9.0 Project Management and Organization

9.1 Decommissioning Management Organization

Kaiser's management team (Project Manager [PM], Health Physics Advisor [HPA]/Radiation Safety Officer [RSO], and Site Administrator [SA]) collectively will ensure that the guidance provided by the contractors in the remediation process (including the design and planning of final status surveys, conduct of final status surveys, and evaluation of results and data quality assessment) is conducted in accordance with the commitments and objectives of the DP.

The following is an outline of the decommissioning organization. This organizational structure may be revised by the Kaiser PM as deemed appropriate to facilitate execution of the project. Any revisions of the organizational structure will be documented by the Kaiser PM. In addition, any one person may fill multiple positions as long as this does not create an organizational conflict. The Kaiser, Tulsa facility decommissioning management organization is shown in Figure 9-1.

9.1.1 Kaiser PM

Kaiser will designate a PM for the decommissioning. The PM has overall responsibility for planning and management of the decommissioning activities. The PM must possess a B.A./B.S. degree and have a minimum of 10 years of management experience, including 5 years of health, safety, and environmental management experience. The PM will ensure that remediation activities meet the established environmental, H&S, and QA requirements, and technical performance in accordance with written procedures. The PM has authority to make necessary changes to the contractor's work and to stop any activity.

9.1.2 Kaiser SA

Kaiser will designate an SA for the decommissioning. This position may be filled either by a Kaiser employee or by a contractor at Kaiser's discretion. The SA has overall responsibility for the on-site planning and management of the decommissioning activities. Kaiser's SA will possess a minimum of a B.S. in Science or Engineering and have 2 years of management experience or equivalent experience. As an agent for the PM, the SA will observe that remediation activities meet the established environmental, H&S, and QA requirements, and technical performance, in accordance with written procedures. The SA will report to the PM. The SA has authority to make necessary changes to the contractor's work and to stop any activity. The SA will conduct site orientation activities with visitors to the site.

9.1.3 Kaiser HPA/RSO

Kaiser's PM will utilize an HPA to provide guidance on special issues and to review procedures. This position may be filled either by a Kaiser employee or by a contractor at Kaiser's discretion. The HPA will be responsible for the radiological health and safety of all license activities involving radioactive materials. The HPA may also review qualifications of personnel designated for certain positions in the Decommissioning Management Organization. The HPA will serve as the RSO. In addition, the RSO will review the implementation and documentation of all work activities involving radioactive materials including surveying, dosimetry, compliance issues, instrumentation, audits, data interpretation, training, wastes, shipping and receiving, decommissioning, decontamination, and emergency response. The RSO will possess a minimum M.S. degree in health physics or related field and have a minimum of 5 years experience in environmental restoration. The RSO will report to the PM. The RSO will be authorized to stop any operation that is unsafe or is in violation of a regulatory requirement.

An Assistant RSO (the Lead HP Technician or other designee) will be appointed for day-to-day responsibilities, when the RSO is not to be scheduled to be on site. The Assistant RSO will be qualified by training and experience for the types and quantities of radionuclides that will be encountered during decommissioning operations. In addition, the Assistant RSO will have "stop-work" authority for all activities involving radioactive material at the site.

9.1.4 Kaiser QA Coordinator (Consultant)

Kaiser will employ the services of a third-party QA Coordinator (QAC). The QAC reports to Kaiser's SA for administrative activities and QA guidance. The QAC communicates and coordinates directly with Kaiser's SA and has the delegated responsibility and authority to assure that QA objectives are met. Responsibilities of the QAC include overseeing decommissioning activities to assure that appropriate quality management, policy, training, and verification controls are present. Additional QAC responsibilities include conducting QA audits, surveillance of contractor activities, and correcting conditions which could adversely affect quality. The contractor will allow the QAC to inspect the work at any time and provide every reasonable facility and equipment necessary to inspect the work. The QAC is not authorized to revoke, alter, or waive any requirements of this plan. The QAC has the authority to reject materials or suspend work until any question at issue can be resolved by Kaiser's SA.

9.1.5 Data Manager (Consultant)

The Data Manager (consultant) reports to QAC (consultant). The Data Manager will ensure that all required surveys and sampling are performed in accordance with the Final Status Survey Plan and

applicable written procedures. Data will be reviewed by the Data Manager to ensure that the requirements stated in the Final Status Survey Plan are implemented as prescribed and that the results of the data collection activities support the objectives of the survey, or permit a determination that these objectives should be modified. The Data Manager will determine if the data are of the right type, quality, and quantity to demonstrate compliance with the plan objective.

9.1.6 Contractor PM

Kaiser will utilize qualified contractor(s) to implement the DP. The contractor(s) will designate a PM (CPM) who will be responsible for planning, managing, and coordinating all contractor activities in accordance with written procedures. The CPM will report to the SA and will ensure that remediation activities meet the established environmental, H&S, QA requirements, technical performance, budgeting, and scheduling criteria. The CPM will be authorized to stop any activity that may be unsafe or is in violation of a regulatory requirement.

9.1.7 Contractor Quality Control Supervisor

The contractor shall designate a Quality Control Supervisor (QCS) who will report to the CPM for administrative activities and QC guidance. The QCS will communicate and coordinate directly with the CPM and will have the delegated responsibility and authority to direct and control contractor QC functions to assure that QC objectives are met. Responsibilities of the QCS include coordination of contractor QC activities and ensuring that appropriate quality management, policy, training, and verification controls are present. The QCS shall provide all necessary QC information to the CPM, Kaiser's SA, and the QAC.

9.1.8 Contractor Lead HPT/Assistant RSO

The QCS shall designate a Lead HPT (LHPT)/Assistant RSO who will ensure all necessary sampling and scanning required in the Final Status Survey Plan are performed in accordance with such plan and written procedures. The LHPT is also responsible for sampling of soil stockpiles, off-site borrow material, and transportation containers, and will perform the preliminary review of survey data and analytical results.

An Assistant RSO (the Lead HP Technician or other designee) will be appointed for day-to-day responsibilities, when the RSO is not to be scheduled to be on site. The Assistant RSO will be qualified by training and experience for the types and quantities of radionuclides that will be encountered during decommissioning operations. In addition, the Assistant RSO will have "stop-work" authority for all activities involving radioactive material at the site.

9.1.9 Contractor Site Supervisor

The contractor shall designate a Site Supervisor responsible for ensuring that contractor activities are performed in accordance with the plans, the specifications, work plans, and safety work permits. The Site Supervisor reports to the CPM, or may be the CPM. The Site Supervisor has the authority to stop any activity that may be unsafe or is in violation of a regulatory requirement.

9.1.10 Contractor H&S Supervisor

The H&S Supervisor will be responsible for implementing measures that provide safe and healthy work conditions, for assuring radiation exposures are maintained ALARA, and for minimizing release of radioactive material to the environment.

9.1.11 Decommissioning Management Organization Chart

Figure 9-1 depicts the Decommissioning Management Organization and reporting hierarchy.

9.2 Decommissioning Task Management

So that the decommissioning tasks can be effectively managed, written plans and procedures and SWPs will be established for the decommissioning as discussed in the following subsections. Procedures will be developed and prepared by the contractor or organization responsible for performing a specific task or tasks. Procedures will include the step-by-step instructions, required equipment, and safety precautions to complete the work. Each procedure receives the review and approval of the Kaiser PM and Kaiser HPA/RSO. Each procedure will have a unique document control number. Revisions and updates are issued with the next consecutive revision number. Written procedures will include a blanket approval system for routine remediation activities. In addition, remediation activities will be managed with the use of an SWP. Superceded copies of revised documents will be voided by written notification. Distribution of approved documents will be controlled to ensure that persons responsible for implementing written project plans and procedures have a current approved copy before work commences.

In the event of unique activities or conditions, the safety requirements will be evaluated and a collective decision will be made. Remediation operations will be controlled to assure that the residual radioactivity is ALARA.

9.2.1 Design and Construction Specifications

An engineering design will be completed and construction specifications will be developed so that the DP can be implemented. Specifications may be performance specifications or may be based upon detailed engineering designs. The design and specifications will be included in bid documents that will be used in contractor procurement. The design and construction specifications will address the following:

- Site Plan
- Erosion and Sedimentation (E&S) Plan
- Storm Water Control Plan
- Phasing Plans
- Construction Details
- Material Specifications
- Installation Specifications

9.2.2 H&S Plans

The contractor will complete an H&S Plan for its activities. These plans will assure management of H&S at the site and conform with Kaiser's H&S Plan.

9.2.3 E&S Plan

An E&S Plan will be completed for the project. The goal of the E&S Plan is to minimize off-site transport of sediment. Elements of the E&S Plan will be included in the construction specifications.

9.2.4 Contractor Work Plan

The selected contractor will submit a work plan that will outline and describe the sequence of construction activities including the following:

- Site security
- Radioactive waste and material management
- Material and equipment monitoring and release
- Effluent monitoring and sampling
- Personnel monitoring
- Sample analysis (on-site and off-site lab support)
- ALARA review and approval procedure
- Personnel training
- SWP preparation
- Radioactive material and waste packaging and shipment
- Disposal site waste acceptance criteria
- Mobilization
- Site access
- Haul roads

- Equipment
- Decontamination of personnel and equipment
- Control of water
- Environmental monitoring
- Excavation
- Dust control
- Soil segregation
- Management of intermodal containers or gondola cars
- Backfill
- Site grading
- Site restoration
- Demobilization

The work plan will be reviewed and approved by Kaiser and will be used to manage contractor activities throughout the project.

9.2.5 QA/QC Plan

A QA/QC Plan will be established for the site. The QA/QC Plan will be used in conjunction with the Final Status Survey Plan to ensure that decommissioning goals are achieved. In addition to radiological concerns, the QA/QC Plan will address civil engineering and site restoration issues such as the following:

- Fill material and placement
- Channel and culvert materials and construction
- Seeding
- Construction monitoring
- Site restoration

9.2.6 Final Status Survey Plan

A Final Status Survey Plan will be completed for the decommissioning activities. The purpose of the Final Status Survey Plan will be to demonstrate that remaining thorium levels are at or below the release criteria established in this DP.

9.2.7 Other Plans and Permits

Other plans and permits will likely be required by local and state authorities. These requirements will be addressed as the design proceeds.

9.3 Decommissioning Management Positions and Qualifications

Duties and reporting responsibilities of each person in the management organization are described above. The minimum qualifications for each position are described in the following subsections.

9.3.1 PM

The PM will be an experienced environmental professional and meet Kaiser's internal requirements (See Section 9.1.1).

9.3.2 SA

The SA will be an experienced environmental professional and meet Kaiser's internal requirements (See Section 9.1.2).

9.3.3 HPA/RSO

The HPA/RSO will be selected by Kaiser, based on experience, advanced education, and industry reputation (See Section 9.1.3).

9.3.4 QAC

The QAC will possess a B.S./B.A. degree in science, or engineering, or have equivalent experience and minimum of 5 years' experience in QA-related activities.

9.3.5 CPM

The CPM will possess a B.S./B.A. degree in science, engineering, or business and have a minimum of 5 years of health, safety, and environmental management experience. Appropriate work experience (for similar radiation remediation projects) may be substituted for the degree requirement.

9.3.6 Contractor QCS

The QCS will possess a B.S./B.A. degree in science, engineering, or business and have a minimum of 3 years' experience in QC-related activities. Appropriate work experience (on similar radiation remediation projects) may be substituted for the degree requirement.

9.3.7 Contractor HPT

The HPT will possess a B.S./B.A. degree in science, or engineering, or have equivalent experience and training and a minimum of 3 years' experience as an HPT.

9.3.8 Contractor Site Supervisor

The Site Supervisor will have appropriate training and experience.

9.3.9 Contractor H&S Supervisor

The H&S Supervisor will possess a B.S. degree in science or engineering, have a minimum of 2 years of experience in health physics/industrial hygiene, and have specific training.

9.4 Training

A training program will be established to meet the following goals:

- Meet or exceed the applicable training requirements specified by NRC, Occupational Safety and Health Administration, and the USEPA.
- Ensure that all personnel are knowledgeable of job requirements and are competent in the operation of the equipment they use, are safe in their work practices, and understand the risks associated with their work environment.
- Ensure that personnel meet the requirements of Kaiser to work at the Tulsa site.
- Indoctrinate new employees to ensure that they understand all requirements they are expected to meet.

All employees and contractors will receive training on the DP to ensure that all personnel understand the objectives of the plan and the routine operations and precautions to meet the plan objectives. The training program will include general radiation safety training/monitoring, site orientation, site-specific training, and training verification and documentation. These aspects of the training program are discussed in the following subsections.

9.4.1 General Radiation Safety Training/Monitoring

At a minimum, all site personnel will be required to have appropriate radiation safety training and to wear radiation-monitoring devices. The contractor will provide radiation badges to personnel who enter and work in radiologically-controlled areas. Workspace air monitoring also will be provided by the contractor as well as other environmental monitoring, where appropriate. The contractor will determine if additional personal monitoring is warranted, in accordance with the H&S Plan. At a minimum, exposure will be monitored in accordance with 10 CFR 20. Exposure results will be reviewed by the RSO and provided to Kaiser on a timely basis.

9.4.2 Site Orientation

Prior to entry into any radiological restricted area of the Kaiser site, personnel and visitors will be given a site and radiological orientation. Objectives of this orientation will be to familiarize personnel and visitors to:

- recognize labeled or posted radioactive materials and understand the meaning of radiological warning signs;
- understand that as long as radiological control procedures and limits are followed, harmful effects to personnel and the environment from radioactivity will be minimized; and
- recognize and understand the meaning of, and proper response to, emergency signals.

9.4.3 Site-Specific Training

Site-specific training will be required of all contractor personnel involved in day-to-day operations of the remediation project, project and management personnel who visit the site regularly, and other personnel identified by Kaiser's SA. Prior to being allowed unescorted access to the site and issuance of a radiation badge, each person shall demonstrate a basic knowledge of radiation worker training.

Radiation safety training for workers will be commensurate with their duties and responsibilities and the magnitude of the potential exposure to direct radiation and contamination in accordance with 10 CFR 19 and 20. The objectives of training are five-fold: (1) provide workers with information about radiologically hazardous substances, sources and types, exposure routes, and effects, (2) provide information on the radiation protection program for the decommissioning activities to enable each worker to comply with safety and health rules and to properly respond to all conditions, (3) provide instruction in the fundamentals of radiation protection to enable workers to meet ALARA objectives, (4) provide information and training on personal protection equipment, monitoring instruments, and equipment available and how to use them, and (5) instruct workers about applicable Federal, State, and site radiation protection rules.

Prior to the initiation of daily work activities, the SA or CPM will hold a "kick-off" meeting to familiarize workers with the day's activities and their associated procedures and safety requirements. Changes to standard procedures as a result of unique project conditions will also be discussed during these "kick off" meetings. Procedure retraining will be provided as necessary prior to implementation.

9.4.4 Training Verification and Documentation

Personnel working on site will present evidence of general radiation safety training and past exposure history in accordance with 10 CFR Parts 19 and 20 and pertinent refresher training (e.g., training certificates, letter of certification) prior to performing work in restricted areas of the site. Initial and annual refresher training shall include instruction in the fundamentals of radiation protection. The degree of instruction will be determined by work assignment and will ensure that workers understand how radiation protection relates to their jobs. The minimum training provided to any worker will include, but not necessarily be limited to, the following subjects:

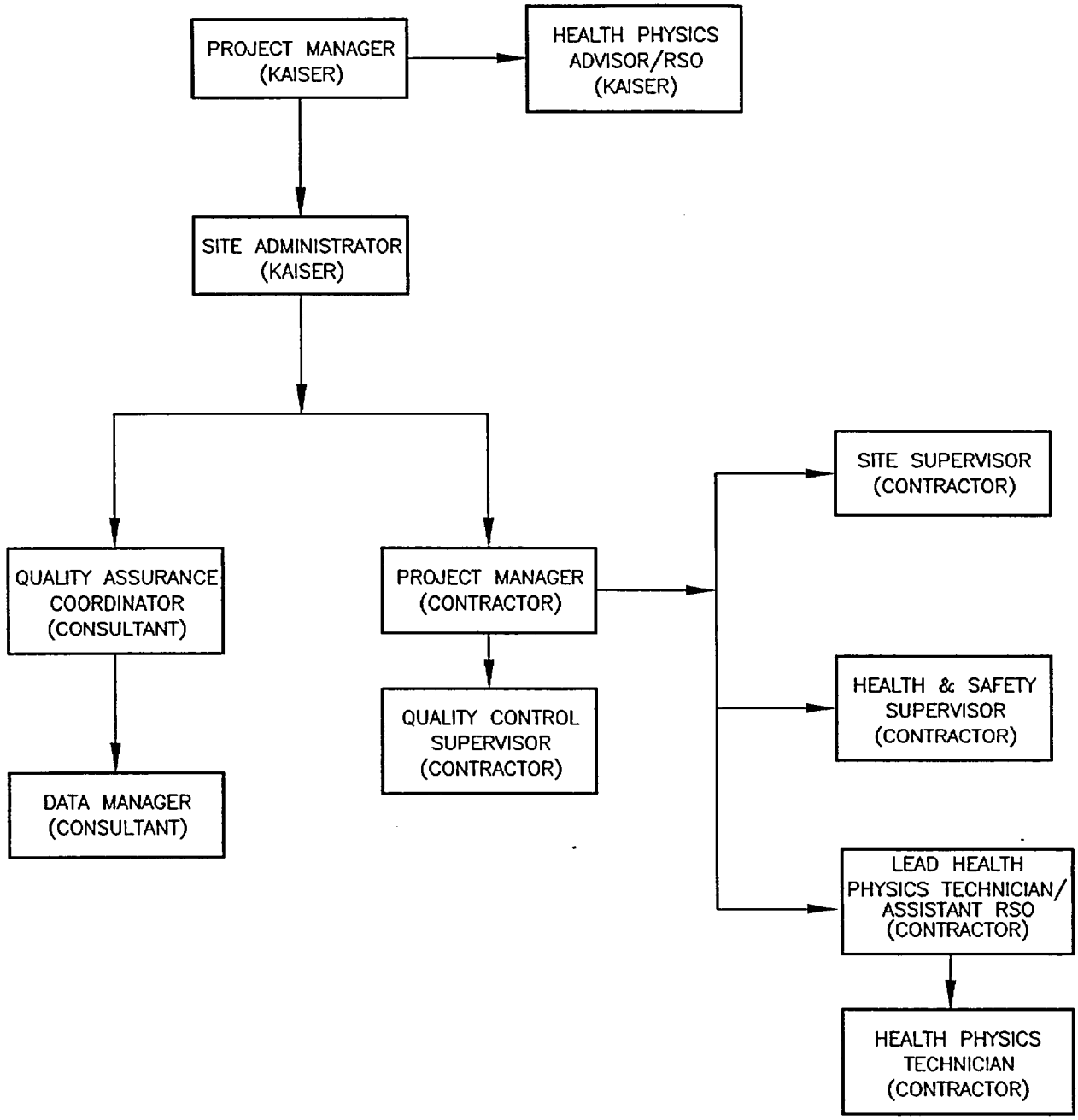
- Radiation monitoring techniques
- Radiation monitoring instrumentation
- Emergency procedures
- Radiation hazards and controls
- Concepts of radiation and contamination
- Provisions of 10 CFR Parts 19 and 20
- Responsibilities of workers and supervisors
- Reporting requirements for workers
- ALARA and exposure control procedures
- Biological effects of radiation
- Radiation control zones procedures
- Safe Work Permits
- Waste Management

Personnel will also be instructed in Kaiser's management commitment to implement ALARA, what ALARA means, why it is important, and how they implement it on their jobs. Workers will be tested upon the conclusion of training and retested on their understanding of the training each year. Records of individual training and qualifications will be maintained at the site until the completion of all remediation activities and will include the trainee's name, training date, subjects covered during training, written test results, and the instructor's name.

