSSB-001
FSS-025
FSS-026
FSS-010
FSS-028
FSSB-007
FSS-013
FSSB-005
FSS-027
FSSB-012
FSS-019
FSSB-008
FSS-009
FSS-012
FSS-008
FSS-005
FSS-001
FSS-002
FSS-004
FSS-003
FSS-007
KAISER-FSSFOA-001
KAISER-FSSFOA-004
KAISER-FSSFOA-003
KAISER-FSSFOA-002
KAISER-FSSFOA-007
KAISER-FSSFOA-008
FSS-030
FSS-029
FSS-020
KAISER-FSSFOA-006
KAISER-FSSFOA-009
KAISER-FSSFOA-005
N 409553
N 409453
N 409353
N 409253
N 409153
N 409053
N 408953
N 408853
N 408753
N 408653
E 2621627
E 2621727
E 2621827
E 2621927
E 2622027
E 2622127
E 2622227
E 2622327
E 2622427
E 2622527
E 2622627
E 2622727
N
SCALE – FEET
0
100
COMPLETED EXCAVATION BOTTOM FINAL STATUS SURVEY UNIT (FSS AND FSSFOA)
COMPLETED BCM FINAL STATUS SURVEY UNIT (FSSB)
PLANNED EXCAVATION/FINAL STATUS SURVEY UNIT (FSS)

FIGURE 3
FINAL STATUS SURVEY UNIT LAYOUT

THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	3-17-06
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SUB-REPORT

SURVEY UNIT KAISER-FSS-001

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ATTACHMENTS

ATTACHMENT A: Figure A-1 Gross Gamma Scan Grid Layout
Figure A-2 Gross Gamma Scan Background Results
Figure A-3 Gross Gamma Scan Results
Figure A-4 Systematic Sampling Locations

ATTACHMENT B: Survey Unit Worksheet No. 1
Survey Unit Worksheet No. 2

ATTACHMENT C: Figure C-1 Elevated Areas
Elevated Measurement Comparison Worksheet
Total Alpha Contamination Survey Data Conversion Form

ATTACHMENT D: Laboratory Analytical Results

ATTACHMENT E: Microshield Output File

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-001
Survey Unit Kaiser-FSS-001
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-001, an "embedded" structure (buried concrete spillway) encountered during the removal of radiologically-affected soil from the southwest corner of the Retention Pond area. The survey unit is bounded to the south by the Union Pacific Railroad right-of-way, to the east by Survey Unit Kaiser-FSS-002, to the north by Survey Unit Kaiser-FSS-008, and to the west by the former freshwater pond non-impacted area (**Figure 3**).

Survey Unit Kaiser-FSS-001 consists of the concrete spillway's structural surface. It is considered a Class 1 survey unit with an approximate surface area of 84.5 m^2. This survey unit is unique for the following reasons:

- The concrete spillway's structural surface was located significantly below grade after the excavation of impacted soil within the unit.
- The concrete spillway's structural surface was damp in places making it difficult to scan for gross (total) alpha activity; therefore, a scan of gross gamma activity was performed and the results converted to units of total alpha contamination.
- The concrete spillway's structural surface exhibited several elevated areas greater than the DCGL-GA (derived concentration guideline value for total alpha contamination).
- Clean import borrow material (soil) was placed over the concrete spillway's structural surface after the final survey was complete.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the structural surface of the "embedded" concrete spillway. The final status survey consisted of a gross gamma scan of the concrete surface and systematic measurements of total and removable alpha contamination.

2.1 Gross Gamma Scan of Structural Surface

The structural surface of the concrete spillway was located below grade in an open excavation and parts of the structural surface remained damp during final survey activities. As such, the exposed concrete surface of the Class 1 survey unit was surveyed through a 100 percent coverage gross gamma scan, in lieu of a gross (total) alpha scan, to confirm acceptable radiological conditions and identify any elevated areas. The concrete surface was divided into 2-meter by 2-meter grids for recording the results of the 100 percent coverage gross gamma scan **(Figure A-1, Attachment A)**. During the scan, the detector was held close to the concrete surface (1 – 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the concrete surface at 5 approximately equal-distant locations within the survey unit. The statistics for the 5 background measurements are provided below in **Table 1.** Background measurements ranged from 34,340 counts per minute (cpm) along the south splash wall of the spillway to 78,463 cpm along the northern survey unit boundary (close to the impacted soil located adjacent to the spillway).

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 19 sets of minimum, maximum, and average gross gamma scan rates were recorded for each 2-meter by 2-meter grid across the survey unit's 84.5 m^2 surface area. The average scan results ranged from 28 to 68 thousand counts per minute (kcpm) and generally increased due to proximity to the impacted material located north of the survey unit. The results are presented below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Grid	Scan Minimum (kcpm)	Scan Maximum (kcpm)	Scan Average (kcpm)	Background (cpm)
A1 (floor)	28	35	32	
A2 (floor)	62	72	65	
B1 (floor)	32	48	43	38,736
B2 (floor)	37	51	43	
C1 (floor)	42	52	46	
C2 (floor)	47	63	54	60,746
D1 (floor)	20	46	35	
D2 (floor)	52	69	65	
E1 (floor)	30	42	36	56,530
E2 (floor)	40	82	65	
F1 (floor)	32	42	37	
F2 (floor)	42	75	68	78,463
G1 (floor)	30	54	43	
A1 (wall)	35	48	42	
B1 (wall)	35	47	38	

Grid	Scan Minimum (kcpm)	Scan Maximum (kcpm)	Scan Average (kcpm)	Background (cpm)
C1 (wall)	32	45	36	
D1 (wall)	22	36	28	34,340
E1 (wall)	20	35	30	
Average	*36*	*53*	*45*	*53,763*
Standard Dev.	*11*	*14*	*13*	*17,816*
Median	*35*	*48*	*43*	*56,530*
Minimum	*20*	*35*	*28*	*34,340*
Maximum	*62*	*82*	*68*	*78,463*

Maps of the gross gamma background and average gross gamma scanning survey results are presented in **Attachment A, Figures A-2 and A-3** respectively. No small areas of elevated activity were identified during the gamma scan of the concrete surface.

2.2 Systematic Measurements of Total and Removable Alpha Contamination

The final status survey also consisted of systematic measurements of total and removable alpha contamination based on a random start point and an equal-distant triangular grid. Although portions of the concrete spillway were damp, precluding a gross alpha scan of the entire structure, small dry flat areas were available within the survey unit for collecting systematic measurements of total and removable alpha contamination.

Since the DCGL values for total and removable contamination contained in the DPA have been revised (and approved by the NRC), the minimum number of sample points for measurement of total and removable alpha contamination has been recalculated. In addition, the minimum number of sample points has been adjusted based on the minimum detectable concentration of total alpha contamination achievable by the gross gamma scan of the concrete surface.

2.2.1 Determination of the Minimum Number of Sample Points (N)

Paramount to determining the minimum number of sample points is the determination of the relative shift, delta over sigma (Δ/σ). Delta is equal to the difference between the DCGL and the lower-bound gray region (LBGR) value. The LBGR value is arbitrarily set at one-half the DCGL value to start the determination. Sigma is an estimate of the variability in a set of sample analysis results from a survey unit. The estimate of sigma used in the determination is based on the standard deviation of a set of total alpha contamination results from the final status survey of the Flux Building (Survey Unit FB-001 Floor Surface: 45.9). Since the gross (total) alpha activity concentration of 944 dpm/100cm^2 is the revised DGCL-GA, Δ is equal to 944 - 472, or 472. Delta divided by the sigma of 45.9 results in a relative shift of 10.3. The minimum number of samples (looked up in Table 5.3 of MARSSIM) corresponding to alpha and beta error rates of 0.05 and a relative shift of 10.3 is 9.

Since a gross gamma scan of the concrete spillway was necessary, the Minimum Detectable Concentration (MDC) of the 2-inch by 2-inch sodium iodide (NaI) detector, in units of total contamination (dpm/100cm^2) was calculated as follows:

1. The Minimum Detectable Count Rate (MDCR) based on the gross gamma background count rate was determined in accordance with the DP as follows:

$$MDCR = s_i\left(\frac{60}{i}\right)$$

$$s_i = d'\sqrt{b_i}$$

where s_i (counts) is the minimal number of net source counts required for a specified level of performance for the counting interval i (seconds); d' is the index of sensitivity; and b_i is the number of background counts in the interval. Index of sensitivity d' values are listed in MARSSIM Table 6.5 based on the proportions for required true positive and tolerable false positive occurrence rates. The index of sensitivity value selected for initial use at the Tulsa facility is 1.38, corresponding to a true positive proportion of 0.95 and a false positive proportion of 0.60. While this index of sensitivity value will result in at least 95 percent "correct" scanning detections as required by the Tulsa facility DQO for Type I error control, up to 60 percent "incorrect" (false positive) scanning detections may occur.

2. The Minimum Detectable Count Rate of the Surveyor ($MDCR_S$) was calculated in accordance with the DP as follows:

$$MDCR_S = \frac{MDCR}{\sqrt{p\varepsilon}}$$

where $MDCR$ is the minimum detectable count rate (cpm); p is the surveyor efficiency (estimated in MARSSIM to be between 0.5 and 0.75; the value of 0.5 results in a more conservative $MDCR_S$ calculation and, therefore, will be used); and ε is the instrument efficiency (830 cpm per µR/hr for Th-232 in equilibrium with progeny; Table 6.4 of NUREG-1507).

3. The resulting MDC value in units of µR/hr was converted to pCi/g of Th-232 using a conversion factor (CF) of 45.8 pCi/g / µR/hr derived in accordance with MARSSIM and NUREG-1507 using Microshield and the following inputs: Th-232 (10 pCi/g) in equilibrium with all progeny, and a 0.1 cm thick layer of contamination on the surface of concrete. The Microshield output file for a 0.1 cm thick concrete cylinder is provided in **Attachment E.**

4. The resulting MDC value (pCi/g) was converted to Equivalent Total Contamination (MDC-ETC) in units of dpm/100cm^2 using the following formula and again assuming a 0.1 cm thick layer of Th-232 surface contamination and a concrete density of 2.35 g/cm^3:

MDC-ETC (dpm/100cm^2) = MDC (pCi/g) x 2.35 g/cm^3 x 2.22 dpm/pCi x 0.1 cm x 100

The resulting MDC-ETC in units of dpm/100cm^2 can then be used to determine if additional samples are needed (in accordance with the DP) by dividing the MDC-ETC value by the

DCGL-GA value (944), both in units of dpm/100cm^2, to determine the area factor. The size of an area of elevated radioactivity corresponding to this area factor is interpolated from the table of area factors and divided into the survey unit area to determine the alternate number of sample locations. These calculations are summarized below in **Table 2** for increasing gross gamma background count rates.

Table 2 – Gross Gamma Scan MDC and Corresponding N Summary[1]

b_i background count rate (cpm)	MDCR (cpm)	Scan MDCR$_S$ (μR/hr)	Scan MDC (pCi/g)	MDC-ETC (dpm/100cm^2)	Corres-ponding Area Factor	Corres-ponding Area (m^2)	Number of Samples N* (-)
20,000	2,138	2.58	118	6,154	6.52	16.1	6
50,000	3,380	4.07	186	9,730	10.31	9.73	10
95,000	4,659	5.61	257	13,412	14.2	7.40	14
100,000	4,780	5.76	264	13,761	14.6	7.21	14
105,000	4,899	5.90	270	14,100	14.9	7.03	14
110,000	5,014	6.04	276	14,432	15.3	6.86	15
115,000	5,126	6.18	283	14,757	15.6	6.70	15
120,000	5,237	6.31	289	15,074	16.0	6.54	15
125,000	5,345	6.44	295	15,385	16.3	6.39	16

* Number of sample points required in a maximum 100 m^2 Class 1 survey unit.
[1] These calculations were performed in an Excel Worksheet and may lead to rounding differences using a calculator.

The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 15 (corresponding to the maximum background count rate of 120,000 cpm) as documented on Survey Unit Worksheet No. 1 (**Attachment B**). However, the number of sample points used for the survey unit was 36. The Survey Unit Area (A) of 84.5 m^2 along with the N of 36 were used to calculate the Triangular Grid Node Length (L) of 1.6 meters and the Height of the Equilateral Triangle (h) of 1.4 meters. A random start point was generated using the random number feature of Excel and documented on Survey Unit Worksheet No. 2 (**Attachment B**).

2.2.2 Total and Removable Alpha Contamination Measurement Results

A layout of the total and removable alpha contamination measurement locations is provided on **Figure A-4** contained in **Attachment A**. At each of the 36 locations, a measurement (static count with a gas proportional detector) of total alpha contamination (identified as MARSSIM-001 through MARSSIM-036) and a smear sample for determination of removable alpha contamination (identified as K-SS-001 through K-SS-036) were collected on the concrete surface. The smear samples were forwarded to Outreach for analysis of alpha activity (per the 100 cm^2 surface area sampled). Total alpha contamination measurement results are provided below in **Table 3**.

Table 3 – Systematic Total Alpha Contamination Measurement Results

Sample ID	DCGL-GA (dpm/100cm^2)	Total Contamination (dpm/100cm^2)	Std. Error (dpm/100cm^2)	MDC (dpm/100cm^2)
MARSSIM-001	944	1,570	336	171
MARSSIM-002	944	1,860	364	171
MARSSIM-003	944	1,130	286	171
MARSSIM-004	944	3,160	471	171
MARSSIM-005	944	911	260	171
MARSSIM-006	944	1,210	297	171
MARSSIM-007	944	911	260	171
MARSSIM-008	944	268	153	171
MARSSIM-009	944	286	157	171
MARSSIM-010	944	339	168	171
MARSSIM-011	944	946	264	171
MARSSIM-012	944	1,210	297	171
MARSSIM-013	944	500	198	171
MARSSIM-014	944	714	232	171
MARSSIM-015	944	536	204	171
MARSSIM-016	944	357	171	171
MARSSIM-017	944	304	160	171
MARSSIM-018	944	179	131	171
MARSSIM-019	944	518	201	171
MARSSIM-020	944	1,210	297	171
MARSSIM-021	944	768	240	171
MARSSIM-022	944	232	144	171
MARSSIM-023	944	107	111	171
MARSSIM-024	944	71.4	99.0	171
MARSSIM-025	944	268	153	171
MARSSIM-026	944	107	111	171
MARSSIM-027	944	268	153	171
MARSSIM-028	944	53.6	92.6	171
MARSSIM-029	944	143	121	171
MARSSIM-030	944	2,050	382	171
MARSSIM-031	944	232	144	171
MARSSIM-032	944	304	160	171
MARSSIM-033	944	500	198	171
MARSSIM-034	944	821	247	171
MARSSIM-035	944	714	232	171
MARSSIM-036	944	214	140	171
Average		***694***		
Standard Dev.		***662***		
Minimum		***53.6***		
Maximum		***3,160***		
Median		***500***		

Nine of the 36 total alpha contamination measurements exceeded the DCGL-GA of 944 dpm/100cm^2. The maximum total alpha contamination was 3,160 dpm/100cm^2. The average total alpha contamination was 694 dpm/100cm^2.

The standard deviation of the 36 equal-distant samples was 662, greater than the estimated standard deviation of 45.9 (based on the Flux Building Survey Unit FB-001 final status survey results) used to calculate the minimum number of samples (N) required. Using the observed standard deviation of 662 and the same methodology to determine N as presented in **Section 2.2.1** above, a relative shift of 0.7 results. The N from Table 5.3 (MARSSIM) corresponding to a relative shift of 0.7 is 61 for a 100 m^2 survey unit. For Survey Unit Kaiser-FSS-001 (84.5 m^2), N would be 51.5. However, the values of N provided in MARSSIM Table 5.3 are increased 20% to account for unusable or lost data during surveys and achieve the desired power level for statistical tests (MARSSIM Section 5.5.2.2, Contaminant Present in Background – Determining Number of Data Points for Statistical Tests). Adjusting the value of 51.5 for the 20% buffer results in a N of 41. Since only 36 sample points were used to complete the survey, a review of the variability in the total alpha contamination results was conducted to ensure an adequate number of data points were used and that the Data Quality Objectives selected for the final survey were met.

In accordance with Section 8.2.4 of MARSSIM (Verify the Assumptions of the Test), the spatial independence of the total alpha contamination data was reviewed. As shown in **Attachment C, Figure C-1**, two distinct populations of total alpha contamination results are present. The first population is the total alpha contamination results within EMC-1, a 25 m^2 elevated area located in the northern section of the survey unit. The remaining survey unit area to the south of EMC-1 is the second population. When the areas are evaluated separately, the minimum number of sample points required in each of the areas is less than the actual number of samples taken. The value of N derived for each of these areas is based on the DCGL for the area and the standard deviation of the samples taken within the area. **Table 4** presents a statistical summary for the two distinct areas. Since the number of data points used for each distinct area exceeds the minimum number required, the data quality objectives of the survey design are upheld.

Table 4 – Evaluation of Data Variability and Minimum Number of Samples

Parameter	Survey Unit Kaiser-FSS-001	EMC-1	Remaining Area of Survey Unit Kaiser-FSS-001
Average (dpm/100cm^2)	694	1,468	436
Standard Deviation (dpm/100cm^2)	662	700	403
Median (dpm/100cm^2)	500	1,214	304
Minimum (dpm/100cm^2)	53.6	911	53.6
Maximum (dpm/100cm^2)	3,160	3160	2053
Number of Samples	36	9	27
DCGL-GA (dpm/100cm^2)	944	3,830	944
Relative Shift	0.7	2.7	1.2
Area (m^2)	84.5	25	59.5
N	61	10	24
N (< 20%)	41*	8	19

* The value of N for Survey Unit Kaiser-FSS-001 has also been adjusted for area (84.5 / 100). The values of N for the other two areas have been adjusted only for the 20% buffer allowed by MARSSIM.

Analytical results of the smear samples are provided below in **Table 5**. The analytical data report is contained in **Attachment D**.

Table 5 – Systematic Removable Alpha Contamination Smear Sample Results

Sample ID	DCGL-GA (dpm/100cm^2)	Removable Contamination (dpm/100cm^2)	Std. Error (dpm/100cm^2)	MDC (dpm/100cm^2)
MARSSIM-001	94.4	2.10	1.11	0.437
MARSSIM-002	94.4	2.78	1.30	0.577
MARSSIM-003	94.4	2.24	1.20	0.577
MARSSIM-004	94.4	4.37	1.59	0.577
MARSSIM-005	94.4	3.02	1.41	0.724
MARSSIM-006	94.4	1.27	0.988	0.617
MARSSIM-007	94.4	2.06	1.12	0.488
MARSSIM-008	94.4	4.08	1.50	0.437
MARSSIM-009	94.4	1.05	0.906	0.577
MARSSIM-010	94.4	0.384	0.693	0.577
MARSSIM-011	94.4	0.253	0.644	0.577
MARSSIM-012	94.4	0.624	0.875	0.724
MARSSIM-013	94.4	0.611	0.797	0.617
MARSSIM-014	94.4	1.39	0.957	0.488
MARSSIM-015	94.4	0.770	0.746	0.437
MARSSIM-016	94.4	0.253	0.644	0.577
MARSSIM-017	94.4	0	0.526	0.577
MARSSIM-018	94.4	0.917	0.868	0.577
MARSSIM-019	94.4	1.02	0.983	0.724

Sample ID	DCGL-GA (dpm/100cm^2)	Removable Contamination (dpm/100cm^2)	Std. Error (dpm/100cm^2)	MDC (dpm/100cm^2)
MARSSIM-020	94.4	0.744	0.839	0.617
MARSSIM-021	94.4	0.730	0.759	0.488
MARSSIM-022	94.4	0.904	0.790	0.437
MARSSIM-023	94.4	0.384	0.693	0.577
MARSSIM-024	94.4	1.05	0.906	0.577
MARSSIM-025	94.4	2.11	1.17	0.577
MARSSIM-026	94.4	0.360	0.795	0.724
MARSSIM-027	94.4	0.080	0.604	0.617
MARSSIM-028	94.4	0.333	0.611	0.493
MARSSIM-029	94.4	0.904	0.790	0.437
MARSSIM-030	94.4	1.31	0.977	0.577
MARSSIM-031	94.4	0.784	0.828	0.577
MARSSIM-032	94.4	3.57	1.45	0.577
MARSSIM-033	94.4	1.55	1.11	0.724
MARSSIM-034	94.4	1.67	1.09	0.617
MARSSIM-035	94.4	0.464	0.664	0.488
MARSSIM-036	94.4	5.02	1.65	0.437
Average		***1.42***		
Standard Dev.		***1.27***		
Minimum		***0***		
Maximum		***5.02***		
Median		***0.969***		

All 36 smear sample results were below the removable contamination DCGL-GA of 94.4 dpm/100cm^2 (10% of the total contamination DCGL-GA value). The maximum removable alpha contamination result was 5.02 dpm/100cm^2. The average removable alpha contamination result was 1.42 dpm/100cm^2, less than 2% of the DCGL-GA value.

2.3 Elevated Measurement Comparison Evaluation

As previously mentioned, 9 measurements of total alpha contamination exceeded the DCGL-GA for the survey unit (Sample Points MARSSIM-001, -002, -003, -004, -006, -011, -012, -020 and -030). The first 8 sample points (MARSSIM-001, -002, -003, -004, -006, -011, -012 and -020 are located in a continuous area of approximately 25 m^2 in the northern portion of the survey unit defined as EMC-1 **(Figure C-1, Attachment C)**. Sample Point MARSSIM-005 also fell within EMC-1.

The remaining elevated sample point (MARSSIM-030) is surrounded by sample points exhibiting total alpha contamination results less than the DCGL-GA. The maximum area of an elevated area not detected by 36 equal-distant sample points (triangular sample grid) in a 84.5 m^2 survey unit is 2.1 m^2 based on a circular hot spot with a diameter equal to the length (L) of the equilateral triangle used to form the sample grid (MARSSIM). The area factor and DCGL$_{EMC}$ values corresponding to an area of 2.1 m^2 are 47.3 and 44,600 dpm/100cm^2 respectively. Conservatively assuming Sample Point MARSSIM-030 represents an elevated area of 2.1 m^2, a second elevated area (EMC-2) is also defined **(Figure C-1, Attachment C)**.

The total alpha contamination results for Elevated Areas EMC-1 and EMC-2 are presented below in **Table 6.**

Table 6 - Total Alpha Contamination Results – Elevated Areas

Sample ID	Total Alpha Contamination (dpm/100cm^2)	Std. Error (dpm/100cm^2)	MDC (dpm/100cm^2)
Elevated Area EMC-1:			
MARSSIM-001	1,570	336	171
MARSSIM-002	1,860	364	171
MARSSIM-003	1,130	286	171
MARSSIM-004	3,160	471	171
MARSSIM-006	1,210	297	171
MARSSIM-011	946	264	171
MARSSIM-012	1,210	297	171
MARSSIM-020	1,210	297	171
Elevated Area EMC-2:			
MARSSIM-030	2,050	382	171

The elevated measurement comparisons are presented in **Section 3.2** of this sub-report and the Elevated Measurement Worksheet is contained in **Attachment C.**

2.4 Wilcoxon Rank Sum (WRS) Testing

The total alpha contamination results were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit total alpha contamination results meet the DP statistical criterion based on the third statistical test described below.

If the difference (3,170 dpm/100cm^2) between any survey unit total alpha contamination (3,160 dpm/100cm^2) result and any reference background area total alpha contamination result (-10.1 dpm/100cm^2) is greater than DCGL-GA (944 dpm/100cm^2), and the difference (614 dpm/100cm^2) between the average survey unit total alpha contamination (694 dpm/100cm^2) and the average reference area total alpha contamination (80.1 dpm/100cm^2) is less than the DCGL-GA (944 dpm/100cm^2), perform the Wilcoxon Rank Sum (WRS) Test to determine if the survey unit meets the release criterion. **Table 7** presents a summary of the data used to complete the WRS Test.

Table 7 – Reference Area and Survey Unit Total Alpha Contamination Results

Reference Group	Sample ID	Total Alpha Contamination (dpm/100cm^2)	Survey Unit Group	Sample ID	Total Alpha[1] Contamination (dpm/100cm^2)
R1	4	33.4	S1	MARSSIM-001	1,571
R2	5	43.2	S2	MARSSIM-002	1,857
R3	11	171	S3	MARSSIM-003	1,125

Reference Group	Sample ID	Total Alpha Contamination (dpm/100cm^2)	Survey Unit Group	Sample ID	Total Alpha[1] Contamination (dpm/100cm^2)
R4	12	50.3	S4	MARSSIM-004	3,160
R5	13	141	S5	MARSSIM-005	911
R6	14	161	S6	MARSSIM-006	1,214
R7	15	62.9	S7	MARSSIM-007	911
R8	17	102	S8	MARSSIM-008	268
R9	18	72.7	S9	MARSSIM-009	286
R10	20	92.3	S10	MARSSIM-010	339
R11	21	80.5	S11	MARSSIM-011	946
R12	22	82.5	S12	MARSSIM-012	1,214
R13	26	111	S13	MARSSIM-013	500
R14	30	92.3	S14	MARSSIM-014	714
R15	31	-10.1	S15	MARSSIM-015	536
R16	32	82.5	S16	MARSSIM-016	357
R17	34	43.2	S17	MARSSIM-017	304
R18	36	101	S18	MARSSIM-018	179
R19	37	33.4	S19	MARSSIM-019	518
R20	38	72.7	S20	MARSSIM-020	1,214
R21	39	33.4	S21	MARSSIM-021	768
R22	41	80.5	S22	MARSSIM-022	232
R23	42	92.3	S23	MARSSIM-023	107
R24	45	62.9	S24	MARSSIM-024	71.4
R25	46	151	S25	MARSSIM-025	268
R26	47	141	S26	MARSSIM-026	107
R27	53	66.4	S27	MARSSIM-027	268
R28	54	66.4	S28	MARSSIM-028	53.6
R29	56	36.2	S29	MARSSIM-029	143
R30	61	50.3	S30	MARSSIM-030	2,053
R31	67	151	S31	MARSSIM-031	232
R32	68	60.4	S32	MARSSIM-032	304
R33	73	112	S33	MARSSIM-033	500
R34	74	13.8	S34	MARSSIM-034	821
R35	75	62.9	S35	MARSSIM-035	714
R36	77	82.5	S36	MARSSIM-036	214
	Average:	***80.1***		***Average:***	***694***
	Standard Dev.	***42.4***		***Standard Dev.***	***662***
	Minimum:	***-10.1***		***Minimum:***	***53.6***
	Maximum:	***171***		***Maximum:***	***3,160***
	Median:	***76.6***		***Median:***	***500***

[1] To eliminate ties during the ranking of the reference and survey unit total alpha contamination values, greater than 3 significant values are displayed.

The null hypothesis is assumed to be true unless the WRS Test indicates that it should be rejected in favor of the alternative. The result of the hypothesis test determines whether or not the survey unit as a whole is deemed to meet the release criterion. The WRS Test was applied as outlined in the following steps.

1. Adjusted reference background area measurements were calculated by adding the DCGL-GA to each reference background area measurement.

2. The m adjusted reference background area sample measurements and the n sample measurements from the survey unit were pooled and ranked in order of increasing size from 1 to N, where N = m + n. (N =72, n = 36 and m =36)

3. If measurements were tied in rank, each of the tied values was assigned the same average rank of that group of tied measurements.

4. The ranks from the adjusted reference background measurements were summed as W_r.

5. The value of W_r was compared with the critical value given in MARSSIM Table I.4 for the appropriate values of m and n at the required Type I error decision rate ($\alpha = 0.05$). If W_r is greater than the critical value, the null hypothesis that the survey unit exceeds the release criterion was rejected.

The W_r value (sum of the ranks of the adjusted reference group values) is 1,673 exceeding the calculated critical value for n = 36 samples and $\alpha = 0.05$ of 1,460. Therefore, the null hypothesis (survey unit exceeds the release criterion) is rejected. The test is summarized below in **Table 8.**

Table 8 – Wilcoxon Rank Sum Test

Sample Number*	Total Alpha Contamination (dpm/100cm^2)	Rank
R1	977	32.0
R10	1036	53.0
R11	1025	47.5
R12	1027	50.0
R13	1055	57.0
R14	1036	53.0
R15	934	28.0
R16	1027	50.0
R17	987	35.5
R18	1045	55.0
R19	977	32.0
R2	987	35.5
R20	1017	45.5
R21	977	32.0
R22	1025	47.5
R23	1036	53.0
R24	1007	41.0
R25	1095	61.5
R26	1085	59.5
R27	1010	43.5
R28	1010	43.5
R29	980	34.0
R3	1115	64.0
R30	994	37.5
R31	1095	61.5
R32	1004	39.0
R33	1056	58.0
R34	958	30.0
R35	1007	41.0
R36	1027	50.0

Sample Number*	Total Alpha Contamination (dpm/100cm^2)	Rank
R4	994	37.5
R5	1085	59.5
R6	1105	63.0
R7	1007	41.0
R8	1046	56.0
R9	1017	45.5
S1	1571	69.0
S10	339	16.0
S11	946	29.0
S12	1214	67.0
S13	500	18.5
S14	714	22.5
S15	536	21.0
S16	357	17.0
S17	304	14.5
S18	179	6.0
S19	518	20.0
S2	1857	70.0
S20	1214	67.0
S21	768	24.0
S22	232	8.5
S23	107	3.5
S24	71	2.0
S25	268	11.0
S26	107	3.5
S27	268	11.0
S28	54	1.0
S29	143	5.0
S3	1125	65.0
S30	2053	71.0
S31	232	8.5
S32	304	14.5
S33	500	18.5
S34	821	25.0
S35	714	22.5
S36	214	7.0
S4	3160	72.0
S5	911	26.5
S6	1214	67.0
S7	911	26.5
S8	268	11.0
S9	286	13.0
	W_r:	***1,673***
	Critical Value:	***1,460***

*Presented in an increasing sample number order.

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the southwest corner of the Retention Pond area revealed the presence of an "embedded" structure (buried concrete spillway) approximately 84.5 m^2 in surface area. This "embedded" structure, identified as Survey Unit Kaiser-FSS-001 is considered a Class 1 survey unit. It is bounded to the south by the Union Pacific Railroad right-of-way, to the east by Survey Unit Kaiser-FSS-002, to the north by Survey Unit Kaiser-FSS-008, and to the west by the former freshwater pond non-impacted area (Figure 3). This section of the sub-report presents a summary of the final status survey findings, an elevated measurement comparison, and an overall summation of fractions for the survey unit.

3.1 Structural Surface - Total and Removable Alpha Contamination

The acceptance criterion for structures remaining at the Tulsa facility is the DCGL-GA of 944 dpm/100cm^2 for total alpha contamination and 94.4 dpm/100cm^2 for removable alpha contamination. Final status survey activities for Survey Unit Kaiser-FSS-001 consisted of a gross gamma scan of the exposed concrete surface of the survey unit and systematic measurements of total and removable alpha contamination. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan of the concrete surface did not indicate the presence of small areas of elevated activity (greater than the scan MDC).
- Nine of the 36 systematic measurements of total alpha contamination were greater than the DCGL-GA of 944 dpm/100cm^2. A spatial independence review of the data revealed the presence of 2 elevated areas of total alpha contamination.
- All 36 smear sample results were below the DCGL-GA of 94.4 dpm/100cm^2 for removable alpha contamination.
- The results meet the DP statistical criterion based on the third statistical evaluation of the data (WRS Test procedure).

3.2 Elevated Measurement Comparison

Consistent with MARSSIM and the DP, elevated areas and the total dose from structures are evaluated as follows. Total alpha contamination results are used to complete the elevated measurement comparison. If residual radioactivity is found in a localized area of elevated activity--in addition to the residual radioactivity distributed relatively uniformly across the survey unit--the Unity Rule is used to ensure that the release criterion has been met as follows:

$$\frac{\delta}{DCGL} + \sum_{x+1}^{n} \frac{(\delta_{EMC} - \delta)}{DCGL_{EMC}} \leq 1$$

where:

δ = is the average total alpha concentration over the entire survey unit,
δ_{EMC} = the average total alpha concentration over the elevated area (x) within the survey unit,
DCGL = the DCGL-GA,
$DCGL_{EMC}$ = (area factor for elevated area x) X (DCGL-GA),
x = refers to one of the elevated areas within the survey unit, and

n = the total number of elevated areas within the survey unit.

The calculation for Survey Unit Kaiser-FSS-001 including two elevated areas is summarized below in the **Table 9.**

Table 9 - Elevated Measurement Comparison and Fraction Summary

Sample Date	Unit / EMC unit	Unit Area (m^2)	Gross Total Alpha Contamination ($dpm/100cm^2$)	Net[1] Total Alpha Contamination ($dpm/100cm^2$)	DCGL-GA ($dpm/100cm^2$)	Fraction (-)	Sample Number
5/23/2004	FSS-001	84.5	694	694	944	0.74	1 through 36
5/23/2004	EMC-1	25	1,468	774	3,830	0.20	1, 2, 3, 4, 5, 6, 11, 12, and 20
5/23/2004	EMC-2	2.1	2,053	1,360	44,600	0.03	30

[1] Net value for Survey Unit Kaiser-FSS-001 is equal to the gross value; no background subtracted. The net value for EMC units is equal to the gross value minus the gross value for the entire survey unit.