All contractor personnel will be required to have OSHA 1910.120 training and the contractor shall meet all the requirements in OSHA 1910.120. The contractor shall provide evidence of this training. In addition, all site personnel shall sign a statement certifying and acknowledging that they have received site-specific training and that they understand the potential site hazards and the necessary control measures to reduce and/or eliminate those hazards. Training documentation, including the content of site-specific training and any other subsequent training (e.g., periodic safety meetings and specific task safety meetings), will be submitted to Kaiser's SA and will be maintained by the contractor for a suitable period to be specified by Kaiser. This information will be available for inspection by Kaiser.

9.5 Contractor Support

As discussed above, Kaiser will utilize qualified contractors and consultants to implement this DP in accordance with the written plans and procedures. Depending on the purpose and objective of off-site lab support, an individual from Kaiser's management team (PM, HPA/RSO, and SA) or a Kaiser designated contractor will coordinate and direct activities associated with off-site analytical support. Specific roles and responsibilities will be detailed in site documents or procedures prior to the start of work.



REVISION	DATE	DESCRIPTION
1	5/14/02	REVISE LEAD HEALTH AND HEALTH PHYSICS BLOCKS

FIGURE 9–1
DECOMMISSIONING MANAGEMENT ORGANIZATION
KAISER ALUMINUM SPECIALTY PRODUCTS
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED BAD 4/03
CHECKED CRB 4/03
DRAWN GJA 4/16/01
DRAWING NUMBER
5427005

Earth Sciences Consultants, Inc.

10.0 H&S Plan

Chapter 10.0 provides the general framework and guidance for H&S policies, programs, procedures and practices to be followed during decommissioning activities at the Kaiser Tulsa site. It is the intent of Kaiser to revise the Radiological Control Program Plan that was approved for the ALRP with the necessary revisions. In addition, contractors engaged to perform work related to site remediation will be required to prepare and submit H&S plans of their own that will be specific to activities and services they are to provide or will be required to comply with the Kaiser H&S Plan.

The Kaiser Radiation Health and Safety Program planned for implementation at the Tulsa, Oklahoma site during the decommissioning and final survey phases of work is designed to conform to two fundamental performance objectives:

- Compliance with the regulatory requirements in 10 CFR Parts 19 and 20 as required by NRC, thus assuring adequate protection of workers from ionizing radiation during decommissioning activities.
- Radiological safety measures (controls and monitoring) for workers commensurate with the risks associated with decommissioning activities at the Tulsa, Oklahoma site as required by 10 CFR 20.

The information presented in this chapter provides a general framework for H&S policies, procedures, and practices that will be followed during decommissioning activities at the Kaiser Tulsa site. Regulatory guidance referenced in this chapter shall be used to develop, revise, and implement plans and procedures used during decommissioning activities as appropriate. As discussed in Chapter 2.0, the Th-232 is present on site at low concentrations with 95 percent of the material containing less than 120 pCi/g. Given this low concentration, the external exposure hazards from radiation and skin contamination are very low. Internal exposure is the primary radiological hazard presented from the material which can easily be controlled with the use of dust minimization controls during planned work activities.

10.1 Radiation Safety Controls and Monitoring for Workers

This chapter also provides a description of the radiation safety controls and types of monitoring to be used to ensure that internal and external exposures to workers are ALARA (including use of administrative controls). These controls and types of monitoring will be implemented using written procedures including a process for managing procedure changes. Audits and inspections (including performance-based oversight) will be conducted periodically by Kaiser and/or Kaiser contractor personnel to assess the

effectiveness of Radiation Health and Safety Plan (RHASP) implementation. Deficiencies and proficiencies identified by audit or inspection will be documented and resolved promptly. Lastly, a record generation and archival program will document RHASP implementation. Existing plans, procedures, and policies will be revised as necessary to include regulatory guidance cited in this chapter.

10.1.1 Workplace Air Sampling Program

The air sampling program will encompass routine, anticipated off normal, and unanticipated conditions. It will be designed to comply with the dose assessment requirements of 10 CFR 20.1204, the survey and monitoring requirements in 10 CFR 20 Subpart F, the requirements in 10 CFR 20.1703 if respirators are worn and posting requirements in 10 CFR 20.1902. Where applicable, the NRC guidance published in Regulatory Guide 8.25 will be followed and used to specify needed performance and surveillance aspects of the air sampling and analysis program.

10.1.2 Respiratory Protection Program

With the application of process controls, engineering controls and procedures to control concentrations of radioactive materials in air as required by 10 CFR 20.1701, the use of respiratory protection during the project is not anticipated. If engineering and process controls do not reduce the levels of airborne radioactivity below 1 derived air concentrations (DAC) limit (or when a worker could receive 12 DAC-hours in a week), the use of respiratory protection will be considered based on a prospective intake evaluation and consideration of industrial safety factors in accordance with 10 CFR 20.1702. The purpose of the respiratory protection program is to adequately limit intakes of airborne radioactive materials for workers in restricted areas and to keep the TEDE ALARA. The respiratory protection program shall incorporate the applicable requirements of 20.1701 - 20.1704, Appendix A of 10 CFR Part 20, and the applicable guidance in Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection," and NUREG-0041, Rev. 1, "Manual of Respiratory Protection Against Airborne Radioactive Material." The program will be implemented using written procedures to address all the elements of the respiratory protection program as required by 10 CFR 20.1703. Training, medical screening, and fit testing shall be performed prior to the issuance of National Institute for Occupational Safety and Health-certified respiratory protection equipment that is used to limit intakes of airborne radioactivity.

10.1.3 Internal Exposure Determination

The purpose of the internal exposure determination method is to assign a worker's internal exposure in compliance with 10 CFR 20.1101, 20.1201, 20.1202, 20.1204, 20.1502(b), and NRC guidance

documents. The NRC guidance documents that will be used to specify the determination method include the following:

- Regulatory Guide 8.9, Rev. 1, "Acceptable Concepts, Models Equations, and Assumptions For A Bioassay Program".
- Regulatory Guide 8.25, "Air Sampling in the Workplace".
- NUREG – 1400 "Air Sampling in the Workplace".
- Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses".
- Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus".

Workers at the Kaiser, Tulsa site shall be monitored in accordance with the requirements of 10 CFR 20.1502(b)(1) and (2) for potential internal exposures during routine operations, special operations, maintenance, and cleanup activities. The RSO shall assess internal exposure from worker intakes based on measurements of airborne radioactivity in work areas, bioassay, or a combination of the two methods. The RSO shall determine bioassay requirements, action levels, and frequency in accordance with Regulatory Guide 8.9. Representative airborne concentration measurements may also be used to assess intakes in accordance with Regulatory Guides 8.25 and 8.34.

10.1.4 External Exposure Determination

External exposure monitoring is required to assign a worker's external exposure in accordance with 10 CFR 20.1101(b), 20.1201, 20.1203, 20.1501(a)(2)(i), and (c), 20.1502(a), 20.1601, and NRC Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses." Radiation dosimeters issued for monitoring the external exposure of workers will be processed by a dosimetry processor that is accredited by the National Voluntary Laboratory Accreditation Program for the energies and types of radiation expected to be encountered at the site. Monitoring devices shall be worn near the location on the human body that is expected to receive the highest external dose, as required by 10 CFR 20.1201(c). Extremity monitoring will be performed in accordance with NRC Regulatory Guide 8.34. and American National Standards Institute (ANSI) Standard HPS N13.41-1997, "Criteria for Performing Multiple Dosimetry.

10.1.5 Summation of Internal and External Exposures

The purpose of the exposure summation method is to calculate summed (external and internal) doses in compliance with 10 CFR 20.1202, 20.1208(c)(1) and (2), 20.2106, and NRC guidance documents. The following NRC guidance documents will be used to assign and record worker doses:

- Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data."
- Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses."
- Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus."

10.1.6 Contamination Control Program

The purpose of the contamination control program is to monitor and control radioactive contamination during decommissioning operations in compliance with the requirements of 10 CFR 20.1501(a), 20.1702, 20.1906 (b), (d), and (f), and NRC guidance documents. The NRC guidance documents that will be used to specify the contamination control program include the following:

- NRC FC 83-23 or Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use.
- Information Notice No. 97-55, "Calculation of Surface Activity for Contaminated Equipment and Materials".
- Regulatory Guide 8.21, "Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants".
- Regulatory Guide 8.25, "Air Sampling in the Workplace".
- NUREG-1660, "Specific Schedules of Requirements for Transport of Specified Types of Radioactive Material Consignments".

The contamination control program shall incorporate routine surveys of fixed, removable, and airborne contamination adjacent to the Kaiser site restricted area. The contamination control program will include the performance of surveys (including gamma exposure rate monitoring and air sample analysis) to supplement personnel monitoring for workers during routine operations, maintenance, cleanup activities, and special operations. NRC FC 83-23 guidelines will be followed for surveys of equipment, vehicles, materials, and clothing prior to release for unrestricted use. Detectable skin contamination identified during whole body frisking will require decontamination in accordance with written guidance.

10.1.7 Instrumentation Program

The purpose of the instrumentation program is to provide operable instruments and equipment to make quantitative radiation measurements during decommissioning operations and final status survey in compliance with 10 CFR 20.1501(b) and (c) and NRC guidance documents. The guidance documents that will be used to specify the instrumentation program include the following:

- NUREG-1506, "Measurement Methods for Radiological Surveys in Support of New Decommissioning Criteria".
- NUREG-1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions".
- NUREG-1549, "Decision Methods for Dose Assessment to Comply With Radiological Criteria for License Termination".
- NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual".
- Table 10.1 of National Council on Radiation Protection and Measurements Report 127, "Operational Radiation Safety Program", 1998.

Instrumentation will be used to conduct radiation and contamination surveys, sample airborne radioactivity, monitor radiation and radioactivity levels in work areas, monitor airborne radionuclides in effluents, monitor personnel dose, and analyze environmental media samples. The instrumentation program and procedures will incorporate the following guidance:

- Specify instruments to be used as recommended in Sections 6.1-6.5.3 and Appendix H of NUREG-1575 including the manufacturer's name, the intended use of the instrument, the number of units available for the intended use, the ranges on each scale, the counting mode, and alarm set points.
- Maintain instrumentation storage, calibration, and maintenance facilities for instruments used in field surveys including on-site facilities used for laboratory analyses of samples collected during surveys.
- Specify the method used to estimate the minimum detectable concentration (MDC) or minimum detectable activity (MDA) (at the 95 percent confidence level) for each type of radiation to be detected. This method will be consistent with the recommendations in Section 6.7 of NUREG-1575. MDC/MDA shifts caused by covered contamination will be anticipated as necessary using the additional information contained in Chapters 4 and 5 of NUREG-1507.
- Specify instrument operability criteria and QA procedures in compliance with Table 10.1 of NCRP Report 127.

- Specify methods used to estimate uncertainty bounds for each type of instrumental measurement as indicated in Section 6.8 of NUREG-1575.

- Specify air sampling equipment calibration procedures when an accredited laboratory does not perform such calibrations.

- Performance specifications and calibrations in accordance with ANSI N42.17A-1989, N42.17B-1989, N42.17C-1989.

10.1.8 Nuclear Criticality Safety

Protection of public health and safety from the risk of nuclear criticality during decommissioning is not required at the Tulsa, Oklahoma site since source materials requiring nuclear criticality safety (NCS) controls do not exist.

10.1.9 Health Physics Audits, Inspections, and Record Keeping Program

The purpose of the health physics audits, inspections, and record keeping is to evaluate, control, and monitor health and safety procedures to ensure timely identification and correction of health and safety issues. The frequency and scope of such activities will be sufficient to ensure uninterrupted compliance with NRC's requirements for the protection of the public health and safety and the environment. This health physics program will comply with 10 CFR 20.1101, 20.2102, and incorporate the following NRC guidance:

- Information Notice 96-28, "Suggested Guidance Relating to Development and Implementation of Corrective Action," dated May 1, 1996.

- NUREG-1460, "Guide to NRC Reporting and Recordkeeping Requirements," Rev. 1, July 1994.

- The radiation protection program will be reviewed prior to the start of work and annually by Kaiser and the RSO to ensure compliance with commitments and regulatory requirements. The radiation protection program and implementing procedures developed prior to work will specify the following: Specify that records be maintained of the annual program review and other audits.

- Specify the types and frequencies of radiological surveys and audits to be performed by or at the direction of the RSO. The frequency of these surveys and audits (including routine unannounced inspections) will be sufficient to ensure close communications and proper surveillance of individual radiation workers, as well as commensurate with the risks posed by the audited activity. The maximum survey or audit frequency will be semiannual.

- Specify the conduct of operations for evaluating and dealing with violations of NRC requirements or commitments identified during audits.

- Specify that records be maintained of RSO audits including the date of each audit, name of person(s) who conducted the audit, persons contacted by the auditor(s), areas audited, audit findings, corrective actions, and follow up.

Records and reports generated as a result of remediation activities and audits will be maintained as part of the Kaiser project file. Chapter 13, (QA Program) contains additional plans for document control, corrective action processes, and audit and surveillance methods.

References

1. Earth Sciences, May 2002, Revised May 2003, Decommissioning Plan Addendum, Tulsa Facility, Tulsa, Oklahoma, Kaiser Aluminum & Chemical Corporation, Baton Rouge, Louisiana.

2. Information Notice 96-18, Compliance with 10 CFR Part 20 For Airborne Thorium, dated March 25, 1996.

3. Information Notice 96-28, Suggested Guidance Relating to Development and Implementation of Corrective Action, dated May 1, 1996.

4. National Council on Radiation Protection and Measurements Report 127, Operational Radiation Safety Program, 1998.

5. U.S. Nuclear Regulatory Commission, Regulatory Guide 8.21, Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants, Revision 1, October 1979.

6. U.S. Nuclear Regulatory Commission, Regulatory Guide 8.25, Air Sampling in the Workplace, Revision 1, June 1992.

7. U.S. Nuclear Regulatory Commission, Regulatory Guide 8.7, Instructions for Recording and Reporting Occupational Radiation Exposure Data, Revision 1, June 1992.

8. U.S. Nuclear Regulatory Commission, Regulatory Guide 8.34, Monitoring Criteria and Methods to Calculate Occupational Radiation Doses, July 1992.

9. U.S. Nuclear Regulatory Commission, Regulatory Guide 8.36, Radiation Dose to the Embryo/Fetus, July 1992.

10. U.S. Nuclear Regulatory Commission, Regulatory Guide 8.9, Rev. 1, Acceptable Concepts, Models Equations, and Assumptions For A Bioassay Program, Revision 1, July 1993.

11. U.S. Nuclear Regulatory Commission, NUREG-1460, Guide to NRC Reporting and Recordkeeping Requirements, Rev. 1, July 1994.

12. U.S. Nuclear Regulatory Commission, NUREG-1506, Measurement Methods for Radiological Surveys in Support of New Decommissioning Criteria, 1995.

13. U.S. Nuclear Regulatory Commission NUREG-1507, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, 1997.

14. U.S. Nuclear Regulatory Commission NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1, 1997.

15. U.S. Nuclear Regulatory Commission NUREG-1549, Decision Methods for Dose Assessment to Comply With Radiological Criteria for License Termination, July 1998.

16. U.S. Nuclear Regulatory Commission, Regulatory Guide 8.13, Instruction Concerning Prenatal Radiation Exposure, Revision 3, June 1999.

17. U.S. Nuclear Regulatory Commission, Regulatory Guide 8.15, Instruction Acceptable Programs for Respiratory Protection, Revision 1, October 1999.

18. U.S. Nuclear Regulatory Commission NUREG-1660, Specific Schedules of Requirements for Transport of Specified Types of Radioactive Material Consignments.

11.0 Environmental Monitoring and Control Program

Kaiser will implement an Environmental Monitoring Program (EMP) during site decommissioning activities for the specific purpose of evaluating whether the decommissioning activities comply with the regulatory requirements in 10 CFR Part 20 and are adequate to protect workers, the public, and the environment from radiation during decommissioning activities.

The following items must be addressed prior to excavation of affected material:

- Management of water encountered in excavations.
- Management of surface water to minimize contact of water with contaminants and minimize erosion.
- Construction of safe stable excavations, particularly deep excavations where water may be encountered.
- Preparation and implementation of a Dust Control Plan to prevent migration of wind-borne contaminants.
- Identification and protection of existing underground and overhead utilities.
- Implementation of site access controls.
- Implementation of internal traffic controls.
- Management of wastewater as a result of remediation activities.

ALARA reviews will be included in regularly scheduled job meetings. The minutes of these meetings will be distributed to the attendees, the PM, and the RSO.

11.1 Environmental ALARA Evaluation Program

Every reasonable effort will be made to limit radiation exposures and releases of radioactive materials in effluents in unrestricted areas as ALARA. The environmental monitoring and control program will include management of surface water and groundwater encountered in excavations as well as monitoring for airborne particulates. Written sampling and analysis procedures shall be developed to implement periodic sampling (frequency and method of sampling described in Section 11.2) to ensure that effluent concentrations of radioactive material in the water and air are ALARA in accordance with the following NRC guidance:

- Regulatory Guide 8.37 "ALARA Levels for Effluents from Materials Facilities," July 1993.
- Regulatory Guide 4.20 "Constraint on Releases of Airborne Radioactive Materials to the Environment for Licensees Other Than Power Reactors," December 1998.

The environmental monitoring and control program will also ensure that effluent concentrations in unrestricted areas are maintained below the values listed in 10 CFR 20 Appendix B, Table 2 (limits for annual average effluent concentrations for air and water) and Table 3 (monthly average concentration limits for releases to sewers using the unity rule). Prior to the release of water to the sanitary sewer system, representative water samples will be obtained in accordance with written procedures and evaluated in accordance with NRC Information Notice 94-07 and written procedures. In addition, water samples must meet the criteria set forth in the following table provided by the City of Tulsa as part of Ordinance 1991.

Maximum Allowable Discharge Concentrations

Pollutant	Limitation	Pollutant	Limitation
Arsenic (Total)	1.0 mg/l	Nickel (Total)	3.25 mg/l
Cadmium (Total)	0.60 mg/l	Zinc (Total)	5.0 mg/l
Chromium (Total)	4.0 mg/l	Cyanide (Total)	2.25 mg/l
Copper (Total)	2.0 mg/l	Silver (Total)	1.2 mg/l
Lead (Total)	0.7 mg/l	Oil and Grease	100 mg/l
Mercury (Total)	0.04 mg/l	PH	6.0 to 10.5 std. pH units

Baseline concentrations have been established for both surface water monitoring and air monitoring. Average water concentrations of Th-232 were 0.146 picocurie per liter (pCi/l). Air concentrations were 4.03×10^{-15} μCi/ml gross alpha. Effluents from the remediation area will be sampled and measured, where applicable. Release of effluents will be restricted to the criteria set forth by the local and regional regulatory bodies. Only effluents which meet the regulatory limits and are approved will be released to the proper environmental channel. Construction management techniques to minimize E&S transport, and E&S control measures to be implemented and maintained during remedial activities are outlined in the later sections of this chapter. In addition, groundwater management methodologies have been outlined in Kaiser's Ground Water Sampling Procedure, KAI–03 in the event groundwater is encountered during soil remediation. Surface water encountered during remediation activities will be monitored and sampled in accordance with the Procedure for General Surface Water Sampling, KAI-07.

The EMP presented below addresses the program that will be conducted during and after remediation, where applicable. In addition, this plan summarizes procedures that will be followed to ensure that samples will be representative of actual conditions as well as methods of environmental record keeping and reporting. Monitoring requirements for airborne particulate addressed in Chapter 10.0 are not included in this EMP. A description of engineering controls to maintain doses ALARA is provided in Section 11.3 of the DP. Water and air sampling results will be evaluated by the RSO. In addition, quarterly summary reports will be prepared evaluating the data of EMP activities and be submitted to the RSO. A post-remedial monitoring report will be completed to document all monitoring activities and results during and subsequent to remediation. Evaluation of air sample results, water sample results, and reports by the RSO will be conducted to ensure that the EMP is maintaining its commitment of ALARA.

11.2 Effluent Monitoring Program

Kaiser will continue to implement an Environmental Monitoring Program during site decommissioning activities. Background and baseline radionuclide concentrations have already been established for the Kaiser Tulsa site.

11.2.1 Physical and Chemical Characteristics of the Site-Specific Radionuclides

The site-specific radionuclides exist as a thoriated dross material at the facility. The dross material is generally gray to blue gray in color when mixed with small quantities of soil. The material contains hydrous magnesium and thorium oxide and is insoluble in water as discussed in Chapter 5.0. This has been demonstrated through the filtering of water samples as well as the settling of water removed from excavations. The material does not become airborne easily. This has been demonstrated through personal and environmental air monitoring during the ALRP.

11.2.2 Sampling and Discharge

Storm water and groundwater collected within an excavation or decontamination area will be contained. Within an excavation, the construction of trenches or berms may be used to isolate storm water and infiltrating groundwater, thereby reducing the potential for contamination of these waters. Representative samples of collected or contained water will be sampled and analyzed for radiological contamination. If activity concentration levels are below the appropriate 10 CFR 20, Appendix B limit (Table 2 or 3), the water collected may be released to surface drainage or the sanitary sewer system as applicable (per the restrictions set forth by the City of Tulsa). Requirements of the City of Tulsa include that the access point to the sewer system be located within the facility. However, manhole locations are also acceptable with

the addition of the proper safety requirements. Specific discharge points for surface water will be identified when design details for surface water control have been completed.

The frequency of air monitor sampling for fugitive dust generated during remediation will be determined by the RSO. Up to four monitoring stations will be established to evaluate off-site releases. Samples for laboratory analysis will be collected in accordance with site-specific procedures. Air filters may be analyzed for gross alpha on site and sent for laboratory analysis based on a gross activity action level determined by the RSO. For off-site analysis, standard chain of custody protocol will be strictly adhered to during all phases of sample collection, transport, and delivery to the laboratory. The MDCs for laboratory analysis will be based on measuring a fraction of the concentration necessary to demonstrate compliance with the dose constraint requirement of 10 CFR 20.1101. MDC calculations and air sampling will be performed in accordance with guidance contained in Chapter 10.

11.2.3 EMP Reporting

Quarterly reports will be prepared summarizing the air monitoring results and the groundwater and surface water sampling results. These analytical results will be reviewed and compared to the baseline sampling results and the required regulatory limits and constraint for effluent sampling. In addition, a postremedial monitoring report will be completed to document all monitoring activities during and after remediation.

11.2.4 EMP QA/QC Program

A QA/QC Program will be implemented as part of the EMP. The quality of data obtained as a result of the implementation of the EMP will be determined primarily on how well procedures were followed, MDCs were met, and whether or not the instruments used were functioning properly and adequately calibrated prior to use. To ensure that procedures are followed, personnel making measurements in the field or in the laboratory must review and understand procedures prior to the initiation of field and laboratory work. The following QA Procedures will be used in the performance of the work: KAI-03 (Groundwater Sampling Procedure), KAI-04 (Procedure for Field Measurement of pH, Conductivity, and Dissolved Oxygen), KAI-06 (QA Plan), KAI-07 (Surface Water Sampling Procedure), KAI-08 (Air Sampling Procedure), GEN 21-3 Rev. 3 (Laboratory QA Manual for Outreach Laboratory, Tulsa, Oklahoma).

11.3 Effluent Control Program

Every reasonable effort will be made to limit radiation exposures and releases of radioactive materials in effluents in unrestricted areas as ALARA. Commonly accepted and well established procedures,

engineering controls, and process controls to achieve ALARA goals shall be utilized for effluent minimization. Where applicable, effluent controls will be utilized to prohibit the influx of effluents into restricted areas as well as to prohibit the release of contaminated effluents. Site procedures for sampling, analysis, and disposition of water will be established to ensure that releases to sewer systems are ALARA and are controlled and maintained to meet the requirements of 10 CFR 20.2003 taking into account the solubility considerations contained in NRC Information Notice 94-07. These procedures will ensure that only the soluble liquid portion of the effluent are released. Sewer releases shall be controlled to limit the annual release of radioactivity to less than 1 Ci per year in accordance with 10 CFR 20.2003 and any other applicable requirements in City of Tulsa in Ordinance 1991.

11.3.1 Water Controls

Water inflow is expected in affected soil excavation locations. Engineering solutions, such as excavation dewatering and installation of drawdown wells or sheet pile, will be required. A dry excavation would be beneficial to the persons performing surveys controlling the soil remediation activities. Water inflow also may affect the stability of excavations.

Dewatering requirements for an excavation depend on the rate of intrusion. Minor inflows can be managed using a pump in a sump to drain the excavation. Standing water in the excavation may be pumped into an area where the water can be sampled and measured before it is released. Chapter 12.0, Section 12.2, addresses liquid material management.

11.3.2 Surface Water Management

Surface or storm water must be managed during remediation. Essential aspects of surface water management will be:

- maintenance and restoration of existing drainage ways,
- minimization of water contacting contaminated materials (contact water),
- control and diversion of storm water around remediation areas,
- pumping of contact water into a holding area,
- minimization of soil E&S, and
- protection of water quality in downstream watercourses.

The following sections describe these considerations in detail.

11.3.2.1 Maintenance and Restoration of Existing Drainageways

The contractor's work plan will address the maintenance of existing drainageways (e.g., pipe outlets, ditches, weirs, and Fulton Creek). Any drainageways interrupted by remediation activities will be temporarily rerouted and later restored or improved after the remediation is completed. Damaged items will be repaired or replaced to at least their original condition prior to remediation. Particular attention will need to be given to remediation in and around Fulton Creek. Necessary permits for interruption of existing drainageways will be obtained.

11.3.2.2 Minimization of Contact Water

It will be essential to minimize storm water contact in contaminated areas and soil stockpiles. Contact water will be pumped into a holding area, where applicable.

Minimization techniques may include the following, as necessary:

- Diverting surface water drainage around remediation and stockpile areas,
- Installing covers over stockpiles,
- Minimizing the time of exposure of open areas, and
- Performing work during dry periods.

11.3.2.3 Storm Water Diversion Around Remediation Areas

Diversion channels, berms, or other structures may be installed to divert surface flow around active remediation/excavation areas and stockpiles. Diversion controls will be designed before remediation implementation. Water entering the excavations or the decontamination area, either as surface water or groundwater, may be pumped into holding tanks.

Water (groundwater and/or surface water) that infiltrates an excavation area may be collected and temporarily stored for settling in holding tanks. This system will consist of a liner on top of a sand berm around the holding tanks. Any water that collects (due to rain event or leak from holding tank) in the containment system will be characterized and compared to the criteria outlined in Sections 11.1 and 11.2 prior to discharge to the surface drainage or the sanitary sewer system.

11.3.2.4 E&S Control

E&S controls are required to prevent sediment pollution resulting from excavation activities. The State of Oklahoma has adopted the USEPA's 40 CFR 120 National Pollutant Discharge Elimination System (NPDES) including specifically 40 CFR 122.26(b)(14)(x) which specifies permit requirements for

discharge to state rivers and streams. NPDES requires permits for construction sites larger than 5 acres. All necessary E&S permits will be obtained. The contractor's work plan will contain a work-specific E&S Control Plan. The following section outlines the primary issues that need to be addressed in the plan.

11.3.2.4.1 Construction Management for E&S Control

The following techniques will be utilized to minimize E&S transport away from the affected areas and stockpiles.

Interim stabilization measures such as:

- temporary seeding,
- straw mulch application,
- erosion control mat,
- cover barriers (such as plastic sheeting), and
- an erosion control surfactant (Soil Master).

Permanent stabilization measures may include:

- top soil placement and grading,
- seeding and mulching,
- sod matting, and
- gravel or riprap placement.

Erosion control measures must be in place and operational before excavation, backfilling, or grading operations can begin. E&S control measures shall be properly constructed and maintained until the disturbed areas are adequately stabilized. These measures may include:

- diversion channels and berms,
- sediment traps,
- temporary covers (such as plastic sheeting),
- silt fence and/or hay bale barriers,
- riprap linings,
- vegetative strips, and
- surface coatings.

An inspection schedule and reporting protocol shall be prescribed in the contractor's work plan. A record of inspection and all repairs made will be noted and kept on site by the CPM. At a minimum, all E&S control measures will be inspected weekly during soil remediation activities, every 2 weeks during

inactive periods, and within 24 hours after each rainfall event exceeding 0.5 inch. During periods when rain is occurring daily, or continuously for days, control measures will be inspected at least daily. Repairs and maintenance will be performed as soon as practical.

11.3.3 Protection of Water Quality in Downstream Watercourses

Adequate controls will be installed and implemented to prevent discharge of contaminated water to downstream watercourses. Contact water will be pumped into holding tanks with a secondary containment system employing a liner on top of a sand berm around the holding tank. Water in the containment system will be characterized and compared to the criteria outlined in Sections 11.1 and 11.2 prior to discharge to the surface drainage or the sanitary sewer system.

11.3.4 Airborne Radioactivity Control Program

Airborne radioactivity monitoring will be conducted to confirm the effectiveness of radioactive material control practices during work activities. Airborne radioactivity will be controlled using water sprays and water trucks for dust suppression. Coverings and enclosures may also be utilized. Administrative controls such as control of vehicle traffic and speed will also be utilized to minimize dust.

11.3.5 EMP Action Levels

Airborne radioactivity monitoring will be conducted to confirm the effectiveness of airborne radioactivity control practices during work activities. Gross alpha activity results will be compared to the 10 CFR Part 20 Appendix B, Table 1, DAC for the mix of radionuclides at the site. The RSO will periodically send composite air filters to an off-site laboratory for isotopic analysis to confirm the results of gross activity measurements made on site. Engineering controls such as water trucks, water spray, and coverings will be maintained to the keep airborne radionuclide levels ALARA.

11.3.6 Estimated Public Dose

Based on recent discharge concentration data obtained during the ALRP, no measurable doses to the public from water are anticipated. The insoluble thorium will settle out in a holding tank and only water which meets the release criteria outlined in Sections 11.1 and 11.2 will be discharged to the sanitary sewer system. Doses due to airborne releases of fugitive dust are also expected to be so low as to challenge the measuring capability of commercial radioactivity detection equipment.

References

(1) City of Tulsa, Oklahoma, 1991 Ordinance, Title 11-C- Waterworks and Sewerage.

(2) Kaiser Aluminum and Chemical Corporation, QA Plan, KAI-06, Revision, August 2000.

(3) Kaiser Aluminum and Chemical Corporation, Air Sampling Procedure, KAI-08, September 2000.

(4) Kaiser Aluminum and Chemical Corporation, Ground Water Sampling Procedure, KAI-03, Revision 2, June 2002.

(5) Kaiser Aluminum and Chemical Corporation, Procedure for Field Measurement of Chemical Parameters, KAI-04, Revision 2, June 2002.

(6) Kaiser Aluminum and Chemical Corporation, Surface Water Sampling Procedure, KAI-07, Revision 2, June 2002.

(7) U.S. Code of Federal Regulations, 40CFR Parts 100 through 135, Protection of the Environment, Revised July 1, 2002.

(8) U.S. Code of Federal Regulations, 40CFR Parts 1 through 50, Energy, Regulations are issued under the Energy Act of 1954, as Amended; and the Energy Reorganization Act of 1974, as Amended, Revised January 1, 2003.

(9) U.S. Nuclear Regulatory Commission, Information Notice 94-07, Solubility Criteria for Liquid Effluent Release to Sanitary Sewerage under the Revised CFR Part 20, January 28, 1984.

(10) U.S. Nuclear Regulatory Commission, Regulatory Guide 8.37, ALARA Levels for Effluents from Materials Facilities, July 1993.

(11) U.S. Nuclear Regulatory Commission, Regulatory Guide 4.20, Constraint on Release of Airborne Radioactive Materials to the Environment for Licensees other than Power Reactors, December 1998.

12.0 Radioactive Waste Management

Solid and liquid materials will be generated during the implementation of the planned decommissioning activities. Kaiser will manage the solid and liquid materials generated from the decommissioning effort in a controlled manner in accordance with applicable NRC, Department of Transportation (DOT), and state regulatory requirements. The management approach is based upon minimizing secondary wastes and radiation exposure. Supplemental information relative to the "former operational area" of the facility is provided in the May 2002 DPA (Revised May 2003).

12.1 Solid Material

Two types of solid materials are expected to be generated during the implementation of the planned decommissioning activities at the Kaiser site: Dry Active Waste (DAW) – Thorium-Containing Soil/Dross and Other Incidental DAW.

12.1.1 Volume Estimate of Thorium-Containing Soil/Dross - Retention Pond and Reserve Pond Area

Volume estimates for the thorium-containing soil/dross in the Retention Pond and Reserve Pond Area have been discussed previously. The volume estimates as calculated from krigging and triangulation are presented in Appendix A. In addition, soil/dross material generated in adjacent land remediation excavations will be managed in this decommissioning project. Estimated volumes of solid materials to be handled are as follows:

- Approximately 285,000 ft^3 of soil/dross excavated during adjacent land remediation and stored on site.
- Approximately 5,060,000 ft^3 of solid material with a Th-232 activity concentration of greater than 6 pCi/g.

12.1.2 Thorium Activity Concentrations

The quantity of material SMC and later Kaiser were authorized to possess at one time was amended from time to time, but generally was limited to 30,000 pounds of magnesium-thorium alloy containing no more than 4 percent thorium. This thorium percentage by weight would equal approximately 4,400 pCi/g.