3.3 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-001 prior to backfill with clean import borrow material, as a whole, the fraction of each survey element's average activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for total alpha contamination, removable alpha contamination, and the elevated areas is presented below in **Table 10.**

Table 10 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

Survey Unit Element	Units	Average Activity	Acceptance Criteria	Fraction
FSS-001 Total Alpha Contamination	$dpm/100cm^2$	694	944	0.74
FSS-001 Removable Alpha Contamination	$dpm/100cm^2$	1.42	94.4	0.02
EMC-1 Total Alpha Contamination	$dpm/100cm^2$	774	3,830	0.20
EMC-2 Total Alpha Contamination	$dpm/100cm^2$	1,360	44,600	0.03
TOTAL SUM OF FRACTIONS				***0.99***

The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-001 meets the DP acceptance criteria.

ATTACHMENT A
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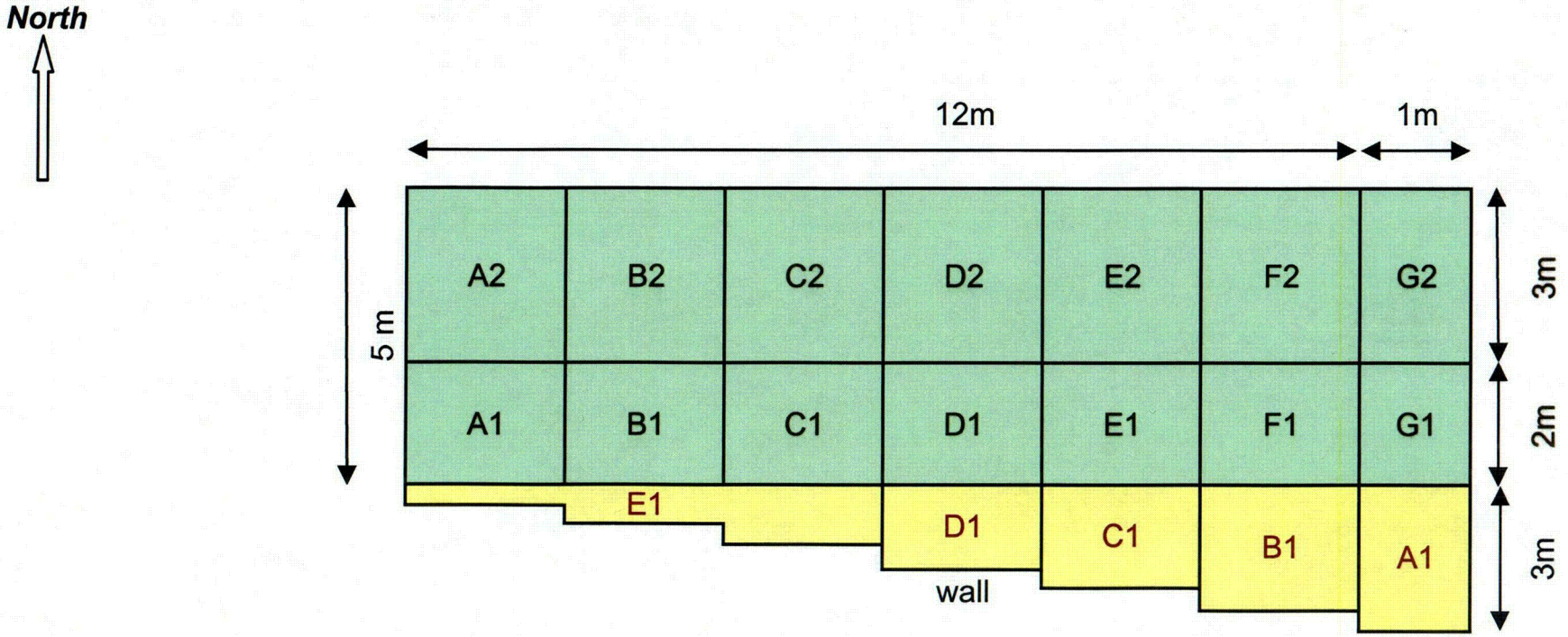
- **FIGURE A-1 Gross Gamma Scan Grid Layout**
- **FIGURE A-2 Gross Gamma Scan Background Results**
- **FIGURE A-3 Gross Gamma Scan Results**
- **FIGURE A-4 Systematic Sampling Locations**

Attachment A, Figure A-1
Gross Gamma Scan Grid Layout
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Survey Unit: Kaiser-FSS-001
Area: 84.5 m^2
Grid: 2 m x 2 m



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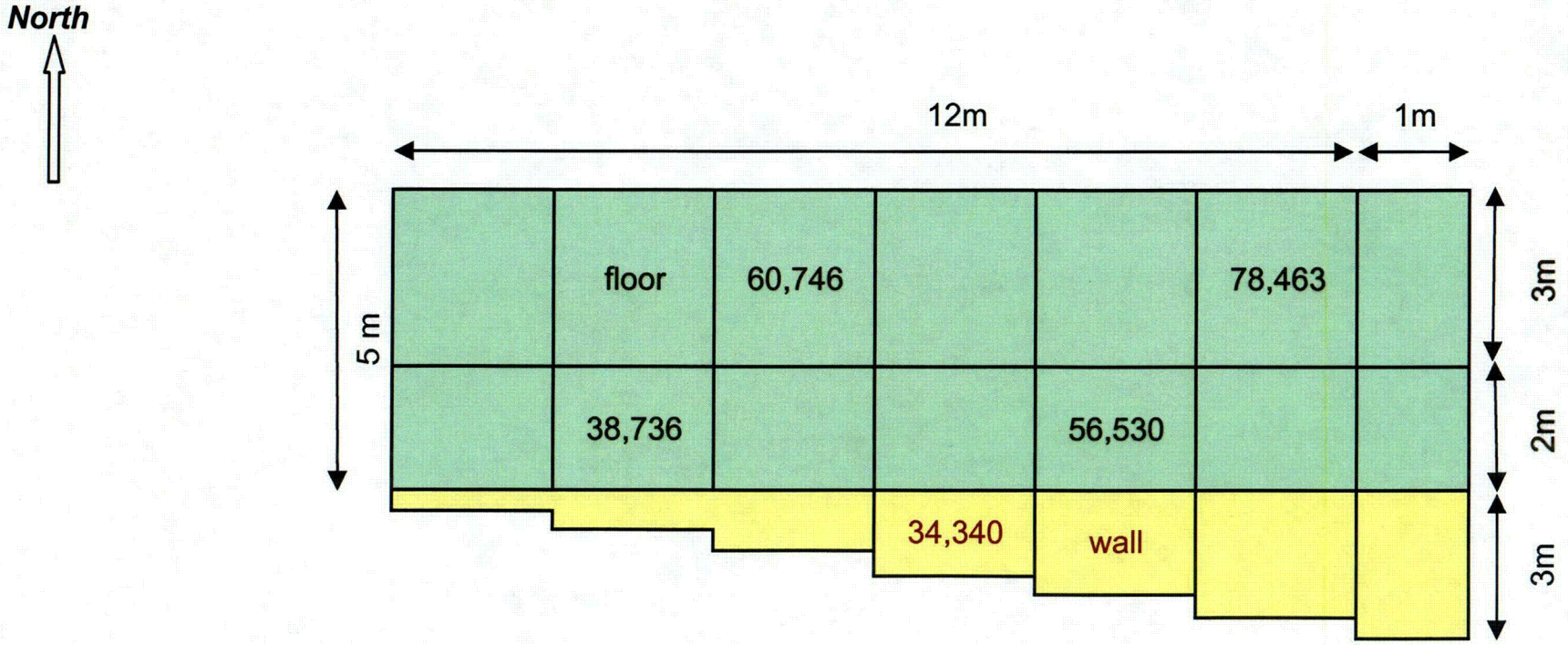
Attachment A, Figure A-2
Gross Gamma Scan Background Results
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

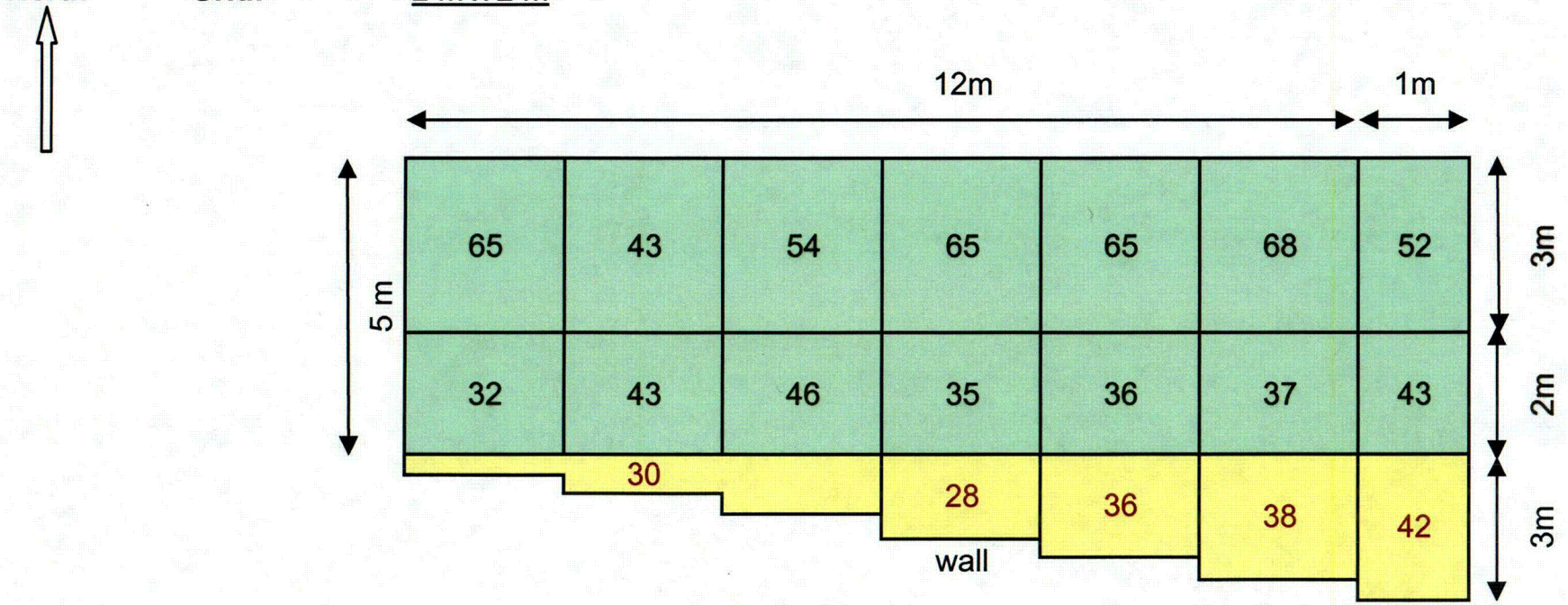
Survey Unit: Kaiser-FSS-001
Area: 84.5 m^2
Grid: 2 m x 2 m



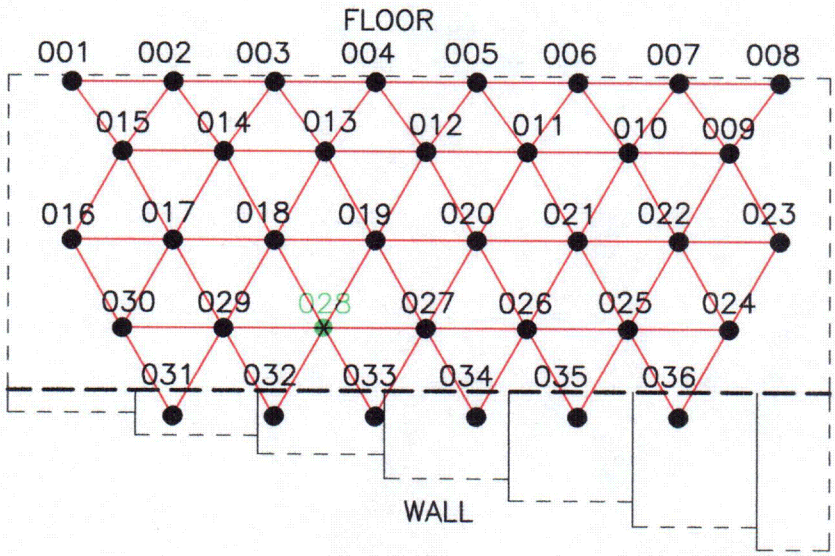
C05

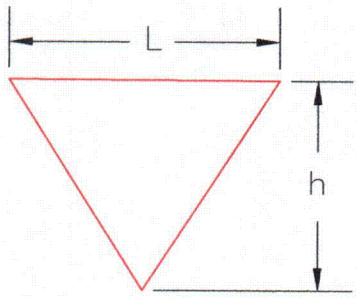
Attachment A, Figure A-3
Gross Gamma Scan Results
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Survey Unit: Kaiser-FSS-001
Area: 84.5 m^2
Grid: 2 m x 2 m

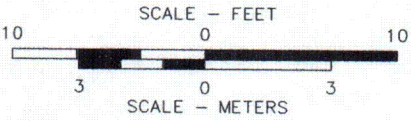


C06





N = 36
L = 1.6m
h = 1.4m
AREA = 84.5m^2



001

● SYSTEMATIC SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

028

● RANDOM START POINT

FIGURE A–4
SYSTEMATIC SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS–001
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RAD 3-3-06
CHECKED	RAD 3-3-06
DRAWN	DEB 1/9/06
DRAWING NUMBER	PA4072062

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Environmental & Remediation, Inc.

C07

ATTACHMENT B
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- **Survey Unit Worksheet No. 1**
- **Survey Unit Worksheet No. 2**

Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Structure Survey Unit: KAISER-FSS-001

2. Description: Retention Pond Area, Embedded Structure (Concrete Spillway)

3. Dimensions (m): Approximately. 13 meters x 8 meters; Area, A (m^2): 84.5

4. Alpha Background: N/A cpm MDC ($dpm/100cm^2$): N/A

Gross Gamma Scan Background Readings (cpm)
Average: 50,000 Minimum: 20,000 Maximum: 120,000

- Note: Gamma scan background only needed in structure survey units that alpha instrumentation cannot be used.

5. Gross Gamma Scan MDC (μR/hr): 6.31 ; $dpm/100cm^2$: 15,074

6. Minimum Number of Samples (N): 15 and Corresponding Triangular Grid Node Length (L) in meters: 1.6 m (based on 36 samples).

7. If the area of the survey unit floor is less than 100 m^2, recalculate the number of samples (N_l) corresponding to L that provides the same coverage in the smaller survey unit as N samples does in 100 m^2 using the following formula: $N_l = A / (0.866 \times L^2)$,
N_l: N/A

8. If N_l is less than 18, use the default N (18) and recalculate the corresponding Triangular Grid Node Length (L_l) for the survey unit floor Area (A) less than 100 m^2, using the following formula: $L_l = (A/(0.866 \times 18))^{1/2}$:
N/A m

9. Calculate the height (h) of the equilateral triangle with side length equal to L (or L_l) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 1.4 m

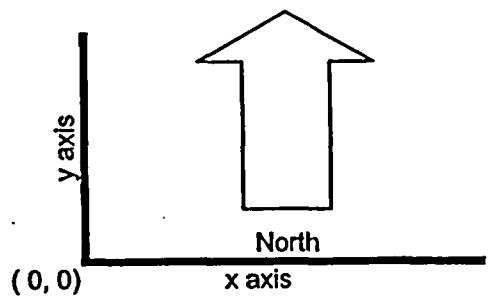
Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-001

RANDOM START POINT

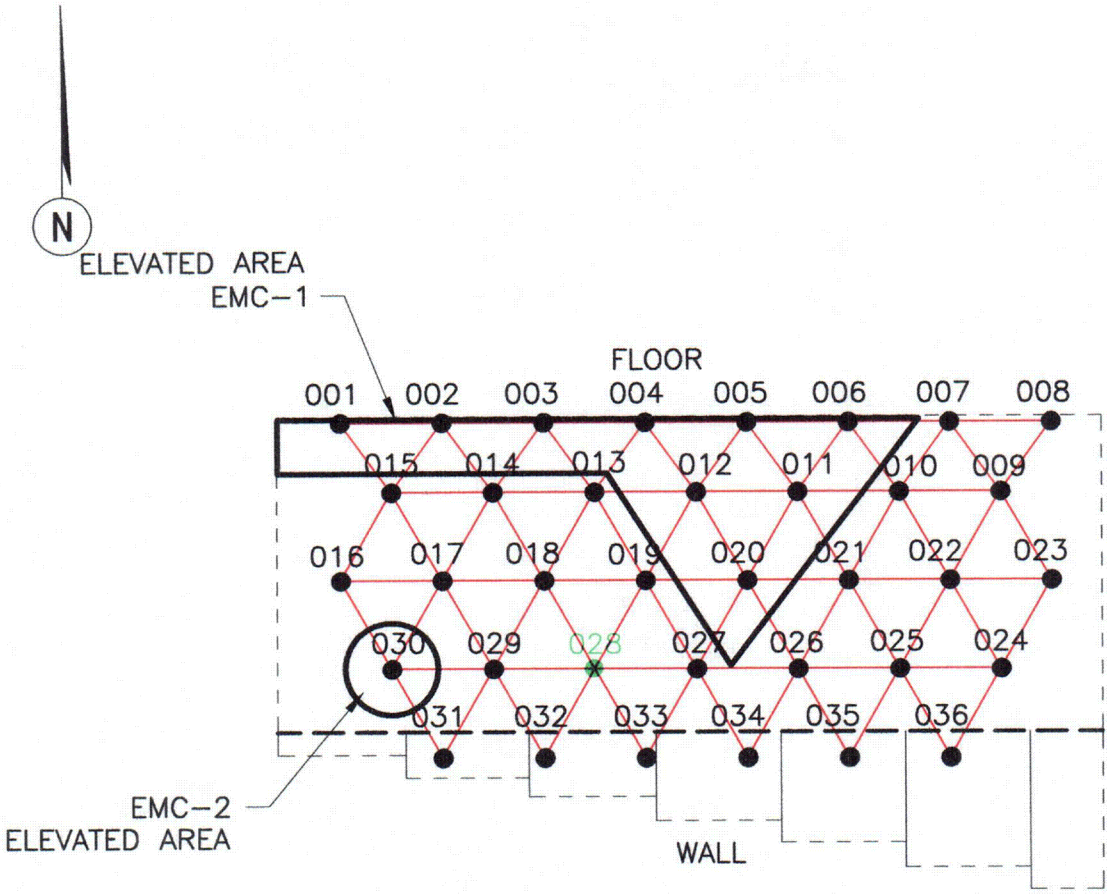
x axis (Meters)	y axis (Meters)
5	4

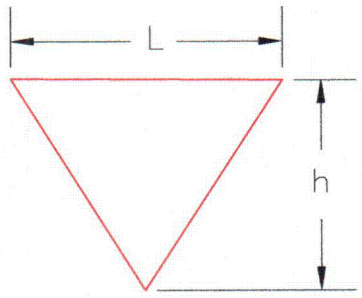
	x axis	y axis
lower bound	0	0
upper bound	13	8



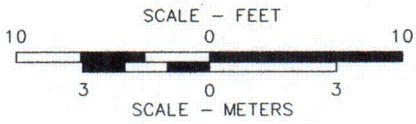
ATTACHMENT C
TABLE OF CONTENTS

- **FIGURE C-1 Elevated Areas**
- **Elevated Measurement Comparison Worksheet**
- **Total Alpha Contamination Survey Data Conversion Form**





N = 36
L = 1.6m
h = 1.4m
AREA = 84.5m^2



001
● SYSTEMATIC SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

028
● RANDOM START POINT

ATTACHMENT C, FIGURE C–1
ELEVATED AREAS

FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RAD 3-3-06
CHECKED	RAD 3-3-06
DRAWN	DEB 1/9/06
DRAWING NUMBER	PA4072062B

Penn E&R
Environmental & Remediation, Inc.

C08

Attachment C
Elevated Measurement Comparison Worksheet
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Survey Unit: Kaiser-FSS-001

$DCGL_{EMC}$ = Area Factor * DCGL-GA

Area Factors

Area Factors								
1 m^2	2 m^2	3 m^2	4 m^2	5 m^2	10 m^2	20 m^2	30 m^2	100 m^2
98.2	49.2	32.9	24.7	19.8	9.91	4.97	3.32	1

$DCGL_{EMC}$ Values Structures

$DCGL_{EMC}$ (dpm/100cm^2)								
1 m^2	2 m^2	3 m^2	4 m^2	5 m^2	10 m^2	20 m^2	30 m^2	100 m^2
9.27E+04	4.64E+04	3.10E+04	2.33E+04	1.87E+04	9.36E+03	4.69E+03	3.13E+03	9.44E+02

$$\frac{\delta}{DCGL} + \sum_{x+1}^{n} \frac{(\delta_{EMC} - \delta)}{DCGL_{EMC}} \leq 1$$

where:

δ = is the average total alpha contamination over the entire survey unit,

δ_{EMC} = the average total alpha contamination over the elevated area (x) within the survey unit,

DCGL = the DCGL-GA ,

$DCGL_{EMC}$ = (area factor for elevated area x) X (DCGL-GA),

x = refers to one of the elevated areas within the survey unit, and

n = the total number of elevated areas within the survey unit.

Elevated Measurement Comparisons

Sample Date	Unit / EMC Unit	Unit Area (m^2)	Gross Alpha (dpm/100cm^2)	Net Alpha (dpm/100cm^2)	DCGL (pCi/g)	Fraction (-)	Sample Number
5/23/2004	FSS-001	84.5	694	694	944	0.74	1 through 36
5/23/2004	EMC-1	25	1470	776	3,830	0.20	1, 2, 3, 4, 5, 6, 11, 12, 20
5/23/2004	EMC-2	2.1	2050	1356	44,600	0.03	30
					Sum of Fractions:	0.97	

Total Alpha Contamination
Survey Unit Kaiser-FSS-001
Survey Data Conversion Form
Form ESC/HPM/M-3-2-2

Date of Survey:	5/24/2004	Type of Radiation:	Alpha
Instrument Serial #:	193686	Calibration Due Date:	5/4/2005
Detector Serial #:	PR190485	Calibration Due Date:	5/4/2005
E_s (Surface Efficiency):	0.25	E_i (Insturment Efficiency):	0.1778
BKG Counts:	2.0	BKG Count Time (min):	1
Active Area of Detector Probe (cm^2):	126	MDC (dpm/100cm^2):	171

FSS Number	Survey Point Count Time (min)	Gross Counts (cts)	Gross Count Rate (cpm)	Net Count Rate (cpm)	Total Contamination (dpm/100cm^2)	95% CL Uncertainty (dpm/100cm^2)
MARSSIM-001	1	90	90	88	1571	336
MARSSIM-002	1	106	106	104	1857	364
MARSSIM-003	1	65	65	63	1125	286
MARSSIM-004	1	179	179	177	3160	471
MARSSIM-005	1	53	53	51	911	260
MARSSIM-006	1	70	70	68	1214	297
MARSSIM-007	1	53	53	51	911	260
MARSSIM-008	1	17	17	15	268	153
MARSSIM-009	1	18	18	16	286	157
MARSSIM-010	1	21	21	19	339	168
MARSSIM-011	1	55	55	53	946	264
MARSSIM-012	1	70	70	68	1214	297
MARSSIM-013	1	30	30	28	500	198
MARSSIM-014	1	42	42	40	714	232
MARSSIM-015	1	32	32	30	536	204
MARSSIM-016	1	22	22	20	357	171
MARSSIM-017	1	19	19	17	304	160
MARSSIM-018	1	12	12	10	179	131
MARSSIM-019	1	31	31	29	518	201
MARSSIM-020	1	70	70	68	1214	297
MARSSIM-021	1	45	45	43	768	240
MARSSIM-022	1	15	15	13	232	144
MARSSIM-023	1	8	8	6	107	111
MARSSIM-024	1	6	6	4	71.4	99.0
MARSSIM-025	1	17	17	15	268	153

Total Alpha Contamination
Survey Unit Kaiser-FSS-001
Survey Data Conversion Form
Form ESC/HPM/M-3-2-2

Date of Survey:	5/24/2004	Type of Radiation:	Alpha
Instrument Serial #:	193686	Calibration Due Date:	5/4/2005
Detector Serial #:	PR190485	Calibration Due Date:	5/4/2005
E_s (Surface Efficiency):	0.25	E_i (Insturment Efficiency):	0.1778
BKG Counts:	2.0	BKG Count Time (min):	1
Active Area of Detector Probe (cm^2):	126	MDC ($dpm/100cm^2$):	171

FSS Number	Survey Point Count Time (min)	Gross Counts (cts)	Gross Count Rate (cpm)	Net Count Rate (cpm)	Total Contamination ($dpm/100cm^2$)	95% CL Uncertainty ($dpm/100cm^2$)
MARSSIM-026	1	8	8	6	107	111
MARSSIM-027	1	17	17	15	268	153
MARSSIM-028	1	5	5	3	53.6	92.6
MARSSIM-029	1	10	10	8	143	121
MARSSIM-030	1	117	117	115	2053	382
MARSSIM-031	1	15	15	13	232	144
MARSSIM-032	1	19	19	17	304	160
MARSSIM-033	1	30	30	28	500	198
MARSSIM-034	1	48	48	46	821	247
MARSSIM-035	1	42	42	40	714	232
MARSSIM-036	1	14	14	12	214	140

Comments:

Prepared By: David B. Weyant	Date: 5/25/2004
Reviewed By: Andrew J. Lombardo	Date: 5/25/2004

ATTACHMENT D

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

May 26, 2004

Paul Handa
Kaiser
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser/PA-4000-4072
OUTREACH LAB ID: 20040370

Dear Mr. Handa:

Please find enclosed the revised analytical report for your samples received in our laboratory May 24, 2004, for the above captioned project.

All QC is within limits.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Quality Assurance Officer

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

CERT. ID #OK001

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
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Client:	Kaiser Aluminum
Client Project:	KAISER
Lab Number:	20040370
Date Reported:	5/26/200
Date Received:	5/24/04
Page Number:	1 of 10

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040370-01**						
Client ID:	**K-SS-001**						
Date Sampled:	**5/24/2004 10:40:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.945 +/- 0.500	pCi/F	0.197	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.794 +/- 1.18	pCi/F	1.18	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-02**						
Client ID:	**K-SS-002**						
Date Sampled:	**5/24/2004 10:42:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	1.25 +/- 0.587	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	1.72 +/- 1.23	pCi/F	1.14	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-03**						
Client ID:	**K-SS-003**						
Date Sampled:	**5/24/2004 10:37:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	1.01 +/- 0.539	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0 +/- 1.18	pCi/F	1.29	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-04**						
Client ID:	**K-SS-004**						
Date Sampled:	**5/24/2004 10:30:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	1.97 +/- 0.714	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.652 +/- 1.17	pCi/F	1.19	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-05**						
Client ID:	**K-SS-005**						
Date Sampled:	**5/24/2004 10:29:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					

BDL = Below Detection Limit

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Client:	Kaiser Aluminum
Client Project:	KAISER
Lab Number:	20040370
Date Reported:	5/26/2004
Date Received:	5/24/04
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Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Gross Alpha	EPA 900/9310	1.36 +/- 0.635	pCi/F	0.326	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	1.74 +/- 1.16	pCi/F	1.04	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-06**						
Client ID:	**K-SS-006**						
Date Sampled:	**5/24/2004 10:27:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.574 +/- 0.445	pCi/F	0.278	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	1.05 +/- 1.15	pCi/F	1.12	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-07**						
Client ID:	**K-SS-007**						
Date Sampled:	**5/24/2004 10:26:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.927 +/- 0.504	pCi/F	0.220	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.160 +/- 1.03	pCi/F	1.10	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-08**						
Client ID:	**K-SS-008**						
Date Sampled:	**5/24/2004 10:25:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	1.84 +/- 0.676	pCi/F	0.197	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	2.58 +/- 1.34	pCi/F	1.18	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-09**						
Client ID:	**K-SS-009**						
Date Sampled:	**5/24/2004 10:24:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.473 +/- 0.408	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0 +/- 1.01	pCi/F	1.14	5/25/2004	5/25/2004	RE

BDL = Below Detection Limit

Outreach Laboratory
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Client:	Kaiser Aluminum
Client Project:	KAISER
Lab Number:	20040370
Date Reported:	5/26/20(
Date Received:	5/24/04
Page Number:	3 of 10

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040370-10**						
Client ID:	**K-SS-010**						
Date Sampled:	**5/24/2004 10:23:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.173 +/- 0.312	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0 +/- 1.17	pCi/F	1.29	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-11**						
Client ID:	**K-SS-011**						
Date Sampled:	**5/24/2004 10:21:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.114 +/- 0.290	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0 +/- 1.08	pCi/F	1.19	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-12**						
Client ID:	**K-SS-012**						
Date Sampled:	**5/24/2004 10:20:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.281 +/- 0.394	pCi/F	0.326	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.320 +/- 1.00	pCi/F	1.04	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-13**						
Client ID:	**K-SS-013**						
Date Sampled:	**5/24/2004 10:19:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.275 +/- 0.359	pCi/F	0.278	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.252 +/- 1.07	pCi/F	1.12	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-14**						
Client ID:	**K-SS-014**						
Date Sampled:	**5/24/2004 10:17:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					

BDL = Below Detection Limit

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Client:	Kaiser Aluminum
Client Project:	KAISER
Lab Number:	20040370
Date Reported:	5/26/2004
Date Received:	5/24/04
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Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Gross Alpha	EPA 900/9310	0.628 +/- 0.431	pCi/F	0.220	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.775 +/- 1.10	pCi/F	1.10	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-15**						
Client ID:	**K-SS-015**						
Date Sampled:	**5/24/2004 10:33:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.347 +/- 0.336	pCi/F	0.197	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.055 +/- 1.10	pCi/F	1.18	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-16**						
Client ID:	**K-SS-016**						
Date Sampled:	**5/24/2004 10:22:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.114 +/- 0.290	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0 +/- 1.03	pCi/F	1.14	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-17**						
Client ID:	**K-SS-017**						
Date Sampled:	**5/24/2004 10:43:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0 +/- 0.237	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.086 +/- 1.20	pCi/F	1.29	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-18**						
Client ID:	**K-SS-018**						
Date Sampled:	**5/24/2004 11:05:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.413 +/- 0.391	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0 +/- 1.04	pCi/F	1.19	5/25/2004	5/25/2004	RE

BDL = Below Detection Limit

Outreach Laboratory
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Client: Kaiser Aluminum
Client Project: KAISER
Lab Number: 2004037[illegible]
Date Reported: 5/26/20[illegible]
Date Received: 5/24/04
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Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20040370-19						
Client ID:	K-SS-019						
Date Sampled:	5/24/2004 11:03:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.461 +/- 0.443	pCi/F	0.326	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.505 +/- 1.02	pCi/F	1.04	5/25/2004	5/25/2004	RE
Lab ID:	20040370-20						
Client ID:	K-SS-020						
Date Sampled:	5/24/2004 11:02:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.335 +/- 0.378	pCi/F	0.278	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.622 +/- 1.11	pCi/F	1.12	5/25/2004	5/25/2004	RE
Lab ID:	20040370-21						
Client ID:	K-SS-021						
Date Sampled:	5/24/2004 11:00:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.329 +/- 0.342	pCi/F	0.220	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.037 +/- 1.02	pCi/F	1.10	5/25/2004	5/25/2004	RE
Lab ID:	20040370-22						
Client ID:	K-SS-022						
Date Sampled:	5/24/2004 10:58:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.407 +/- 0.356	pCi/F	0.197	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	1.29 +/- 1.23	pCi/F	1.18	5/25/2004	5/25/2004	RE
Lab ID:	20040370-23						
Client ID:	K-SS-023						
Date Sampled:	5/24/2004 10:57:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					