One biased sample of a unique dross material (wrapped in plastic) taken in the area of the original Smelter Building during radiological characterization survey activities in February 2002 contained a Th-232 concentration of 6,429 pCi/g. This elevated concentration is most likely the result of the magnesium

recovery process, which removed magnesium mass from the scrap feed material. The removal of magnesium during the process would have decreased the mass of the material, thereby increasing the concentration of Th-232 in the dross residue. Consequently, Th-232 concentrations in dross could have been increased above the 4 percent by weight limit for the scrap feed material. However, since thorium alloy material only comprised a small fraction of the total magnesium refined and records indicate that thorium-bearing materials were generally only a small fraction (5 percent) of each production batch, it is not surprising that most samples were found to have concentrations well below 4 percent by weight.

Thorium activity concentrations for the soil/dross materials were determined using existing characterization data for both the on-site and adjacent land remediation areas. Based on data generated by ARS in 1995, Th-228 + Th-232 activity concentration for the on-site material typically ranges from approximately 2 pCi/g to 416 pCi/g. As indicated in Table A-2, 95 percent of the material on-site has a concentration of Th-232 less than 120 pCi/g. The adjacent land remediation area material exhibited Th-228 + Th-232 activity concentrations ranging from less than minimum detectable activity to 728 pCi/g.

12.1.3 Management of Thorium-Containing Soil/Dross

Thorium-containing soil/dross will be excavated during remediation efforts for the on-site areas. During the site preparation phase of the decommissioning, a controlled stockpile and material handling/processing/storage area will be constructed in the western part of the property (Figure 8-1). Excavated materials will be transported to the stockpile area for segregation into above- and below-criteria materials.

Segregated above-criteria material (greater than 31.1 pCi/g Th-232) will be loaded directly into trucks, railcars, or storage containers. Containers awaiting shipment will be placed in a designated Storage Area (Figure 8-1). An off-site disposal facility has not yet been selected due to dynamic market conditions. As discussed in Chapter 8.0 of this plan, segregated below-criteria material (less than 31.1 pCi/g Th-232) will be used as backfill in Phase II and Phase III excavation areas. Stockpiled materials will be protected against inclement weather. Storm water runoff will be controlled in the material handling/processing/storage area until the materials are packaged for shipment or determined to be acceptable for use as backfill.

12.1.4 Management of Other Dry Active Waste

Other DAW will consist mainly of compatible paper and plastic (gloves, anticontamination clothing, poly sheeting, etc.). This type of material will be collected in a manner in which it can be easily characterized for radioactivity and shipped to a properly licensed waste processing or disposal facility, if contaminated. DAW of the aforementioned type found to be noncontaminated will be placed in a staged refuse container and disposed as nonradioactive waste at an appropriate facility.

12.2 Liquid Material Management

Liquid materials that may be generated during decommissioning efforts include collected infiltration waters from excavation areas and decontamination process fluids. Minimization of the quantity of liquids requiring disposal as a radioactive waste will be a high priority during the project. Decontamination process activities will be well planned to minimize the generation of secondary waste volumes. Pre-decommissioning closure of the Freshwater Pond is expected to lower the groundwater table significantly. Primary groundwater control for the deepest excavations will be accomplished by sheet piling. Secondary control will be pumping. For estimate purposes, it is assumed that not more than 200,000 gallons of water (approximately 20 frac-tanks) will be generated through the collection of waters infiltrating the excavation areas.

During the excavation activities, infiltrating water may be collected and managed, where practical. Collected waters will be managed in accordance with local, state, and federal laws, regulations, and permits as well as procedures and regulatory guidance outlined in Chapter 11.0.

During the adjacent land remediation project, waters infiltrating the excavation areas were collected, temporarily stored for settling, and characterized. Ultimately, the water was discharged to the sanitary sewer system. No collected waters required off-site processing. The average concentration of Th-232 in the collected waters was 1.2 pCi/l (7.7 pCi/l maximum) which is far below the Part 20 Release to Sewers Average Concentration Standard of 300 pCi/l.

12.3 Radioactive Waste Disposal

12.3.1 Waste Classification

All radioactive waste materials are expected to be exempt quantities and will be disposed using procedures that follow the applicable requirements of federal regulations (10 CFR 61) and the receiving disposal facility requirements. Use of procedures will ensure that an accurate profile of the waste is made

and that classification is performed in a consistent manner. The following basic methods may be used to ensure materials are exempt:

- Field measurements of gross activity
- Analytical measurements of specific activity

Waste material characterization will be performed based on remediation area or process. Individual waste stream designations will be established for remediation areas or processes that have similar radionuclide profiles and physical properties (e.g., soil/dross, other incidental DAW, or liquids). Waste material characterization will be performed by monitoring with appropriate instrumentation and/or sampling before packaging. The total activity (i.e., curie content) of each waste container will be determined based on the radionuclides present and the activity concentrations of Th-232 (through waste characterization sampling and calculations based on known ratios of thorium isotopes). In addition, characterization data will be utilized to assure that the material meets the exempt waste acceptance criteria of the disposal facility. Profiling of radiological waste for disposal purposes will be completed by a disposal site-approved and/or state-approved laboratory using accepted analytical methods and reporting limits.

An estimate of the volume of above-criteria solid material to be generated during remediation of the site soils has been performed. Approximately 1,200,000 ft^3 of above-criteria soil/dross material may be generated for off-site disposal. Based on existing site characterization data, it is anticipated that this material will be exempt.

12.3.2 Waste Packaging, Transfer, and Storage

Radioactive waste materials will be packaged for disposal in the controlled material handling/processing/storage area (Figure 8-1). Packaging will include DOT and disposal facility-approved containers (minimum of strong tight) such as intermodals, metal drums or boxes, and/or impervious bagging. Containers will be appropriately labeled as they are filled and a control number will be assigned to each container. The control number will be entered in a master log and placed on the container surface. After packaging, the radioactive waste will be transferred to a secured on-site storage area and prepared for shipping or loaded directly for shipping. Solid radioactive waste materials may also be loaded directly into gondola rail cars.

12.3.3 Waste Transportation

Each waste package will be thoroughly inspected prior to shipment to ensure it meets all applicable design and/or certification requirements and is free of damage or impairment. Waste shipments are

expected either to be nonradioactive material or low-specific activity material. The waste material will be transported by truck or rail based on volume of material and packaging requirements.

Waste shipments will conform to DOT and other applicable federal regulations as well as the requirements of the receiving waste facilities. Shipping documentation will be maintained in accordance with 49 CFR and 10 CFR Part 71, and the receiving waste facility's requirements.

12.3.4 Waste Disposal

As discussed above, an estimate of the volume of above-criteria solid material to be generated during remediation of the site soils has been performed. Approximately 1,200,000 ft^3 of above-criteria soil/dross material will be generated for off-site disposal.

12.3.5 Material Segregation

Material segregation activities that will be conducted that during the Kaiser Tulsa site remediation are described in Chapter 8.0. Chapter 14.0 contains a description of the techniques and instrumentation that will be used to conduct segregation and clearance activities. All waste management and material segregation activities will be performed in accordance with the QA Program described in Chapter 13.0.

12.4 Mixed Waste

Based on recent additional site characterization activity (ASCA) efforts, solid and liquid mixed waste are not expected to be generated during decommissioning operations. However, should mixed waste be identified during remediation activities, Kaiser will notify the NRC and provide a characterization of such wastes, identify alternate disposal methods to accommodate such wastes, and assess all additional treatment and disposal costs, as needed.

References

1. Advanced Recovery Systems/Nuclear Fuel Services, Inc., April 25, 1995, Kaiser Aluminum Specialty Products, Field Characterization Report, Tulsa, Oklahoma.

2. Earth Sciences, May 2002 , Revised May 2003, Decommissioning Plan Addendum, Tulsa Facility, Tulsa, Oklahoma, Kaiser Aluminum & Chemical Corporation, Baton Rouge, Louisiana.

13.0 QA Program

It is Kaiser's policy and intention to implement its current QA Plan, KAI-06, for remediation activities at the Kaiser facility. Aspects of the plan which do not cover current guidance or may be outdated will be revised prior to the onset of remediation activities. It is Kaiser's intention to implement appropriate QA program controls for work related to remediation and final radiological survey activities that may affect the health and safety of the public and personnel at the site, or the quality of the final survey data. The current QA Plan also will be revised to address project personnel responsibilities and activities in support of remediation. The plans and procedures identified in this plan will be selected to control remediation and final radiological survey activities.

The NRC will be notified of changes in plans, procedures, and personnel that would impact the commitments of the DP before implementation of the changes. Editorial changes or personnel reassignments of a nonsubstantive nature would not require NRC notification.

13.1 Organization

Responsibility for the development, implementation, and revision of the QA Plan for the Kaiser DP is shared by corporate and on-site personnel as delineated below. The organizational structure presented in Figure 13-1 may be revised by the Kaiser PM as deemed appropriate to facilitate execution of the project. Any revisions will be documented by the Kaiser PM. In addition, any one person may fill multiple positions as long as this does not create an organizational conflict.

13.1.1 Kaiser PM

The PM has the overall responsibility for planning and managing remediation activities. The PM is responsible for ensuring that the Kaiser Remediation Project activities meet the established environmental, health and safety, QA requirements, technical performance, budgeting, and scheduling criteria. However, the Kaiser PM will consult with the RSO and SA. In addition, the Kaiser PM has the authority to make appropriate changes to the QA Plan deemed necessary, as the remediation activities progress.

13.1.2 SA

Kaiser's SA is responsible for overseeing site remediation activities and day-to-day administration of contractor performance to assure that remediation activities are performed safely, in accordance with approved plans, design specifications, and government permits and regulations. Kaiser's SA has the

authority to stop work that may be unsafe or that may violate an approved plan, design specification, government permit ,or regulation.

13.1.3 Kaiser QAC

Kaiser will employ the services of a third-party QAC. The QAC reports to Kaiser's SA for administrative activities and QA guidance. The QAC communicates and coordinates directly with Kaiser's SA and has the delegated responsibility and authority to assure that QA objectives are met. Responsibilities of the QAC include overseeing that appropriate quality management, policy, training, and verification controls are present. Additional QAC responsibilities include conducting QA audits, surveillance of contractor activities, and correcting conditions which could adversely affect quality. The contractor will allow the QAC to inspect the work at any time and provide every reasonable facility and equipment necessary to inspect the work. The QAC is not authorized to revoke, alter, or waive any requirements of this plan. The QAC has the authority to reject materials or suspend work until any question at issue can be resolved by Kaiser's SA.

13.1.4 Data Manager

The Data Manager will report to the QAC and will ensure that all required surveys and sampling are performed in accordance with the Final Status Survey Plan and applicable written procedures. Data will be reviewed by the Data Manager to ensure that the requirements stated in the Final Status Survey Plan are implemented as prescribed and that the results of the data collection activities support the objectives of the survey, or permit a determination that these objectives will be modified. The Data Manager will determine if the data are of the right type, quality, and quantity to demonstrate compliance with the plan objective.

13.1.5 Contractor LHPT

The QCS shall designate an LHPT who will ensure all necessary sampling and scanning required in the Final Status Survey Plan are performed in accordance with such plan and written procedures. The LHPT is also responsible for sampling of soil stockpiles, off-site borrow material, and transportation containers, and will perform the preliminary review of survey data and analytical results.

13.1.6 CPM

Kaiser will utilize qualified contractor(s) to implement the DP. The contractor(s) will designate a PM who will be responsible for planning, managing, and coordinating all contractor activities in accordance with written procedures. The CPM will report to the SA and will ensure that remediation activities meet

the established environmental, H&S, and QC requirements; technical performance; and budgeting and scheduling criteria. The CPM will be authorized to stop any activity that may be unsafe or is in violation of a regulatory requirement.

13.1.7 Contractor QCS

The contractor shall designate a QCS who will report to the CPM for administrative activities and QC guidance. The QCS communicates and coordinates directly with the CPM and will have the delegated responsibility and authority to direct and control contractor QC functions to assure that QC objectives are met. Responsibilities of the QCS include coordination of contractor QC activities and ensuring that appropriate quality management, policy, training, and verification controls are present. The QCS shall provide all necessary QC information to the CPM, Kaiser's SA, and the QAC.

13.2 QA Program

The goals of Kaiser's QA program for the Tulsa site are as follows:

- To prevent the uncontrolled release of radioactive materials off site.
- To ensure that the radiation exposure to workers and to the public from decommissioning activities is below the limits established in 10 CFR Part 20 and maintained ALARA.
- To minimize adverse impacts on the health and safety of the public.
- To meet the requirements for the packaging and shipping radioactive and hazardous wastes, as delineated primarily in 10 CFR Part 71, 49 CFR Parts 172 and 173 and the disposal site Waste Acceptance Criteria (WAC), as well as, the NRC Final Waste Classification and Waste Form Branch Technical Position as applicable.
- To ensure that work practices employed during all phases of the project are controlled to comply with requirements, that waste is characterized and measured for proper disposition, and that the quality of radiological measurements is suitable to permit regulators to release the site.
- To prevent the unnecessary spread of radiological contamination to uncontaminated areas and minimize the amount of waste generated.

Prior to the implementation of field activities, written procedures consistent with the approved plan and current guidance will be prepared, reviewed by Kaiser management, and submitted to the NRC. Revisions to the written procedures will be documented and kept as part of the Kaiser project file. Written procedures and plans will have the appropriately controlled Kaiser management signatures for review and approval. H&S Plans will be submitted to Kaiser as part of the project file.

It is Kaiser's intention to develop its QA/QC program based on its current QA Plan for remediation activities to assure that the objectives stated above are met. It is also based on the concept that the QC Supervisor will implement and support the QA program when performing daily management and supervisory functions. The Kaiser QAC (Consultant) is responsible for performing independent reviews, as necessary, to ensure that each contractor is in compliance with the Kaiser QA program. The written QA/QC program will address project personnel roles and responsibilities. Audits as outlined in Section 13.7 (Audits and Surveillance) will be documented and kept as part of the Kaiser project file. The following is a summary of what the program will also address:

- Authority and Responsibility. Written definitions of authority, duties, and responsibilities of managerial, operation, and safety personnel; a defined organizational structure; assigned responsibility for review and approval of plans, specifications, designs, procedures, data, and reports; and assigned responsibility for procurement and oversight of services (e.g., analytical laboratory). Assigned authority to persons performing QA functions to allow them to identify quality problems; to initiate, recommend, and provide solutions; and to verify implementation of solutions.

- Personnel Training. An indoctrination and training program to provide staff that are trained and qualified in principles and techniques of jobs assigned such as survey or sampling, aware of the nature and goals of the QA aspects of their respective jobs, and able to demonstrate proficiency. Proficiency is maintained by retraining and/or periodic performance reviews. Individuals who collect samples and/or operate survey instruments or analytical counting systems will be trained accordingly and such training documented. Training will be commensurate with the education, experience, and proficiency of the individual and the scope, complexity, and nature of the assigned activity.

- Qualification. Individuals who collect samples and/or operate survey instruments or analytical counting systems will be qualified and such qualification documented. Qualification requirements will be commensurate with the scope, complexity, and nature of the assigned activity.

- Procedures. Written procedures for decommissioning activities (such as SWPs/ALARA reviews, surveys, sampling activities, sample chain of custody, selection, calibration and sensitivity of instruments, and equipment maintenance and calibration) that are prepared, reviewed, and approved by knowledgeable persons.

- Documentation and Data Management. Records to document the sequence of significant activities performed and to track and control significant tasks. Steps of the process including, but not limited to, training, calibration of the instrumentation, daily checks, surveys, sampling, and results analysis and interpretation will be documented such that the records will stand up to audits. Records will be kept as part of the Kaiser project file.

- Data Assessment. Review and analysis of data. Examining data for reasonableness and consistency and establishing general criteria for recognizing deficiencies.

- Corrective Action Process. Process to document and correct recognized deficiencies and document corrective actions.

Work performance will be evaluated through the lines of responsibility presented in the organizational chart (Figure 13-1). For persons performing more than one task, there may be multiple persons who will be required to evaluate their work performance. Performance evaluations may include but will not be limited to: daily oversight by persons responsible for daily activities at the site, management audits as outlined in Chapter 13.0, and regulatory audits as part of the NRC QA/QC program.

13.3 Quality Control Requirements

The unique requirements for remediation of the Tulsa site include the need to provide a consistent basis for preparing SWPs and ALARA reviews, ensure procedural compliance, and provide reliable tool and equipment calibration. In addition, the traceability of radiologically-contaminated materials shipped off site for processing or disposal and associated records retention and management will support the waste management effort. Quality control activities will include the following:

- Control and calibration of radiation measurement equipment
- Receipt inspections of packaging materials and shipping containers
- Work observations and SWP/ALARA compliance
- Control of liquid waste discharges and airborne radioactivity to the environment and consideration of exposure to the public
- Control of waste handling operations and removal of waste from the site
- Control of excavation backfilling operations
- Control of site surveys
- Accuracy and completeness of project records

13.4 Document Control

Preparation, review, approval, distribution, and revisions of QA, H&S plans, and procedures will be controlled in a manner which will allow for documents to be revised as needed. Superceded copies of revised documents will be voided by written notification. Distribution of approved documents will be controlled to ensure that persons responsible for implementing written project plans and procedures have a current approved copy before work commences.

Aspects of the DP including, but not limited to, training, calibration of the instrumentation, daily checks, surveys, sampling, and results analysis and interpretation will be documented such that all records will stand up to audits. Records related to the DP will be maintained by Kaiser's SA or other persons designated by Kaiser's PM.

QA records which will fall within the document control program include the following:

- Kaiser site-specific procedures
- Kaiser site-specific plans
- Contractor site-specific procedures
- Contractor site-specific plans
- Nonconformance reports
- Corrective Action reports
- Audit reports
- Final Status Survey Data
- Final Status Survey Report
- Instrument Response Check Data
- Instrument Calibration and Repair Records
- Personnel Radiation Exposure Records
- Effluent and Environmental Monitoring Data
- Radiological Data and Survey Reports
- Training Records
- Safe Work Permits and ALARA Documentation

13.5 Control of Measuring and Testing Equipment

For all counting systems and instruments used as part of analytical analyses, at a minimum, the following QA/QC principles will be applied.

13.5.1 Procedures

Counting systems and instruments will be used in accordance with approved procedures. Soil samples will be collected in accordance with written procedures. Sampling tools will be cleaned and monitored, as appropriate, after each use.

Samples will be collected in clean/unused sealable containers. Sample containers will be permanently labeled/marked in the field at the time of collection by the technician collecting the sample. At a minimum, the following information will be recorded on the sample container: sample date/time, sample identification number, sample location, and name of person collecting the sample. Samples which may contain radionuclide levels in excess of 100 times the baseline concentration or which, because of their

form, may be a potential laboratory contamination concern will be identified on the outside of the container with a "radioactive material" caution label. Written documentation on sample collection, analysis, and audits will be kept as part of the Kaiser project file. An approved procedure will be used for strict chain of custody to ensure that the integrity of the sample is maintained throughout sampling, transportation, analysis, and archiving.

For each type of laboratory analysis requested, a specification for the following (at a minimum) will be made: required analysis and/or analytical methodology, the required MDC value for each radionuclide, any result presentation requirements, sample disposition, and turnaround time require to support the project. In addition, for all analytical laboratories (vendors) used, at a minimum, the following QA/QC principles will be applied: proper maintenance, storage, and archiving of samples after transfer to laboratory will be practiced; and an approved internal QA program will be in place.

13.5.2 Source and Instrument Checks

Each day that a counting system and instrument are used, the response will be checked using an appropriate source before initial use. Additional response checks may be necessary depending on the counting system used. In addition:

- For laboratory counting systems, source check acceptance criteria (e.g., $\pm 2\ \sigma$ of the average response determined after the most recent calibration or otherwise linking the response to the current calibration) will be established prior to using the counting system. Control charts will be used to evaluate the data.
- For field instrumentation, source check acceptance criteria (e.g., $\pm 2\ \sigma$ for direct [integrated] measurements and ± 20 percent for rate measurements) will be established.
- For field instruments of increased complexity (e.g., single-channel analyzers), additional checks such as energy calibration and efficiency checks will be performed and documented.
- All source check results will be documented.
- Failed source checks will be repeated. Consecutive failure will result in additional testing of the counting system in accordance with the applicable procedure and ultimately removing the counting system from service.
- The LHPT will notify the PM (Contractor) of an instrument failure and corrective actions that were taken by the end of the work shift.
- The LHPT will notify the Data Manager of any instrument failure or performance check deficiencies and corrective actions that were taken as soon as practicable and by the end of the work shift in which the deficiency is identified.

- The corrective actions taken by the HPT may include battery replacement, cable replacement, detector replacement, resetting of the detector voltage or threshold to calibrated presets if the voltage or threshold changed due to instrument handling.

- Out-of-calibration or malfunctioning equipment shall be tagged out-of-service.

- The Data Manager will immediately notify the QAC who will conduct an investigation which typically involves the use of a properly operating instrument to repeat the measurements previously performed with the "failed" instrument to evaluate whether any of the previous measurements acquired since the last successful response check is useable.

- Survey data acquired prior to an instrument failing a source check will be reviewed by the Data Manager to determine the validity of the data. This review will be documented.

- Data quality evaluation will be performed by the Data Manager using the Data Quality Objective (DQO) and Data Quality Assurance (DQA) process and directives in MARSSIM. Potential deficiencies in data quality shall be corrected prior to use of the data.

- Instrument failures in the field will be followed by an investigation by the Data Manager of suspect data. Investigations will be documented.

13.5.3 Background Determination

Each day that an analysis is performed, the ambient background will be determined and documented at least once daily, depending on the counting system and instrument used and the variability in the background.

13.5.4 Calibration

Counting systems and instruments will be calibrated with a NIST traceable source at intervals not exceeding 12 months. The source used will be appropriate for the type and the energy of the radiation to be detected. Calibrations will be documented and include the source data.

13.6 Corrective Action

A deficiency or nonconformance that potentially invalidates the quality of measurement subject to this plan or that is an exception to this plan must be reported to the Data Manager, QAC, SA, or PM. Any appropriate person may report a deficiency or nonconformance. Identified exceptions to this plan and the reason for them will be documented and retained with project quality records.

Nonconformances shall be investigated and resolved. The investigation report will identify any substantial undesirable impact caused by the nonconformance, the resolution, and recommended measure(s)

to reduce the likelihood or preclude the same of similar nonconformance in the future. An informational copy of the investigation report will be provided to the PM, the SA, and affected contractors.

Corrective action will be taken in accordance with Kaiser Procedure KAI-11, (Procedure to Audit, Investigate and Rectify Items of Nonconformance)." The QAC is responsible for investigating deficiencies and nonconformances and reporting them to the SA. For minor items of nonconformance, the Kaiser SA will conduct a review of the circumstances that led to the nonconformance, identify the root cause and take actions to correct the item of nonconformance and document actions taken. For major items of nonconformance, the Kaiser PM will review the item with the Kaiser SA to verify that a major item of nonconformance has been identified. If the PM determines that a major item of nonconformance has been identified, the PM or designee will conduct a review of the circumstances that led to the nonconformance, identify the root cause, take prompt and comprehensive corrective action that will address immediate concerns and prevent recurrence of the item nonconformance, and document the actions taken. The decision to stop work will be evaluated on a case-specific basis by the Kaiser PM and or SA. Kaiser's PM will notify NRC by telephone in the event that a deficiency cannot be corrected. Procedure KAI-11 will be updated to provide additional guidance related to timeliness of regulatory notification requirements and the timeliness for correcting deficiencies prior to remedial action activities at the Kaiser site.

13.7 QA Records

Records will be maintained to confirm that actions essential to meeting quality objectives were performed. Nonconformance reports, corrective action reports, audit reports, records, log books, or forms used to document field activities (plans, technical procedures, survey results, analytical data, and survey data) will be retained and managed as quality records. Data of records subject to this plan will be recorded in an orderly and verifiable way. Written instructions will designate documents that must be retained as quality records and maintained on site. QA records will be stored in a lockable fire proof cabinet at the Tulsa facility. Duplicate records also will be maintained by the contractor PM at an alternate secure location.

13.8 Audits and Surveillance

To assure that remediation activities are being conducted in accordance with site plans, policies, and procedures, audits will be conducted in accordance with Kaiser procedure KAI-11 (Procedure to Audit, Investigate and Rectify Items of Nonconformance). Audits shall be conducted within 3 weeks of the start of remediation activities and annually thereafter by the Kaiser PM or his or her designee. A formal report

shall be issued detailing the findings of the audit." Procedure KAI-11 will be updated to provide additional guidance related to timeliness of requirements for changing QA policy and procedures in light of identified deficiencies and nonconformances.

13.8.1 Maintenance of the QA Plan

Quality assessments will be preformed to provide added assurance that quality-related activities meet applicable requirements. This QA Plan will be the basis for quality assessments and for necessary response actions. Quality assessments will evaluate whether technical and regulatory requirements are met as well as procedural conformance. Changes in QA policy and procedures will be documented in a timely fashion. Active contractors and affected personnel performing remediation work will be given timely notification of changes to the QA Plan to keep them appraised of the current requirements.

Site surveys will be performed in a manner that ensures results are accurate and sources of uncertainty are identified and controlled. Radiological surveys and sampling will be planned using the DQO Process. The DQO Process assures that the right type, quantity, and quality of data used in decision making is appropriate for the intended application. An overview of QA and QC activities to be implemented during surveying and sampling are contained in Chapter 14.0. Details of the final status survey QA/QC will be in the Final Status Survey Plan and implementing procedures.

During the course of remediation activities, a DQA will be conducted to verify and validate the survey data and assessment of the quality of the data. Data verification is used to ensure that the requirements stated in the planning documents are implemented as prescribed. Data validation is used to ensure that the results of the data collection activities support the objectives of the survey as documented in Chapter 14.0. The DQA provides the assessment needed to determine that the planning objectives are achieved.

13.8.2 Quality Assessments

The QAC or his/her designee will determine:

- assessment method(s),
- assessment schedule, and
- the planning and implementation process.

Quality assessments will be performed in accordance with written procedures, and will examine the programmatic and technical elements of the QA program. Management will conduct a complete program review at least annually. Assessment methods will include a combination of the following:

- readiness review,
- data quality evaluation,
- surveillance or performance evaluation,
- management review,
- technical review, and
- periodic audit.

The PM will decide:

- responsibilities, authorities, participants, and roles of persons performing quality assessments;
- how the organization will respond to the need for changes;
- how, when, and by whom actions will be taken in response to assessment findings and directives; and
- whether the response has been effective.

Persons conducting quality assessments will have access to managers, documents, and records to:

- identify quality-related problems,
- make directives to resolve quality-related problems,
- confirm implementation and effectiveness of corrective responses, and
- report a deficiency or nonconformance to the PM in accordance with the outlined Section 13.5, Corrective Action.

Reference

(1) Earth Sciences, May 2002, Revised May 2003, Decommissioning Plan Addendum, Tulsa Facility, Tulsa, Oklahoma, Kaiser Aluminum & Chemical Corporation, Baton Rouge, Louisiana.

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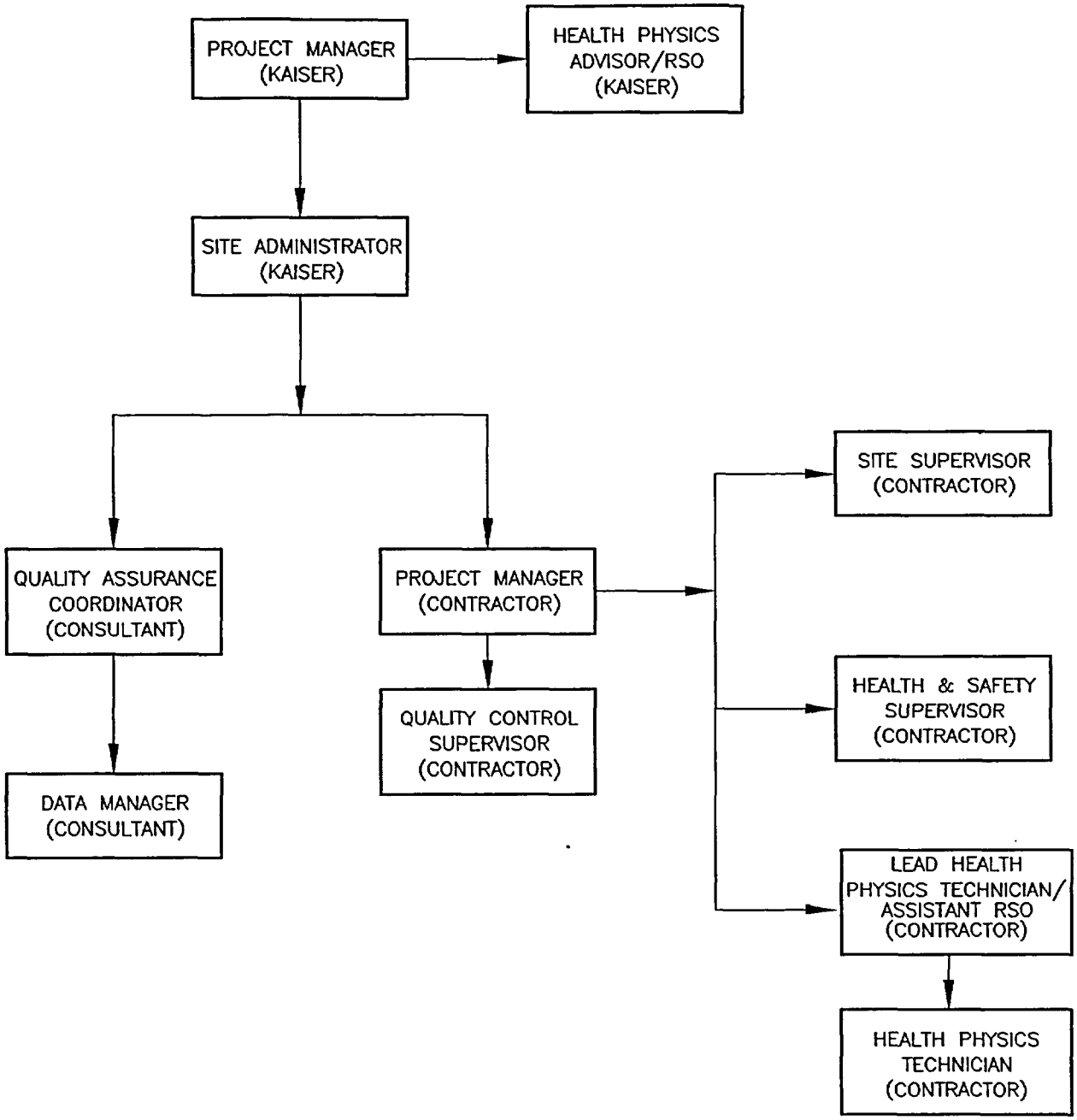

REVISION	DATE	DESCRIPTION
1	5/14/02	REVISE LEAD HEALTH AND HEALTH PHYSICS BLOCKS

FIGURE 13-1
DECOMMISSIONING MANAGEMENT ORGANIZATION
KAISER ALUMINUM SPECIALTY PRODUCTS
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED RFD 4/03
CHECKED CEB 4/03
DRAWN GJA 4/16/01

DRAWING NUMBER
5427005

Earth Sciences Consultants, Inc.

14.0 Facility Radiation Surveys

This chapter presents the general framework for facility radiation surveys relative to the decommissioning of the Tulsa facility. The chapter focuses on the 14-acre Pond Parcel area. Supplemental information relative to facility radiation surveys for the "former operational area" of the facility is provided in Chapter 14.0 of the May 2002 DPA (Revised May 2003).

14.1 Release Criteria

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.

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 $DCGL_W$. Preliminary $DCGL_W$ values for the radionuclides of concern at the Kaiser site have been calculated using the guidance provided in NUREG-1549, Decision Methods for Dose Assessment to Comply With Radiological Criteria for License Termination. In order to account for the presence of multiple radionuclides, the Unity Rule was applied, and $DCGL_W$ values adjusted as shown in Table 14-1.

Table 14-1
$DCGL_W$ Values

Radionuclide	Single Radionuclide $DCGL_W$ (pCi/g)	Ratio to Th-232 Assuming Equilibration	Average Concentration with Th-232 at Single Rad $DCGL_W$ (pCi/g)	Adjusted $DCGL_W$ to Meet Unity Rule (pCi/g)
Pb-210	1.751	0.043	0.15	0.12
Ra-226	5.9	0.082	0.28	0.24
Ra-228	4.3	1	3.4	3
Th-228	3.4	1	3.4	3
Th-230	102	3.5	12	10
Th-232	3.4	1	3.4	3

In developing the remedial action plan, a derived cutoff concentration level (DCCL) of 31.1 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 on site under an unrestricted release scenario. Based upon kriging analyses (Appendix A), on average, material above the DCCL is exempt. Moreover, the kriging volume estimates together with the dose assessment presented in Chapter 5.0 demonstrate that unrestricted release dose levels can be achieved when material below the DCCL is returned to the excavation as described in Chapter 8.0. The average concentration of below-criteria material remaining on site is termed herein as the Average Derived Concentration Level ($ADCL_W$). Based upon dose evaluations, the $ADCL_W$, rounded to 7 pCi/g Th-232, results in a postremediation TEDE well below 1 mrem/yr. This $ADCL_W$ is the release criterion for material returned to the excavation after separation of above-DCCL material.

The three important threshold concentration criteria and their significance are summarized below in Table 14-2.

Table 14-2
Threshold Concentration Criteria

Parameter	Value (pCi/g Th-232)	Application
$DCGL_W$	3.0	Release criterion for soil stockpile/processing area
DCCL	31.1	Dividing line for off-site disposal of material
$ADCL_W$	7.0	Average concentration (release criterion) of material left on site as backfill

Table 14-3 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 is greater than the appropriate $DCGL_W$ or $ADCL_W$. The appropriate $DCLG_{EMC}$ and $ADCL_{EMC}$ values are calculated by multiplying the appropriate $DCGL_W$ or $ADCL_W$ by the area factors presented in Table 14-3. $ADCL_{EMC}$ values estimated for the excavation area are presented in Table 14-4. Those for the processing area (area where material will be separated into above- and below-criteria material) were estimated based on the $DCGL_W$ and are presented in Table 14-5.

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

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

Table 14-3
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 14-4
$ADCL_{EMC}$ Values for Excavation Areas

$ADCL_{EMC}$ (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

Table 14-5
$DCGL_{EMC}$ Values for Processing Area

$DCGL_{EMC}$ (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

14.2 Characterization Surveys

A series of radiological characterization surveys of the site have been performed from 1994 to 2001. A summary of each survey is provided.

14.2.1 ADA 1994

In February of 1994, the site was divided into eight sections and a gamma walk-over survey was performed. Measurements were taken at 1 m above the ground every 15 feet. A Ludlum Model 3-97 Survey Meter (internal 1-inch-by-1-inch NaI [Tl] scintillator detector) calibrated to read micro-Roentgen per hour (μR/hr) was used. Background was established as 10 μR/hr, and readings of greater than twice background were observed in all eight sections of the site including a maximum of 400 μR/hr. Five 18-inch core boring samples, one background core boring, and four additional soil samples from test digs were taken. The samples were oven dried at approximately 50°C for 12 hours and then counted for a minimum

of 100 minutes using an ORTEC Multichannel Analyzer connected to a Canberra High Purity Intrinsic Germanium Detector. Analytical results confirmed the presence of Th-228 in secular equilibrium with Th-232. Th-230 (from the natural uranium decay chain) also was identified. The Th-230 was 2.4 to 3.4 times the Th-232 activity.

14.2.2 ARS 1995

In October of 1994, a more extensive characterization of the site was performed. Two hundred and fifty samples were systematically collected from 90 borehole locations. Samples were collected in 500-ml Marinelli containers, weighed to the nearest 0.1 g, and counted for 10 minutes with a shielded 2-inch-by-2-inch NaI (Tl) scintillator detector. The instrument was a Bicron LabTech Dual Channel Analyzer.