BDL = Below Detection Limit

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Client:	Kaiser Aluminum
Client Project:	KAISER
Lab Number:	20040370
Date Reported:	5/26/2004
Date Received:	5/24/04
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Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Gross Alpha	EPA 900/9310	0.173 +/- 0.312	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.117 +/- 1.07	pCi/F	1.14	5/25/2004	5/25/2004	RE
Lab ID:	20040370-24						
Client ID:	K-SS-024						
Date Sampled:	5/24/2004 10:56:00 AM						
Matrix:	Filter						
	Radiochemical Analyses						
Gross Alpha	EPA 900/9310	0.473 +/- 0.408	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0 +/- 1.15	pCi/F	1.29	5/25/2004	5/25/2004	RE
Lab ID:	20040370-25						
Client ID:	K-SS-025						
Date Sampled:	5/24/2004 10:55:00 AM						
Matrix:	Filter						
	Radiochemical Analyses						
Gross Alpha	EPA 900/9310	0.951 +/- 0.526	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.652 +/- 1.17	pCi/F	1.19	5/25/2004	5/25/2004	RE
Lab ID:	20040370-26						
Client ID:	K-SS-026						
Date Sampled:	5/24/2004 10:54:00 AM						
Matrix:	Filter						
	Radiochemical Analyses						
Gross Alpha	EPA 900/9310	0.162 +/- 0.358	pCi/F	0.326	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.874 +/- 1.06	pCi/F	1.04	5/25/2004	5/25/2004	RE
Lab ID:	20040370-27						
Client ID:	K-SS-027						
Date Sampled:	5/24/2004 10:52:00 AM						
Matrix:	Filter						
	Radiochemical Analyses						
Gross Alpha	EPA 900/9310	0.036 +/- 0.272	pCi/F	0.278	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0 +/- 1.02	pCi/F	1.12	5/25/2004	5/25/2004	RE

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
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Client:	Kaiser Aluminum
Client Project:	KAISER
Lab Number:	2004037^
Date Reported:	5/26/20
Date Received:	5/24/04
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Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20040370-28						
Client ID:	K-SS-028						
Date Sampled:	5/24/2004 10:50:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.150 +/- 0.275	pCi/F	0.220	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.591 +/- 1.08	pCi/F	1.10	5/25/2004	5/25/2004	RE
Lab ID:	20040370-29						
Client ID:	K-SS-029						
Date Sampled:	5/24/2004 10:49:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.407 +/- 0.356	pCi/F	0.197	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.732 +/- 1.17	pCi/F	1.18	5/25/2004	5/25/2004	RE
Lab ID:	20040370-30						
Client ID:	K-SS-030						
Date Sampled:	5/24/2004 10:48:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.592 +/- 0.440	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.117 +/- 1.07	pCi/F	1.14	5/25/2004	5/25/2004	RE
Lab ID:	20040370-31						
Client ID:	K-SS-031						
Date Sampled:	5/24/2004 10:12:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.353 +/- 0.373	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0 +/- 1.16	pCi/F	1.29	5/25/2004	5/25/2004	RE
Lab ID:	20040370-32						
Client ID:	K-SS-032						
Date Sampled:	5/24/2004 10:14:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					

BDL = Below Detection Limit

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Client:	Kaiser Aluminum
Client Project:	KAISER
Lab Number:	20040370
Date Reported:	5/26/2004
Date Received:	5/24/04
Page Number:	8 of 10

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Gross Alpha	EPA 900/9310	1.61 +/- 0.654	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.960 +/- 1.20	pCi/F	1.19	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-33**						
Client ID:	**K-SS-033**						
Date Sampled:	**5/24/2004 10:15:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.700 +/- 0.502	pCi/F	0.326	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.751 +/- 1.05	pCi/F	1.04	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-34**						
Client ID:	**K-SS-034**						
Date Sampled:	**5/24/2004 10:31:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.754 +/- 0.489	pCi/F	0.278	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0 +/- 0.979	pCi/F	1.12	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-35**						
Client ID:	**K-SS-035**						
Date Sampled:	**5/24/2004 10:35:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.209 +/- 0.299	pCi/F	0.220	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0 +/- 0.953	pCi/F	1.10	5/25/2004	5/25/2004	RE
Lab ID:	**20040370-36**						
Client ID:	**K-SS-036**						
Date Sampled:	**5/24/2004 10:36:00 AM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	2.26 +/- 0.743	pCi/F	0.197	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	2.46 +/- 1.33	pCi/F	1.18	5/25/2004	5/25/2004	RE

BDL = Below Detection Limit

Outreach Laboratory
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Client:	Kaiser Aluminum
Client Project:	KAISER
Lab Number:	20040370
Date Reported:	5/26/20
Date Received:	5/24/04
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Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20040370-37						
Client ID:	K-SS-037						
Date Sampled:	5/24/2004 10:38:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.353 +/- 0.373	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	0.117 +/- 1.07	pCi/F	1.14	5/25/2004	5/25/2004	RE
Lab ID:	20040370-38						
Client ID:	K-SS-038						
Date Sampled:	5/24/2004 10:39:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	2.21 +/- 0.752	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	1.32 +/- 1.31	pCi/F	1.29	5/25/2004	5/25/2004	RE
Lab ID:	20040370-39						
Client ID:	K-SS-039						
Date Sampled:	5/24/2004 10:41:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	7.60 +/- 1.34	pCi/F	0.260	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	8.41 +/- 1.79	pCi/F	1.19	5/25/2004	5/25/2004	RE
Lab ID:	20040370-40						
Client ID:	K-SS-040						
Date Sampled:	5/24/2004 10:45:00 AM						
Matrix:	Filter						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	3.33 +/- 0.925	pCi/F	0.326	5/25/2004	5/25/2004	RE
Gross Beta	EPA 900/9310	4.44 +/- 1.41	pCi/F	1.04	5/25/2004	5/25/2004	RE

BDL = Below Detection Limit

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Client:	Kaiser Aluminum
Client Project:	KAISER
Lab Number:	20040370
Date Reported:	5/26/2004
Date Received:	5/24/04
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QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Gross Alpha	1.74+/-0.71	71.0			NC				5/25/2004
Gross Alpha	1.62+/-0.69	73.0			NC				5/25/2004
Gross Beta	0+/-1.37	109.0			NC				5/25/2004
Gross Beta	2.39+/-1.56	94.0			NC				5/25/2004

QA Approval:

Lab Approval:

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: Company Dallas B. Weyand
Name Paul Ean
Address 7311 E. 41st St.
City Tulsa State OK Zip 74145
Phone 918-394-0546 Fax # 918-394-3371

Bill To: Company Kaiser Aluminum
Name Paul Hanna
Address 7311 E. 41st St.
City Tulsa State OK Zip 74145

Cell 724-794-0071

PO #
PROJECT # DA-4000-4072
PROJECT NAME Kaiser
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 2 DAY
SAMPLER David R. Weyand (Signature)

ANALYSIS REQUESTED

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2, 2. Ice <4°C, 3. HCl pH<2, 4. H_2SO_4 pH<2, 5. NaOH pH>11)	Grab	REMARKS (i.e. FILTERED, UNFILTERED, GRAB, COMPOSITE)
1	K-SS-001	5-7-04	1040	Soil	1	Cloth	Tape	X	
2	002		1042					X	
3	003		1037					X	
4	004		1030					X	
5	005		1029					X	
6	006		1027					X	
7	007		1026					X	
8	008		1025					X	
9	009		1024					X	
10	010		1023					X	
11	011		1021					X	
12	012		1020					X	
13	013		1019					X	
14	014		1017					X	

RELINQUISHED BY: David R. Weyand DATE 5-7-04 TIME 2:00 RECEIVED BY: DC DATE 5/7/04 TIME 1200

RELINQUISHED BY: DC DATE 5/7/04 TIME 1200 RECEIVED BY Michelle Dotts DATE 5-7-04 TIME 12:00

FOR LABORATORY USE ONLY: 20040-370-1

Sample Condition Upon Receipt Good

Custody Seals Intact Y N

Cooler Temperature Amb

By signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company DAVID R. WEAVER
Name PETE & BR
Address 7311 E. 41ST ST.
City TULSA State OK Zip 74145
Phone 918-364-0466 Fax # 918-364-3171

(CELL 724-799-0071)

Bill To:
Company KAISER Alum & Chem.
Name PAUL HADA
Address 7311 E. 41ST ST.
City TULSA State OK Zip 74145

PO # PA-4088-4072
PROJECT # KAISER
PROJECT NAME
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 2 DAY
SAMPLER David R. Weaver (Signature)

ANALYSIS REQUESTED

LAB SERVICE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
15	K-53-015	5-24-04	1033	Solid	1	Cloth	None	X	
16	016		1022					X	
17	017		1043					X	
18	018		1105					X	
19	019		1103					X	
20	020		1102					X	
21	021		1107					X	
22	022		1058					X	
23	023		1057					X	
24	024		1056					X	
25	025		1055					X	
26	026		1054					X	
27	027		1052					X	
28	028		1050					X	

RELINQUISHED BY: David Weaver DATE 5-24-2004 TIME 1200 RECEIVED BY: DATE 5/24/04 TIME 1200

RELINQUISHED BY: DATE 5/24/04 TIME 1200 RECEIVED BY: Michelle Dalton DATE 5/24/04 TIME 12:00

By signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to recall the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: 0504370-2

Sample Condition Upon Receipt good
Custody Seals Intact (Y) N
Cooler Temperature Amb

OUTREACH LABORATORY

111 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: Company [illegible]
Name [illegible]
Address [illegible]
City [illegible] State OK Zip 74145
Phone [illegible]

Bill To:
Company [illegible]
Name [illegible]
Address [illegible]
City [illegible] State OK Zip [illegible]

PO #
PROJECT # PA-Vroom 4572
PROJECT NAME [illegible]
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 2 DAY
SAMPLER [illegible]

ANALYSIS REQUESTED

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gross α, Ra-226	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
29	K-SJ-029	5-24-16	1049	Swim	1	Cloth	2	X	
30	030		1048					X	
31	031		1017					X	
32	032		1014					X	
33	033		1015					X	
34	034		1031					X	
35	035		1035					X	
36	036		1036					X	
37	037		1038					X	
38	038		1039					X	
39	039		1041					X	
40	040		1045					X	

RELINQUISHED BY: [illegible] DATE 5-24-16 TIME 12 RECEIVED BY: [illegible] DATE 5/24/16 TIME 200

RELINQUISHED BY: [illegible] DATE 5/24/16 TIME 1120 RECEIVED BY: Michelle Dutton DATE 5-24-16 TIME 12:00

By signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) fee charge. In the event of default, the company recognizes legally binding for any reasonable attorney and/or collection fees and all related costs necessary to recover the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL non-hazardous samples must be disposed of 30 days after issue of final report. All others will be returned at [illegible] expense.

FOR LABORATORY USE ONLY: 2016320-3

Sample Condition Upon Receipt Good
Custody Seals Intact Y N
Cooler Temperature Amb

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: Company DAVID R. WEAVER
Name PEER E&R
Address 7311 E. 41ST ST.
City TULSA State OK Zip 74145
Phone 918-794-0866 Fax # 918-794-7171

Bill To: Company KAISER Blum & Clark
Name Paul Haas
Address 7311 E. 41ST ST.
City TULSA State OK Zip 74145

(281) 724-799-0071

PO # PA-4088-4077
PROJECT # KAISER
PROJECT NAME
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 2 DAY
SAMPLER David R. Weaver (Signature)

ANALYSIS REQUESTED

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE (1. HNO_3 pH<2; 2. Ice 4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GRO 8015	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
15	K-SS-015	5-24-04	1033	Soil	1	Cloth	None	X	
16	016		1022					X	
17	017		1043					X	
18	018		1105					X	
19	019		1103					X	
20	020		1102					X	
21	021		1107					X	
22	022		1038					X	
23	023		1057					X	
24	024		1056					X	
25	025		1055					X	
26	026		1054					X	
27	027		1052					X	
28	029		1050					X	

RELINQUISHED BY: David Weaver DATE 5-24-2004 TIME 2pm RECEIVED BY: DATE 5/24/04 TIME 1100

RELINQUISHED BY: DATE 5/24/04 TIME 1200 RECEIVED BY: Michelle Dalton DATE 5/24/04 TIME 12:00

By signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to enroll the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: ORB3720-2

Sample Condition Upon Receipt good
Custody Seals Intact Y / N
Cooler Temperature Cool

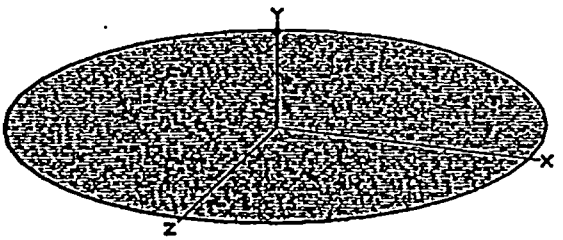
ATTACHMENT E

MicroShield v6.02 (6.02-00204)
CEC,_Inc.

Page : 1
DOS File : K_10pCi_Th232_0.1cm_concrete.ms6
Run Date: July 8, 2004
Run Time: 11:55:04 AM
Duration : 00:00:00

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: Kaiser Concrete
Description: Kaiser Surface Survey 10 pCi/g Th-232, 0.1 cm Depth, @ 10 cm
Geometry: 8 - Cylinder Volume - End Shields



Source Dimensions

Height	0.1 cm	0.0 in
Radius	28.0 cm	11.0 in

Dose Points

	X	Y	Z
# 1	0 cm	10.1 cm	0 cm
	0.0 in	4.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	246.301 cm³	Concrete	2.35
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Included
Library : Grove

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Ac-228	5.7881e-009	2.1416e+002	2.3500e-005	8.6950e-001
Bi-212	5.7881e-009	2.1416e+002	2.3500e-005	8.6950e-001
Pb-212	5.7881e-009	2.1416e+002	2.3500e-005	8.6950e-001
Po-212	3.7044e-009	1.3706e+002	1.5040e-005	5.5648e-001
Po-216	5.7881e-009	2.1416e+002	2.3500e-005	8.6950e-001
Ra-224	5.7881e-009	2.1416e+002	2.3500e-005	8.6950e-001
Ra-228	5.7881e-009	2.1416e+002	2.3500e-005	8.6950e-001
Th-228	5.7881e-009	2.1416e+002	2.3500e-005	8.6950e-001
Th-232	5.7881e-009	2.1416e+002	2.3500e-005	8.6950e-001
Tl-208	2.0837e-009	7.7097e+001	8.4600e-006	3.1302e-001

Buildup
The material reference is : Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.750e+02	1.691e-04	1.729e-04	1.450e-05	1.483e-05
0.04	2.190e+00	1.714e-05	1.826e-05	7.580e-08	8.077e-08
0.06	1.481e+00	1.848e-05	1.970e-05	3.670e-08	3.912e-08
0.08	9.243e+01	1.563e-03	1.652e-03	2.473e-06	2.615e-06
0.1	1.520e+01	3.232e-04	3.398e-04	4.945e-07	5.199e-07
0.15	9.001e+00	2.891e-04	3.008e-04	4.761e-07	4.954e-07
0.2	1.163e+02	4.999e-03	5.170e-03	8.823e-06	9.124e-06
0.3	5.585e+01	3.614e-03	3.709e-03	6.856e-06	7.036e-06

Page : 2
DOS File : K_10pCi_Th232_0.1cm_concrete.ms6
Run Date: July 8, 2004
Run Time: 11:55:04 AM
Duration : 00:00:00

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.4	5.067e+00	4.384e-04	4.478e-04	8.542e-07	8.726e-07
0.5	2.953e+01	3.200e-03	3.260e-03	6.282e-06	6.399e-06
0.6	6.822e+01	8.885e-03	9.029e-03	1.734e-05	1.762e-05
0.8	6.826e+01	1.188e-02	1.204e-02	2.260e-05	2.289e-05
1.0	1.247e+02	2.718e-02	2.748e-02	5.010e-05	5.065e-05
1.5	2.873e+01	9.416e-03	9.492e-03	1.584e-05	1.597e-05
2.0	6.499e-01	2.845e-04	2.864e-04	4.400e-07	4.429e-07
3.0	7.694e+01	5.063e-02	5.087e-02	6.868e-05	6.902e-05
TOTALS:	8.696e+02	1.229e-01	1.243e-01	2.159e-04	2.186e-04

SUB-REPORT

SURVEY UNIT KAISER-FSS-002

TABLE OF CONTENTS

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2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil	3
2.3 Wilcoxon Rank Sum (WRS) Testing	4
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3.1 Excavation Bottom/ Side Wall Surface Soils	5
3.2 Sum of Fractions for Entire Survey Unit	5

ATTACHMENTS

ATTACHMENT A: Figure A-1 Gross Gamma Background and Scanning Survey Results
Figure A-2 Systematic Soil Sampling Locations

ATTACHMENT B: Soil Survey Unit Worksheet No. 1
Soil Survey Unit Worksheet No. 2

ATTACHMENT C: Laboratory Analytical Results

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-002
Survey Unit Kaiser-FSS-002
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility **(Figure 1)**. Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-002, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the southwestern portion of the Retention Pond area. Survey Unit Kaiser-FSS-002 is considered a Class 1 survey unit with an approximate surface area of 126.5 m^2. The survey unit is bounded to the east by Survey Unit Kaiser-FSS-003, to the south by the Union Pacific Railroad right-of-way, to the north by Survey Unit Kaiser-FSS-008, and to the west by Survey Unit Kaiser-FSS-001 **(Figure 3)**.

Survey Unit Kaiser-FSS-002 consists of an excavation bottom surface soil with two side walls (east wall and south wall). No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom, eastern side wall, and southern side wall surface soil of Survey Unit Kaiser-FSS-002. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom, eastern side wall, and southern side wall) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 9 approximately equal-distant locations in the survey unit. The statistics for the 9 background measurements are provided below in **Table 1.** Background measurements ranged from 45,071 counts per minute (cpm) to 123,316 cpm moving southwest to northeast across the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the east-northeast of the survey unit.

A total of 26 area-averaged measurements of gross count rate were made across the survey unit's 126.5 m^2 surface area. The results ranged from 43,000 cpm to 90,000 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	126.5 m^2	
Number of Scan Measurements (Recorded Average per 2 m^2 grid area)	26	
Scan Rate: (Swinging the detector a width of 1-meter side to side)	0.5 m/s (MARSSIM recommends 0.5m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	45,071	43,000
Maximum	123,316	90,000
Average	71,389	57,000
Standard Deviation	28,698	14,000
Median	61,076	52,000

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).

2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 **(Attachment B)**. Once N was determined, the Survey Unit Area (A) of 126.5 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 4.0 meters and the Height of the Equilateral Triangle (h) of 3.5 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 **(Attachment B)**.

A layout of the soil sampling locations is provided on **Figure A-2** contained in **Attachment A**. The soil sampling locations were demarcated in the field using a GPS unit. A total of 9 soil samples (identified as K-019 through K-027) were collected at the excavation bottom/side wall surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 2**. Analytical data reports are contained in **Attachment C**.

Table 2 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-019	0.391	0.078	0.190	0	3.0
K-020	0.986	0.113	0.473	0	3.0
K-021	0.821	0.103	0.340	0	3.0
K-022	1.02	0.097	0.249	0	3.0
K-023	1.03	0.118	0.440	0	3.0
K-024	1.22	0.119	0.252	0.12	3.0
K-025	1.11	0.070	0.336	0.01	3.0
K-026	1.63	0.116	0.476	0.53	3.0
K-027	0.941	0.116	0.414	0	3.0
Average	*1.02*				
Standard Dev.	*0.328*				
Minimum	*0.391*				
Maximum	*1.63*				
Median	*1.02*				

All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.63 pCi/g, which fell slightly above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 1.02 pCi/g. The standard deviation of the 9 equal-distant samples was 0.328, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (1.06 pCi/g) between the maximum survey unit soil sample activity concentration (1.63 pCi/g) and the minimum reference background area soil sample activity concentration (0.57 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 3** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 3 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	299	1.24	S1	K-019	0.391
R2	263	1.54	S2	K-020	0.986
R3	96	0.57	S3	K-021	0.821
R4	20	1.38	S4	K-022	1.02
R5	262	1.63	S5	K-023	1.03
R6	255	1.42	S6	K-024	1.22
R7	263	1.54	S7	K-025	1.11
R8	343	1.14	S8	K-026	1.63
R9	156	0.96	S9	K-027	0.941
	Average	***1.27***		***Average***	***1.02***
	Standard Dev.	***0.34***		***Standard Dev.***	***0.328***
	Minimum	***0.57***		***Minimum***	***0.391***
	Maximum	***1.63***		***Maximum***	***1.63***
	Median	***1.38***		***Median***	***1.02***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the southwestern portion of the Retention Pond area resulted in an open land area consisting of an excavation approximately 126.5 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-002 is considered a Class 1 survey unit. The survey unit is bounded to the east by Survey Unit Kaiser-FSS-003, to the south by the Union Pacific Railroad right-of-way, to the north by Survey Unit Kaiser-FSS-008, and to the west by Survey Unit Kaiser-FSS-001 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom/Side Wall Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-002 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom, eastern side wall, and southern side wall) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-002 prior to backfill with clean import borrow material, as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 4.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

Table 4 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-002 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	$dpm/100cm^2$	0		0.00
TOTAL SUM OF FRACTIONS				***0.00***

The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-002 meets the DP acceptance criteria.

ATTACHMENT A
TABLE OF CONTENTS

- **FIGURE A-1 Gross Gamma Background and Scanning Survey Results**
- **FIGURE A-2 Systematic Soil Sampling Locations**

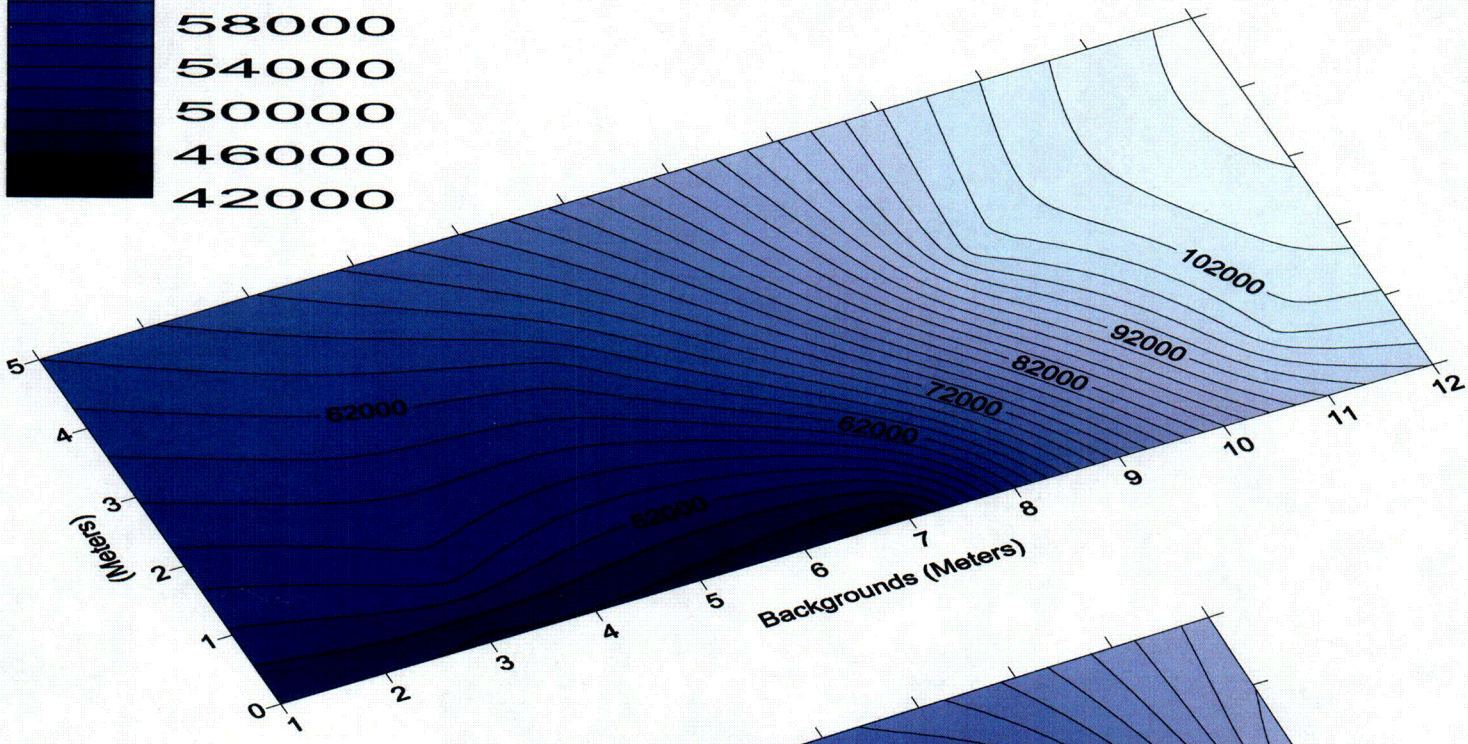
CPM NaI # 2

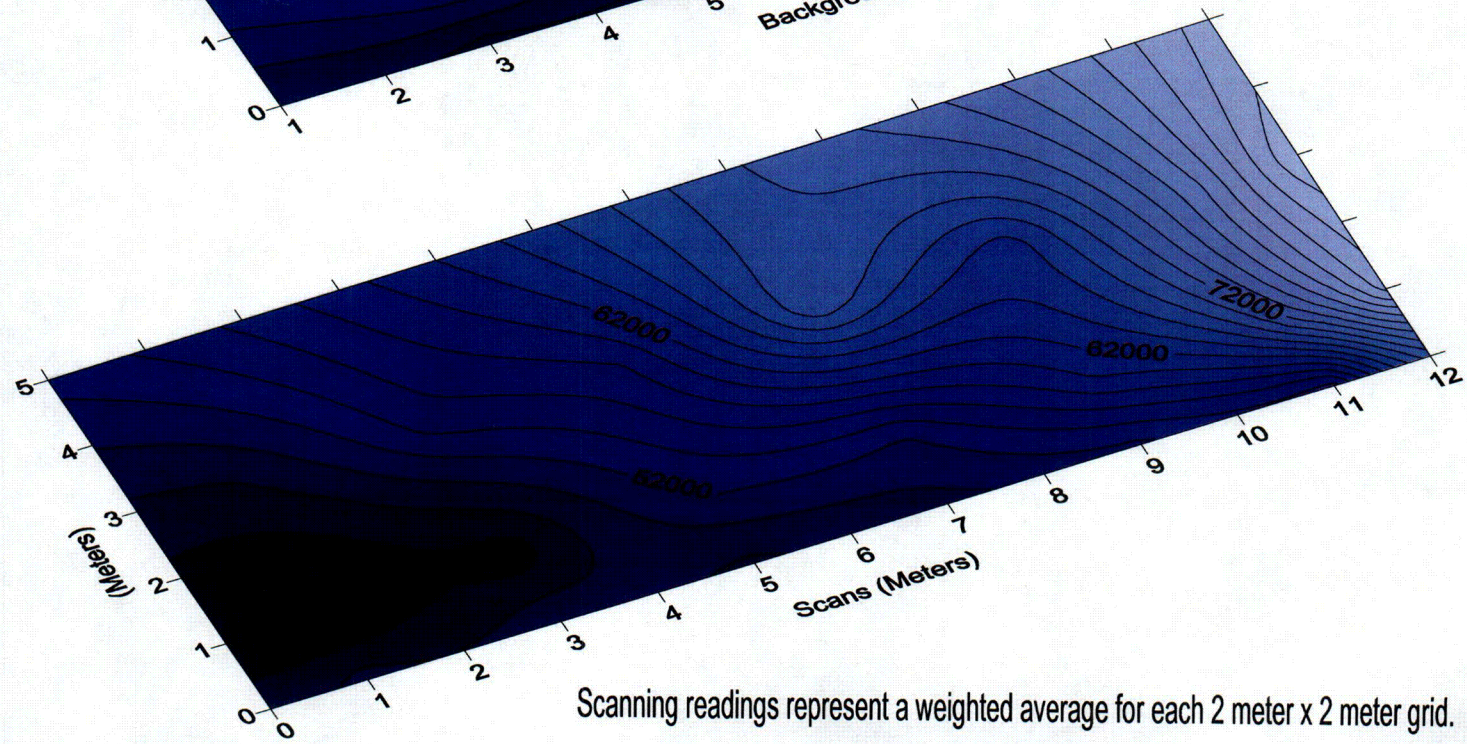
110000
106000
102000
98000
94000
90000
86000
82000
78000
74000
70000
66000
62000
58000
54000
50000
46000
42000

Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-002

N

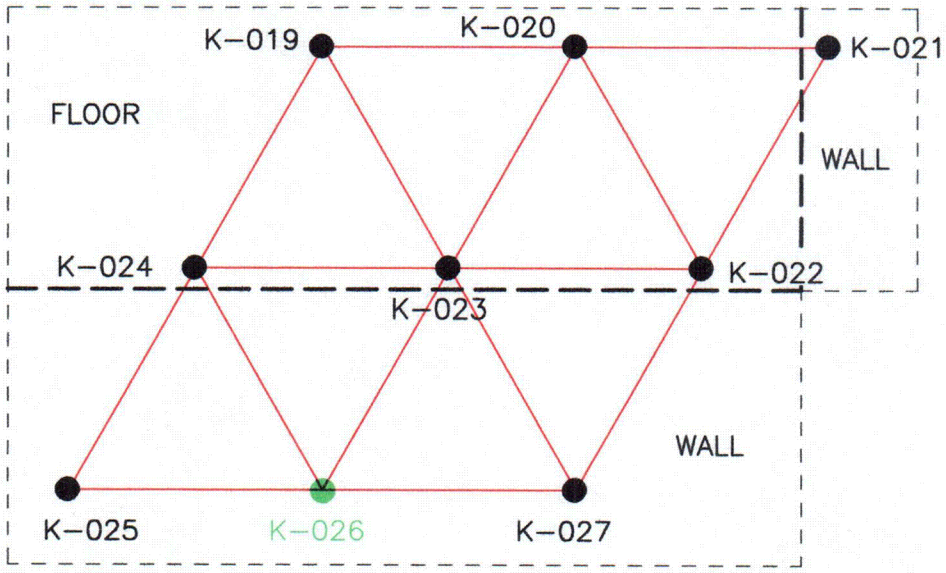
Backgrounds are 1 minute readings.

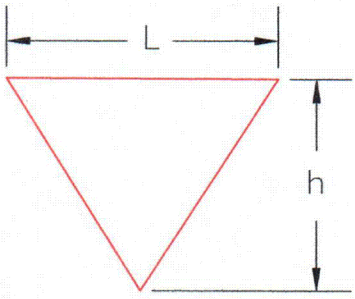




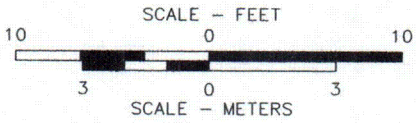
Scanning readings represent a weighted average for each 2 meter x 2 meter grid.

C09





N = 9
L = 4m
h = 3.5m
AREA = 126.5m^2



K–019

● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K–026

● RANDOM START POINT

FIGURE A–2
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS–002
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RAJ 3-3-06
CHECKED	RAJ 3-3-06
DRAWN	DEB 12/27/05
DRAWING NUMBER	PA4072050

Penn E&R
Environmental & Remediation, Inc.

ATTACHMENT B
TABLE OF CONTENTS

- **Soil Survey Unit Worksheet No. 1**
- **Soil Survey Unit Worksheet No. 2**

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-002

2. Description: Retention Pond Area, East of Survey Unit Kaiser-FSS-001

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – Approx. 13 meters x 9.5 meters; Area, A (m^2): 126.5

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 50,000 Minimum: 40,000 Maximum: 100,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 5.7
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 4.0 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or (L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 3.5 m.

1

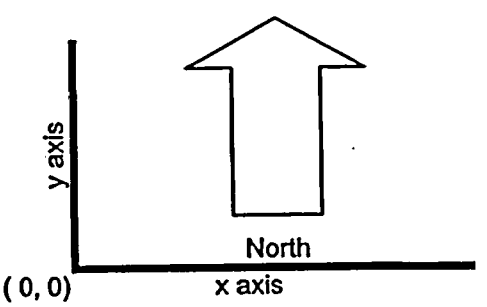
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-002

RANDOM START POINT

x axis (Meters)	y axis (Meters)
5	3

	x axis	y axis
lower bound	0	0
upper bound	13	9.5



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

TMS
3 pages
6/2

K-019

K-027

May 26, 2004

Paul Handa
Kaiser
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser/PA-4000-4072
OUTREACH LAB ID: 20040371

Dear Mr. Handa:

Please find enclosed the revised analytical report for your samples received in our laboratory May 25, 2004, for the above captioned project.