Sixty 200-ml subsamples were taken from the 250 field samples. Subsamples were analyzed using a density compensating gamma spectroscopy system (Nuclear Fuel Systems, Inc.) for U-234, U-235, U-238, and Th-232. Referred to as the At Line Solution Assay System (ALSAS), it provided density corrected pCi/g values. A correlation coefficient (r) of 0.990 relating the total counts of the field 2-inch-by-2-inch NaI (Tl) detector field count to the analytical results (pCi/g) of the same sample was completed. Linear regression was used to determine an equation to calculate pCi/g values from counts. The results of the survey were total thorium (Th-232 + Th-228) pCi/g values ranging from below the MDA of 1 pCi/g to 425.6 pCi/g.

Alpha spectroscopy was performed on 11 of the samples and confirmed the previously established ratio of Th-232 to Th-230 in dross of between 1:2.4 and 1:3.4. The 11 samples were selected from 60 sample results that fell in the 1 to 50 pCi/g total thorium range. The 11 samples represented 3 of the 4 main areas surveyed including the Retention Pond, the Reserve Pond, and the land area between the railroad and the Retention Pond. The ratios calculated from these data ranged from 1:0.62 to 1:3.15. Data were consistent with previous characterization survey results and were used to estimate volumes of contaminated material and to map contamination at depth.

Surface water from the Retention Pond (two samples) and from Fulton Creek (one sample) were collected and analyzed by gamma spectroscopy. Results were below the MDA value of approximately 1.0 pCi/l Th-232.

14.2.3 Adjacent Land Remediation Plan Appendix A

In 1999, 24 samples were selected (on site) to confirm the Th-232 to Th-230 ratio in the dross. The samples were selected based on geographical distribution and included both the Retention and Reserve ponds and a range of depths. The data approximate the ratio to be 1:3.5. This ratio was used to calculate the Th-230 activity based on the measured Th-232 activity during Phase I remediation of adjacent (to Kaiser property) land.

14.2.4 Summary

NUREG-1575 (MARSSIM) defines areas that have no reasonable potential for residual contamination as "nonimpacted." These areas have no radiological impact from site operations. Areas with some potential for residual contamination are defined as "impacted." Impacted areas are further divided into Class 1, 2, or 3 areas based on the potential for contamination.

The former Freshwater Pond area is nonimpacted. Results of characterization surveys indicate that the remainder of the pond parcel east of the former Freshwater Pond area is impacted. The land areas have been classified in accordance with MARSSIM based on the existing characterization survey data. The classification is provided in the Final Status Survey Design section below. In addition, part of the adjacent land was impacted and was remediated in 2000-2001. The adjacent land area was surveyed under NUREG/CR-5849 and the unrestricted release approved by the NRC in 2002. Therefore, the entire area adjacent to the site as delineated by grids in Figure 2-4, is not addressed in this phase of decommissioning.

In addition to the characterization events detailed in Sections 14.2.1, 14.2.2, and 14.2.3, composite samples of characterization core samples and final status samples were taken during adjacent land remediation surveys. The composite samples were analyzed by alpha spectroscopy to further evaluate the Th-232 to Th-230 activity ratio. The results yielded Th-232 to Th-230 ratios from 1:0.32 to 1:2.95. A summary of soil sample analyses performed to calculate the ratio of Th-232 to Th-230 activity is presented in the table below. A compilation of the analytical data used to calculate the ratio of Th-232 to Th-230 is presented in Appendix E. The established ratio of Th-232 to Th-230 of 1:3.5 will continue to be used during Phase II of the decommissioning of the site because this is the most conservative (protective) approach. A summary of sample result Th-232 to Th-230 activity ratios for the Kaiser site is provided in Table 14-6 below.

Table 14-6

Measured Th-232 to Th-230 Ratios

Reference	Number of Samples	Minimum Ratio of Th-232:Th-230	Maximum Ratio of Th-232:Th-230	Average Ratio of Th-232:Th-230
ADA 1994	3	1:2.4	1:3.4	NA
ARS 1995	11	1:0.6	1:3.1	1:1.7
Kaiser 1999	24	1:1.5	1:6.4	1:3.4
ES 2002	14	1:0.32	1:3.0	1:2.1

Characterization activities concerning water sample analysis have also shown that the contaminated material is not soluble.

The characterization of the site is complete. Extensive characterization surveys and sample analysis have been reviewed to provide the initial classification of the site open land areas and structural surfaces. The majority of the land area is impacted and classified as Class 1. The only nonimpacted area is the Freshwater Pond parcel based on site history and the adjacent land based on final status survey results. The only identified subsurface structural surface is the spillway. The spillway is classified as impacted Class 1. All additional subsurface structures discovered during excavation in Class 1 open land areas will be classified as Class 1. Reclassification of any areas would be based on final status survey measurements secured as detailed in the following parts of Section 14.0.

14.3 Remedial Action Support Surveys

Segregation of impacted soil during remediation may be aided by an automated system equipped with NaI (or equivalent) gamma detectors. Alternatively, HPTs may segregate impacted soil using portable survey instruments equipped with NaI detectors. Both detection methods have the sensitivity to detect Th-232 (surrogate radionuclide) below the most restrictive threshold value of 3 pCi/g above background. Th-232 is an alpha emitter but is in secular equilibrium with several progeny that emit high-energy photons. Detection of Th-232 is based on the detection of these high-energy photons. Table 14-7 provides MDC values calculated using the guidance provided in NUREG-1575, MARSSIM, for increasing background values. The calculation of MDC is based on the detection of high-energy emitting Th-232 progeny.

Table 14-7
MARSSIM Calculated Minimum Detectable Concentration Values
For Increasing Background (2-inch-by-2-inch NaI Detectors)

Background (cpm)	Minimum Detectable Count Rate (ncpm)	Scan Minimum Detectable Concentration (μR/hr)	Scan Minimum Detectable Concentration (pCi/g Th-232)
3,000	585	1.00	1.0
5,000	756	1.29	1.3
7,000	894	1.52	1.5
9,000	1,014	1.73	1.7
11,000	1,121	1.91	1.9
13,000	1,219	2.08	2.1
15,000	1,309	2.23	2.2
16,000	1,352	2.30	2.3
17,000	1,394	2.37	2.3
18,000	1,434	2.44	2.4
19,000	1,473	2.51	2.5
20,000	1,512	2.58	2.5
21,000	1,549	2.64	2.6

Remedial action support surveys will be performed while remediation is being conducted and will guide the remedial action in a real-time mode. These surveys will be used to determine when a survey unit is ready for the final status survey. The remedial action surveys will rely principally on direct radiation measurement using gamma-sensitive instrumentation. Scan MDC will be determined for remediation survey instrumentation using the same protocol as final status surveys. The determination of a survey unit's readiness for a final status survey will rely on the on-site knowledge of the area (i.e., kriging information and area classification) and the results from the survey instrumentation.

During remediation, excavated material will be characterized into one of the following four categories based on physical description and/or radiological survey:

- Contaminated Soil (or soil-like material) – Soil above the $DCGL_W$ or DCCL value for the processing and Retention Pond areas respectively.
- Acceptable Backfill Soil (or soil-like material) – Soil containing radioactivity above the $DCGL_W$ but below the DCCL value.
- Suspect Contaminated Soil (or soil like material) – Soil which requires additional characterization for the determination of whether it is below the $DCGL_W$ or DCCL value.

- Debris (Structural Surface Survey Material) – Nonsoil material that is oversized (e.g., concrete fragments, bricks, and construction debris). Surveys of debris consist of surveys of structural surfaces for total (fixed) and removable contamination in units of disintegrations per minute per one hundred centimeters squared (dpm/100 cm^2).

Debris is subdivided into two categories: 1) removable debris that can be easily removed from an excavation and 2) permanent structures such as the concrete spillway contained beneath Characterization Grids 1-4 (ALRP). Removable debris will be segregated from soil to the extent practical by visual inspection. Debris buried within the dross and soil mixture will be evaluated in accordance with NRC Fuel Cycle Policy and Guidance Directive FC 83-23 to determine whether they are potential candidates for clearance surveys considering such factors as volumetric contamination and accessibility of surfaces for survey. Clearance surveys may be performed if large, nonporous, solid debris with only surface contamination are uncovered during residue excavation. In this case, clearance surveys for total and loose alpha will be performed on the debris to ensure that released items are released in accordance with NRC Fuel Cycle Policy and Guidance Directive FC 83-23. Otherwise, debris material will be packaged to meet the applicable disposal facility waste acceptance criteria. Permanent structures will be surveyed for unrestricted release in accordance with the guidance provided in the May 2002 DPA for structural surface surveys.

The area containing the Characterization Grids 1-4 (ALRP) is known to contain a concrete spillway. As shown in Figure 4-1, the spillway starts slightly west of Characterization Grid 1 and runs from west to east. The spillway turns north at Characterization Grid 4 and proceeds toward the Retention Pond. The spillway is considered a permanent structure and will be surveyed as a Class 1 structure.

Additional subsurface structures may be encountered during excavation. The structures will first be categorized as permanent or removable. If the structures are permanent, a final status survey of structural surfaces will be performed. Since thorium is highly insoluble, it is not anticipated that structures will be volumetrically contaminated. However, subsurface culverts and/or piping may be encountered. Structures with internal surfaces will receive final status surveys of both external and internal surfaces. Consideration will be given to nonaccessible surfaces. Residues, sediments, and/or liquids encountered will be collected and held for sampling. Based on the results of the sample analysis, the material will be dispositioned accordingly. Gas proportional detectors will be used to survey structural surfaces when possible. The final and clearance survey protocols for structures are detailed in subsequent parts of Chapter 14.0. Soil and/or soil like material surrounding structures will be segregated in accordance with this plan.

Based on survey instrument DCCL, $DCGL_W$, and $ADCL_W$ values, survey instrumentation threshold values will be determined. The lower bound threshold is the value below which surveyed soil is acceptable backfill soil. The upper bound threshold is the value above which surveyed soil is contaminated soil. The two threshold values will be conservatively set based on empirical data (e.g., the lower bound threshold value will be set at the average net counts per minute [ncpm] value corresponding to the $DCGL_W$ less one standard deviation and the upper bound threshold will be set at the average plus one standard deviation) to ensure that soil is acceptable backfill or that soil is contaminated. The average ncpm value will be derived from empirical data and will be continually checked as survey and analytical data are collected. Soil surveyed with results between the two threshold values will be stockpiled as suspect contaminated soil and will be sampled for laboratory analysis to determine if the soil is acceptable backfill or contaminated.

14.4 Final Status Survey Design

14.4.1 Survey Objective

The objective of this survey is to demonstrate that residual radioactivity levels meet the site release criteria.

14.4.2 Basic Design

14.4.2.1 MARSSIM's Wilcoxon Rank Sum Test

The final status survey will use systematic grid sampling to determine the average radionuclide concentration in a survey unit and gross gamma scans to screen for elevated areas. At least the minimum number of samples (N/2) will be taken in each survey unit. Since the radionuclides of interest occur naturally in background, the minimum number of samples (N/2) from the reference background area will also be used to complete the Wilcoxon Rank Sum (WRS) Test.

Minimum Number of Samples (N/2)

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. 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. The estimate of sigma used is based on the standard deviations in Th-232 activity measured in survey units during the final status sampling of the adjacent land remediation final survey (0.42). Sigma may be increased if the spatial variability of contaminants within a given survey unit is expected to be greater than 0.42. Since the Th-232 activity concentration of 3.0 pCi/g will be used as the surrogate DGCLw, 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 number of samples can be calculated using the following formula or looked up in Table 5.3 of MARSSIM:

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{3(P_r - 0.5)^2}$$

where:

$Z_{1-\alpha}$ = percentile represented by selected value of α, Table 5.2 of MARSSIM
$Z_{1-\beta}$ = percentile represented by selected value of β, Table 5.2 of MARSSIM
P_r = value obtained from Table 5.1 of MARSSIM

Based on a relative shift of 3.5, the following number of samples are required to meet the DQOs:

Size of Survey Unit	Class	DQOs for α and β	Number of Sampling Locations
≥ 10 m^2 <2,000 m^2	1	0.05, 0.05	9
≥ 2,000 m^2 and <10,000 m^2	2	0.05, 0.05	9
≥ 10,000 m^2	3	0.05, 0.05	9

The number of samples in the above table includes a factor to increase the number of required samples by 20 percent, as recommended by MARSSIM, to allow for lost or unusable data. The number of required samples may be further increased to increase the power level of the statistical tests. Additional sampling locations may also be necessary if characterization data and remedial action surveys and sampling indicate that there is greater than expected spatial variability (σ)of sample results within specific survey units.

14.4.2.2 Discrete Soil Sampling

The results of discrete soil sampling will be used to verify that the average soil concentration is less than the appropriate $DCGL_W$ or ADCL values. Regardless of the survey unit classification (Class 1, Class 2, or Class 3), a predetermined minimum number of samples will be collected in each survey unit. A random-start triangular grid pattern will be used in Class 1 and Class 2 survey units. This sampling

pattern is generally the most efficient means of identifying small areas of elevated activity. The distance between the grid nodes (L) will be determined by

$$L = [A/(0.866 \times n)]^{1/2}$$

where A is the survey unit area to be covered by the grid pattern and n is the number of samples.

The random start point will be selected by use of readily available random point generators such as provided by the spreadsheet Excel. Sample points will be located by use of a global positioning system (GPS) or equivalent survey equipment.

14.4.2.3 Scanning

Scanning surveys will be used to identify small areas of elevated activity. The percentage of the survey unit to be covered by scans will be based upon the survey unit classification in accordance with the following table.

Table 14-8

Survey Unit Classification	Scanning Coverage
Class 1	100 percent coverage
Class 2	10 to 100 percent Systematic and Judgmental
Class 3	Judgmental

One hundred percent coverage means that the entire surface area of the survey unit has been covered by the field of view of the detector. The scanning coverage for Class 1 areas will be 100 percent. The scanning coverage for Class 2 areas will be adjusted based on the level of confidence supplied by existing data. Whenever less than 100 percent of the survey unit is scanned, the Data Manager will determine the degree of scan coverage and which areas are to be scanned based on the information available at the time of survey. For example, if the potential for contamination in a section of the survey unit is higher than the rest, i.e., the section that borders a Class 1 survey unit, this section may receive 100 percent coverage, while the remaining section may receive 50 percent systematic coverage. If the survey unit has an equally unlikely potential for contamination, e.g., isolated with no previous history of contamination, a systematic coverage at 25 percent coverage may be appropriate.

14.4.2.4 Null Hypothesis

The null hypothesis (H_o) to be tested is that the residual contamination exceeds the remedial objective (release criteria are not met) and the alternative hypothesis (H_A) is that the residual contamination meets the remedial objective (release criteria is met).

14.4.2.5 Decision Error Rates

There are two types of decision errors as shown below:

		DECISION/OUTCOME OF STATISTICAL TEST	
		Reject H_o	Accept H_O
TRUE CONDITION OF SURVEY UNIT	Meets remedial objective (below $DCGL_W$)	No decision error (probability = 1 -α)	Incorrectly fail to release survey unit Type II error (probability = β)
	Exceeds remedial objective (exceeds $DCGL_W$)	Incorrectly release survey unit Type I error (probability = α)	No decision error (probability = 1 - β)

Examination of this table highlights the importance of limiting the Type I error rate (or α) in terms of protection of human health and the environment. The DQO selected for α is 0.05. The DQO selected for β is 0.05.

14.5 Use of a Surrogate Radionuclide

Characterization activities have verified that the primary radionuclides of concern are isotopes of thorium. Th-232 and Th-228 are part of the natural thorium decay chain and have been verified to be in secular equilibrium (i.e., the activity of Th-228 is equal to that of Th-232). Another isotope of thorium, Th-230, has been identified as a primary radionuclide of concern. Although Th-230 is part of the natural uranium decay chain, no uranium has been identified. However, in the estimated 55 years since Th-230 was separated from the uranium decay chain, some Ra-226, a member of the decay chain below Th-230, has grown in. The relationship of Th-230 activity to that of Th-232 has been established in previous characterization of the site. The relationship of Th-230 activity is 3.5 times Th-232 activity. Not all of the radionuclides present can be identified by real-time gamma surveys or by gamma spectroscopy of soil samples--the most efficient and cost-effective measurements. In addition, each of the radionuclides contributes to the total dose to varying degrees of magnitude. In order to save both time and resources, it is

desirable to select a surrogate radionuclide to demonstrate compliance for all the radionuclides and to guide remediation activities. Th-232 has been selected as the surrogate radionuclide.

14.6 Establishing Background

Appendix F contains the reference area, surface soil, and background data consisting of two different reference areas located approximately 1 mile apart. The results of 30 different sampling locations in each reference area presented in the *Adjacent Land Characterization*, Kaiser Aluminum Specialty Products, Appendix A, Estimate of Volume of Off-Site Contaminated Soil, Adjacent Land Characterization Report, ADA, March 1999. These data were also used for the background determination during the Kaiser Adjacent Land Area Remediation Project. Based on a review of the data in both reference areas, there appears to be no significant variability between the two reference areas that were sampled. The mean Th-232 concentration in the reference area located on the nonimpacted northwest Kaiser property is 0.94 +/- 0.11 pCi/g at the 95 percent confidence level, and mean Th-232 concentration in a reference area located approximately 1 mile away is 1.06 +/- 0.10 pCi/g at the 95 percent confidence level. The reference area data standard deviations were 0.30 and 0.28 respectively. According to NUREG 1727, "When there may be significant difference in backgrounds between different areas, a Kruskal-Wallis test...can be used to determine whether there are, in fact, significant differences in mean background concentrations among potential reference areas." Based on the agreement between the mean of both reference areas, it is not necessary to conduct a Kruskal-Wallis test on the reference area data, because there is no significant variability between the two reference areas that have been sampled. The established background value was 1.1 pCi/g Th-232.

14.7 Area Classifications

All of the areas have undergone either a characterization study or historical site assessment that is used as the basis for the initial determination of the area classification established in this section. The former Freshwater Pond area currently is not impacted. However, DPs call for use of this area (after closure) as a material processing area. Therefore, all areas in the Pond Parcel with the exception of the clean backfill cover have been designated as impacted for purposes of classification and survey. In addition, gamma surveys will be performed in areas adjacent to the dross pond to confirm that elevated gamma levels measured during the ALRP were due to gamma contribution from the pond.

Definitions

Class	Definition	Survey Unit Size
1 Land Areas	Areas known or expected to have radionuclide concentrations above the $DCGL_W$	Up to 2,000 m^2
2 Land Areas	Areas known or expected to have radionuclide concentrations above normal background concentrations but that are not expected to be above the $DCGL_W$	2,000 to 10,000 m^2
3 Land Areas	Areas that are not expected to have radionuclide concentrations detectable above normal background concentrations	No limit
1 Structural Surfaces	Areas known or expected to have radionuclide concentrations above the $DCGL_W$	Up to 100 m2 of floor area
2 Structural Surfaces	Areas known or expected to have radionuclide concentrations above normal background concentrations but that are not expected to be above the $DCGL_W$	100 to 1,000 m2
3 Structural Surfaces	Areas that are not expected to have radionuclide concentrations detectable above normal background concentrations	No limit

Initial Area Classifications

Area	Description	Classification
Processing Area (Fresh Water Pond)	Area currently occupied by a Freshwater Pond which will be used for processing/stockpiling excavated materials (≈9 survey units).	1
Former Retention Pond Area Bottom	Area formerly occupied by the dross Retention Pond and Reserve Pond, post excavation of dross (≈21 survey units).	1
Former Retention Pond Area	Area formerly occupied by the dross Retention Pond and Reserve Pond, backfilled with below-criteria material in 2-foot survey lifts (≈21 survey units per lift).	1
Former Operational Area	The triangular parcel of land north of 41st Street and south of the Union Pacific Railroad right-of-way in which plant processes and operations occurred.	1
Spillway/Other Permanent Structures	Structures (such as the spillway) located where thoriated material is known to exist. The total area of these structures cannot be determined until uncovered by excavation.	1

14.7.1 Process for Reassignment of Area Classifications

All areas will not have the same potential for residual contamination and, accordingly, will not need the same level of survey coverage to achieve the established release criteria. The initial area classifications are based on a combination of characterization data and historical information. Additional information obtained during the remediation process may lead to the determination that the initial classifications established should be revised to be consistent with the definitions given.

14.7.2 Classification Upgrades

Any area classification may be upgraded (e.g., from Class 2 to Class 1) by the Data Manager based on the receipt of additional survey or measurement information that justifies the need for such action.

14.7.3 Classification Downgrades

Any area classification may be downgraded (e.g., from Class 1 to Class 2) by the Data Manager based on the receipt of additional survey or measurement information that justifies the lower classification provided that the approval of the Kaiser RSO and the NRC is obtained.

14.7.4 Documentation of Classification Changes

All changes to the initial area classifications will be documented and included in the final soil remediation documentation.

14.8 Selection of Survey Units

Each impacted area will be divided into a number of survey units based on the classification defined above. Selection of the survey units will be based on areas having similar operational history or similar potential for residual radioactivity to the extent practical. Survey units also will have relatively compact shapes unless an unusual shape is appropriate for the site operational history or site conditions.

14.9 Field Instrumentation

The gamma-emitting progeny of the surrogate radionuclide Th-232 emit high-energy photons and are easily detected using survey instruments equipped with NaI scintillation crystal detectors. Scanning for gross gamma activity will be used to guide remediation activities and as part of the final status survey when remediation is complete. The following survey instruments (or equivalents) as appropriate will be used to scan soil:

Manufacturer and Meter	Manufacturer and Detector Model	Detector Type	Use
Ludlum 2221	Ludlum 44-10 2"-x-2" NaI scintillator	Sodium Iodide (unshielded)	Scans for Gamma-Emitting Radionuclides

Use of these field instruments or acceptable equivalents are evaluated against the goal of achieving MDCs of less than 75 percent of the $DCGL_W$ for direct measurements and/or scanning measurements. MDCs were calculated for scanning instruments using the method provided in MARSSIM for calculating MDCs that control both Type I and Type II errors (i.e., elimination of false negatives and false positives) as follows:

$$\text{Scan MDCR}_{\text{surveyor}} = \frac{\text{MDCR}}{\sqrt{p}\,\epsilon_i}$$

Where MDCR is the minimum detectable count rate in counts per minute (cpm), ϵ_i is the instrument efficiency (cpm/μR/hour), and p is the surveyor efficiency. The value of p has been estimated to be between 0.5 and 0.75. The value of 0.5 is conservative. In addition:

$$MDCR = s_i \times (60/i)$$

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

where si is the minimal number of net source counts required for a specified level of performance for the interval i, in seconds; d′ is the value selected from MARSSIM Table 6.5 based on the required true positive and false positive rates; and bi is the number of background counts in the intervali. The value of d′ used to calculate the detector sensitivity values is 1.38, corresponding to an alpha of 0.05 and beta of 0.40. This value of d′ will result in less than 5 percent false negatives and about 40 percent false positives. Typical scan MDCs using the MARSSIM two stage scan methodology for survey instruments equipped with 2-inch-by-2-inch NaI detectors are summarized in Table 14-7 for increasing background count rates. Static and scan MDCs for surface contamination detectors are presented in Chapter 14.0 and Appendix D of the May 2002 DPA.

For surface contamination scanning and static measurements, the radionuclides of concern and/or their progeny emit alpha and/or beta particles that are easily detected using survey instruments equipped with gas proportional detectors and scalers. Scanning for gross alpha or gross beta activity will be used as part of status surveys of structural surface survey units to ensure elevated areas of activity are not missed. In addition, static counts of structural surfaces at predetermined sample points are used to assess total contamination of structural surfaces. The following survey instruments (or equivalents) will be used to scan structural surfaces:

Manufacturer and Meter	Manufacturer and Detector Model	Detector Type	Use
Ludlum 2224	Ludlum 43-89 Dual Phosphor Alpha/Beta Detector	Zinc Sulfide Scintillator	Scans and Static Counts for Alpha and Beta Emitting Radionuclides
Ludlum 2221	Ludlum 43-68 Gas Proportional	Gas Proportional	Scans and Static Counts for Alpha and Beta Emitting Radionuclides

Use of these field instruments or acceptable equivalents are evaluated against the goal of achieving MDCs of less than the $DCGL_w$s for direct measurements and/or scanning measurements. MDCs will be calculated for scanning instruments using the method provided in MARSSIM for calculating MDC that controls both Type I and Type II errors (i.e., elimination of false negatives and false positives) as follows:

Alpha Scan

There are two equations based on the MARSSIM two-stage scan methodology used to determine the alpha scanning MDC depending on the background level. 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 ≥ 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).

Increase the value of G until the corresponding probability equals the desired confidence level, e.g., 95 percent. For a background level of 3 cpm to about 10 cpm, the probability of detecting two or more counts while passing over the contaminated area is:

$$P(n \geq 2) = 1 - \left(1 + \frac{(GE + B)d}{60v}\right)\left(e^{-\frac{(GE+B)d}{60v}}\right)$$

where:

P(n ≥ 2)	=	probability of observing two or more counts,
G	=	activity (dpm),
E	=	4π detector efficiency (cpd),
B	=	background count rate (cpm),
d	=	width of detector in direction of scan (cm), and
v	=	scan speed (cm/s).

Increase the value of G until the corresponding probability equals the desired confidence level, e.g., 95 percent.

Beta Scan

Based on the MARSSIM two-stage scan methodology, the beta scanning MDC at a 95 percent confidence level is calculated using the following equation which is a combination of MARSSIM Equations 6-8, 6-9, and 6-10:

$$MDC_{scan} = \frac{d'\sqrt{b_i}\left(\frac{60}{i}\right)}{\sqrt{p} \cdot E_{tot} \cdot \frac{A}{100\,cm^2}}$$

where:

MDC_{scan} = MDC level in dpm/100 cm^2,
d' = desired performance variable (usually 1.38 corresponding to alpha and beta errors of 0.05),
b_i = background counts during the residence interval,
i = residence interval in seconds,
ρ = surveyor efficiency (0.5 – 0.75, 0.5 is conservative),
A = detector probe physical (active) area in cm^2, and
E_{tot} = total detector efficiency for radionuclide emission of
= E_i x E_s,
where:
E_i = 2π instrument efficiency in counts per disintegration (cpd) and
E_s = source (or surface contamination) efficiency.

Note: Es 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.

Alpha or Beta Static Counts

Minimum counting times for static counts of total and removable contamination will be chosen to provide a MDC that is a fraction (25 – 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: Es 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.

14.10 Laboratory Analysis

With the exception of radiation badge service, laboratory analytical services are expected to be provided by Outreach of Broken Arrow, Oklahoma. In the event that Outreach is not available, Kaiser will select another qualified analytical laboratory.

Soil samples will be analyzed by gamma spectroscopy. 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. Th-232 activity will be identified based on the Ac-228 activity (primary gamma energy of 911.1 keV). The Th-228 activity will be calculated by multiplying the Th-232 activity by 1. The Th-230 activity will be calculated by multiplying the Th-232 activity by 3.5.

A minimum of five of the QC samples taken as part of the final status survey will also be analyzed by alpha spectroscopy for Th-232, Th-230, and Th-228. The data will be used to confirm the activity ratio of Th-232 to Th-230 of 1:3.5. The required MDC for the alpha spectroscopy analysis will be 0.5 pCi/g.

14.11 Sampling and Measurement Technique

A combination of the following techniques may be used to achieve the desired survey requirements for an area.

14.11.1 Surface Scans

Depending on the area classification (Class 1, Class 2, or Class 3), scanning coverage will range in accordance with Table 14-8, Section 14.4.2.3. 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 0.5 m per second will be used. In the scanning mode, the audio response will be used to prevent lack of detection of an elevated area due to meter response time. The "two-stage" scan methodology will be utilized.

14.11.2 On Site Gamma Spectrometry

An on-site gamma-ray spectroscopy system may be utilized to provide qualitative and quantitative analysis of the Th-232 content in waste samples and final status survey screening samples.

14.11.3 Soil Sampling

14.11.3.1 Surface Sampling

Surface soil sampling will be conducted to evaluate the average remaining activity concentration of a survey unit. Surface samples will be collected from the top 15 cm (6 inches) of soil that correspond to the soil mixing or plow depth in several environmental pathway models. Grass, rocks, sticks, and foreign objects will be removed from the soil samples to the degree practical at the time of sampling. If there is reason to believe these materials contain activity, they will be retained as separate samples.

14.11.3.2 Core Sampling

Core samples will be collected after backfilling of below-release criteria material is complete. For purposes of a final status survey, the entire backfilled retention pond area will be considered as a unit and divided into survey units based on m2, i.e., Class 1 survey units of less than 2,000 m^2. A random start, triangular grid pattern will be used to take the required number of samples (N/2) in each survey unit. The sample will consist of a core sample through the approximate 3-meter layer of placed material and 6 inches of the excavation bottom. The entire core will be scanned using a 2-inch-by-2-inch NaI detector in a low background area sufficient to achieve a scan-MDC of less than 3 pCi/g Th-232. The core will be subdivided as follows: the bottom 6 inches of excavation bottom will be separated, mixed, and containerized. The remaining 3 meters will be subdivided into three consecutive 1-meter segments in accordance with Appendix E of the NMSS Decommissioning Standard Review Plan. Each 1-meter segment will be mixed and containerized. All four segments (one 6-inch and three 1-meter) will be analyzed by gamma spectroscopy for Th-232. The MDC required will be 3 pCi/g.

14.12 Final Status Survey Implementation

The final status survey will be used to select/verify survey unit classification and to demonstrate that the objectives have been achieved. Two situations that require final status surveys are detailed in this section. The first involves the final status survey of remediated areas (e.g., the Retention/Reserve Pond Area), and the second involves the final status survey of the processing area. The surveys will be performed using gamma-sensitive instrumentation and analytical analyses described above.

14.12.1 Postremediation Surveys

The final status survey units will be defined and marked. When remediation activities in a survey unit are completed, the following will be performed.

14.12.1.1 Gamma Scans

A gamma scan as defined by classification will be performed in accordance with the area classification. For the Retention Pond area, each 2-foot-thick lift that is placed in an excavation will receive a 100 percent scan to ensure that there are no areas that exceed the $ADCL_{EMC}$.

14.12.1.2 Grids

The sample grid and starting location will be established.

14.12.1.3 Sample Number

The required number of samples will be taken and analyzed as described above.

14.12.1.4 Data Evaluation

The data will be evaluated as described below.

14.12.2 Postremediation Surveys for Returned Overburden Material

When remediation activities in a survey unit that required the excavation of substantial overburden soil are completed, the following will be performed:

- The bottom of the excavation will be surveyed as detailed in 14.12.1.1 above.
- A 2-foot layer of acceptable (below 31.1 pCi/g) backfill material will be placed in the excavation.
- A gamma scan as defined by classification will be performed.
- The sequence of 2-foot layers of acceptable backfill and subsequent survey will be repeated as necessary to fill excavation (prior to placement of off-site backfill).

Once the excavation is filled with below-criteria material:

- the sample grid and starting location will be established,
- the number of core samples required will be taken and analyzed, and
- the data will be evaluated as described below.

14.13 Data Evaluation

Data will be reviewed by the Data Manager to ensure that the requirements are implemented as prescribed and that the results of the data collection activities support the objectives of the survey, or permit a determination that these objectives should be modified.

14.13.1 Preliminary Data Review

The Data Manager will review QA and QC reports, prepare graphs of the data, and calculate basic statistical quantities to analyze the structure of the data and identify patterns, relationships, or potential anomalies. The survey data shall be reviewed as it is collected. The preliminary data examination includes the following:

- Evaluation of data completeness.
- Verification of instrument calibration.
- Verification of sample identification and traceability back to sampling location.
- Measurement of precision using duplicates, replicates, or split samples.
- Measurement of bias using reference materials or spikes examination of blanks for contamination.
- Assessment of adherence to method specifications and QC limits.
- Evaluation of method performance in the sample matrix.
- Applicability and validation of analytical procedures for site-specific measurements.
- Assessment of external QC measurement results and QA assessments, including the results of analytical laboratory QA/QC reports related to the analysis of final status survey samples.

14.13.2 Data Evaluation and Conversion

For comparison of survey data to $DCGL_W$s, ADCLs, or DCCLs, the survey data from field and laboratory measurements will be converted to $DCGL_W$, ADCL, or DCCL units. The Data Manager will ensure data

measurements retain traceability to NIST and conversion factors are appropriate for the radiation quantity. The preliminary data reports will be reviewed to ensure adequate measurement sensitivity is being achieved and to resolve any detector sensitivity problems. Analytical reports will be reviewed for proper MDC values. The results of analytical results will be reported whether the result is above or below the reported MDC value so that the MDC value is not used in the data assessment. Preliminary scan data will also be reviewed against the percent coverage requirement of the survey unit.

An evaluation will be made to determine that the data are consistent with the underlying assumptions made for survey plan statistical procedures. The basic statistical quantities that will be calculated for the survey unit are the following:

- Mean
- Standard deviation
- Median
- Minimum
- Maximum

The parameter of interest is the mean concentration in the survey unit. The two-sample statistical test (WRS Test) will be used. The two-sample WRS Test will evaluate whether the median of the data is above or below the $DCGL_W$ or $ADCL_W$.

Summary of Statistical Tests

Survey Result	Conclusion
Difference between maximum survey unit measurement and minimum reference area measurements is less than $DCGL_W/ADCL_W$	Survey unit meets release criterion
Difference of survey unit average and reference area average is greater than $DCGL_W/ADCL_W$	Survey unit does not meet release criterion
Difference between any survey unit measurement and any reference area measurement greater than $DCGL_W/ADCL_W$ or the difference of survey unit average and reference area average is less than $DCGL_W/ADCL_W$	Conduct WRS Test and elevated measurement comparison

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 will be applied as outlined in the following steps.

1. Adjusted reference area measurements will be obtained by adding the $DCGL_W$ to each reference area measurement.

2. The m adjusted reference area sample measurements and the n sample measurements from the survey unit will be pooled and ranked in order of increasing size from 1 to N, where N = m + n.

3. If measurements are tied in rank, each of the tied values will be assigned the same average rank of that group of tied measurements.

4. The ranks from the reference area will be summed as W_r.

5. The value of W_r will be 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.

Both the measurements at discrete locations and the scans will be used to identify elevated areas within a survey unit. Analytical results of soil samples will be 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 discussed above will be 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 concentration of Th-232 over the entire survey unit
δ_{EMC} = the average concentration of Th-232 over the elevated area x within the survey unit
DCGL = the $DCGL_w$ or $ADCL_w$ for Th-232
$DCGL_{EMC}$ = (area factor for elevated area x) X (DCGL)
x = refers to one of the elevated areas within the survey unit
n = the total number of elevated areas within the survey unit

If there is more than one elevated area, a separate term will be included for each area. The result of the EMC will be used as a trigger for further investigation. The investigation may involve taking further measurements to determine that the area and level of the elevated residual radioactivity are such that the resulting dose or risk meets the release criterion. The investigation will provide adequate assurance, using the DQO process, that there are no other undiscovered areas of elevated residual radioactivity in the survey unit that might otherwise result in a dose or risk exceeding the release criterion. In some cases, this may lead to reclassifying a survey unit--unless the results of the investigation indicate that reclassification is not necessary.

14.13.3 Investigation Levels

The Data Manager will use radionuclide-specific investigation levels to indicate when additional investigations may be necessary. Investigation levels will also serve as a QC check to determine when a measurement process begins to get out of control. A measurement that exceeds the investigation level may indicate that the survey unit has been improperly classified or it may indicate a failing instrument. When an investigation level is exceeded, the first step will be to confirm that the initial measurement/sample actually exceeds the particular investigation level. This may involve taking further measurements to determine that the area and level of the elevated residual radioactivity are such that the resulting dose or risk meets the release criterion. Depending on the results of the investigation actions, the survey unit may require reclassification, remediation, and/or resurvey. The following table lists the investigation levels which will be used by the Data Manager.