All QC is within limits.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Quality Assurance Officer

Laboratory Director

ACCREDITED IN ACCORDANCE WITH nelac

CERT. ID #OK001

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

Outreach Laboratory
111 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: KAISER/PA-4000-4072
Lab Number: 200403
Date Reported: 5/27/20
Date Received: 5/25/04
Page Number: 1 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20040371-01						
Client ID:	K-019						
Date Sampled:	5/24/2004 6:00:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.391 +/- 0.078	pCi/g	0.190		5/25/2004	SD
Lab ID:	20040371-02						
Client ID:	K-020						
Date Sampled:	5/24/2004 6:05:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.986 +/- 0.113	pCi/g	0.473		5/25/2004	SD
Lab ID:	20040371-03						
Client ID:	K-021						
Date Sampled:	5/24/2004 6:10:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.821 +/- 0.103	pCi/g	0.340		5/25/2004	SD
Lab ID:	20040371-04						
Client ID:	K-022						
Date Sampled:	5/24/2004 6:15:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	1.02 +/- 0.097	pCi/g	0.249		5/25/2004	SD
Lab ID:	20040371-05						
Client ID:	K-023						
Date Sampled:	5/24/2004 6:20:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	1.03 +/- 0.118	pCi/g	0.440		5/25/2004	SD

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	KAISER/PA-4000-4072
Lab Number:	20040371
Date Reported:	5/26/2004
Date Received:	5/25/04
Page Number:	2 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040371-06**						
Client ID:	**K-024**						
Date Sampled:	**5/24/2004 6:25:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.22 +/- 0.119	pCi/g	0.252		5/25/2004	SD
Lab ID:	**20040371-07**						
Client ID:	**K-025**						
Date Sampled:	**5/24/2004 6:30:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.11 +/- 0.070	pCi/g	0.336		5/25/2004	SD
Lab ID:	**20040371-08**						
Client ID:	**K-026**						
Date Sampled:	**5/24/2004 6:35:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.63 +/- 0.116	pCi/g	0.476		5/25/2004	SD
Lab ID:	**20040371-09**						
Client ID:	**K-027**						
Date Sampled:	**5/24/2004 6:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.941 +/- 0.116	pCi/g	0.414		5/25/2004	SD

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	KAISER/PA-4000-4072
Lab Number:	20040371
Date Reported:	5/26/200
Date Received:	5/25/04
Page Number:	3 of 3

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					NC				5/25/2004
Am-241		91.0	93.0	1.8					5/25/2004
Co-60		92.0	93.0	1.3					5/25/2004
Cs-137		97.0	94.0	3.6					5/25/2004

QA Approval:

Lab Approval:

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company DAVID B. WEYANT
Name PERRY E&R
Address 7311 E. 41ST ST.
City TULSA State OK Zip 74145
Phone 918-384-0566 Fax # 918-384-7171
Cell- 724-799-9071

Bill To:
Company Kaiser Alum. & Chem.
Name PAUL HAZDA
Address 7311 E. 41ST ST.
City TULSA State OK Zip 74145

ANALYSIS REQUESTED

PO #
PROJECT # SC [illegible] PA-4on-4072
PROJECT NAME Kaiser
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) * 2 DAY T.A.T.
SAMPLER David R. Weyant Signature 2004

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GAMMA (1-232) SAC	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-019	5-24	1800	Soil	1	500ml PLASTIC	None	X	<0.5 pCi/g MDC - * GRAB *
	K-020	5-24	1805		1			X	*
	K-021	5-24	1810		1			X	*
	K-022	5-24	1815		1			X	*
	K-023	5-24	1820		1			X	*
	K-024	5-24	1825		1			X	*
	K-025	5-24	1830		1			X	*
	K-026	5-24	1835		1			X	*
	K-027	5-24	1840		1			X	*
	K-028	5-24	1900	Concrete	1	500ml	None	X	<0.5 MDC pCi/g. 10 DAY T.A.T. (CRUSH CONCRETE & USE SAME GEOMETRY AS SOIL)
						→ PLACE 1 270 500ml BOTTLE Crushed.			

RELINQUISHED BY: David R. Weyant 2004 DATE 5-25 TIME 0830 RECEIVED BY: DATE 5/25/04 TIME 0830

RELINQUISHED BY: DATE TIME RECEIVED BY: DATE 5/25 TIME 8:45

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY

SUB-REPORT

SURVEY UNIT KAISER-FSS-003

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2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil	3
2.3 Wilcoxon Rank Sum (WRS) Testing	4
3.0 SUMMARY OF FINDINGS	6
3.1 Excavation Bottom/Side Wall Surface Soil	6
3.2 Sum of Fractions for Entire Survey Unit	6

ATTACHMENTS

ATTACHMENT A: Figure A-1 Gross Gamma Background and Scanning Survey Results
Figure A-2 Systematic Soil Sampling Locations

ATTACHMENT B: Soil Survey Unit Worksheet No. 1
Soil Survey Unit Worksheet No. 2

ATTACHMENT C: Laboratory Analytical Results

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-003
Survey Unit Kaiser-FSS-003
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-003, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the southwestern portion of the Retention Pond area. Survey Unit Kaiser-FSS-003 is considered a Class 1 survey unit with an approximate surface area of 80 m^2. This limited size survey unit was demarcated due to the presence of a metal utility pole. The soils immediately surrounding the utility pole were not radiologically-affected. The survey unit is bounded to the south and east by the Union Pacific Railroad right-of-way, to the north by Survey Unit Kaiser-FSS-005, and to the west by Survey Unit Kaiser-FSS-002 (**Figure 3**).

Survey Unit Kaiser-FSS-003 consists of an excavation bottom surface soil with two side walls (east wall and south wall). No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom, eastern side wall, and southern side wall surface soil of Survey Unit Kaiser-FSS-003. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom, eastern side wall, and southern side wall) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 7 approximately equal-distant locations in the survey unit. The statistics for the 7 background measurements are provided below in **Table 1.** Background measurements ranged from 24,383 counts per minute (cpm) to 101,422 cpm moving southeast to northwest within the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the northwest of the survey unit.

A total of 20 area-averaged measurements of gross count rate were made across the survey unit's 80 m^2 surface area. The results ranged from 16,000 cpm to 86,000 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	80 m^2	
Number of Scan Measurements (Recorded Average per 2 m^2 grid area)	20	
Scan Rate: (Swinging the detector a width of 1-meter side to side)	0.5 m/s (MARSSIM recommends 0.5m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	24,383	16,000
Maximum	101,422	86,000
Average	58,767	37,000
Standard Deviation	28,467	21,000
Median	52,539	30,000

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site). As part of the gross gamma survey, 4 biased soil samples were collected at locations exhibiting the highest scan rates on the soil walls (1 sample per wall) surrounding the utility pole concrete footing **(Figure A-2, Attachment A).** The biased soil samples were

forwarded to Outreach for analysis of Th-232 activity concentration. The analytical results are provided below in **Table 2**. The biased soil sample results were below the $DCGL_W$ for the site.

Table 2 – Biased Soil Sample Analytical Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)
$DCGL_W$	*3.0*		
Site Background	*1.1*	*0.3*	
K-042 (Point A)	2.64	0.131	0.349
K-043 (Point B)	1.29	0.085	0.255
K-044 (Point C)	0.974	0.086	0.329
K-045 (Point D)	0.724	0.076	0.200

2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 (**Attachment B**). Once N was determined, the Survey Unit Area (A) of 80 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 3.2 meters and the Height of the Equilateral Triangle (h) of 2.8 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 (**Attachment B**).

A layout of the soil sampling locations is provided on **Figure A-2** contained in **Attachment A**. The soil sampling locations were demarcated in the field using a GPS unit. A total of 9 soil samples (identified as K-032 through K-034, and K-036-POST through K-041) were collected at the excavation bottom/side wall surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3**. Analytical data reports are contained in **Attachment C**.

Table 3 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-032	0.878	0.064	0.215	0	3.0
K-033	1.02	0.060	0.177	0	3.0
K-034	0.713	0.065	0.194	0	3.0
K-036-POST	1.06	0.075	0.227	0	3.0
K-037	1.11	0.078	0.194	0.01	3.0
K-038	1.16	0.088	0.279	0.06	3.0
K-039	1.09	0.074	0.198	0	3.0
K-040	1.19	0.069	0.259	0.09	3.0
K-041	1.05	0.078	0.231	0	3.0
Average	***1.03***				
Std. Dev.	***0.149***				
Minimum	***0.713***				
Maximum	***1.19***				
Median	***1.06***				

All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.19 pCi/g, which fell slightly above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 1.03 pCi/g. The standard deviation of the 9 equal-distant samples was 0.149, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (0.83 pCi/g) between the maximum survey unit soil sample activity concentration (1.19 pCi/g) and the minimum reference background area soil sample activity concentration (0.36 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	5	0.90	S1	K-032	0.878
R2	353	0.79	S2	K-033	1.02
R3	342	1.26	S3	K-034	0.713
R4	186	1.36	S4	K-036-POST	1.06
R5	19	0.36	S5	K-037	1.11
R6	351	1.07	S6	K-038	1.16
R7	146	1.23	S7	K-039	1.09
R8	52	1.63	S8	K-040	1.19
R9	193	1.16	S9	K-041	1.05
	Average	***1.08***		***Average***	***1.03***
	Std. Dev.	***0.37***		***Std. Dev.***	***0.149***
	Minimum	***0.36***		***Minimum***	***0.713***
	Maximum	***1.63***		***Maximum***	***1.19***
	Median	***1.16***		***Median***	***1.06***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the southwestern portion of the Retention Pond area resulted in an open land area consisting of an excavation approximately 80 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-003 is considered a Class 1 survey unit. The survey unit is bounded to the south and east by the Union Pacific Railroad right-of-way, to the north by Survey Unit Kaiser-FSS-005, and to the west by Survey Unit Kaiser-FSS-002 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom/Side Wall Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-003 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom, eastern side wall, and southern side wall) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-003 prior to backfill with clean import borrow material, as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 5.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

Table 5 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-003 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	dpm/100cm^2	0		0.00
TOTAL SUM OF FRACTIONS				***0.00***

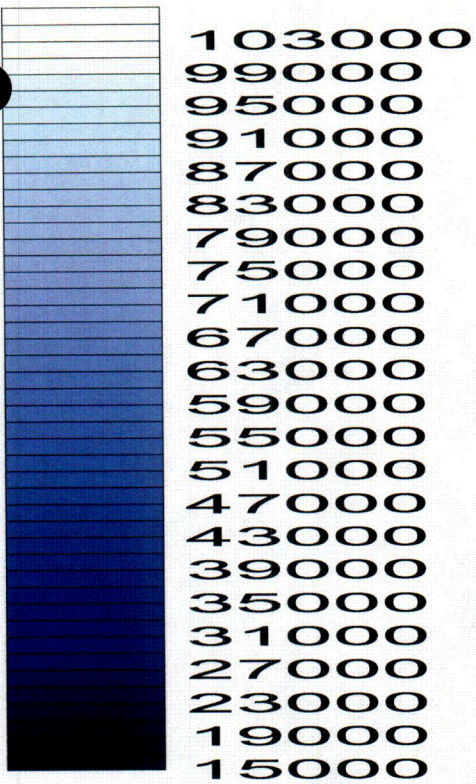
The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-003 meets the DP acceptance criteria.

ATTACHMENT A
TABLE OF CONTENTS

- **FIGURE A-1 Gross Gamma Background and Scanning Survey Results**
- **FIGURE A-2 Systematic Soil Sampling Locations**

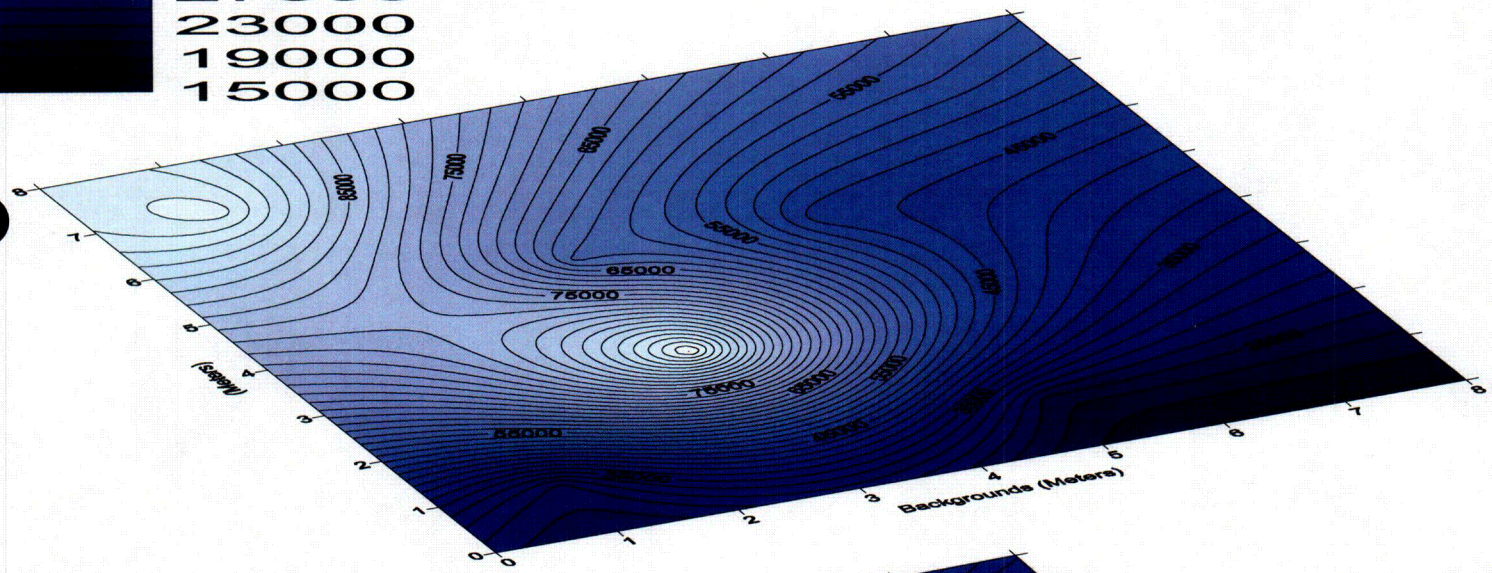
CPM NaI # 1

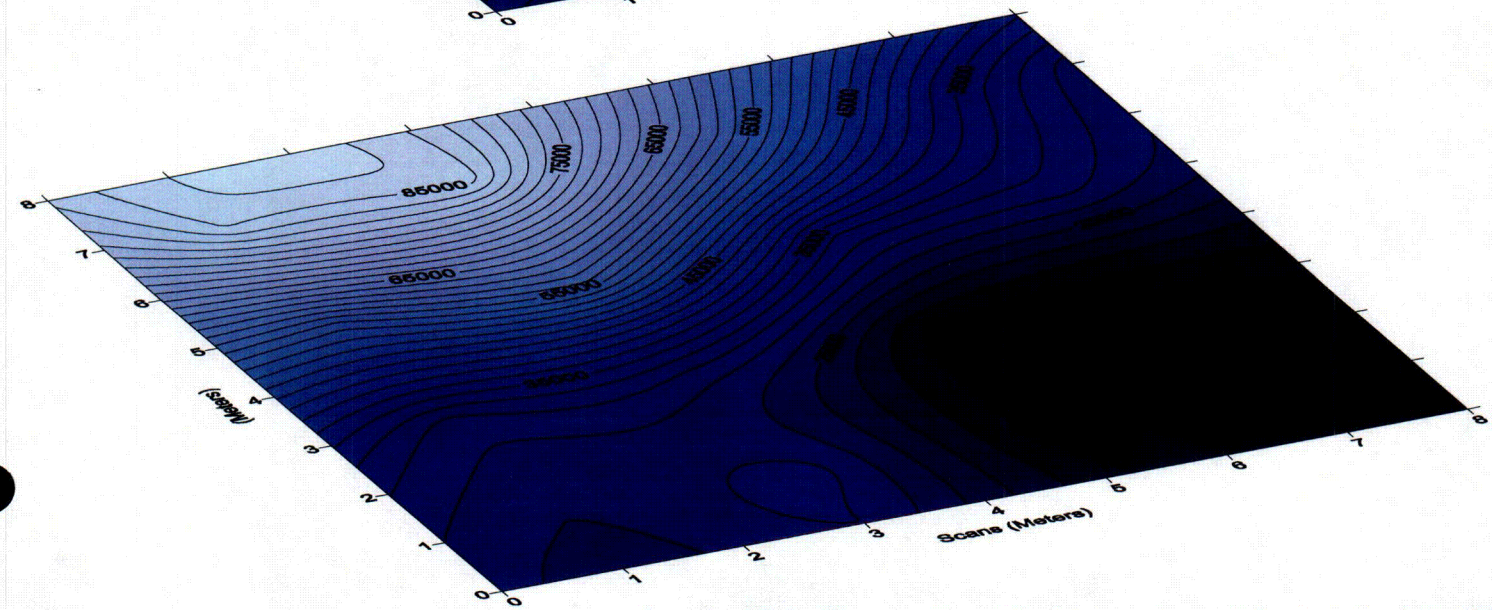
Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-003



N

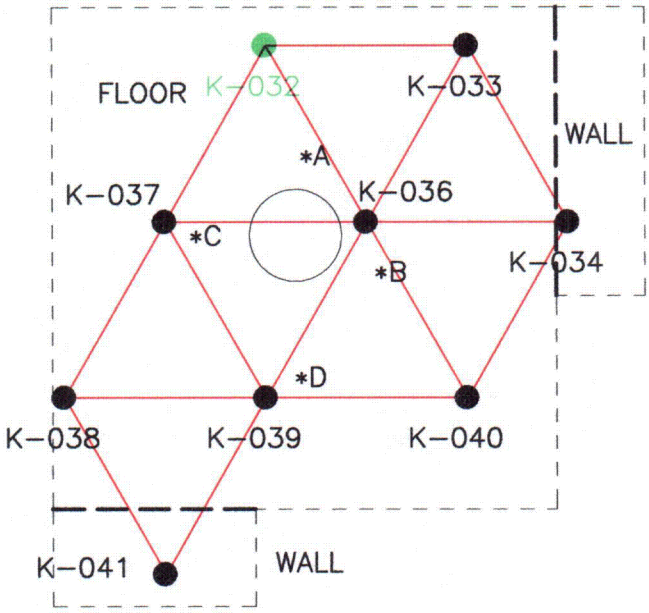
Backgrounds are 1 minute readings.

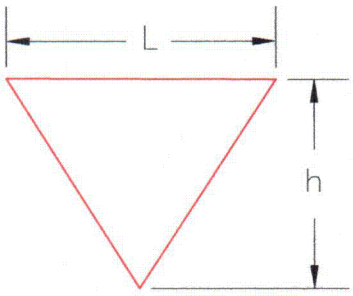




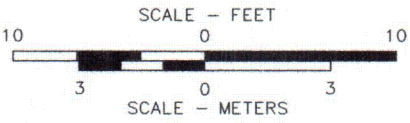
Scanning readings represent a weighted average for each 2 meter x 2 meter grid.

C11





N = 9
L = 3.2m
h = 2.8m
AREA = 80m^2



K-032
● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K-033
● RANDOM START POINT

○ UTILITY POLE/CONCRETE FOOTER

*A THROUGH D ARE BIASED SAMPLES OF SOIL AROUND THE CONCRETE FOOTING OF A UTILITY POLE (SAMPLES K-042 THROUGH K-045 RESPECTIVELY).

FIGURE A-2
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER - FSS-003
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RFD 3-3-06
CHECKED	RFD 3-3-06
DRAWN	DEB 12/27/05
DRAWING NUMBER	PA4072051

Penn E&R
Environmental & Remediation, Inc.

C12

ATTACHMENT B
TABLE OF CONTENTS

- **Soil Survey Unit Worksheet No. 1**
- **Soil Survey Unit Worksheet No. 2**

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-003

2. Description: Retention Pond Area, East of Survey Unit Kaiser-FSS-002

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – Approx. 10 meters x 8 meters; Area, A (m^2): 80

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 50,000 Minimum: 40,000 Maximum: 100,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 5.7
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 3.2 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or (L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 2.8 m.

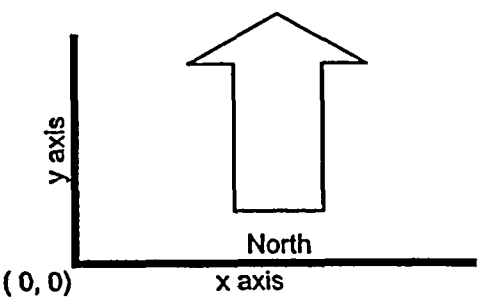
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-003

RANDOM START POINT

x axis (Meters)	y axis (Meters)
2	8

	x axis	y axis
lower bound	0	0
upper bound	10	8



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

K-082 - K-047

June 18, 2004

Invoice # 10114
D/. 6/28/04

David Weyant
Kaiser
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Tulsa
OUTREACH LAB ID: 20040412

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory June 12, 2004, for the above captioned project.

Nine soil samples were received in good condition and analyzed for Th-232 by Gamma Spec without drying and grinding with a five work day turn. Results were faxed 6/18/04.

All QC is within limits.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072
Lab Number:	2004041
Date Reported:	6/18/200
Date Received:	6/14/04
Page Number:	1 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040412-01**						
Client ID:	**K-032**						
Date Sampled:	**6/12/2004 10:35:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.878 +/- 0.064	pCi/g	0.215		6/14/2004	SD
Lab ID:	**20040412-02**						
Client ID:	**K-033**						
Date Sampled:	**6/12/2004 10:40:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.02 +/- 0.060	pCi/g	0.177		6/14/2004	SD
Lab ID:	**20040412-03**						
Client ID:	**K-034**						
Date Sampled:	**6/12/2004 10:46:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.713 +/- 0.065	pCi/g	0.194		6/14/2004	SD
Lab ID:	**20040412-04**						
Client ID:	**K-036**						
Date Sampled:	**6/12/2004 10:15:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	2.37 +/- 0.120	pCi/g	0.313		6/14/2004	SD
Lab ID:	**20040412-05**						
Client ID:	**K-037**						
Date Sampled:	**6/12/2004 10:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.11 +/- 0.078	pCi/g	0.194		6/15/2004	SD

NOT FSS Data

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072
Lab Number:	20040412
Date Reported:	6/18/2004
Date Received:	6/14/04
Page Number:	2 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040412-06**						
Client ID:	**K-042**						
Date Sampled:	**6/12/2004 10:28:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	2.64 +/- 0.131	pCi/g	0.349		6/15/2004	SD
Lab ID:	**20040412-07**						
Client ID:	**K-043**						
Date Sampled:	**6/12/2004 10:55:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.29 +/- 0.085	pCi/g	0.255		6/15/2004	SD
Lab ID:	**20040412-08**						
Client ID:	**K-036-POST**						
Date Sampled:	**6/12/2004 12:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.06 +/- 0.075	pCi/g	0.227		6/17/2004	SD

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: PA-4000-4072
Lab Number: 2004041
Date Reported: 6/18/200
Date Received: 6/14/04
Page Number: 3 of 3

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					NC				6/14/2004
Am-241		87.0	93.0	6.5					6/14/2004
Co-60		91.0	95.0	3.5					6/14/2004
Cs-137		95.0	96.0	1.3					6/14/2004

Lab Approval: _____

BDL = Below Detection Limit

SAMPLE LOGIN

Date Received: *6/14/2004 10:11:3* **Lab Number:** 20040412 **Due:** 6/18/2004

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20040412-01 A	K-032	Soil	06/12/04	Plastic	16 oz	None	No	No
Th-232 by Gamma Spec								
20040412-02 A	K-033	Soil	06/12/04	Plastic	16 oz	None	No	No
Th-232 by Gamma Spec								
20040412-03 A	K-034	Soil	06/12/04	Plastic	16 oz	None	No	No
Th-232 by Gamma Spec								
20040412-04 A	K-036	Soil	06/12/04	Plastic	16 oz	None	No	No
Th-232 by Gamma Spec								
20040412-05 A	K-037	Soil	06/12/04	Plastic	16 oz	None	No	No
Th-232 by Gamma Spec								
20040412-06 A	K-042	Soil	06/12/04	Plastic	16 oz	None	No	No
Th-232 by Gamma Spec								
20040412-07 A	K-043	Soil	06/12/04	Plastic	16 oz	None	No	No
Th-232 by Gamma Spec								
20040412-08 A	K-036-POST	Soil	06/12/04	Plastic	16 oz	None	No	No
Th-232 by Gamma Spec								

CONTAINER INSPECTION

Coolers 0 Custody Seals Broken - Y/N Temperature _____ Blue Ice / Wet Ice Radiation Survey _____fixed_____removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies: _____

Inspected By: _____ DATE 6/14/04

QA or Designee Review: Raymond Thomas DATE 06/14/04

Sample Custodian Review: _____ DATE _____

Project Notes:

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company: Kaiser Alum & Chem Inc.
Name: Attn: David B. Weyant
Local: 918-384-0516
Cell: 724-799-0671
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3520 Fax #: 918-384-3171

Bill To:
Company: Beaver / Kaiser
Name: David B. Weyant / Paul Hand
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser-Alum & Chem.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 5 DAYS
SAMPLER: Signature

ANALYSIS REQUESTED

LAB SAMPLE #	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec Th-232	MDC ≤0.5 pCi/g	Return to Client for Archive	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-032	6-12	1035	Soil	1	500ml Plastic	None	X	X	X	Grab
	K-033	6-12	1040	Soil	1			X	X	X	
	K-034	6-12	1046	Soil	1			X	X	X	
	K-036	6-12	1015	Soil	1			X	X	X	
	K-037	6-12	1020	Soil	1			X	X	X	
	K-038	6-12-04				Plastic					
	K-042	6-12	1028	Soil	1	500ml	None	X	X	X	Grab
	K-043	6-12	1055	Soil	1			X	X	X	
	K-036-Post	6-12	1200	Soil	1			X	X	X	

RELINQUISHED BY: DATE 6-12-2004 TIME 1355 RECEIVED BY: DATE 6/12/04 TIME 1355

RELINQUISHED BY: DATE TIME RECEIVED BY: DATE TIME

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

K-035 - K-048

June 16, 2004

Paul Handa
Kaiser
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Tulsa
OUTREACH LAB ID: 20040413

Dear Mr. Handa:

Please find enclosed the analytical report for your samples received in our laboratory June, 2004, for the above captioned project.

Seven soil samples were received in good condition and analyzed for Th-232 by Gamma Spec without drying and grinding with a two work day turn. Results were faxed 6/15/04.

All QC is within limits.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072
Lab Number:	20040413
Date Reported:	6/15/2004
Date Received:	6/14/04
Page Number:	1 of 2

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040413-01**						
Client ID:	**K-035**						
Date Sampled:	**6/11/2004 2:10:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	61.8 +/- 1.45	pCi/g	0.827		6/15/2004	SD
Lab ID:	**20040413-02**						
Client ID:	**K-038**						
Date Sampled:	**6/11/2004 11:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.16 +/- 0.088	pCi/g	0.279		6/14/2004	SD
Lab ID:	**20040413-03**						
Client ID:	**K-039**						
Date Sampled:	**6/11/2004 11:15:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.09 +/- 0.074	pCi/g	0.198		6/14/2004	SD
Lab ID:	**20040413-04**						
Client ID:	**K-040**						
Date Sampled:	**6/11/2004 11:18:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.19 +/- 0.069	pCi/g	0.259		6/15/2004	SD
Lab ID:	**20040413-05**						
Client ID:	**K-041**						
Date Sampled:	**6/11/2004 11:25:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.05 +/- 0.078	pCi/g	0.231		6/14/2004	SD

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072
Lab Number:	20040413
Date Reported:	6/15/2004
Date Received:	6/14/04
Page Number:	2 of 2

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20040413-06						
Client ID:	K-044						
Date Sampled:	6/11/2004 11:30:00 AM						
Matrix:	Soil						
	Radiochemical Analyses						
Th-232	HASL 300	0.974 +/- 0.086	pCi/g	0.329		6/14/2004	SD
Lab ID:	20040413-07						
Client ID:	K-045						
Date Sampled:	6/11/2004 11:35:00 AM						
Matrix:	Soil						
	Radiochemical Analyses						
Th-232	HASL 300	0.724 +/- 0.076	pCi/g	0.200		6/14/2004	SD

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					NC				6/14/2004
Am-241		87.0	93.0	6.5					6/14/2004
Co-60		91.0	95.0	3.5					6/14/2004
Cs-137		95.0	96.0	1.3					6/14/2004

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Louis H
918-384-0566
Cell 724-794-0071

Company Kaiser Alum & Chem Trc.
Name ATTN: David B. Weyant
Address 7311 E. 41st Street
City Tulsa State OK Zip 74145
Phone 724 934-3330 Fax # 918-384-2171

Bill To:
Company Trc Env/Kaiser
Name David Weyant/Paul Hanol
Address 7311 E 41st St.
City Tulsa State OK Zip 74145

ANALYSIS REQUESTED

PO # Kaiser - 4072
PROJECT # PA-4000-4072
PROJECT NAME Kaiser - Alum & Chem.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 2 Days.
SAMPLER David B. Weyant / Signature 2004

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec + Ra-226 + Th-232	MDC <0.5pCi/gm	Return to Client for Archive	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-035	6-11	1410	Soil	1	500ml Plastic	None	X	X	X	Grab
	K-038	6-11	1110	Soil	1			X	X	X	
	K-039	6-11	1115	Soil	1			X	X	X	
	K-040	6-11	1118	Soil	1			X	X	X	
	K-041	6-11	1125	Soil	1			X	X	X	
	K-044	6-11	1130	Soil	1			X	X	X	
	K-045	6-11	1135	Soil	1			X	X	X	

RELINQUISHED BY: David B. Weyant DATE 6-11-04 TIME 1700 RECEIVED BY: [signature] DATE 6/11/04 TIME 602

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: 2004.0[illegible]
Sample Condition Upon Receipt: [illegible]
Custody Seal: [illegible]
Cooler Temp: [illegible]

SUB-REPORT

SURVEY UNIT KAISER-FSS-004

TABLE OF CONTENTS

	Page
1.0 BACKGROUND	1
2.0 SURVEY ACTIVITIES AND RESULTS	2
2.1 Gross Gamma Scan	2
2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil	2
2.3 Wilcoxon Rank Sum (WRS) Testing	3
3.0 SUMMARY OF FINDINGS	5
3.1 Excavation Bottom/Side Wall Surface Soil	5
3.2 Sum of Fractions for Entire Survey Unit	5

ATTACHMENTS

ATTACHMENT A: Figure A-1 Gross Gamma Background and Scanning Survey Results
Figure A-2 Systematic Soil Sampling Locations

ATTACHMENT B: Soil Survey Unit Worksheet No. 1
Soil Survey Unit Worksheet No. 2

ATTACHMENT C: Laboratory Analytical Results

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-004
Survey Unit Kaiser-FSS-004
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-004, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the southwestern portion of the Retention Pond area. Survey Unit Kaiser-FSS-004 is considered a Class 1 survey unit with an approximate surface area of 107 m^2. This limited size survey unit was demarcated due to the presence of three wooden utility poles. The soils surrounding the utility poles were not radiologically-affected. The survey unit is bounded to the south by the Union Pacific Railroad right-of-way, to the east and north by Survey Unit Kaiser-FSS-007, and to the west by Survey Unit Kaiser-FSS-005 (**Figure 3**).

Survey Unit Kaiser-FSS-004 consists of an excavation bottom surface soil with one side wall (south wall). No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom and southern side wall surface soil of Survey Unit Kaiser-FSS-004. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom and southern side wall) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 9 approximately equal-distant locations in the survey unit. The statistics for the 9 background measurements are provided below in **Table 1.** Background measurements ranged from 36,123 counts per minute (cpm) to 75,991 cpm moving east to west within the survey unit. The scan results increase as the surveyor moves closer to impacted material located west of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 25 area-averaged measurements of gross count rate were made across the survey unit's 107 m^2 surface area. The results ranged from 25,000 cpm to 75,000 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	107 m^2	
Number of Scan Measurements (Recorded Average per 2 m^2 grid area)	25	
Scan Rate: (Swinging the detector a width of 1-meter side to side)	0.5 m/s (MARSSIM recommends 0.5m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	36,123	25,000
Maximum	75,991	75,000
Average	48,954	42,000
Standard Deviation	15,674	16,500
Median	41,623	35,000

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).

2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 (**Attachment B**). Once N was determined, the Survey Unit Area (A) of 107 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 3.7 meters and the Height of the Equilateral Triangle (h) of 3.2 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 (**Attachment B**).

A layout of the soil sampling locations is provided on **Figure A-2** contained in **Attachment A**. The soil sampling locations were demarcated in the field using a GPS unit. A total of 9 soil samples (identified as K-046 through K-054) were collected at the excavation bottom/side wall surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 2**. Analytical data reports are contained in **Attachment C**.

Table 2 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-046	1.00	0.090	0.340	0	3.0
K-047	0.689	0.103	0.183	0	3.0
K-048	0.917	0.126	0.396	0	3.0
K-049	0.983	0.129	0.416	0	3.0
K-050	0.841	0.153	0.393	0	3.0
K-051	0.873	0.115	0.306	0	3.0
K-052	1.11	0.144	0.448	0.01	3.0
K-053	1.35	0.166	0.420	0.25	3.0
K-054	0.765	0.088	0.308	0	3.0
Average	***0.948***				
Standard Dev.	***0.197***				
Minimum	***0.689***				
Maximum	***1.35***				
Median	***0.917***				

All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.35 pCi/g, which fell slightly above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 0.948 pCi/g. The standard deviation of the 9 equal-distant samples was 0.197, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (0.65 pCi/g) between the maximum survey unit soil sample activity concentration (1.35 pCi/g) and the minimum reference background area soil sample activity concentration (0.70 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 3** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 3 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	338	1.04	S1	K-046	1.00
R2	27	1.24	S2	K-047	0.689
R3	363	0.97	S3	K-048	0.917
R4	270	1.46	S4	K-049	0.983
R5	53	1.29	S5	K-050	0.841
R6	80	1.25	S6	K-051	0.873
R7	305	1.50	S7	K-052	1.11
R8	39	0.70	S8	K-053	1.35
R9	184	1.08	S9	K-054	0.765
	Average	***1.17***		***Average***	***0.948***
	Std. Dev.	***0.25***		***Std. Dev.***	***0.197***
	Minimum	***0.70***		***Minimum***	***0.689***
	Maximum	***1.50***		***Maximum***	***1.35***
	Median	***1.24***		***Median***	***0.917***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the southwestern portion of the Retention Pond area resulted in an open land area consisting of an excavation approximately 107 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-004 is considered a Class 1 survey unit. The survey unit is bounded to the south by the Union Pacific Railroad right-of-way, to the east and north by Survey Unit Kaiser-FSS-007, and to the west by Survey Unit Kaiser-FSS-005 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom/Side Wall Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-004 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom and southern side wall) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-004 prior to backfill with clean import borrow material, as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 4.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

Table 4 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

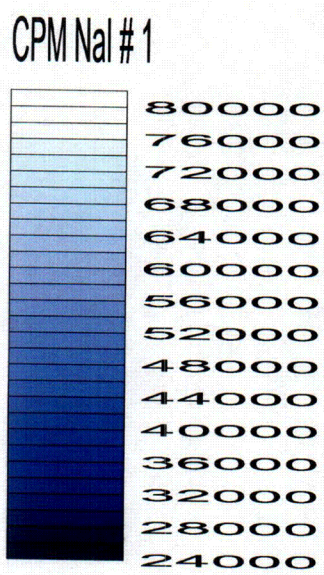
Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-004 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	dpm/100cm^2	0		0.00
TOTAL SUM OF FRACTIONS				*0.00*

The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-004 meets the DP acceptance criteria.

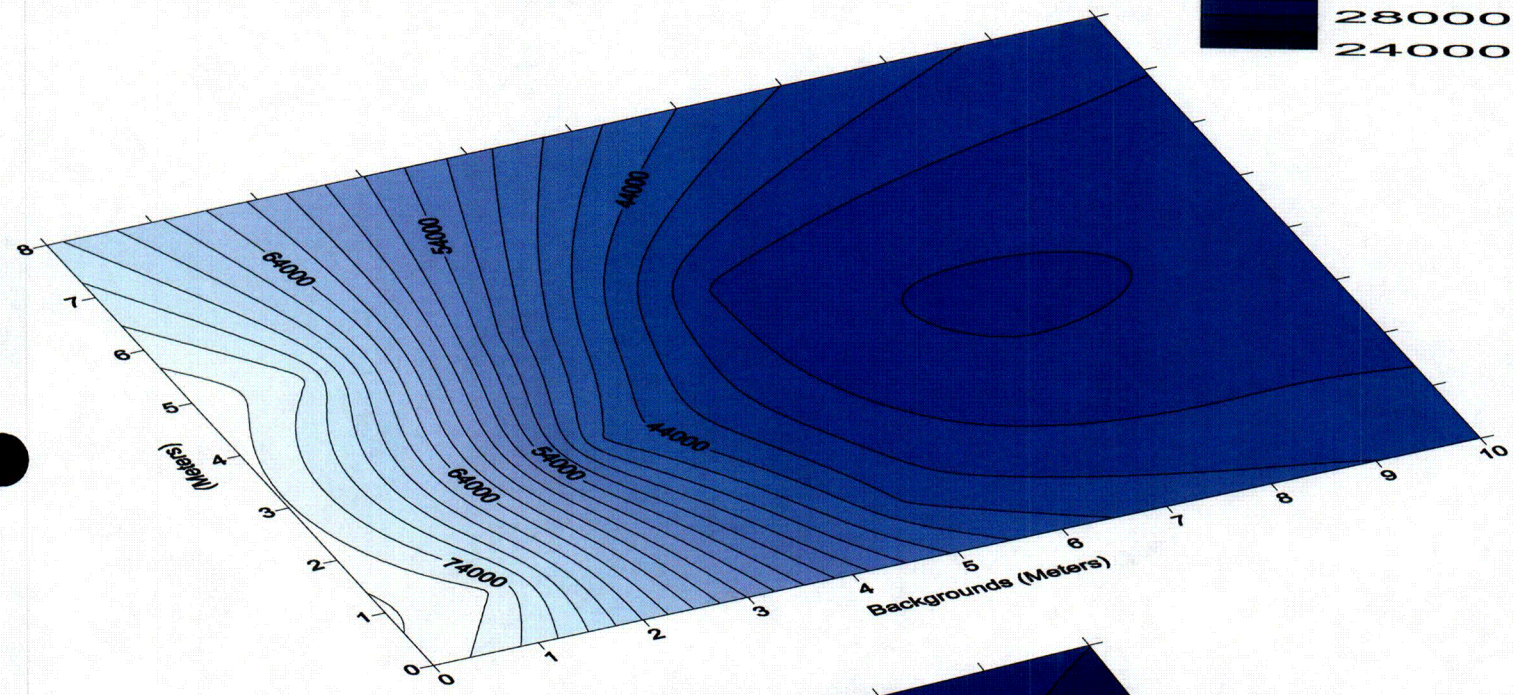
ATTACHMENT A
TABLE OF CONTENTS

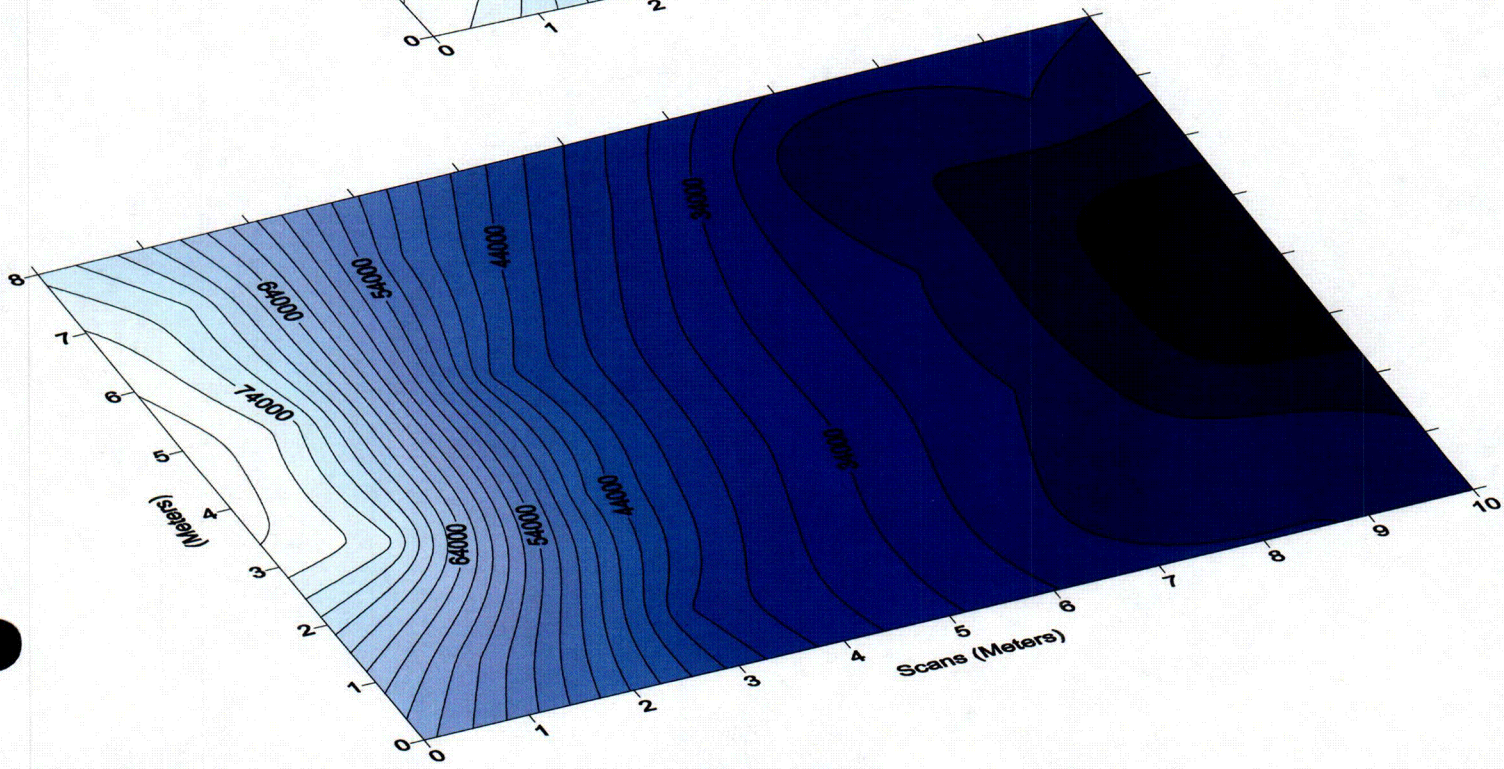
- **FIGURE A-1 Gross Gamma Background and Scanning Survey Results**
- **FIGURE A-2 Systematic Soil Sampling Locations**

Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-004



Backgrounds are 1 minute readings.





Scanning readings represent a weighted average for each 2 meter x 2 meter grid

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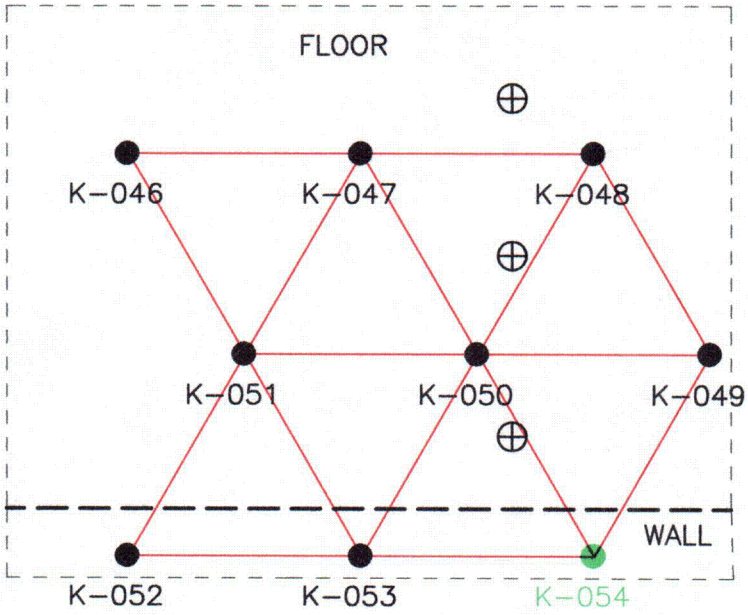

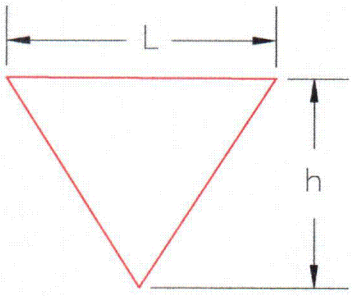

N = 9
L = 3.7m
h = 3.2m
AREA = 107m^2

SCALE – FEET
10 0 10
3 0 3
SCALE – METERS

K–046
- SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K–054
- RANDOM START POINT

⊕ WOODEN UTILITY POLE

FIGURE A–2
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS–004
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RFD 3·3·06
CHECKED	RFD 3·3·06
DRAWN	DEB 12/27/05
DRAWING NUMBER	PA4072052

Penn E&R
Environmental & Remediation, Inc.

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ATTACHMENT B
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- **Soil Survey Unit Worksheet No. 1**
- **Soil Survey Unit Worksheet No. 2**

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-004

2. Description: Retention Pond Area, East of Survey Unit Kaiser-FSS-005

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – Approx. 11.5 meters x 9 meters; Area, A (m^2): 107

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 50,000 Minimum: 40,000 Maximum: 100,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 5.7
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 3.7 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or (L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 3.2 m.

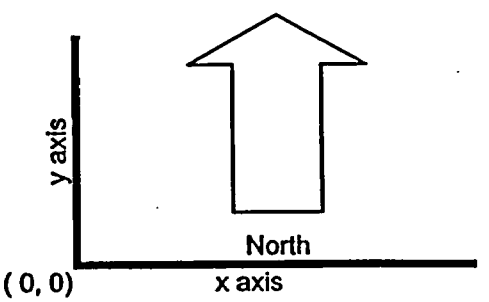
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-004

RANDOM START POINT

x axis (Meters)	y axis (Meters)
10	1

	x axis	y axis
lower bound	0	0
upper bound	11.5	9



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach
aboratory
North Aspen
oken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

K-045 - K-054

June 18, 2004

David Weyant
Kaiser
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Tulsa
OUTREACH LAB ID: 20040421

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory June 15, 2004, for the above captioned project.

Nine soil samples were received in good condition and analyzed for Th-232 by Gamma Spec without drying and grinding with a five work day turn. Results were faxed 6/18/04.

All QC is within limits.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH
nelac
CERT. ID #OK001

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Tulsa
Lab Number:	20040421
Date Reported:	6/18/2004
Date Received:	6/16/04
Page Number:	1 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040421-01**						
Client ID:	**K-046**						
Date Sampled:	**6/14/2004 3:10:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.00 +/- 0.090	pCi/g	0.340		6/17/2004	SD
Lab ID:	**20040421-02**						
Client ID:	**K-047**						
Date Sampled:	**6/14/2004 3:15:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.689 +/- 0.103	pCi/g	0.183		6/17/2004	SD
Lab ID:	**20040421-03**						
Client ID:	**K-048**						
Date Sampled:	**6/14/2004 3:21:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.917 +/- 0.126	pCi/g	0.396		6/17/2004	SD
Lab ID:	**20040421-04**						
Client ID:	**K-049**						
Date Sampled:	**6/14/2004 3:28:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.983 +/- 0.129	pCi/g	0.416		6/17/2004	SD
Lab ID:	**20040421-05**						
Client ID:	**K-050**						
Date Sampled:	**6/14/2004 3:35:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.841 +/- 0.153	pCi/g	0.393		6/17/2004	SD

BDL = Below Detection Limit

Outreach Laboratory
111 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Tulsa
Lab Number:	20040421
Date Reported:	6/18/2004
Date Received:	6/16/04
Page Number:	2 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040421-06**						
Client ID:	**K-051**						
Date Sampled:	**6/14/2004 3:42:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.873 +/- 0.115	pCi/g	0.306		6/17/2004	SD
Lab ID:	**20040421-07**						
Client ID:	**K-052**						
Date Sampled:	**6/14/2004 3:50:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.11 +/- 0.144	pCi/g	0.448		6/17/2004	SD
Lab ID:	**20040421-08**						
Client ID:	**K-053**						
Date Sampled:	**6/14/2004 4:05:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.35 +/- 0.166	pCi/g	0.420		6/17/2004	SD
Lab ID:	**20040421-09**						
Client ID:	**K-054**						
Date Sampled:	**6/14/2004 4:15:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.765 +/- 0.088	pCi/g	0.308		6/17/2004	SD

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Tulsa
Lab Number:	20040421
Date Reported:	6/18/2004
Date Received:	6/16/04
Page Number:	3 of 3

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					NC				6/17/2004
Am-241		94.0	98.0	3.4					6/17/2004
Co-60		94.0	96.0	2.2					6/17/2004
Cs-137		96.0	95.0	1.0					6/17/2004

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
LOCAL: 918-384-0566
CELL: 724-799-0071

Company: KAISER ALUM & CHEM. INC.
Name: ATTN: DAVID B. WEYANT
Address: 7311 E. 41ST STREET
City: TULSA State: OK Zip: 74145
Phone: 724-934-3530 Fax #: 918-384-3171

Bill To:
Company: PENN E&R / KAISER
Name: DAVID B. WEYANT / PAUL HAND
Address: 7311 E. 41ST STREET
City: TULSA State: OK Zip: 74145

PO #: KAISER 4072
PROJECT #: PA-4000-4072
PROJECT NAME: KAISER - Alum & Chem.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 5 DAYS
SAMPLER: [signature] Signature 2004

ANALYSIS REQUESTED

PRESERVATIVE #: 1. HNO_3 pH<2 2. Ice <4°C 3. HCl pH<2 4. H_2SO_4 pH<2 5. NaOH pH>11

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE PLASTIC OR GLASS	PRESERVATIVE	GAMMA SPEC Th-232	MOC 10% pCi/g	RETURN TO CLIENT FOR ARCHIVE	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-046	6-14	1510	SOIL	1	PLASTIC Round	NONE	X	X	X	GRAB
	K-047	6-14	1515	SOIL	1	↓	↓	X	X	X	↓
	K-048	6-14	1521	SOIL	1			X	X	X	
	K-049	6-14	1528	SOIL	1			X	X	X	
	K-050	6-14	1535	SOIL	1			X	X	X	
	K-051	6-14	1542	SOIL	1			X	X	X	
	K-052	6-14	1550	SOIL	1			X	X	X	
	K-053	6-14	1605	SOIL	1			X	X	X	
	K-054	6-14	1615	SOIL	1			X	X	X	

NA NA NA

RELINQUISHED BY: [signature] DATE: 6-15-2004 TIME: 430pm RECEIVED BY: [signature] DATE: 6/15/04 TIME: 430pm

RELINQUISHED BY: ______ DATE ______ TIME ______ RECEIVED BY: ______ DATE: ______ TIME ______

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

SAMPLE LOGIN

Date Received: *6/16/2004 11:05:1* **Lab Number:** 20040421 **Due:** 6/21/2004

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20040421-01 A	K-046	Soil	06/14/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040421-02 A	K-047	Soil	06/14/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040421-03 A	K-048	Soil	06/14/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040421-04 A	K-049	Soil	06/14/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040421-05 A	K-050	Soil	06/14/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040421-06 A	K-051	Soil	06/14/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040421-07 A	K-052	Soil	06/14/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040421-08 A	K-053	Soil	06/14/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040421-09 A	K-054	Soil	06/14/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								

CONTAINER INSPECTION

Coolers 0 Custody Seals Broken - Y/N Temperature _____ Blue Ice / Wet Ice Radiation Survey _____fixed_____removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies: _____

_____

_____

Inspected By: _____ DATE 06/16/04

QA or Designee Review: Raymond Thomas DATE 06/16/04

Sample Custodian Review: _____ DATE _____

Project Notes:

SUB-REPORT

SURVEY UNIT KAISER-FSS-005

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2.0 SURVEY ACTIVITIES AND RESULTS	2
2.1 Gross Gamma Scan	2
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2.3 Wilcoxon Rank Sum (WRS) Testing	4
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3.1 Excavation Bottom Surface Soil	6
3.2 Sum of Fractions for Entire Survey Unit	6

ATTACHMENTS

ATTACHMENT A: Figure A-1 Gross Gamma Background and Scanning Survey Results
Figure A-2 Systematic Soil Sampling Locations

ATTACHMENT B: Soil Survey Unit Worksheet No. 1
Soil Survey Unit Worksheet No. 2

ATTACHMENT C: Laboratory Analytical Results

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-005
Survey Unit Kaiser-FSS-005
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-005, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the southwestern portion of the Retention Pond area. Survey Unit Kaiser-FSS-005 is considered a Class 1 survey unit with an approximate surface area of 35 m^2. This limited size survey unit was demarcated due to the presence of guide wires from nearby utility poles. The survey unit is bounded to the south by Survey Unit Kaiser-FSS-003, to the east by Survey Unit Kaiser-FSS-004, to the north by Survey Unit Kaiser-FSS-008, and to the west by Survey Unit Kaiser-FSS-002 (**Figure 3**).

Survey Unit Kaiser-FSS-005 consists of an excavation bottom surface soil with no side walls. No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom surface soil of Survey Unit Kaiser-FSS-005. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 5 approximately equal-distant locations in the survey unit. The statistics for the 5 background measurements are provided below in **Table 1.** Background measurements ranged from 45,054 counts per minute (cpm) to 60,946 cpm moving southeast to northwest within the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the north-northwest of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 8 area-averaged measurements of gross count rate were made across the survey unit's 35 m^2 surface area. The results ranged from 43,000 cpm to 52,000 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	35 m^2	
Number of Scan Measurements (Recorded Average per 2 m^2 grid area)	8	
Scan Rate: (Swinging the detector a width of 1-meter side to side)	0.5 m/s (MARSSIM recommends 0.5m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	45,054	43,000
Maximum	60,946	52,000
Average	53,885	47,000
Standard Deviation	7,204	2,900
Median	56,261	46,500

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).

2.2 Systematic Soil Sampling – Excavation Bottom Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 (**Attachment B**). Once N was determined, the Survey Unit Area (A) of 35 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 2.1 meters and the Height of the Equilateral Triangle (h) of 1.8 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 (**Attachment B**).

A layout of the soil sampling locations is provided on **Figure A-2** contained in **Attachment A**. The soil sampling locations were demarcated in the field using a GPS unit. A total of 9 soil samples (identified as K-055 through K-063) were collected at the excavation bottom surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 2**. Analytical data reports are contained in **Attachment C**.

Table 2 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-055	0.591	0.126	0.481	0	3.0
K-056	0.752	0.112	0.236	0	3.0
K-057	2.27	0.168	0.547	1.17	3.0
K-058	1.48	0.191	0.352	0.38	3.0
K-059	0.821	0.134	0.380	0	3.0
K-060	0.960	0.146	0.429	0	3.0
K-061	0.943	0.140	0.429	0	3.0
K-062	0.818	0.120	0.438	0	3.0
K-063	1.14	0.128	0.442	0.04	3.0
Average	***1.09***				
Standard Dev.	***0.512***				
Minimum	***0.591***				
Maximum	***2.27***				
Median	***0.943***				

All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 2.27 pCi/g, which fell above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 1.09 pCi/g. The standard deviation of the 9 equal distant samples was 0.512, which fell above the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

Since the estimated variance (standard deviation) is greater than the variance used to calculate the minimum number of samples required (N), N was recalculated using the measured variance of 0.512 to ensure enough samples were taken, as follows:

Paramount to determining the minimum number of samples is the determination of the relative shift, delta over sigma (Δ/σ). Delta is equal to the DCGL minus the lower-bound gray region (LBGR) value. The LBGR value is arbitrarily set at one-half the DCGL value to start the determination. Sigma is an estimate of the variability in a set of sample analysis results from a survey unit. In the DP the estimate of sigma used was based on the standard deviations in Th-232 activity measured in survey units during the FSS sampling of the adjacent land remediation final survey (0.42). The net Th-232 activity concentration of 3.0 pCi/g was used as the DCGL and Δ was equal to 3.0 - 1.5, or 1.5. Delta divided by the sigma of 0.42 resulted in a relative shift of 3.57 which is rounded to 3.5 for the purpose of determining the required number of samples. The number of samples was then looked up in Table 5.3 of MARSSIM (9 for selected alpha and beta error rates of 0.05).

Using the original net DCGL value of 3.0 pCi/g, a recalculation of N results in a delta of (3 – 1.5) of 1.5 and a relative shift of (1.5 / 0.512) of 2.93. The resulting N for a standard Class 1 survey unit of 2,000 m^2 is 10 (MARSSIM Table 5.3). However, the number of sample values provided in MARSSIM Table 5.3 is increased 20% to account for unusable or lost data during surveys and achieve the desired power level for statistical tests (MARSSIM Section 5.5.2.2, Contaminant Present in Background – Determining Number of Data Points for Statistical Tests). Adjusting the value of 10 for the 20% buffer results in a minimum number of samples required of 8, one less than the number taken in Survey Unit Kaiser-FSS-005.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (1.66 pCi/g) between the maximum survey unit soil sample activity concentration (2.27 pCi/g) and the minimum reference background area soil sample activity concentration (0.61 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 3** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 3 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	178	0.71	S1	K-055	0.591
R2	78	1.04	S2	K-056	0.752
R3	61	0.92	S3	K-057	2.27
R4	4	0.61	S4	K-058	1.48
R5	261	1.30	S5	K-059	0.821
R6	265	1.18	S6	K-060	0.960
R7	143	1.03	S7	K-061	0.943
R8	337	1.21	S8	K-062	0.818
R9	268	2.32	S9	K-063	1.14
	Average	***1.15***		***Average***	***1.09***
	Std. Dev.	***0.50***		***Std. Dev.***	***0.512***
	Minimum	***0.61***		***Minimum***	***0.591***
	Maximum	***2.32***		***Maximum***	***2.27***
	Median	***1.04***		***Median***	***0.943***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the southwestern portion of the Retention Pond area resulted in an open land area consisting of an excavation approximately 35 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-005 is considered a Class 1 survey unit. It is bounded to the south by Survey Unit Kaiser-FSS-003, to the east by Survey Unit Kaiser-FSS-004, to the north by Survey Unit Kaiser-FSS-008, and to the west by Survey Unit Kaiser-FSS-002 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-005 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-005 prior to backfill with clean import borrow material, as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey elements average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 4.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

Table 4 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

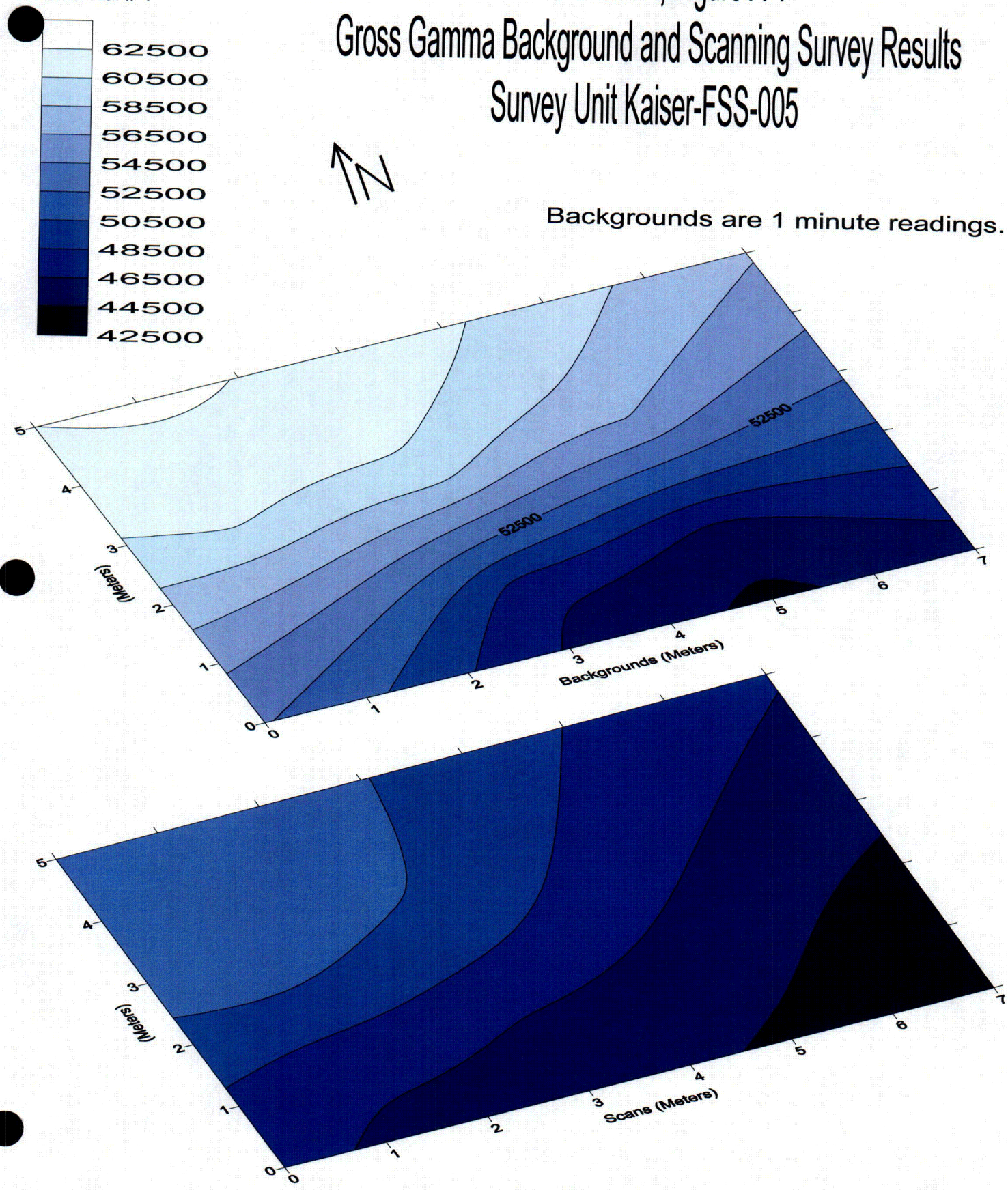
Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-005 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	dpm/100cm^2	0		0.00
TOTAL SUM OF FRACTIONS				*0.00*

The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-005 meets the DP acceptance criteria.

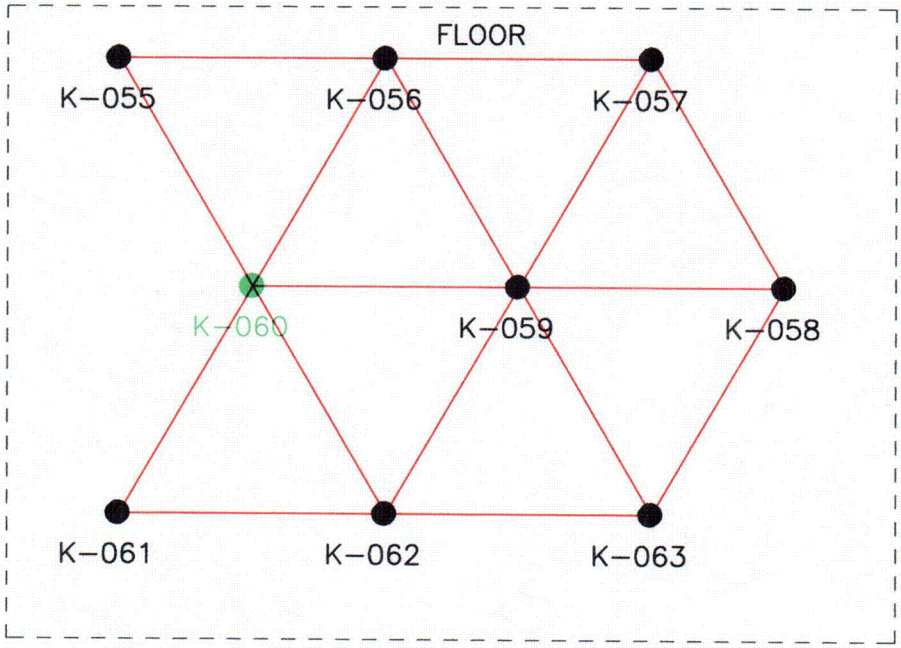
ATTACHMENT A
TABLE OF CONTENTS

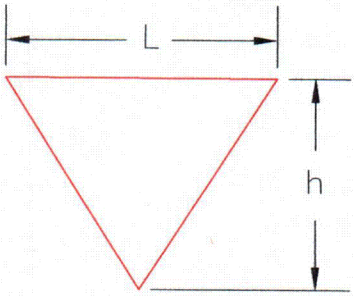
- **FIGURE A-1 Gross Gamma Background and Scanning Survey Results**
- **FIGURE A-2 Systematic Soil Sampling Locations**

Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-005



Scanning readings represent a weighted average for each 2 meter x 2 meter grid





N = 9
L = 2.1m
h = 1.8m
AREA = 35m^2

SCALE – FEET
5 0 5
1 0 1
SCALE – METERS

K–055

● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K–060

● RANDOM START POINT

FIGURE A–2
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS–005
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RFD 3·3·06
CHECKED	RFD 3·3·06
DRAWN	DEB 12/27/05
DRAWING NUMBER	PA4072053

Penn E&R
Environmental & Remediation, Inc.

ATTACHMENT B
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- **Soil Survey Unit Worksheet No. 1**
- **Soil Survey Unit Worksheet No. 2**

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-005

2. Description: Retention Pond Area, South of Survey Unit Kaiser-FSS-008

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – Approx. 7 meters x 5 meters; Area, A (m^2): 35

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 50,000 Minimum: 40,000 Maximum: 100,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 5.7
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 2.1 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or (L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 1.8 m.