Postremediation Survey Investigation Levels

Survey Unit Classification	Flag Direct Measurement or Sample Result When:	Flag Scanning Measurement Result When:
Class 1	$>DCGL_{EMC}$ / $ADCL_{EMC}$ or $> DCGL_W$ / $ADCL_W$ and the mean of the survey unit is greater than 0.75 of the $DCGL_W$ / $ADCL_W$	$>DCGL_{EMC}$ or $>ADCL_{EMC}$
Class 2	$> DCGL_W$	$> DCGL_W$ or >MDC
Class 3	> 0.5 of the $DCGL_W$ + background	$> DCGL_W$ or >MDC

If the data suggest that the survey unit was misclassified, the original DQOs will be redeveloped for the correct classification. The sampling design and data collection documentation will be reviewed for consistency with the DQOs.

14.14 Final Status Survey Report

A report will be prepared to document the final conditions of the site. The report will include information concerning the following:

- An overview of the results of the survey.
- A discussion of any changes that were made in the survey from what was proposed in the Soil Remediation Plan.

- A description of the method by which the number of samples was determined for each survey unit.
- A summary of the values used to determine the number of samples and justification for these values.

The survey results for each survey unit including the following:

- The number of samples taken for the survey unit.
- A map or drawing of the survey unit showing the reference system and random-start systematic sample locations.
- The measured sample concentrations.
- The statistical evaluation of measured concentrations.
- Judgmental and miscellaneous sample data sets reported separately from those samples collected for performing the statistical evaluation.
- A discussion of anomalous data including any areas of elevated direct radiation detected during scanning that exceeded the investigation level or measurement locations in excess of the $DCGL_W$ or $ADCL_W$.
- A statement that a given survey unit satisfied the $DCGL_W$Wor ADCL $_W$Wand the elevated measurement comparison, if any sample points exceeded the $DCGL_W$ or $ADCL_W$.
- A description of any changes in initial survey unit assumptions relative to the extent of residual radioactivity.
- A discussion of a survey unit reclassification including applicable data.

References

1. ADA Consultants, Inc., April 1, 1994, Radiological Survey Report, Kaiser Aluminum & Chemical Corporation, Tulsa, Oklahoma.

2. Advanced Recovery Systems, 1995, Volume II, Plate 1, Field Characterization Report, Appendix F.

3. Advanced Recovery Systems/Nuclear Fuel Services, Inc., April 25, 1995, Kaiser Aluminum Specialty Products, Field Characterization Report, Tulsa, Oklahoma.

4. Earth Sciences Consultants, Inc., February 2002, Final Status Survey Report, Adjacent Land Area, Tulsa, Oklahoma Facility.

5. Earth Sciences Consultants, Inc., May 2002, Revised May 2003, Decommissioning Plan Addendum, Tulsa Facility, Tulsa, Oklahoma, Kaiser Aluminum & Chemical Corporation, Baton Rouge, Louisiana.

6. Kaiser, August 1998, Adjacent Land Remediation Plan for Kaiser Aluminum & Chemical Corporation, Tulsa, Oklahoma.

7. NMSS Decommissioning Standard Review Plan Appendix E – Rev 0, September 2000, Implementing the MARSSIM Approach for Conducting Final Radiological Survey.

8. Nuclear Regulatory Commission, July 1998, Draft NUREG-1549: Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination.

9. NUREG-1507, December 1997, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions.

10. NUREG/CR-1575, August 2000, MARSSIM, Rev. 1

Chapter 15.0 is considered Privileged and Confidential and is being submitted under separate cover.

Appendix A

Volume Estimates

Appendix A

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Appendix A

Volume Estimates

Central to the problem of estimating the volume of contaminated material above a particular cleanup level is understanding the spatial distribution of contamination. Typically, isoconcentration contour maps are used to present this type of information. Several techniques are widely used to produce these types of maps, such as hand contouring, regression analysis, inverse distance, triangulation, and kriging. All of these techniques are predicated on the notion that data values closest to the point or block where the concentration is being estimated contain more information than data further away, and hence get more weight. Hand contouring may only consider the two or three adjacent points without explicit weights. Triangulation considers the three closest points (triangular facets). More sophisticated quantitative techniques consider more points.

The differences in the techniques are how the weights are estimated. Kriging is a weighted, moving-average estimation technique where the weights are determined by using the spatial correlation structure of the contaminant of interest. The difficulty in kriging is estimating the correlation structure. The correlation structure is described by a semivariogram. If there is no spatial correlation, then contour maps are meaningless, and the semivariogram will look like random scatter. The semivariogram presents the spatial structure as a graph with the abscissa the distance between sample locations (lags) and the ordinate the square of the difference in the contaminant concentrations at the sampling locations.

The typical semivariogram is a rising curve showing that points close together (few lags) are more alike (correlated). The semivariogram curve has a horizontal asymptote or maximum variance. This is called the sill. The distance on the abscissa from the origin to the point where the semivariogram curve stops rising and begins to run parallel to the sill is called the range of correlation (or range). This range suggests the size and shape of the ideal sampling grid (i.e., the maximum distance between grid nodes that still allows prediction of contaminant concentrations between grid nodes).

Appendix I of the ARS report (1995) included a summary of the geostatistical analyses (kriging) and the resulting volume estimates. The appendix included a brief description of the geostatistical method, data processing, and modeling results. Modeling results were presented as estimated volumes of contaminated soil above several different thorium concentration levels for four areas (identified as Areas 1, 2, 3, and 4). The total estimated volume above 10 pCi/g was 3,173,200 ft^3). These volume estimates presumably were incorporated into the 3.5-million-cubic-foot estimate cited elsewhere in the report.

The description provided in Appendix I (ARS, 1995) raised several concerns. Most importantly, documentation provided in Appendix I is insufficient to evaluate the credibility of the resulting volume estimates. Furthermore, the description provided suggests some errors in the analyses. Specifically, the following text is erroneous "A pure nugget (Co = 0) effect indicates a complete lack of spatial correlation." In fact, the opposite is true; what the author may have intended to say was that a high nugget (i.e., when the nugget (Co) equals the sill Co = Co + C, and C = 0) indicates a complete lack of spatial correlation. The analyses also include some unconventional data preparation. Results for a given interval, 13 pCi/g for BH-1, 2 to 5 feet, were split into 6-inch intervals, as in 2 to 2.5 feet, 2.5 to 3 feet, and assigned the same result, 13 pCi/g. This treatment of the data would produce an artificial correlation with depth. Consequently, the resulting estimate can be seriously biased.

Although the existing geostatistical analysis is of uncertain value, the technique itself is quite useful. As described earlier, if the semivariogram does not show any structure, it indicates there is no spatial correlation and contouring is meaningless. It also indicates optimum grid spacing for subsequent investigations. Kriging also uses more of the available data than most other techniques; resulting in more reliable estimates particularly when the underlying correlation structure is sound. Kriging also provides a quantitative description of the uncertainty in the estimated value. The technique can be further extended using probability kriging to incorporate specific Type I and II error rates relative to comparisons to a specific cleanup level. Probability kriging also is more robust to extremely high values than ordinary kriging.

The data set provided in Appendix I (ARS, 1995) was evaluated using both kriging and triangulation methods to produce contour maps and volume estimates. Correlation estimation and kriging were done on the log-transformed data. Semivariograms were developed using all the on-site data and just the pond data. Because the distribution of thorium in the pond resulted from a relatively predictable long-term process, it was hypothesized that the resulting semivariogram would have a better correlation structure. As anticipated, the pond-only semivariogram has a larger range (220 vs. 110 feet) and smaller nugget (0.07 vs. 0.10) and sill (0.267 vs. 0.414) than the site-wide semivariogram.

For comparison, the pond-only semivariogram kriging model, the site-wide semivariogram kriging model, and triangulation each were used to estimate the volume of thorium-bearing material in excess of 10 pCi/g total thorium for on site (see Table B-1). Although the contour maps (Figures B-1 to B-8) look somewhat different, the areas below 10 or 15 pCi/g are fairly similar for the 0-2-, 2-5-, and 5-10-foot intervals. The total kriging-estimated volume of material above 10 pCi/g is 4,008,000 cubic feet for the on-site area using the pond semivariogram and 4,559,000 cubic feet using the site-wide semivariogram

(Figures B-1 to B-4). The triangulated volume estimate is approximately 2,644,000 cubic feet, but as stated earlier, this likely to be an underestimate. Triangulated results for the on-site area are biased low by the inability of the method to estimate areas on the periphery of the sampled area (Figure B-5 to B-8). Incorporating the off-site data into the analysis would improve the accuracy of these estimates.

Tables B-2 and B-3 present volumes of material with concentrations (C) above the indicated picocurie/gm value over the indicated intervals and the total thickness under consideration as calculated by kriging and triangulation techniques respectively. The volumes in each interval are added together to get the cumulative value for each concentration. Volumes of material for intervals less than a given concentration or between two concentrations are calculated by subtracting the lesser volume from the greater volume, or total volume. The volumes were required to assist with calculating costs for several alternatives.

It is evident from the contour maps that the volume is fairly constant for cleanup levels between 5 and 15 pCi/g. Significant volume reductions can be achieved at cleanup levels on the order of 40 pCi/g.

Tables

Table A-1
Comparison of Volume Estimates for Natural Thorium Concentrations > 10 pCi/g, by Kriging and Triangulation Techniques

Estimation Method	Kriging				Triangulation	
Selected Variogram →	Pond	Sitewide	Pond	Sitewide		
Area Considered →	Pond	Pond	Site	Site	Pond	Site
Depth↓	Volume (in ft^3)	Volume (in ft^3)	Volume (in ft^3)	Volume (in ft^3)	Volume (in ft^3)	Volume (in ft^3)
0-2	464,842	468,254	704,316	739,946	430,702	615,786
2-5	653,472	622,155	977,073	942,033	531,519	780,012
5-10	1,045,640	1,150,760	1,578,780	1,690,705	728,225	1,165,965
10-15	499,007	816,170	747,740	1,187,220	82,268	82,268
Sum Total	2,662,961	3,057,339	4,007,909	4,559,904	1,772,714	2,644,031

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Table A-2
Volumes by Kriging, Greater than Concentration (C)

Depth (in ft.)	Total Volume	C* > 6.24 pCi/g	C > 10 pCi/g	C > 12.48 pCi/g	C > 20 pCi/g	C > 30 pCi/g	C > 40 pCi/g	C > 50 pCi/g	C > 60 pCi/g	C > 70 pCi/g	C > 80 pCi/g
0-2	767,299	761,966	704,316	670,676	538,020	384,626	304,132	240,560	188,182	138,187	77,259
2-5	1,178,645	1,091,793	977,073	864,807	683,220	517,320	419,730	364,839	321,021	284,004	248,789
5-10	1,771,688	1,760,275	1,578,780	1,482,025	1,180,130	897,040	691,265	536,815	445,648	377,612	322,541
10-15	1,771,686	1,445,580	747,740	462,612	83,333	11,952	0	0	0	0	0
Sum Total	5,489,318	5,059,614	4,007,909	3,480,120	2,484,703	1,810,938	1,415,127	1,142,214	954,851	799,803	648,589

Depth (in ft.)	C > 90 pCi/g	C > 100 pCi/g	C > 110 pCi/g	C > 120 pCi/g	C > 140 pCi/g	C >160 pCi/g	C >180 pCi/g	C > 200 pCi/g	C > 220 pCi/g	C > 240 pCi/g	C > 260 pCi/g
0-2	32,550	10,600	1,021	0	0	0	0	0	0	0	0
2-5	216,931	188,371	163,184	121,187	63,864	28,954	16,335	8,059	2,285	0	0
5-10	276,462	238,207	201,430	170,326	115,540	58,561	28,294	11,367	0	0	0
10-15	0	0	0	0	0	0	0	0	0	0	0
Sum Total	525,943	437,178	365,635	291,513	179,404	87,515	44,629	19,426	2,285	0	0

* C = Concentration of Natural Thorium (Th-232 + Th-228) in pCi/g.

Table A-3
Volumes By Triangulation, Greater than Concentration (C)

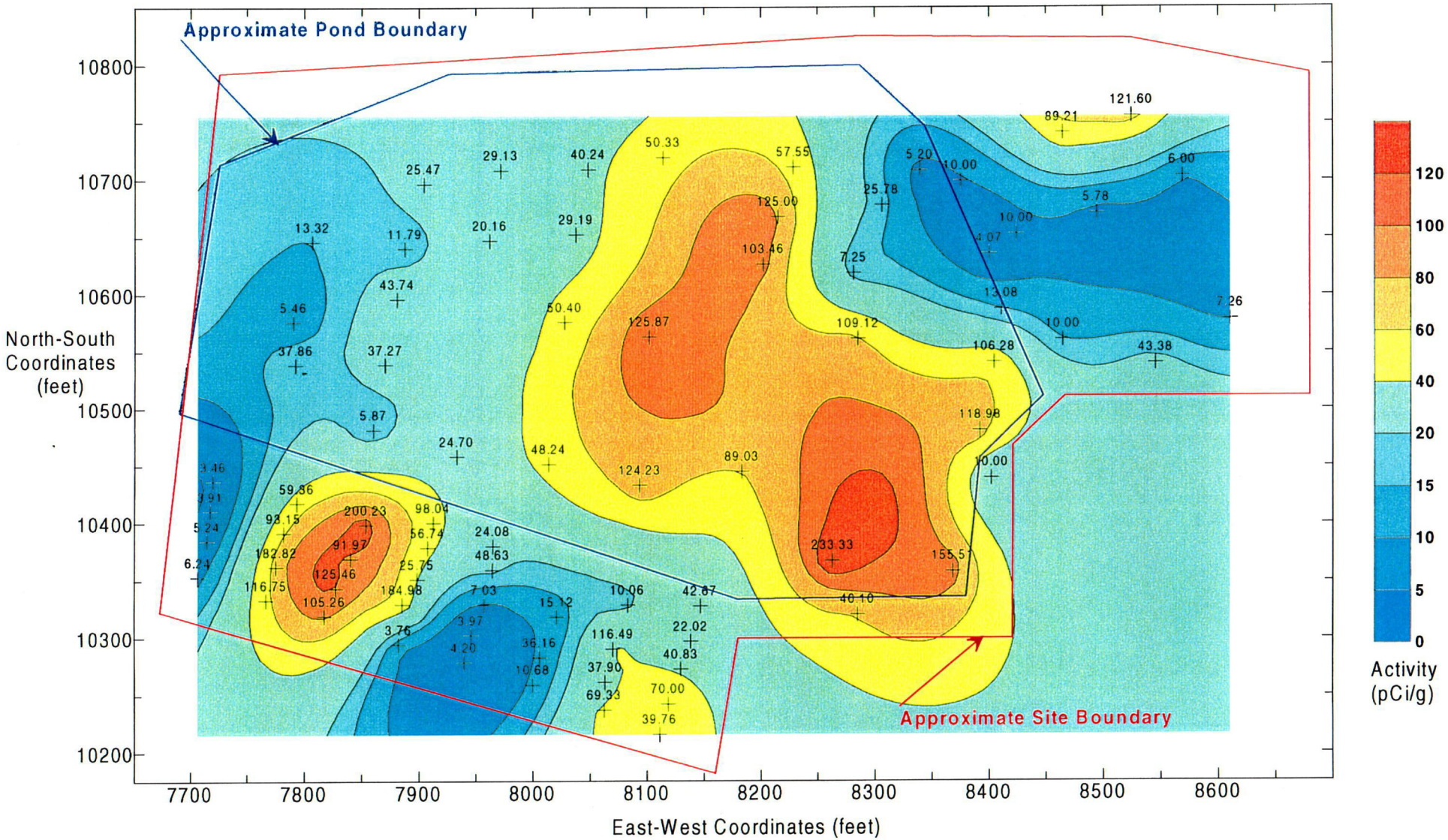
Depth (in ft.)	Total Volume	C* > 6.24 pCi/g	C > 10 pCi/g	C > 12.48 pCi/g	C > 20 pCi/g	C > 30 pCi/g	C > 40 pCi/g	C > 50 pCi/g	C > 60 pCi/g	C > 70 pCi/g	C > 80 pCi/g
0-2	849,725	734,684	615,786	558,742	444,850	339,664	256,980	196,330	160,319	130,827	104,579
2-5	1,274,589	957,099	780,012	715,650	594,096	504,555	442,548	396,261	357,738	322,422	287,979
5-10	2,073,430	1,531,840	1,165,965	1,062,295	865,575	712,705	614,915	542,800	483,618	432,851	390,714
10-15	2,073,425	741,540	82,268	44,281	5,043	0	0	0	0	0	0
Sum Total	6,271,169	3,965,163	2,644,031	2,380,968	1,909,564	1,556,924	1,314,443	1,135,391	1,001,675	886,100	783,272

Depth (in ft.)	C > 90 pCi/g	C > 100 pCi/g	C > 110 pCi/g	C > 120 pCi/g	C > 140 pCi/g	C > 160 pCi/g	C > 180 pCi/g	C > 200 pCi/g	C > 220 pCi/g	C > 240 pCi/g	C > 260 pCi/g
0-2	81,852	60,509	44,309	30,810	17,947	9,603	4,262	296	0	0	0
2-5	261,594	239,126	219,335	198,385	145,839	89,071	61,133	40,005	23,423	11,886	4,271
5-10	352,159	318,219	285,737	260,486	212,002	150,307	94,956	61,195	34,923	17,969	6,531
10-15	0	0	0	0	0	0	0	0	0	0	0
Sum Total	695,605	617,854	549,381	489,681	375,788	248,981	160,351	101,496	58,346	29,855	10,802

* C = Concentration of Natural Thorium (Th-232 + Th-228) in pCi/g.