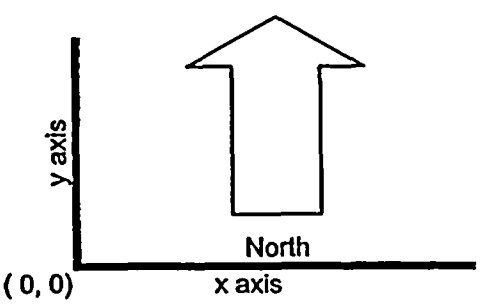
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-005

RANDOM START POINT

x axis (Meters)	y axis (Meters)
2	3

	x axis	y axis
lower bound	0	0
upper bound	7	5



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

K-055 - K-063

June 18, 2004

David Weyant
Kaiser
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Tulsa
OUTREACH LAB ID: 20040422

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory June 16, 2004, for the above captioned project.

Nine soil samples were received in good condition and analyzed for Th-232 by Gamma Spec without drying and grinding with a five work day turn. Results were faxed 6/18/04.

All QC is within limits.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac

CERT. ID #OK001

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Tulsa
Lab Number: 2004042
Date Reported: 6/18/20
Date Received: 6/16/04
Page Number: 1 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040422-01**						
Client ID:	**K-055**						
Date Sampled:	**6/15/2004 4:37:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.591 +/- 0.126	pCi/g	0.481		6/17/2004	SD
Lab ID:	**20040422-02**						
Client ID:	**K-056**						
Date Sampled:	**6/15/2004 4:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.752 +/- 0.112	pCi/g	0.236		6/17/2004	SD
Lab ID:	**20040422-03**						
Client ID:	**K-057**						
Date Sampled:	**6/15/2004 4:43:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	2.27 +/- 0.168	pCi/g	0.547		6/17/2004	SD
Lab ID:	**20040422-04**						
Client ID:	**K-058**						
Date Sampled:	**6/15/2004 4:46:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.48 +/- 0.191	pCi/g	0.352		6/17/2004	SD
Lab ID:	**20040422-05**						
Client ID:	**K-059**						
Date Sampled:	**6/15/2004 4:49:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.821 +/- 0.134	pCi/g	0.380		6/17/2004	SD

BDL = Below Detection Limit

Outreach Laboratory
111 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Tulsa
Lab Number:	20040422
Date Reported:	6/18/2004
Date Received:	6/16/04
Page Number:	2 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040422-06**						
Client ID:	**K-060**						
Date Sampled:	**6/15/2004 4:51:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.960 +/- 0.146	pCi/g	0.429		6/17/2004	SD
Lab ID:	**20040422-07**						
Client ID:	**K-061**						
Date Sampled:	**6/15/2004 4:54:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.943 +/- 0.140	pCi/g	0.429		6/17/2004	SD
Lab ID:	**20040422-08**						
Client ID:	**K-062**						
Date Sampled:	**6/15/2004 4:57:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.818 +/- 0.120	pCi/g	0.438		6/17/2004	SD
Lab ID:	**20040422-09**						
Client ID:	**K-063**						
Date Sampled:	**6/15/2004 5:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.14 +/- 0.128	pCi/g	0.442		6/17/2004	SD

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Tulsa
Lab Number:	20040422
Date Reported:	6/18/200
Date Received:	6/16/04
Page Number:	3 of 3

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					NC				6/17/2004
Am-241		94.0	98.0	3.4					6/17/2004
Co-60		94.0	96.0	2.2					6/17/2004
Cs-137		96.0	95.0	1.0					6/17/2004

Lab Approval:

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
LOCAL # 918-384-0516
CELL 724-799-0071

Company KAISER Alum & Chem INC.
Name ATTN: DAVID B. WEYANT
Address 7311 E. 41ST STREET
City TULSA State OK Zip 74145
Phone 724-934-3536 Fax # 918-384-3171

Bill To:
Company PEAPEAR / KAISER
Name DAVID B. WEYANT/PAM PARDA
Address 7311 E. 41ST ST
City TULSA State OK Zip 74145

ANALYSIS REQUESTED

PO # KAISER-4072
PROJECT # PA-4000-4072
PROJECT NAME KAISER-Alum & Chem.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 5 DAYS
SAMPLER Signature

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec 1k-237	MDC < 0.05 pCi/gm	Return to client for Archive						REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-055	6-15	1637	SOIL	1	500ml PLASTIC	NONE	X	X	X						GRAB
	K-056		1640		1			X	X	X						
	K-057		1643		1			X	X	X						
	K-058		1646		1			X	X	X						
	K-059		1649		1			X	X	X						
	K-060		1651		1			X	X	X						
	K-061		1654		1			X	X	X						
	K-062		1657		1			X	X	X						
	K-063		1700		1			X	X	X						

RELINQUISHED BY: DATE 6-16 TIME 810 RECEIVED BY: DATE 6/16/16 TIME 810

RELINQUISHED BY: DATE TIME RECEIVED BY: DATE TIME

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: 2.0°C

SAMPLE LOGIN

Date Received: *6/16/2004 11:11:2* **Lab Number:** 20040422 **Due:** 6/21/2004

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20040422-01 A	K-055	Soil	06/15/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040422-02 A	K-056	Soil	06/15/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040422-03 A	K-057	Soil	06/15/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040422-04 A	K-058	Soil	06/15/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040422-05 A	K-059	Soil	06/15/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040422-06 A	K-060	Soil	06/15/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040422-07 A	K-061	Soil	06/15/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040422-08 A	K-062	Soil	06/15/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								
20040422-09 A	K-063	Soil	06/15/04	Plastic	16 oz	None	Yes	Yes
Th-232 by Gamma Spec								

CONTAINER INSPECTION

Coolers 0 Custody Seals Broken - Y/N Temperature _____ Blue Ice / Wet Ice Radiation Survey _____fixed_____removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N NO Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

6/16/04

Anomalies: _____

Inspected By: _____ DATE 6/16/04

QA or Designee Review: Raymond Thomas DATE 06/16/04

Sample Custodian Review: _____ DATE _____

Project Notes:

SUB-REPORT

SURVEY UNIT KAISER-FSS-006

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2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil	3
2.3 Wilcoxon Rank Sum (WRS) Testing	4
3.0 SUMMARY OF FINDINGS	6
3.1 Excavation Bottom/Side Wall Surface Soil	6
3.2 Sum of Fractions for Entire Survey Unit	6

ATTACHMENTS

ATTACHMENT A: Figure A-1 Gross Gamma Background and Scanning Survey Results
Figure A-2 Systematic Soil Sampling Locations

ATTACHMENT B: Soil Survey Unit Worksheet No. 1
Soil Survey Unit Worksheet No. 2

ATTACHMENT C: Laboratory Analytical Results

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-006
Survey Unit Kaiser-FSS-006
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-006, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the northwestern corner of the Retention Pond area. Survey Unit Kaiser-FSS-006 is considered a Class 1 survey unit with an approximate surface area of 2,670 m^2. It is bounded to the south by Survey Units Kaiser-FSS-010 and Kaiser-FSS-011, to the east by Survey Unit Kaiser-FSS-022, to the north by Fulton Creek, and to the west by the former freshwater pond non-impacted area (**Figure 3**).

Survey Unit Kaiser-FSS-006 consists of an excavation bottom surface soil with two side walls (north wall and west wall). No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom, northern side wall, and the western side wall surface soil of Survey Unit Kaiser-FSS-006. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom, northern side wall, and western side wall) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 30 approximately equal-distant locations in the survey unit. The statistics for the 30 background measurements are provided below in **Table 1.** Background measurements ranged from 12,465 counts per minute (cpm) to 24,597 cpm moving northwest to southeast within the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the east-southeast of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 7,551 measurements of gross count rate were made at one second intervals across the survey unit's 2,670 m^2 surface area. The results ranged from 11,814 cpm to 30,131 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	2,670 m^2	
Number of Scan Measurements (1-Second Intervals)	7,551	
Scan Rate: (Swinging the detector a width of 1-meter side to side)	0.35 m/s (MARSSIM recommends 0.5m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	12,465	11,814
Maximum	24,597	30,131
Average	16,348	16,903
Standard Deviation	2,637	2,168
Median	15,573	16,488

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site). As part of the gross gamma survey, 1 biased soil sample was collected at a

location exhibiting the highest scan rate on the excavation bottom (**Figure A-2, Attachment A**). The biased soil sample was forwarded to Outreach for analysis of Th-232 activity concentration. The analytical result is provided below in **Table 2**. The biased soil sample result was below the $DCGL_W$ for the site.

Table 2 – Biased Soil Sample Analytical Result

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)
$DCGL_W$	*3.0*		
Site Background	*1.1*	*0.3*	
K-108	1.20	0.139	0.422

2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 (**Attachment B**). The default Class 1 survey unit area of 2,000 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 16.0 meters and the Height of the Equilateral Triangle (h) of 13.9 meters. Since A was greater than 2,000 m^2, the number of samples (N_1) was recalculated (12) to correspond to the L of 16.0 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 (**Attachment B**).

A layout of the soil sampling locations is provided on **Figure A-2** contained in **Attachment A**. The soil sampling locations were demarcated in the field using a GPS unit. A total of 12 soil samples (identified as K-064 through K-075) were collected at the excavation bottom/side wall surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3**. Analytical data reports are contained in **Attachment C**.

Table 3 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-064	1.22	0.150	0.375	0.12	3.0
K-065	0.997	0.145	0.498	0	3.0
K-066	1.40	0.093	0.458	0.3	3.0
K-067	0826	0.106	0.321	0	3.0
K-068	0.576	0.111	0.327	0	3.0
K-069	0.600	0.094	0.448	0	3.0
K-070	0.840	0.143	0.409	0	3.0
K-071	0.843	0.150	0.297	0	3.0
K-072	0.817	0.111	0.407	0	3.0
K-073	0.880	0.103	0.273	0	3.0
K-074	0.807	0.115	0.356	0	3.0
K-075	0.834	0.135	0.495	0	3.0
Average	***0.887***				
Standard Dev.	***0.231***				
Minimum	***0.576***				
Maximum	***1.40***				
Median	***0.837***				

All 12 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.40 pCi/g, which fell slightly above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 0.887 pCi/g. The standard deviation of the 12 equal-distant samples was 0.231, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (0.85 pCi/g) between the maximum survey unit soil sample activity concentration (1.40 pCi/g) and the minimum reference background area soil sample activity concentration (0.55 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	160	1.20	S1	K-064	1.22
R2	192	1.32	S2	K-065	0.997
R3	263	1.54	S3	K-066	1.40
R4	132	1.48	S4	K-067	0826
R5	331	0.55	S5	K-068	0.576
R6	113	1.28	S6	K-069	0.600
R7	374	0.95	S7	K-070	0.840
R8	265	1.18	S8	K-071	0.843
R9	82	1.43	S9	K-072	0.817
R10	327	1.32	S10	K-073	0.880
R11	129	0.93	S11	K-074	0.807
R12	309	2.04	S12	K-075	0.834
	Average	***1.27***		***Average***	***0.887***
	Std. Dev.	***0.37***		***Std. Dev.***	***0.231***
	Minimum	***0.55***		***Minimum***	***0.576***
	Maximum	***2.04***		***Maximum***	***1.40***
	Median	***1.30***		***Median***	***0.837***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the northwestern corner of the Retention Pond area resulted in an open land area consisting of an excavation approximately 2,670 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-006 is considered a Class 1 survey unit. It is bounded to the south by Survey Units Kaiser-FSS-010 and Kaiser-FSS-011, to the east by Survey Unit Kaiser-FSS-022, to the north by Fulton Creek, and to the west by the former freshwater pond non-impacted area (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom/Side Wall Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-006 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom, northern side wall, and western side wall) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 12 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-006 prior to backfill with below criteria material (BCM), as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey elements average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 5.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

Table 5 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

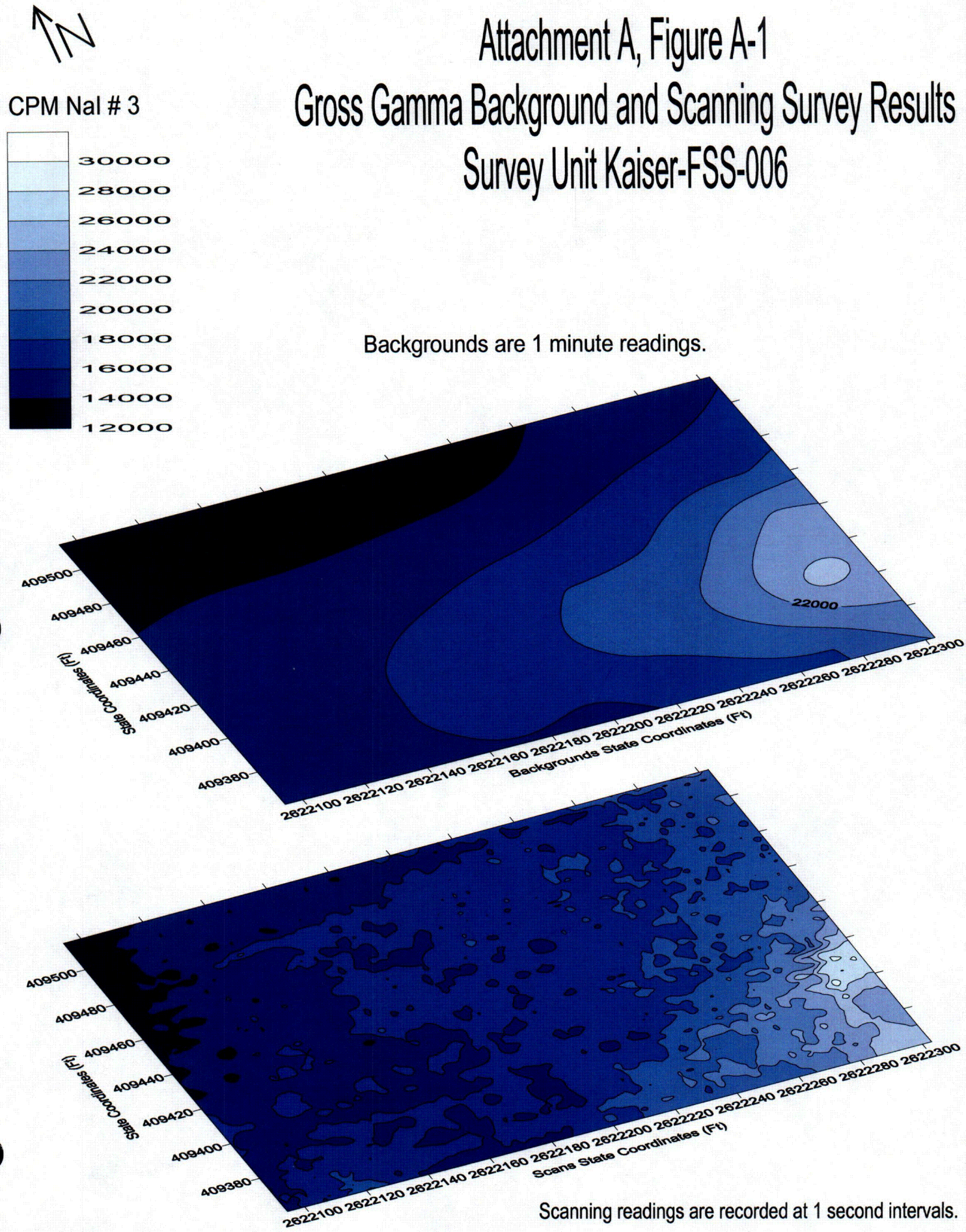
Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-006 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	dpm/100cm^2	0		0.00
TOTAL SUM OF FRACTIONS				***0.00***

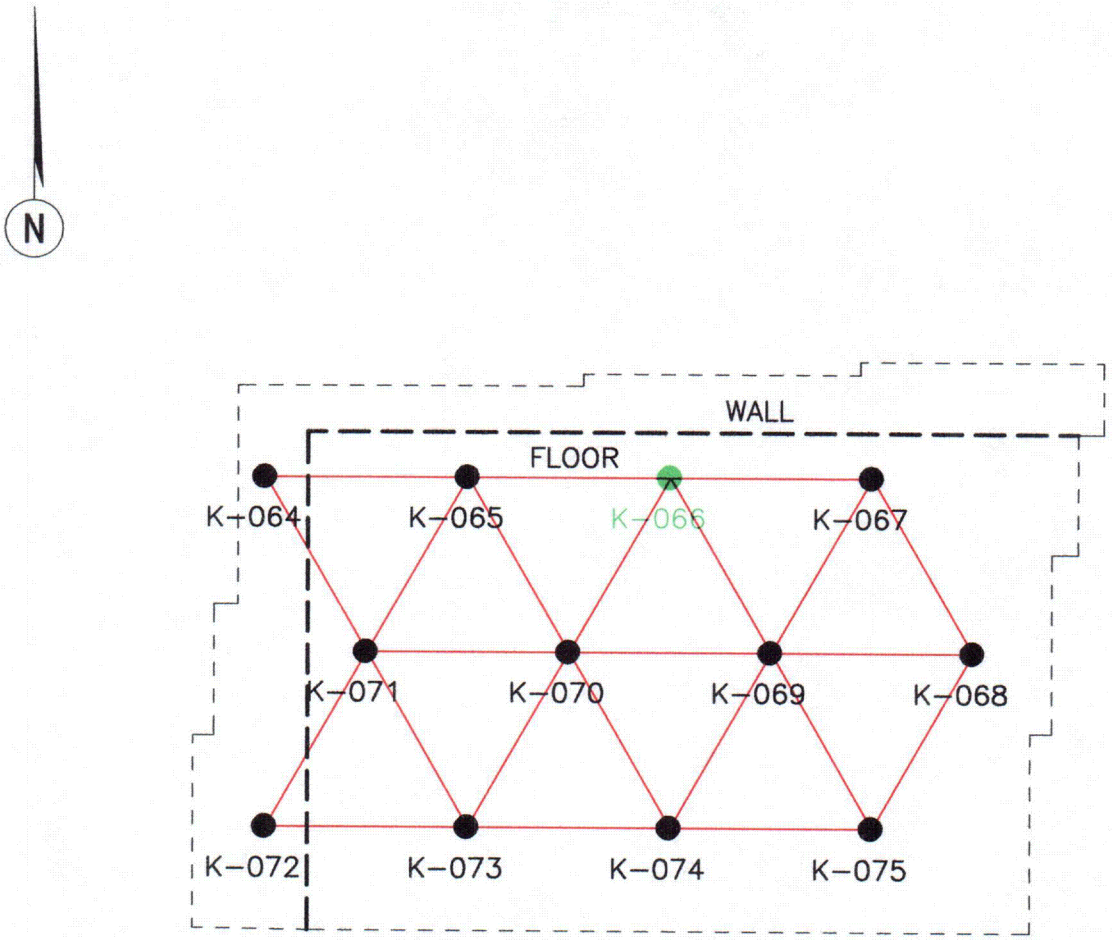
The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-006 meets the DP acceptance criteria.

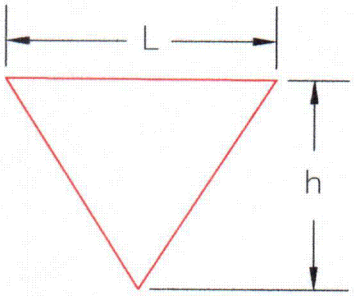
ATTACHMENT A
TABLE OF CONTENTS

- **FIGURE A-1 Gross Gamma Background and Scanning Survey Results**
- **FIGURE A-2 Systematic Soil Sampling Locations**

Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-006







N = 12
L = 16m
h = 13.9m
AREA = 2,670m^2

SCALE - FEET
50 0 50
12 0 12
SCALE - METERS

K-064
- SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K-066
- RANDOM START POINT

FIGURE A-2
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER - FSS-006
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RFD 3.3.06
CHECKED	RFD 3.3.06
DRAWN	DEB 12/27/05
DRAWING NUMBER	PA4072054

Penn E&R
Environmental & Remediation, Inc.

C-18

ATTACHMENT B
TABLE OF CONTENTS

- **Soil Survey Unit Worksheet No. 1**
- **Soil Survey Unit Worksheet No. 2**

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-006

2. Description: Retention Pond Area, West of Survey Unit Kaiser-FSS-022

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – Approx. 65 meters x 42 meters; Area, A (m^2): 2,670

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: N/A

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: 12

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or (L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 13.9 m.

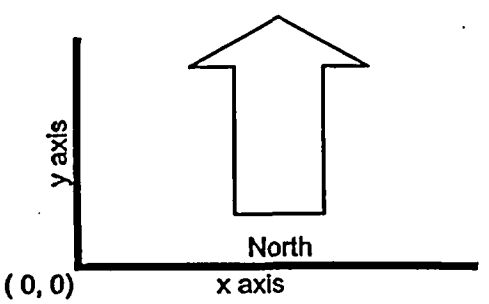
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-006

RANDOM START POINT

x axis (Meters)	y axis (Meters)
37	36

	x axis	y axis
lower bound	0	0
upper bound	65	42



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Invoice # 10178 7/19/2004

K-064 → K-078 ; K-107

July 19, 2004

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20040506

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory July 14, 2004 for the above captioned project.

Thirteen soil samples were received in good condition and analyzed for Th-232 by Gamma Spec and Percent Moisture without drying and grinding with a 5 work day turn. Gamma Spec results were faxed early on 7/16/04.

All QC is within control limits. The samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
.1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation PA4000
Lab Number: 20040506
Date Reported: 7/16/200
Date Received: 7/14/04
Page Number: 1 of 4

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040506-01**						
Client ID:	**K-064**						
Date Sampled:	**7/13/2004 3:30:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.22 +/- 0.150	pCi/g	0.375		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	13.6	%		7/14/2004	7/15/2004	RT
Lab ID:	**20040506-02**						
Client ID:	**K-065**						
Date Sampled:	**7/13/2004 3:35:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.997 +/- 0.145	pCi/g	0.498		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	11.1	%		7/14/2004	7/15/2004	RT
Lab ID:	**20040506-03**						
Client ID:	**K-066**						
Date Sampled:	**7/13/2004 4:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.40 +/- 0.093	pCi/g	0.458		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	11.1	%		7/14/2004	7/15/2004	RT
Lab ID:	**20040506-04**						
Client ID:	**K-067**						
Date Sampled:	**7/13/2004 4:05:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.826 +/- 0.106	pCi/g	0.321		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	16.1	%		7/14/2004	7/15/2004	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation PA4000
Lab Number:	20040506
Date Reported:	7/16/2004
Date Received:	7/14/04
Page Number:	2 of 4

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20040506-05						
Client ID:	K-068						
Date Sampled:	7/13/2004 4:10:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.576 +/- 0.111	pCi/g	0.327		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	17.5	%		7/14/2004	7/15/2004	RT
Lab ID:	20040506-06						
Client ID:	K-069						
Date Sampled:	7/13/2004 4:15:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.600 +/- 0.094	pCi/g	0.448		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	14.3	%		7/14/2004	7/15/2004	RT
Lab ID:	20040506-07						
Client ID:	K-070						
Date Sampled:	7/13/2004 4:20:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.840 +/- 0.143	pCi/g	0.409		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	10.5	%		7/14/2004	7/15/2004	RT
Lab ID:	20040506-08						
Client ID:	K-071						
Date Sampled:	7/13/2004 4:28:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.843 +/- 0.150	pCi/g	0.297		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	9.2	%		7/14/2004	7/15/2004	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation PA4000
Lab Number: 20040506
Date Reported: 7/16/2004
Date Received: 7/14/04

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040506-09**						
Client ID:	**K-072**						
Date Sampled:	**7/13/2004 4:35:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.817 +/- 0.111	pCi/g	0.407		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	17.1	%		7/14/2004	7/15/2004	RT
Lab ID:	**20040506-10**						
Client ID:	**K-073**						
Date Sampled:	**7/13/2004 4:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.880 +/- 0.103	pCi/g	0.273		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	9.3	%		7/14/2004	7/15/2004	RT
Lab ID:	**20040506-11**						
Client ID:	**K-074**						
Date Sampled:	**7/13/2004 4:50:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.807 +/- 0.115	pCi/g	0.356		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	13.4	%		7/14/2004	7/15/2004	RT
Lab ID:	**20040506-12**						
Client ID:	**K-075**						
Date Sampled:	**7/13/2004 4:55:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.834 +/- 0.135	pCi/g	0.495		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	14.7	%		7/14/2004	7/15/2004	RT

BDL = Below Detection Limit

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation PA4000
Lab Number: 20040506
Date Reported: 7/16/2004
Date Received: 7/14/04
Page Number: 4 of 4

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20040506-13						
Client ID:	K-107						
Date Sampled:	7/13/2004 3:00:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	18.6 +/- 0.613	pCi/g	0.866		7/14/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	27.8	%		7/14/2004	7/15/2004	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Am-241		116.0	89.0	25.8					7/14/2004
Co-60		95.0	93.0	2.9					7/14/2004
Cs-137		96.0	96.0	0.0					7/14/2004
Percent Moisture					3.9				7/15/2004
Th-232					3.8				7/14/2004

Lab Approval:

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company: Kaiser-Alum & Chem Inc.
Name: David B. Weyant
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3530 Fax #: 918-384-3171
Local: 918-384-0565
Cell: 724-799-0071

Bill To:
Company: Kaiser/Penn & Inc
Name: David B. Weyant / Paul Hanna
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser Thorium Remediation
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 5 DAY
SAMPLER: David B. Weyant / Brad Baker
Signature

ANALYSIS REQUESTED

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec (Th-232)	Radon Sample + Client for Archive	MDC 20.5 pCi/gm	MDC 7.0 pCi/gm	ASTM D2216, 92 Moisture Content					REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
1	K-064	7-13	15:30	Soil	1	500ml Plastic	None	X	X	X		X					Grab
2	K-065	"	15:35	"	1	"	"	X	X	X							"
3	K-066	"	16:00	"	1	"	"	X	X	X							"
4	K-067	"	16:05	"	1	"	"	X	X	X							"
5	K-068	"	16:10	"	1	"	"	X	X	X							"
6	K-069	"	16:15	"	1	"	"	X	X	X							"
7	K-070	"	16:20	"	1	"	"	X	X	X							"
8	K-071	"	16:28	"	1	"	"	X	X	X							"
9	K-072	"	16:35	"	1	"	"	X	X	X							"
10	K-073	"	16:40	"	1	"	"	X	X	X							"
11	K-074	"	16:50	"	1	"	"	X	X	X							"
12	K-075	"	16:55	"	1	"	"	X	X	X							"
13	K-107	"	15:00	"	1	"	"	X	X		X						"
14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

RELINQUISHED BY: David B. Weyant DATE 7-14-2004 TIME 820 RECEIVED BY: _____ DATE 7/14/04 TIME 820

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY

SAMPLE LOGIN

Date Received: *7/14/2004 10:56:3* **Lab Number:** 20040506 **Due:** 7/21/2004

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20040506-01 A	K-064	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040506-02 A	K-065	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040506-03 A	K-066	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040506-04 A	K-067	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040506-05 A	K-068	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040506-06 A	K-069	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040506-07 A	K-070	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040506-08 A	K-071	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes

Percent Moisture Th-232 by Gamma Spec								
20040506-09 A	K-072	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture Th-232 by Gamma Spec								
20040506-10 A	K-073	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture Th-232 by Gamma Spec								
20040506-11 A	K-074	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture Th-232 by Gamma Spec								
20040506-12 A	K-075	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture Th-232 by Gamma Spec								
20040506-13 A	K-107	Soil	07/13/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture Th-232 by Gamma Spec								

CONTAINER INSPECTION

Coolers 2 hand Custody Seals Broken - Y/N Temperature _____ Blue Ice / Wet Ice Radiation Survey _____fixed_____removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies: _____

Inspected By: _____ DATE 7/14/04

QA or Designee Review: _____ DATE 7/14/04

Sample Custodian Review: _____ DATE 7/14/04

Project Notes:

Outreach
Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Invoice # 10182 dated 7/20/2004

K-103, K-109

July 21, 2004

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20040508

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory July 15, 2004 for the above captioned project.

Two soil samples were received in good condition and analyzed for Th-232 by Gamma Spec and Percent Moisture without drying and grinding with a 5 work day turn. Results were faxed early.

All QC is within control limits. The samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH
CERT. ID #OK001

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation PA4000-4072
Lab Number:	20040508
Date Reported:	7/20/04
Date Received:	7/15/04
Page Number:	1 of 1

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040508-01**						
Client ID:	**K-103**						
Date Sampled:	**7/14/04 1:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.568 +/- 0.072	pCi/g	0.190		7/15/04	SD
		Inorganics Analyses					
Percent Moisture	LOD	14.2	%			7/16/04	RE
Lab ID:	**20040508-02**						
Client ID:	**K-108**						
Date Sampled:	**7/14/04 2:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.20 +/- 0.139	pCi/g	0.422		7/15/04	SD
		Inorganics Analyses					
Percent Moisture	LOD	16.2	%			7/16/04	RE

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Am-241		90.0	113.0	22.0					7/15/04
Co-60		91.0	95.0	4.5					7/15/04
Cs-137		95.0	97.0	2.0					7/15/04
Percent Moisture					3.5				7/16/04
Th-232					NC				7/15/04

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: Local: 918-384-0566 Cell-734-799-0071

Company: Kaiser-Alum & Chem. Inc.
Name: David B. Weyant
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145
Phone: 774-934-3530 Fax #: 918-384-3171

Bill To:

Company: Kaiser/Penn E&R
Name: David B. Weyant/Paul Hanna
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser-Thorium Remediation
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 5 DAY
SAMPLER: David B. Weyant (Signature)

CHECKED BY	CLIENT SAMPLE ID	DATE SAMPLED (2004)	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE (PLASTIC OR GLASS) Plastic	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec (Th-232)	Gamma Spec (Th-232) + Split for Archive	MOC Co. 5' Pellet	ASTM D2216.92 Moisture Content					REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-107.3'	7-14	1300	Soil	1	500 ml	None	X	X	X	X					GRAB
	K-108(5')	7-14	1400	"	1	"	"	X	X	X	X					"

N/A

RELINQUISHED BY: David B. Weyant DATE: 7/14/04 TIME: 527 RECEIVED BY: [signature] DATE: 7/14/04 TIME: 527

RELINQUISHED BY: ______ DATE: ______ TIME: ______ RECEIVED BY: ______ DATE: ______ TIME: ______

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally [illegible] for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to [illegible]ch Technologies, Inc. (Outreach Laboratory).

SAMPLE RETU[illegible]SPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be [illegible]d at client's expense.

FOR LABORATORY USE ONLY: 2004 0505

Sample Condition Upon Receipt: Good
Custody Seals Intact: (Y) N
Cooler Temperature: Amb.

SAMPLE LOGIN

Date Received: *7/15/2004 10:58:4* Lab Number: 20040508 Due: 7/22/2004

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20040508-01 A	K-103	Soil	07/14/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040508-02 A	K-108	Soil	07/14/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								

CONTAINER INSPECTION

Coolers ~~1~~ 1 and Custody Seals Broken - Y(N) Temperature AMB Blue Ice / Wet Ice Radiation Survey WDKE fixed _____ removable

SAMPLE INSPECTION

Custody Seals Broken - Y(N) Chain of Custody Record (Y)N Labels in Tact (Y)N Radiation Survey Complete (Y)N

Anomalies: _____

Inspected By: _____ DATE 07/15/04

QA or Designee Review: _____ DATE 07/15/04

Sample Custodian Review: _____ DATE 07/15/04

Project Notes:

SUB-REPORT

SURVEY UNIT KAISER-FSS-007

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ATTACHMENTS

ATTACHMENT A: Figure A-1 Gross Gamma Background and Scanning Survey Results
Figure A-2 Systematic Soil Sampling Locations

ATTACHMENT B: Soil Survey Unit Worksheet No. 1
Soil Survey Unit Worksheet No. 2

ATTACHMENT C: Laboratory Analytical Results

ATTACHMENT D: Figure D-1 Embedded Structure Location Map
Alpha Scan MDC Calculation
Table D-1 Embedded Structure Gross Alpha Scan Results
Total Alpha Contamination Survey Data Conversion Form

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-007
Survey Unit Kaiser-FSS-007
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-007, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the southern portion of the Retention Pond area. Survey Unit Kaiser-FSS-007 is considered a Class 1 survey unit with an approximate surface area of 1,182 m^2. The survey unit is bounded to the south by the Union Pacific Railroad right-of-way, to the west by Survey Units Kaiser-FSS-004 and Kaiser-FSS-008, to the east by Survey Unit Kaiser-FSS-030, and to the north by Survey Unit Kaiser-FSS-012 (**Figure 3**).

Survey Unit Kaiser-FSS-007 consists of an excavation bottom surface soil with one side wall (south wall). Another feature or element of the survey unit is an approximate 14-meter long by 1.22-meter wide by 4.6-meter deep trench oriented west to east in the northwestern corner of the unit. The trench is associated with a groundwater collection system installed for the remediation project. No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. During the removal of the radiologically-affected soil, one embedded "structure" was encountered and left in-place along the south wall of the excavation. The structure was identified as a 10-foot long by 24-inch diameter concrete pipe.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the following physical features or elements of Survey Unit Kaiser-FSS-007:

- Excavation bottom surface soil, including the south wall surface soil,
- Surface soil associated with the approximate 14-meter long by 1.22-meter wide by 4.6-meter deep trench oriented west to east in the northwestern corner of the unit, and
- An embedded structure (concrete pipe) remaining in the south wall of the survey unit.

2.1 Excavation Bottom/Side Wall Surface Soil

The final status survey of the excavation bottom and side wall surface soil consisted of a gross gamma scan of the exposed surface soil and systematic soil sampling. The trench was surveyed through a gross gamma scan of the removed materials and composite soil sampling of the exposed surface soil.

2.1.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom and southern side wall) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 – 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 10 approximately equal-distant locations within the survey unit. The statistics for the 10 background measurements are provided below in **Table 1.** Background measurements ranged from 13,520 counts per minute (cpm) to 20,803 cpm moving west to east within the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the east of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 4,048 measurements of gross count rate were made at one second intervals across the survey unit's 1,182 m^2 surface area. The results ranged from 11,352 cpm to 31,690 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	1,182 m^2	
Number of Scan Measurements (1-Second Intervals)	4,048	
Scan Rate: (Swinging the detector a width of 1-meter side to side)	0.29 m/s (MARSSIM recommends 0.5m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	13,520	11,352
Maximum	20,803	31,690
Average	18,834	18,655
Standard Deviation	2,077	1,946
Median	18,943	18,511

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).

The soil associated with the approximate 14-meter long by 1.22-meter wide by 4.6-meter deep trench was surveyed (in the excavator bucket) as it was removed. The gross gamma scan results for the excavated trench soil ranged from 14,000 to 16,000 cpm which were similar to the measured background gross gamma reading for the trenching activities of 16,000 cpm.

2.1.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 **(Attachment B).** The Survey Unit Area (A) of 1,182 m^2 and sample number of 9 were used to calculate the Triangular Grid Node Length (L) of 12.3 meters and the Height of the Equilateral Triangle (h) of 10.7 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 **(Attachment B).**

A layout of the soil sampling locations is provided on **Figure A-2** contained in **Attachment A.** The soil sample locations were demarcated in the field using a GPS unit. A total of 16 soil samples (identified as K-078 through K-086, K-088 through K-093, and K-097) were collected at the excavation bottom/side wall surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 2.** Analytical data reports are contained in **Attachment C.**

Table 2 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-078	0.969	0.126	0.458	0	3.0
K-079	1.05	0.239	0.323	0	3.0
K-080	1.31	0.218	0.132	0.21	3.0
K-081	0.890	0.139	0.393	0	3.0
K-082	0.781	0.139	0.201	0	3.0
K-083	0.593	0.120	0.346	0	3.0
K-084	0.694	0.077	0.219	0	3.0
K-085	0.792	0.153	0.398	0	3.0
K-086	2.22	0.192	0.392	1.12	3.0
K-088	1.07	0.177	0.184	0	3.0
K-089	0.908	0.150	0.441	0	3.0
K-090	0.801	0.200	0.174	0	3.0
K-091	0.737	0.076	0.139	0	3.0
K-092	0.725	0.120	0.478	0	3.0
K-093	1.18	0.163	0.222	0.08	3.0
K-097	1.02	0.157	0.481	0	3.0
Average	***0.995***				
Standard Dev.	***0.377***				
Minimum	***0.593***				
Maximum	***2.22***				
Median	***0.932***				

All 16 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 2.22 pCi/g, which fell above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 0.995 pCi/g. The standard deviation of the 16 equal-distant samples was 0.377, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

The trench was also sampled as part of the FSS. Three composite samples were taken: one from the north wall of the trench, one from the trench bottom/east wall, and one from the south wall of the trench (Samples K-094, K-095 and K-096 respectively). The three composite samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3**. The results for the three composite samples were below the $DCGL_W$ for the site.

Table 3 – Trench Composite Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-094	0.694	0.104	0.334	0	3.0
K-095	0.646	0.116	0.366	0	3.0
K-096	0.651	0.110	0.415	0	3.0

2.1.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (1.67 pCi/g) between the maximum survey unit soil sample activity concentration (2.22 pCi/g) and the minimum reference background area soil sample activity concentration (0.55 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	195	1.48	S1	K-078	0.969
R2	10	0.57	S2	K-079	1.05
R3	331	0.55	S3	K-080	1.31
R4	356	1.45	S4	K-081	0.890
R5	246	1.46	S5	K-082	0.781
R6	161	1.20	S6	K-083	0.593
R7	71	1.07	S7	K-084	0.694
R8	48	1.10	S8	K-085	0.792
R9	222	1.19	S9	K-086	2.22
R10	366	0.99	S10	K-088	1.07
R11	103	1.12	S11	K-089	0.908
R12	18	0.60	S12	K-090	0.801
R13	46	0.58	S13	K-091	0.737
R14	347	0.90	S14	K-092	0.725
R15	188	1.25	S15	K-093	1.18
R16	280	1.17	S16	K-097	1.02
	Average	***1.04***		***Average***	***0.995***
	Standard Dev.	***0.32***		***Standard Dev.***	***0.377***
	Minimum	***0.55***		***Minimum***	***0.593***
	Maximum	***1.48***		***Maximum***	***2.22***
	Median	***1.11***		***Median***	***0.932***

2.2 Embedded Structure

As previously noted, one embedded "structure" (a 10-foot long by 24-inch diameter concrete pipe) was encountered along the south wall of the excavation (**Figure D-1, Attachment D**). The structure was surveyed and sampled in-place. A description of the survey and sample activities used to evaluate any potential exposure from the structure is presented in this section.

The supporting documentation for the surveying and sampling of the Survey Unit Kaiser-FSS-007 embedded structure is contained in **Attachment D** and includes the following:

- **Figure D-1,** Embedded Structure Location Map
- Alpha Scan MDC Calculation Form
- Total Alpha Contamination Survey Data Conversion Form
- **Table D-1,** Embedded Structure Gross Alpha Scan Results

The pipe was surveyed through scanning and static counts for total alpha contamination and sampling (smear) for removable alpha contamination. No elevated areas were detected during scanning. Scan results are provided in **Attachment D, Table D-1.** Two static counts to determine total alpha contamination were taken at the highest scan result for the top and the bottom inside surfaces of the pipe. Corresponding smear samples of removable alpha contamination were also taken at the same locations (K-SS-041 and K-SS-042). The results of the total and removable alpha contamination measurements are presented below in **Table 5.**

Table 5 – Concrete Pipe Total and Removable Alpha Contamination Results

Sample ID	$DCGL_W$ (dpm/100cm^2)	Alpha (dpm/100cm^2)	Std. Error (dpm/100cm^2)	MDC (dpm/100cm^2)
Total Contamination				
Static Count Bottom	944	64.3	45.4	68.3
Static Count Top	944	3.57	35.0	68.3
Removable Contamination				
K-SS-041	94.4	0.355	0.466	0.360
K-SS-042	94.4	0.0	0.406	0.475

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the southern portion of the Retention Pond area resulted in an open land area consisting of an excavation approximately 1,182 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-007 is considered a Class 1 survey unit. The survey unit is bounded to the south by the Union Pacific Railroad right-of-way, to the west by Survey Units Kaiser-FSS-004 and Kaiser-FSS-008, to the east by Survey Unit Kaiser-FSS-030, and to the north by Survey Unit Kaiser-FSS-012 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit including an identified embedded structure (concrete pipe).

3.1 Excavation Bottom/Side Wall Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the DCGLw of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-007 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom and southern side wall) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 16 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

The results of the final status survey activities associated with the trench were as follows:

- The gross gamma scan of the excavated trench soil did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All three composite soil sample results were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-007 prior to backfill with clean import borrow material, as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively

is presented below in **Table 6.** As previously mentioned, no elevated areas were left in-place for the survey unit.

Table 6 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

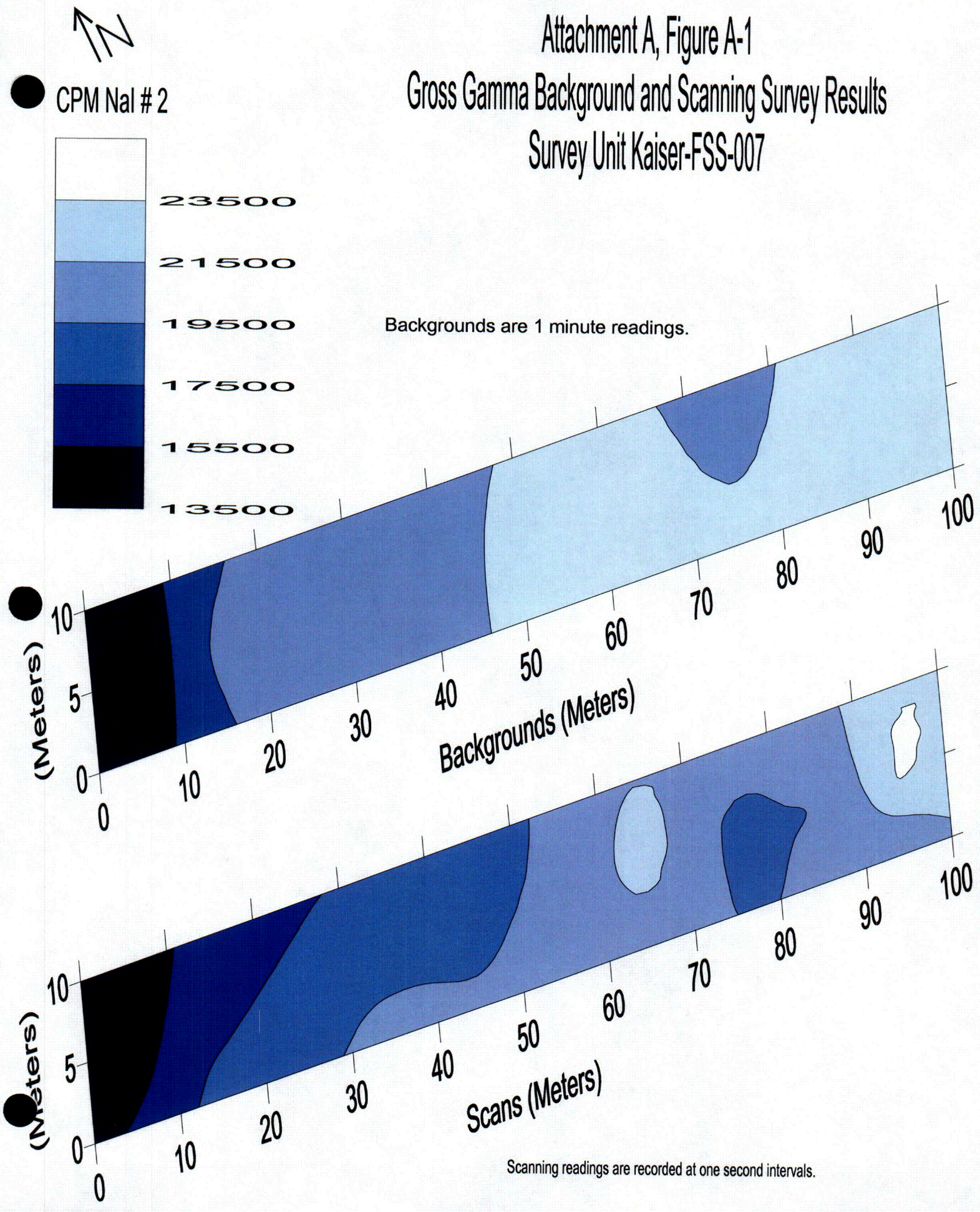
Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-007 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
Concrete Pipe (Removable Contamination)	dpm/100cm^2	0.178	94.4	0.00
Concrete Pipe (Total Contamination)	dpm/100cm^2	33.9	944	0.04
TOTAL SUM OF FRACTIONS				***0.04***

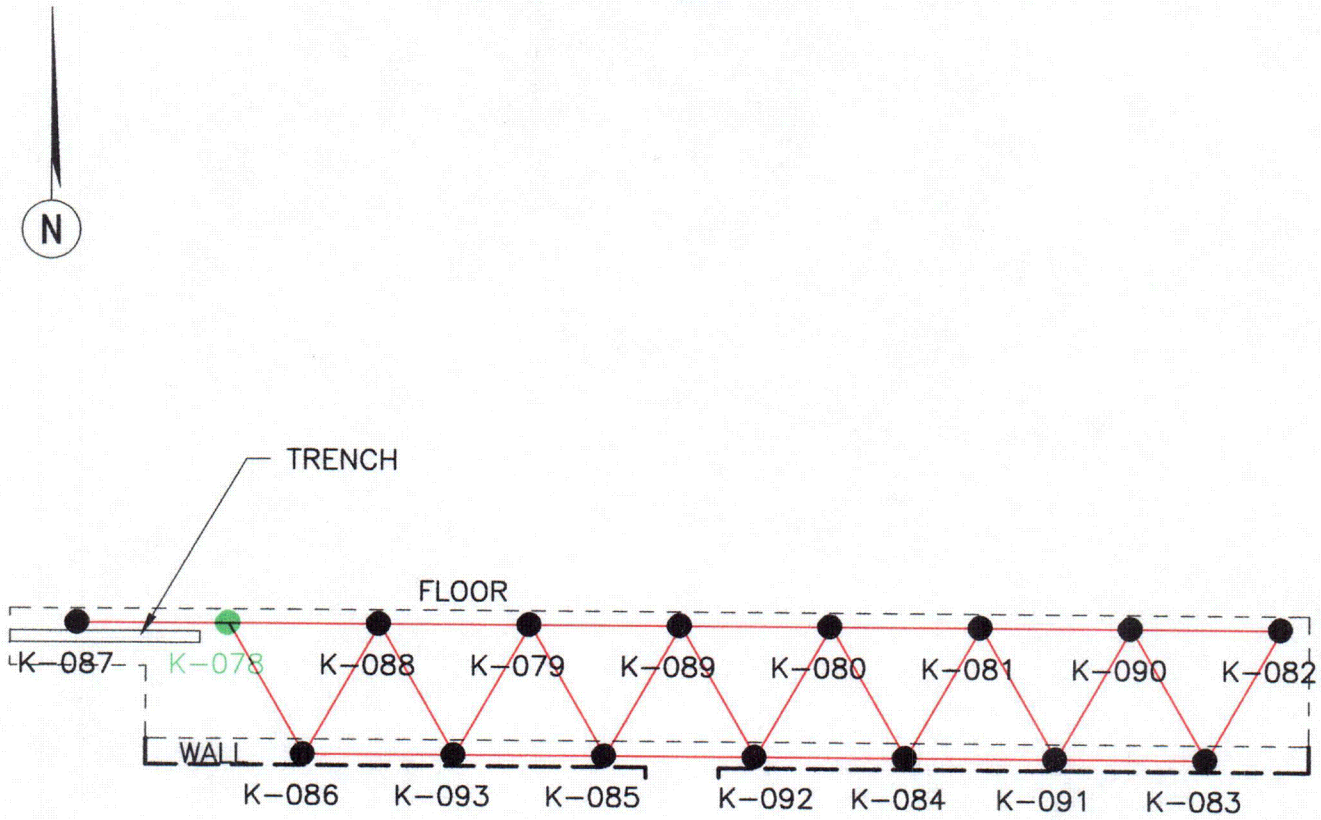
The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-007 meets the DP acceptance criteria.

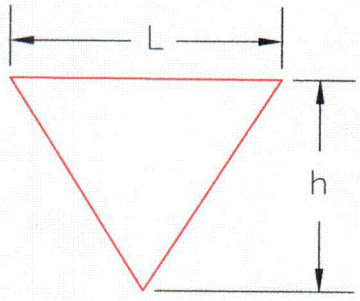
ATTACHMENT A
TABLE OF CONTENTS

- **FIGURE A-1 Gross Gamma Background and Scanning Survey Results**
- **FIGURE A-2 Systematic Soil Sampling Locations**

Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-007







N = 9
L = 12.3m
h = 10.7m
AREA = 1,182m^2

SCALE – FEET
50 0 50
12 0 12
SCALE – METERS

K–079

● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K–078

● RANDOM START POINT

FIGURE A–2
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS–007
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RAD 5.3.06
CHECKED	RAD 3.3.06
DRAWN	DEB 12/27/05
DRAWING NUMBER	PA4072055

Penn E&R
Environmental & Remediation, Inc.

ATTACHMENT B
TABLE OF CONTENTS

- **Soil Survey Unit Worksheet No. 1**
- **Soil Survey Unit Worksheet No. 2**

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-007

2. Description: Retention Pond Area, South of Survey Unit Kaiser-FSS-012

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – Approx. 102.5 meters x 11.5 meters; Area, A (m^2): 1,182

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 12.3 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or (L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 10.7 m.

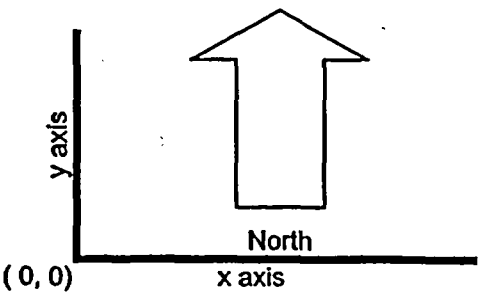
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-007

RANDOM START POINT

x axis (Meters)	y axis (Meters)
17	11

	x axis	y axis
lower bound	0	0
upper bound	102.5	11.5



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
1 North Aspen
oken Arrow, OK 74012
918) 251-2515
FAX (918) 251-0008

K-078|081|089|092|093.

July 2, 2004

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20040466

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory June 30, 2004 for the above captioned project.

Five soil samples were received in good condition and analyzed for Th-232 by Gamma Spec and Percent Moisture without drying and grinding with a 2 work day turn. Results were faxed on 7/02/04.

All QC is within control limits. The samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: PA-4000-4072
Lab Number: 20040466
Date Reported: 7/2/2004
Date Received: 7/1/04

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040466-01**						
Client ID:	**K-078**						
Date Sampled:	**6/28/2004 2:50:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.969 +/- 0.126	pCi/g	0.458		7/1/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	17.9	%		7/1/2004	7/2/2004	RT
Lab ID:	**20040466-02**						
Client ID:	**K-081**						
Date Sampled:	**6/28/2004 3:20:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.890 +/- 0.139	pCi/g	0.393		7/1/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	17.0	%		7/1/2004	7/2/2004	RT
Lab ID:	**20040466-03**						
Client ID:	**K-089**						
Date Sampled:	**6/29/2004 3:28:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.908 +/- 0.150	pCi/g	0.441		7/1/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	18.4	%		7/1/2004	7/2/2004	RT
Lab ID:	**20040466-04**						
Client ID:	**K-092**						
Date Sampled:	**6/29/2004 3:50:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.725 +/- 0.120	pCi/g	0.478		7/1/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	16.8	%		7/1/2004	7/2/2004	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
oken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072
Lab Number:	20040466
Date Reported:	7/2/2004
Date Received:	7/1/04
Page Number:	2 of 2

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20040466-05						
Client ID:	K-093						
Date Sampled:	6/29/2004 4:00:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	1.18 +/- 0.163	pCi/g	0.222		7/1/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	16.8	%		7/1/2004	7/2/2004	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					NC				7/1/2004
Am-241		119.0	95.0	22.4					7/1/2004
Co-60		94.0	97.0	2.8					7/1/2004
Cs-137		96.0	99.0	2.9					7/1/2004
Percent Moisture					0.3				7/2/2004

Lab Approval:

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
LOCAL: 918-384-0566
CELL 724-799-0071

Company KAISER - ALUM & CHEM CORP.
Name ATTN: DAVID R. WEYANT
Address 7311 E. 41ST STREET
City TULSA State OK Zip 74145
Phone 724-934-3530 Fax # 918-384-3171

Bill To:
Company KAISER / PEAK ERC
Name DAVID R. WEYANT / PAUL HANDA
Address 7311 E. 41ST STREET
City TULSA State OK Zip 74145

ANALYSIS REQUESTED

PO # KAISER - 4072
PROJECT # PA - 4000 - 4072
PROJECT NAME KAISER - THORIUM REMEDIATION
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) ~~5 DAY~~ DR→ 6-30-04 2 DAY
SAMPLER DAVID R. WEYANT Signature 2004 DAN BAKER

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GAMMA SPEC (Th-232)	RETURN SAMPLE to Client for ARCHIVE	MDC < 0.5 pCi/g	ASTM 2216-92 MOISTURE CONTENT	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-078	6-28	14:50	SOIL	1	500ml PLASTIC	NONE	X	X	X	X	GRAB
	K-081	6-28	15:20		1			X	X	X	X	
	K-089	6-29	15:28		1			X	X	X	X	
	K-092	6-29	15:50		1			X	X	X	X	
	K-093	6-29	16:00		1			X	X	X	X	

RELINQUISHED BY: _____ DATE 6-30-2004 TIME 1750 RECEIVED BY: _____ DATE 6/30/04 TIME 1750

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURNAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY

SAMPLE LOGIN

Date Received: *7/1/2004 12:21:18* **Lab Number:** 20040466 **Due:** 7/2/2004

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20040466-01 A	K-078	Soil	06/28/04	Plastic	500 ml	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040466-02 A	K-081	Soil	06/28/04	Plastic	500 ml	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040466-03 A	K-089	Soil	06/29/04	Plastic	500 ml	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040466-04 A	K-092	Soil	06/29/04	Plastic	500 ml	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040466-05 A	K-093	Soil	06/29/04	Plastic	500 ml	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								

CONTAINER INSPECTION

Coolers 0 Custody Seals Broken - Y/N Temperature _____ Blue Ice / Wet Ice Radiation Survey _____fixed_____removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies: _____

_____

_____

Inspected By: _____ DATE 6 7/1/04 6/30/04

QA or Designee Review: SD DATE 7/1/04

Sample Custodian Review: _____ DATE _____

Project Notes:

Outreach
Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

K-083
K-084 | 085 | 086
Invoice- 10123 ✓

July 5, 2004

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20040457

Dear Mr. Weyant:

Please find enclosed an amended analytical report for your samples received in our laboratory June 28, 2004 for the above captioned project.

The Total Solids number was reported instead of the Percent Moisture number. The correct results now appear on your report. Nothing else has changed.

All QC is within control limits. The samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach
Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072 Thorium Remed
Lab Number:	20040457
Date Reported:	7/5/2004
Date Received:	6/28/04
Page Number:	1 of 2

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040457-01**						
Client ID:	**K-084**						
Date Sampled:	**6/25/2004 2:45:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.694 +/- 0.077	pCi/g	0.219		6/28/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	16.7	%		6/29/2004	6/30/2004	RT
Lab ID:	**20040457-02**						
Client ID:	**K-085**						
Date Sampled:	**6/25/2004 3:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.792 +/- 0.153	pCi/g	0.398		6/28/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	18.2	%		6/29/2004	6/30/2004	RT
Lab ID:	**20040457-03**						
Client ID:	**K-086**						
Date Sampled:	**6/25/2004 3:15:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	2.22 +/- 0.192	pCi/g	0.392		6/28/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	16.8	%		6/29/2004	6/30/2004	RT
Lab ID:	**20040457-04**						
Client ID:	**K-083**						
Date Sampled:	**6/25/2004 2:30:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.593 +/- 0.120	pCi/g	0.346		6/28/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	18.1	%		6/29/2004	6/30/2004	RT

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072 Thorium Remed
Lab Number:	20040457
Date Reported:	7/5/2004
Date Received:	6/28/04
Page Number:	2 of 2

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					1.3				6/28/2004
Am-241		99.0	103.0	3.3					6/28/2004
Co-60		93.0	100.0	8.1					6/28/2004
Cs-137		96.0	98.0	1.6					6/28/2004
Percent Moisture					21.5				6/30/2004

Lab Approval:

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: Local 918-384-0586 Cell: 724-799-6071
Company: Kaiser Alum. & Chem. Inc.
Name: Attn: David B. Weydal
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3530 Fax #: 918-384-3171

Bill To:
Company: Kaiser/Penn ENR
Name: David B. Weydal / Paul Hasch
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: Kaiser - 4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser Thorium Remediation
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): *
SAMPLER Signature: David B. Weydal / Daniel Baker

CONTAINER SIZE: PLASTIC OR GLASS

PRESERVATIVE #: 1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE	PRESERVATIVE	Gamma Spec (Th-232)	Return samples + client for archive	MDC ≤0.5 pCi/g	ASTM D2216-92 moisture content	2 DAY * TAT	10 DAY * TAT			REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
[illegible]	K-084	6-25-04	14:45	Soil	1	Plastic 500ml	None	X	X	X	X	X				Grab
	K-085	|	15:00	|	1	|	|	X	X	X	X	X				|
	K-086	|	15:15	|	1	|	|	X	X	X	X	X				|
	K-087	6-26-04	10:10	|	1	|	|	X	X	X			X			Composite Ranked.
	K-083	6-25-04	14:30	Soil	1	|	|	X	X	X	X	X				Grab

N/A

RELINQUISHED BY: David B. Weydal / [signature] DATE: 6-26-2004 TIME: 745 RECEIVED BY: [signature] DATE: 6/28/04 TIME: 745

RELINQUISHED BY: DATE: TIME: RECEIVED BY: DATE: TIME:

FOR LABORATORY USE ONLY: 2004[illegible]

Outreach
Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

K-094 through K-097

Invoice # 10143 dt- 7/6/2004
Processed

July 6, 2004

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20040472

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory July 1, 2004 for the above captioned project.

Four soil samples were received in good condition and analyzed for Th-232 by Gamma Spec and Percent Moisture without drying and grinding with a 2 work day turn. Gamma Spec results were faxed on 7/03/04.

All QC is within control limits. The samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach
boratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072
Lab Number:	20040472
Date Reported:	7/6/2004
Date Received:	7/2/04
Page Number:	1 of 2

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040472-01**						
Client ID:	**K-094**						
Date Sampled:	**7/1/2004 1:50:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.694 +/- 0.104	pCi/g	0.334		7/2/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	19.3	%		7/2/2004	7/6/2004	RT
Lab ID:	**20040472-02**						
Client ID:	**K-095**						
Date Sampled:	**7/1/2004 2:05:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.646 +/- 0.116	pCi/g	0.366		7/2/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	20.2	%		7/2/2004	7/6/2004	RT
Lab ID:	**20040472-03**						
Client ID:	**K-096**						
Date Sampled:	**7/1/2004 2:15:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.651 +/- 0.110	pCi/g	0.415		7/2/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	15.9	%		7/2/2004	7/6/2004	RT
Lab ID:	**20040472-04**						
Client ID:	**K-097**						
Date Sampled:	**7/1/2004 2:30:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.02 +/- 0.157	pCi/g	0.481		7/2/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	13.1	%		7/2/2004	7/6/2004	RT

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: PA-4000-4072
Lab Number: 20040472
Date Reported: 7/6/2004
Date Received: 7/2/04

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					NC				7/1/2004
Am-241		119.0	95.0	22.4					7/1/2004
Co-60		94.0	97.0	2.8					7/1/2004
Cs-137		96.0	99.0	2.9					7/1/2004
Percent Moisture					1.6				7/6/2004

Lab Approval: 

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
LOCAL: 918-384-0566
Cell: 724-799-0071
Company: Kaiser Alum & Chem Inc.
Name: Attn: David B. Weyant
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3536 Fax #: 918-384-3171

Bill To:
Company: Kaiser / Pearl Eyre /
Name: David B. Weyant / Pat Hand
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser-Thorium Remediation
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 2 DAY
SAMPLER: David B. Weyant
Signature
2004

ANALYSIS REQUESTED

LAB SAMPLE #	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec (Th-232)	Return Sample to Client for Archive	MDC <0.5 pCi/gm	ASTM D2216-92 (Moisture Content)	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-094	7-1	13:50	SOIL	1	500ml Plastic	None	X	X	X	X	7-1-04 Grab Composite
	K-095	7-1	14:05		1			X	X	X	X	
	K-096	7-1	14:15		1			X	X	X	X	
	K-097	7-1	14:30		1			X	X	X	X	Composite Grab 7-1-04

RELINQUISHED BY: David B. Weyant DATE 7-1-04 TIME 1715 RECEIVED BY: DATE 7-1-04 TIME 1715

RELINQUISHED BY: DATE TIME RECEIVED BY: DATE TIME

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURNAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY

SAMPLE LOGIN

Date Received: *7/2/2004 9:41:56* **Lab Number:** 20040472 **Due:** 7/6/2004

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20040472-01 A	K-094	Soil	07/01/04	Plastic	16 oz	None	No	No
Percent Moisture								
Th-232 by Gamma Spec								
20040472-02 A	K-095	Soil	07/01/04	Plastic	16 oz	None	No	No
Percent Moisture								
Th-232 by Gamma Spec								
20040472-03 A	K-096	Soil	07/01/04	Plastic	16 oz	None	No	No
Percent Moisture								
Th-232 by Gamma Spec								
20040472-04 A	K-097	Soil	07/01/04	Plastic	16 oz	None	No	No
Percent Moisture								
Th-232 by Gamma Spec								

CONTAINER INSPECTION

Coolers 1 Custody Seals Broken - Y/N (HAND) Temperature NA Blue Ice / Wet Ice Radiation Survey _____fixed_____removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies: _____

Inspected By: _____ DATE 7/2/04

QA or Designee Review: Raymond Thomas DATE 07/02/04

Sample Custodian Review: Mitchell Letton DATE 7-2-04

Project Notes:

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

December 30, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20051029

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on December 21 2005 for the above captioned project. Nine soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5-work day turn. Results were faxed on 12/30/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20051029
Date Reported: 12/30/05
Date Received: 12/21

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20051029-01**						
Client ID:	**K-128**						
Date Sampled:	**7/22/04 12:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.779 +/- 0.106	pCi/g	0.171		12/29/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	9.2	%		12/21/05	12/28/05	RT
Lab ID:	**20051029-02**						
Client ID:	**K-132**						
Date Sampled:	**7/26/04 4:10:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.910 +/- 0.153	pCi/g	0.148		12/29/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.6	%		12/21/05	12/28/05	RT
Lab ID:	**20051029-03**						
Client ID:	**K-182**						
Date Sampled:	**8/13/04 11:40:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.955 +/- 0.198	pCi/g	0.175		12/29/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.3	%		12/21/05	12/28/05	RT
Lab ID:	**20051029-04**						
Client ID:	**K-088**						
Date Sampled:	**6/29/04 3:22:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	1.07 +/- 0.177	pCi/g	0.184		12/29/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.2	%		12/21/05	12/28/05	RT
Lab ID:	**20051029-05**						
Client ID:	**K-090**						
Date Sampled:	**6/29/04 3:35:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20051029
Date Reported: 12/30/05
Date Received: 12/21/05

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	0.801 +/- 0.200	pCi/g	0.174		12/29/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.4	%		12/21/05	12/28/05	RT
Lab ID:	20051029-06						
Client ID:	K-091						
Date Sampled:	6/29/04 3:40:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.737 +/- 0.076	pCi/g	0.139		12/29/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.3	%		12/21/05	12/28/05	RT
Lab ID:	20051029-07						
Client ID:	K-082						
Date Sampled:	6/28/04 3:30:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.781 +/- 0.139	pCi/g	0.201		12/29/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	11.0	%		12/21/05	12/28/05	RT
Lab ID:	20051029-08						
Client ID:	K-079						
Date Sampled:	6/28/04 3:00:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	1.05 +/- 0.239	pCi/g	0.323		12/29/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	12.5	%		12/21/05	12/28/05	RT
Lab ID:	20051029-09						
Client ID:	K-080						
Date Sampled:	6/28/04 3:10:00 PM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	1.31 +/- 0.218	pCi/g	0.132		12/29/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.8	%		12/21/05	12/28/05	RT

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20051029
Date Reported:	12/30/05
Date Received:	12/21
Page Number:	3 of

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					NC				12/29/05
Am-241		83.0	90.0	8.6					12/29/05
Co-60		96.0	93.0	2.9					12/29/05
Cs-137		94.0	94.0	0.3					12/29/05
Percent Moisture					18.4				12/28/05

Lab Approval: .....

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

K-SJ-41 → K-SJ-42

July 1, 2004

Invoice # 10120 dated 6/30/04

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20040455

Dear Mr. Weyant,

Please find enclosed the analytical report for your sample received in our laboratory on June 28, 2004 for the above captioned project. Two filters were received in good condition and analyzed on 6/29/04 for Gross Alpha/Beta. Results were faxed 6/30/04.

All QC is within limits. The samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID# OK001

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

Outreach Laboratory
211 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072 Thorium Remed
Lab Number:	20040455
Date Reported:	6/30/200
Date Received:	6/28/04
Page Number:	1 of 1

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040455-01**						
Client ID:	**K-SS-041**						
Date Sampled:	**6/25/2004 4:20:00 PM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.355 +/- 0.466	DPM/F	0.360		6/29/2004	SD
Gross Beta	EPA 900/9310	0.686 +/- 1.51	DPM/F	1.58		6/29/2004	SD
Lab ID:	**20040455-02**						
Client ID:	**K-SS-042**						
Date Sampled:	**6/25/2004 4:22:00 PM**						
Matrix:	**Filter**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.0 +/- 0.406	DPM/F	0.475		6/29/2004	SD
Gross Beta	EPA 900/9310	0.861 +/- 1.47	DPM/F	1.52		6/29/2004	SD

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Gross Alpha	0+/-0..17	84.0	82.0	1.7	NC				6/29/2004
Gross Beta	0+/-0.639	79.0	86.0	4.1	NC				6/29/2004

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: Local: 918-384-7166, Cell - 724-794-0071

Company: Kaiser-Alum & Chem Inc.
Name: ATTN: David B. Weyant
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3530 Fax #: 918-384-3171

Bill To:
Company: Kaiser / Penn E&R
Name: David B. Weyant / Paul Hanna
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser Thorium Remediation
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 2 DAY (041, 042) / 30 DAY (043)
SAMPLER: David B. Weyant / Darnell Kaiser — Signature

ANALYSIS REQUESTED

Preservative #: 1. HNO_3 pH<2 2. Ice <4°C 3. HCl pH<2 4. H_2SO_4 pH<2 5. NaOH pH>11

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE (PLASTIC OR GLASS)	PRESERVATIVE #	Gross α/β	Th NAT dpm/100cm²	U NAT dpm/100cm²	Return to Client for Archive	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
[illegible]	K-SS-041	6-28	1620	Swipe	1	Cloth	None	X	X	X	X	Report Units In dpm/100cm²
[illegible]	K-SS-042	6-28	1622		1	Cloth	None	X	X	X	X	
[illegible]	K-SS-043	6-28	1625		1	Cloth	None	X	X	X	X	

RELINQUISHED BY: [signature] DATE 6-28-2004 TIME 745 RECEIVED BY: [signature] DATE 6/28/04 TIME 745

RELINQUISHED BY: ______ DATE ______ TIME ______ RECEIVED BY: ______ DATE ______ TIME ______

FOR LABORATORY USE ONLY: [illegible]

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

SAMPLE LOGIN

Date Received: *6/28/2004 10:38:4* **Lab Number:** 20040455 **Due:** 6/30/2004

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20040455-01 A Gross Alpha/Beta	K-SS-041	Filter	06/25/04	Other	N/A	None	Yes	Yes
20040455-02 A Gross Alpha/Beta	K-SS-042	Filter	06/25/04	Other	N/A	None	Yes	Yes

CONTAINER INSPECTION

Coolers 0 Custody Seals Broken - Y/N Temperature _____ Blue Ice / Wet Ice Radiation Survey _____fixed_____removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N AA 6/28/04

Anomalies: _____

Inspected By: _____ DATE 6/28/04

QA or Designee Review: _____ DATE _____

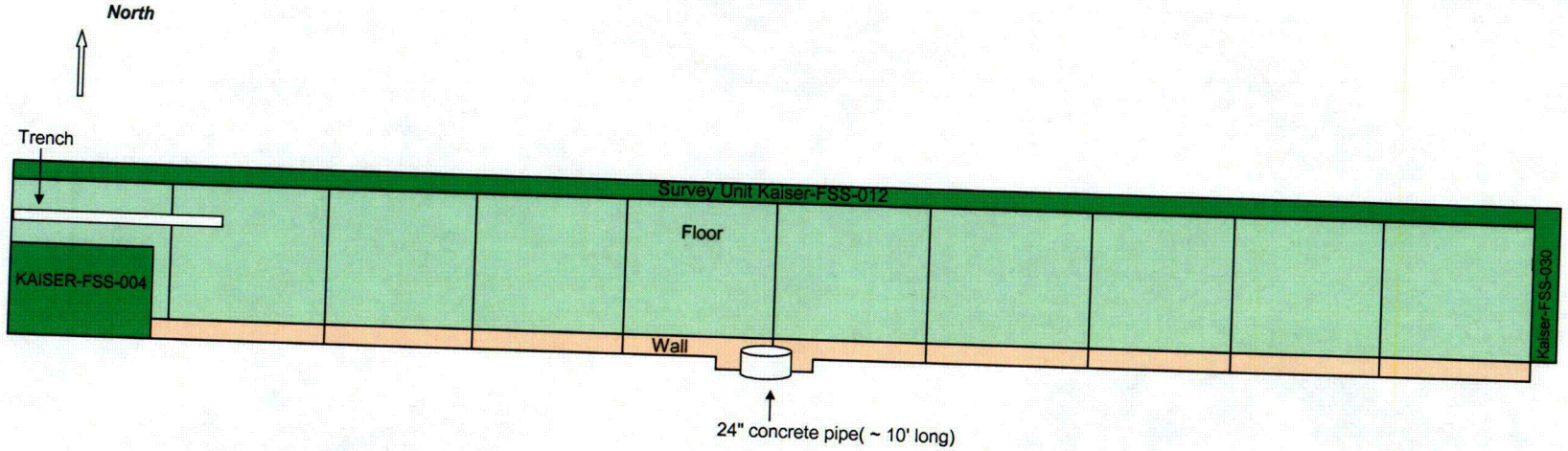
Sample Custodian Review: _____ DATE 6/28/04

Project Notes:

ATTACHMENT D
TABLE OF CONTENTS

- **FIGURE D-1 Embedded Structure Location Map**
- **Alpha Scan MDC Calculation**
- **TABLE D-1 Embedded Structure Gross Alpha Scan Results**
- **Total Alpha Contamination Survey Data Conversion Form**

Attachment D, Figure D-1
Embedded Structure Location Map
Survey Unit Kaiser-FSS-007
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation



Q:\P4000\PA4072\FSS Reports\Volume I\Survey Unit Kaiser-FSS-007\Attachment D\Figure D-1

CZ1

Alpha Scan MDC Calculation

Instrument Serial Number:	193686	Cal. Due:	5/4/2005
Detector Serial Number:	PR190485	Cal. Due:	5/4/2005
Radiation Detected:	Alpha		<3 cpm

Probability of observing 2 or more counts:

$$P(n \geq 2) = 1 - \left(1 + \frac{(GE+B)d}{60v}\right)\left(e^{\frac{(GE+B)d}{60v}}\right)$$

Probability of observing a single count:

$$P(n \geq 1) = 1 - e^{\frac{-GEd}{60v}}$$

	D Date	G Activity (dpm)	d Detector Width (cm)	E Instrument Efficiency (cpm)	v Scan Speed (cm/s)	B Background Countrate (cpm)	P Probability (-)
1	6/25/2004	330	11.7	0.1778	3.90	2.4	0.95
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							

Comments:

Survey Unit Kaiser-FSS-007, 24" Concrete Pipe in S. Wall of Excavation

Prepared By: David B. Weyant	Date: 6/26/04
Reviewed By: Andrew J. Lombardo	Date: 6/26/04

Notes:

1.) Instrument Efficiency is the 4π instrument efficiency

Attachment D, Table D-1
Embedded Structure Gross Alpha Scan Results
Survey Unit Kaiser-FSS-007
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Survey Number: KAISER-FSS-007		Instrument Serial Number: 193686				Cal. Due: 5/4/2005	
Tech:DBW		Detector Serial Number: PR190485				Cal. Due: 5/4/2005	
Structure/Location	***Area***	***Date***	***Scan***		***weighted***	***Bgrd***	***Average***
			cpm min	***cpm*** max	***cpm*** ave	***cpm*** (5 min)	***(dpm/100cm^2)*** net
I/S Concrete Pipe		6/25/2004	0	0	0	2.4	0

Notes:

1. The weighted cpm is determined by the surveyor. Since alpha counts (clicks on audible) are infrequent, and 1 count may equal 10 cpm, the surveyor determines the "weighted average".
2. The acceptance criteria for Total Contamination is 944 dpm/100cm^2. 10 cpm is approximately 150 dpm/100cm^2.
3. Scans are used to identify elevated area above the acceptance criteria.
4. Compliance is demonstrated by static counts and smear (sample) results.

Total Alpha Contamination
Survey Unit Kaiser-FSS-007
Survey Data Conversion Form
Form ESC/HPM/M-3-2-2

Date of Survey:	5/23/2004	Type of Radiation:	Alpha
Instrument Serial #:	193686	Calibration Due Date:	5/4/2005
Detector Serial #:	PR190485	Calibration Due Date:	5/4/2005
E_s (Surface Efficiency):	0.25	E_i (Insturment Efficiency):	0.1778
BKG Counts:	12	BKG Count Time (min):	5
Active Area of Detector Probe (cm^2):	126	MDC ($dpm/100cm^2$):	68.3

Location	Survey Point Count Time (min)	Gross Counts (cts)	Gross Count Rate (cpm)	Net Count Rate (cpm)	Total Contamination ($dpm/100cm^2$)	95% CL Uncertainty ($dpm/100cm^2$)
Concrete-Pipe-I/S-Bottom	5	30	6.00	3.60	64.3	45.4
Concrete-Pipe-I/S-Top	5	13	2.60	0.20	3.57	35.0

Comments:

Concrete Pipe

Prepared By: David B. Weyant	Date: 6/26/2004
Reviewed By: Andrew J. Lombardo	Date: 6/26/2004

SUB-REPORT

SURVEY UNIT KAISER-FSS-008

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2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil	3
2.3 Wilcoxon Rank Sum (WRS) Testing	4
3.0 SUMMARY OF FINDINGS	5
3.1 Excavation Bottom/Side Wall Surface Soil	5
3.2 Sum of Fractions for Entire Survey Unit	5

ATTACHMENTS

ATTACHMENT A: Figure A-1 Gross Gamma Background and Scanning Survey Results
Figure A-2 Systematic Soil Sampling Locations

ATTACHMENT B: Soil Survey Unit Worksheet No. 1
Soil Survey Unit Worksheet No. 2

ATTACHMENT C: Laboratory Analytical Results

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-008
Survey Unit Kaiser-FSS-008
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-008, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the southwestern corner of the Retention Pond area. Survey Unit Kaiser-FSS-008 is considered a Class 1 survey unit with an approximate surface area of 424 m^2. It is bounded to the south by Survey Units Kaiser-FSS-001, Kaiser-FSS-002, and Kaiser-FSS-005, to the east by Survey Unit Kaiser-FSS-007, to the north by Survey Unit Kaiser-FSS-009, and to the west by the former freshwater pond non-impacted area (**Figure 3**).

Survey Unit Kaiser-FSS-008 consists of an excavation bottom surface soil with one side wall (west wall). No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom and western side wall surface soil of Survey Unit Kaiser-FSS-008. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom and western side wall) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 13 approximately equal-distant locations in the survey unit. The statistics for the 13 background measurements are provided below in **Table 1.** Background measurements ranged from 13,499 counts per minute (cpm) to 15,477 cpm.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 1,276 measurements of gross count rate were made at one second intervals across the survey unit's 424 m^2 area. The results ranged from 11,501 cpm to 19,078 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	424 m^2	
Number of Scan Measurements (1-Second Intervals)	1,276	
Scan Rate: (Swinging the detector a width of 1-meter side to side)	0.33 m/s (MARSSIM recommends 0.5m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	13,499	11,501
Maximum	15,477	19,078
Average	14,559	15,258
Standard Deviation	589	1,091
Median	14,567	15,354

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).

2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 (**Attachment B**). Once N was determined, the Survey Unit Area (A) of 424 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 7.4 meters and the Height of the Equilateral Triangle (h) of 6.4 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 (**Attachment B**).

A layout of the soil sampling locations is provided on **Figure A-2** contained in **Attachment A**. The soil sampling locations were demarcated in the field using a GPS unit. A total of 9 soil samples (identified as K-098 through K-106) were collected at the excavation bottom/side wall surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 2**. Analytical data reports are contained in **Attachment C**.

Table 2 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-098	1.12	0.116	0.409	0.02	3.0
K-099	0.892	0.148	0.445	0	3.0
K-100	0.988	0.164	0.402	0	3.0
K-101	0.725	0.139	0.450	0	3.0
K-102	0.757	0.160	0.498	0	3.0
K-103	0.568	0.072	0.190	0	3.0
K-104	0.889	0.125	0.449	0	3.0
K-105	1.06	0.157	0.340	0	3.0
K-106	0.961	0.140	0.338	0	3.0
Average	*0.884*				
Standard Dev.	*0.175*				
Minimum	*0.568*				
Maximum	*1.12*				
Median	*0.892*				

All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.12 pCi/g, which fell slightly above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 0.884 pCi/g. The standard deviation of the 9 equal-distant samples was 0.175, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (0.71 pCi/g) between the maximum survey unit soil sample activity concentration (1.12 pCi/g) and the minimum reference background area soil sample activity concentration (0.41 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 3** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 3 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	346	0.84	S1	K-098	1.12
R2	123	0.57	S2	K-099	0.892
R3	369	1.21	S3	K-100	0.988
R4	355	0.96	S4	K-101	0.725
R5	236	1.14	S5	K-102	0.757
R6	330	1.22	S6	K-103	0.568
R7	81	1.25	S7	K-104	0.889
R8	372	1.06	S8	K-105	1.06
R9	36	0.41	S9	K-106	0.961
	Average	***0.96***		***Average***	***0.884***
	Std. Dev.	***0.30***		***Std. Dev.***	***0.175***
	Minimum	***0.41***		***Minimum***	***0.568***
	Maximum	***1.25***		***Maximum***	***1.12***
	Median	***1.06***		***Median***	***0.892***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the southwestern corner of the Retention Pond area resulted in an open land area consisting of an excavation approximately 424 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-008 is considered a Class 1 survey unit. The survey unit is bounded to the south by Survey Units Kaiser-FSS-001, Kaiser-FSS-002, and Kaiser-FSS-005, to the east by Survey Unit Kaiser-FSS-007, to the north by Survey Unit Kaiser-FSS-009, and to the west by the former freshwater pond non-impacted area (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom/Side Wall Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-008 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom and western side wall) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-008 prior to backfill with clean import borrow material, as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey elements average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 4**. As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

Table 4 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

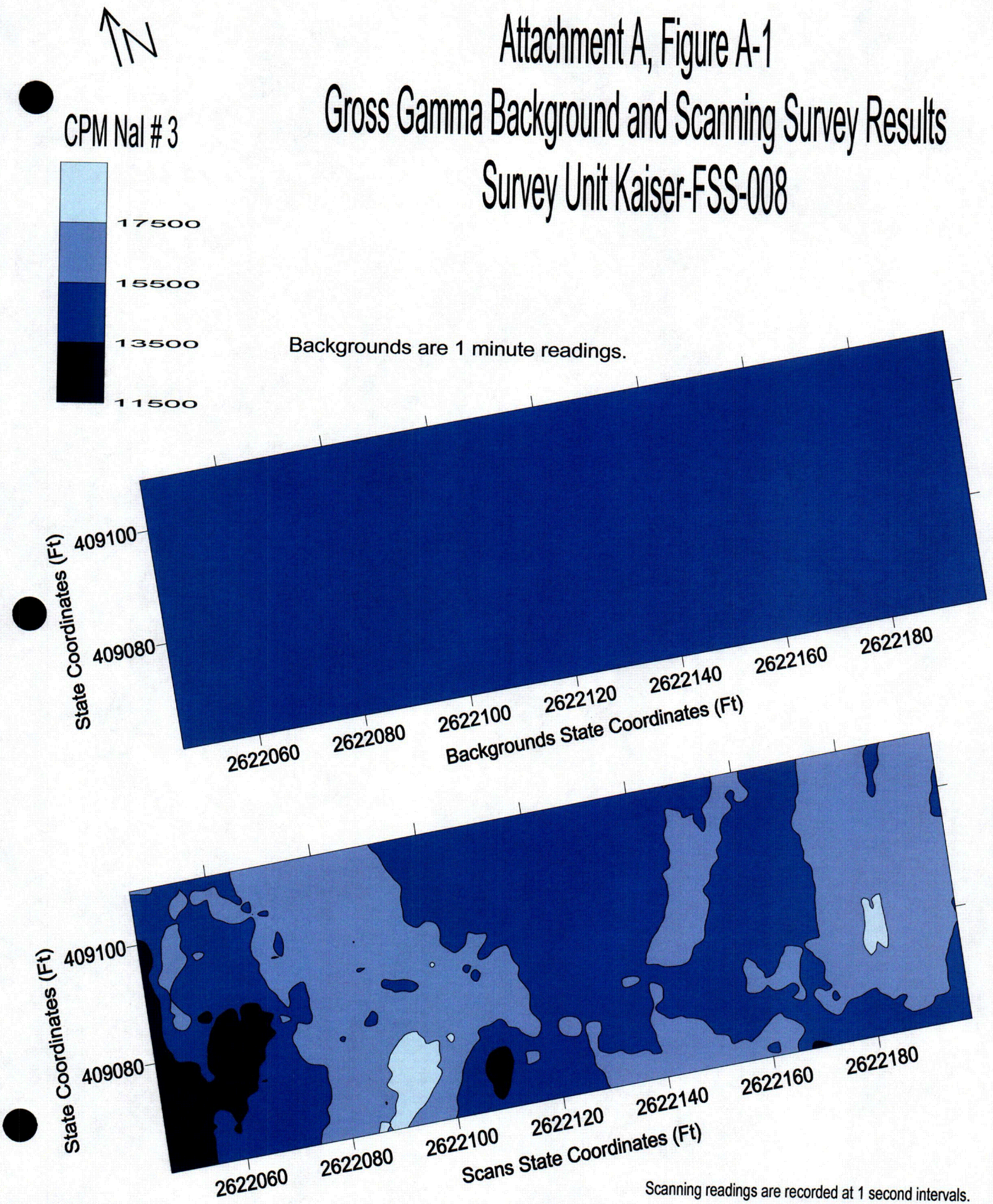
Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-008 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	dpm/100cm^2	0		0.00
TOTAL SUM OF FRACTIONS				***0.00***

The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-008 meets the DP acceptance criteria.

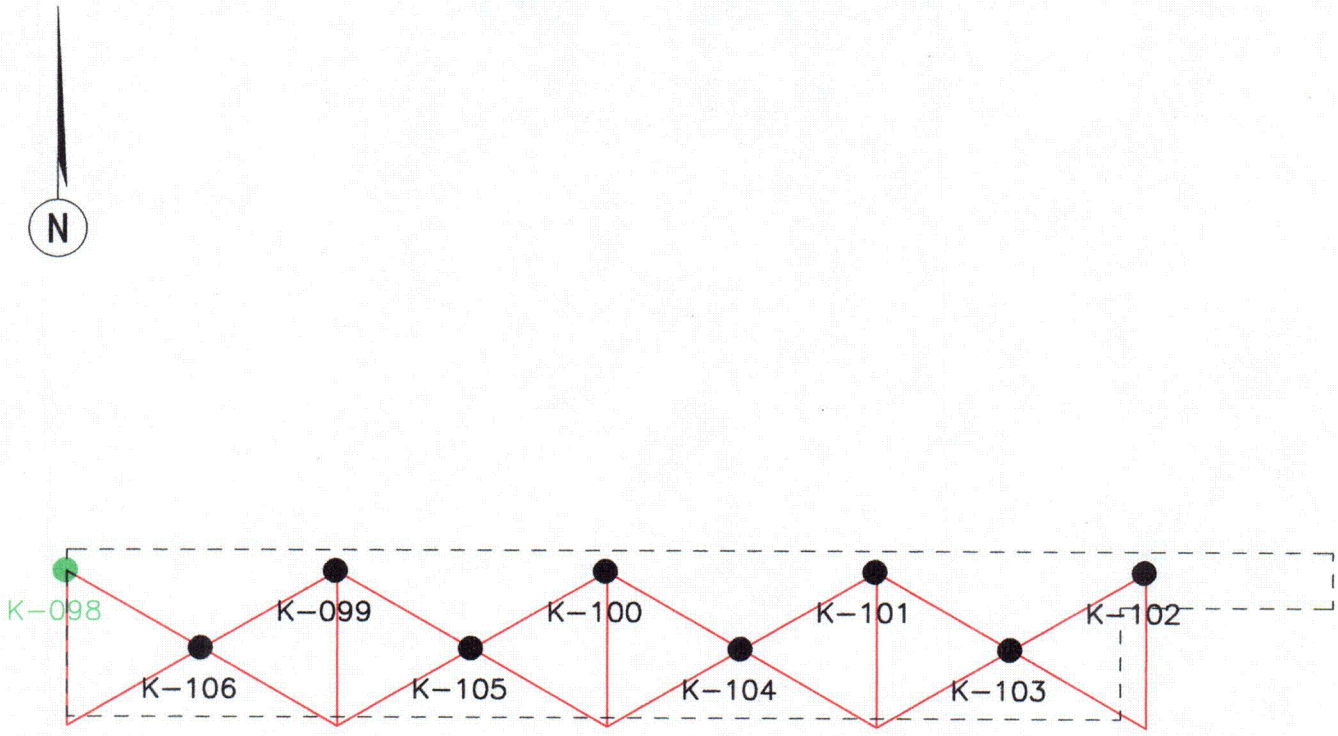
ATTACHMENT A
TABLE OF CONTENTS

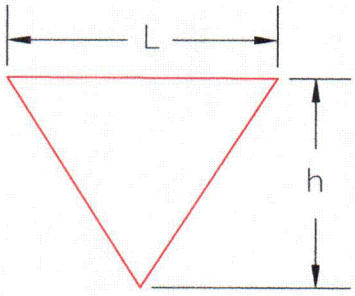
- **FIGURE A-1 Gross Gamma Background and Scanning Survey Results**
- **FIGURE A-2 Systematic Soil Sampling Locations**

Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-008



C22





N = 9
L = 7.4m
h = 6.4m
AREA = 424m^2

SCALE – FEET
30 0 30
9 0 9
SCALE – METERS

K–099

● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K–098

● RANDOM START POINT

FIGURE A–2
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS–008
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RFD 3·3·06
CHECKED	RFD 5·3·06
DRAWN	DEB 12/27/05
DRAWING NUMBER	PA4072056

Penn E&R
Environmental & Remediation, Inc.

C23

ATTACHMENT B
TABLE OF CONTENTS

- **Soil Survey Unit Worksheet No. 1**
- **Soil Survey Unit Worksheet No. 2**

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-008

2. Description: Retention Pond Area, South of Survey Unit Kaiser-FSS-009

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – Approx. 62 meters x 7 meters; Area, A (m^2): 424

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 7.4 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or (L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 6.4 m.

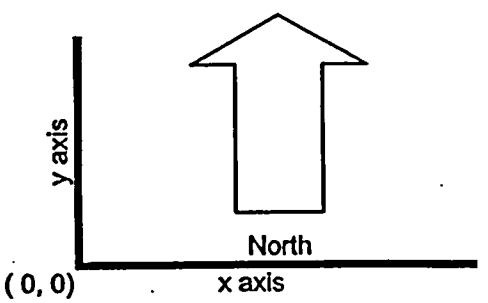
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-008

RANDOM START POINT

x axis (Meters)	y axis (Meters)
0	7

	x axis	y axis
lower bound	0	0
upper bound	62	7



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach
Laboratory
1 North Aspen
ken Arrow, OK 74012
(8) 251-2515
FAX (918) 251-0008

K-098 - K-103
K-104 - K-106

Invoice # 10177 D/- 7/19/04

July 19, 2004

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20040509

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory July 14, 2004 for the above captioned project.

Eight soil samples were received in good condition and analyzed for Th-232 by Gamma Spec and Percent Moisture without drying and grinding with a 2 work day turn per Paul Handa. Gamma Spec results were faxed on time.

All QC is within control limits. The samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation PA4000-4072
Lab Number: 20040509
Date Reported: 7/16/2004
Date Received: 7/16/04

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040509-01**						
Client ID:	**K-098**						
Date Sampled:	**7/15/2004 7:40:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.12 +/- 0.116	pCi/g	0.409		7/16/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	11.3	%		7/16/2004	7/16/2004	RT
Lab ID:	**20040509-02**						
Client ID:	**K-099**						
Date Sampled:	**7/15/2004 7:45:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.892 +/- 0.148	pCi/g	0.445		7/16/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	18.1	%		7/16/2004	7/16/2004	RT
Lab ID:	**20040509-03**						
Client ID:	**K-100**						
Date Sampled:	**7/15/2004 7:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.988 +/- 0.164	pCi/g	0.402		7/16/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	10.2	%		7/16/2004	7/16/2004	RT
Lab ID:	**20040509-04**						
Client ID:	**K-101**						
Date Sampled:	**7/15/2004 8:00:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.725 +/- 0.139	pCi/g	0.450		7/16/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	15.6	%		7/16/2004	7/16/2004	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation PA4000-4072
Lab Number:	20040509
Date Reported:	7/16/2004
Date Received:	7/16/04
Page Number:	2 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040509-05**						
Client ID:	**K-102**						
Date Sampled:	**7/15/2004 8:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.757 +/- 0.160	pCi/g	0.498		7/16/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	10.0	%		7/16/2004	7/16/2004	RT
Lab ID:	**20040509-06**						
Client ID:	**K-104**						
Date Sampled:	**7/15/2004 8:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.889 +/- 0.125	pCi/g	0.449		7/16/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	11.6	%		7/16/2004	7/16/2004	RT
Lab ID:	**20040509-07**						
Client ID:	**K-105**						
Date Sampled:	**7/15/2004 8:28:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.06 +/- 0.157	pCi/g	0.340		7/16/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	20.6	%		7/16/2004	7/16/2004	RT
Lab ID:	**20040509-08**						
Client ID:	**K-106**						
Date Sampled:	**7/15/2004 8:35:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.961 +/- 0.140	pCi/g	0.338		7/16/2004	SD
		Inorganics Analyses					
Percent Moisture	LOD	14.0	%		7/16/2004	7/16/2004	RT

BDL = Below Detection Limit

Outreach Laboratory
.1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation PA4000-4072
Lab Number:	20040509
Date Reported:	7/16/2004
Date Received:	7/16/04
Page Number:	3 of 3

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Am-241		92.0	89.0	2.7					7/16/2004
Co-60		95.0	92.0	3.5					7/16/2004
Cs-137		98.0	97.0	1.3					7/16/2004
Percent Moisture					9.2				7/16/2004
Th-232					NC				7/16/2004

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
LOCAL 918-384-0566
CELL: 724-799-0071

Company: KAISER Alum & Chem LLC.
Name: ATTN: DAVID R. WEYANT
Address: 7311 E. 41ST STREET
City: TULSA State: OK Zip: 74145
Phone: 724-934-3533 Fax #: 918-384-3171

Bill To:
Company: KAISER / FEAR ERC
Name: DAVID R. WEYANT / PAM HAAG
Address: 7311 E. 41ST STREET
City: TULSA State: OK Zip: 74145

PO #: KAISER - 4072
PROJECT #: PA - 4000 - 4072
PROJECT NAME: KAISER - THORIUM REMEDIATION
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 5 DAY
SAMPLER: David R. Weyant
Signature
2004

ANALYSIS REQUESTED

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GAMMA SPEC (Th-232)	RADON SAMPLE + CLOSE for Analysis	EDC 40.5 pCi/g	ASTM D2216.92 MOISTURE CONTENT	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-098	7-15	07:40	Soil	1	500ml PLASTIC	None	X	X	X	X	GRAB
	K-099	7-15	07:45		1			X	X	X	X	
	K-100	7-15	07:50		1			X	X	X	X	
	K-101	7-15	08:00		1			X	X	X	X	
	K-102	7-15	08:16		1			X	X	X	X	
	K-104	7-15	08:20		1			X	X	X	X	
	K-105	7-15	08:28		1			X	X	X	X	
	K-106	7-15	08:35		1			X	X	X	X	

RELINQUISHED BY: David R. Weyant DATE 7-15 2004 TIME 8:10 RECEIVED BY: _____ DATE 7/16/04 TIME 8:10
7-16-04

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY

SAMPLE LOGIN

Date Received: *7/16/2004 9:53:11* **Lab Number:** 20040509 **Due:** 7/16/2004

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20040509-01 A	K-098	Soil	07/15/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040509-02 A	K-099	Soil	07/15/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040509-03 A	K-100	Soil	07/15/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040509-04 A	K-101	Soil	07/15/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040509-05 A	K-102	Soil	07/15/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040509-06 A	K-104	Soil	07/15/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040509-07 A	K-105	Soil	07/15/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040509-08 A	K-106	Soil	07/15/04	Plastic	16 oz	None	Yes	Yes

Percent Moisture
Th-232 by Gamma Spec

CONTAINER INSPECTION

Coolers 1 Custody Seals Broken - Y/N Temperature Ambient Blue Ice / Wet Ice Radiation Survey <300 fixed _____ removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies: _____

Inspected By: _____ DATE _____

QA or Designee Review: Raymond Thorn DATE 07/16/04

Sample Custodian Review: Michelle Sutton DATE 7/16/04

Project Notes:

Outreach
Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Invoice # 10182 dated 7/20/2004

K-103, K-108

July 21, 2004

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20040508

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory July 15, 2004 for the above captioned project.

Two soil samples were received in good condition and analyzed for Th-232 by Gamma Spec and Percent Moisture without drying and grinding with a 5 work day turn. Results were faxed early.

All QC is within control limits. The samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation PA4000-4072
Lab Number: 20040508
Date Reported: 7/20/04
Date Received: 7/15/04
Page Number: 1 of 1

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20040508-01**						
Client ID:	**K-103**						
Date Sampled:	**7/14/04 1:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.568 +/- 0.072	pCi/g	0.190		7/15/04	SD
		Inorganics Analyses					
Percent Moisture	LOD	14.2	%			7/16/04	RE
Lab ID:	**20040508-02**						
Client ID:	**K-108**						
Date Sampled:	**7/14/04 2:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.20 +/- 0.139	pCi/g	0.422		7/15/04	SD
		Inorganics Analyses					
Percent Moisture	LOD	16.2	%			7/16/04	RE

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Am-241		90.0	113.0	22.0					7/15/04
Co-60		91.0	95.0	4.5					7/15/04
Cs-137		95.0	97.0	2.0					7/15/04
Percent Moisture					3.5				7/16/04
Th-232					NC				7/15/04

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To: Company Kaiser-Alum & Chem Inc. Name David B. Weyand Address 7311 E. 41st Street City Tulsa State OK Zip 74145 Phone 724-934-3530 Fax # 918-384-3171

Local: 918-384-0566, Cell - 724-799-0071

Bill To: Company Kaiser/Penn E&R Name David B. Weyand/Paul Hanoa Address 7311 E. 41st Street City Tulsa State OK Zip 74145

PO # Kaiser-4072

PROJECT # PA-4000-4072

PROJECT NAME Kaiser-Thorium Remediation

REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 5 DAY

SAMPLER David B. Weyand (Signature) 2004

ANALYSIS REQUESTED

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec (Th-232)	Retain Samples for Archive	MOC C0.5 (Sieve)	ASTM D2216-92 Moisture Content				REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-107(3)	7-14	1300	Soil	1	Plastic 500 ml	None	X	X	X	X				Grab
	K-108(8)	7-14	1400	↓	1	↓	↓	X	X	X	X				↓

N/A

RELINQUISHED BY: David B. Weyand DATE 7/14/04 TIME 527 RECEIVED BY: [signature] DATE 7/14/04 TIME 527

RELINQUISHED BY: ______ DATE ______ TIME ______ RECEIVED BY: ______ DATE ______ TIME ______

FOR LABORATORY USE ONLY 2004-0506
Sample Condition Upon Receipt: Good
Custody Seals Intact: N/A

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liab[le for an]y reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to O[utreac]h Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/[DISPO]SAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be re[turned] at client's expense.

SAMPLE LOGIN

Date Received: *7/15/2004 10:58:4* **Lab Number:** 20040508 **Due:** 7/22/2004

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20040508-01 A	K-103	Soil	07/14/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								
20040508-02 A	K-108	Soil	07/14/04	Plastic	16 oz	None	Yes	Yes
Percent Moisture								
Th-232 by Gamma Spec								

CONTAINER INSPECTION

Coolers ~~1 and~~ Custody Seals Broken - Y (N) Temperature ~~AMB~~ Blue Ice / Wet Ice Radiation Survey NO ice fixed _____ removable

SAMPLE INSPECTION

Custody Seals Broken - Y (N) Chain of Custody Record (Y) N Labels in Tact (Y) N Radiation Survey Complete (Y) N

Anomalies: _____

Inspected By: _____ DATE 07/15/04

QA or Designee Review: Raymond Thomas DATE 07/15/04

Sample Custodian Review: _____ DATE 07/15/04

Project Notes: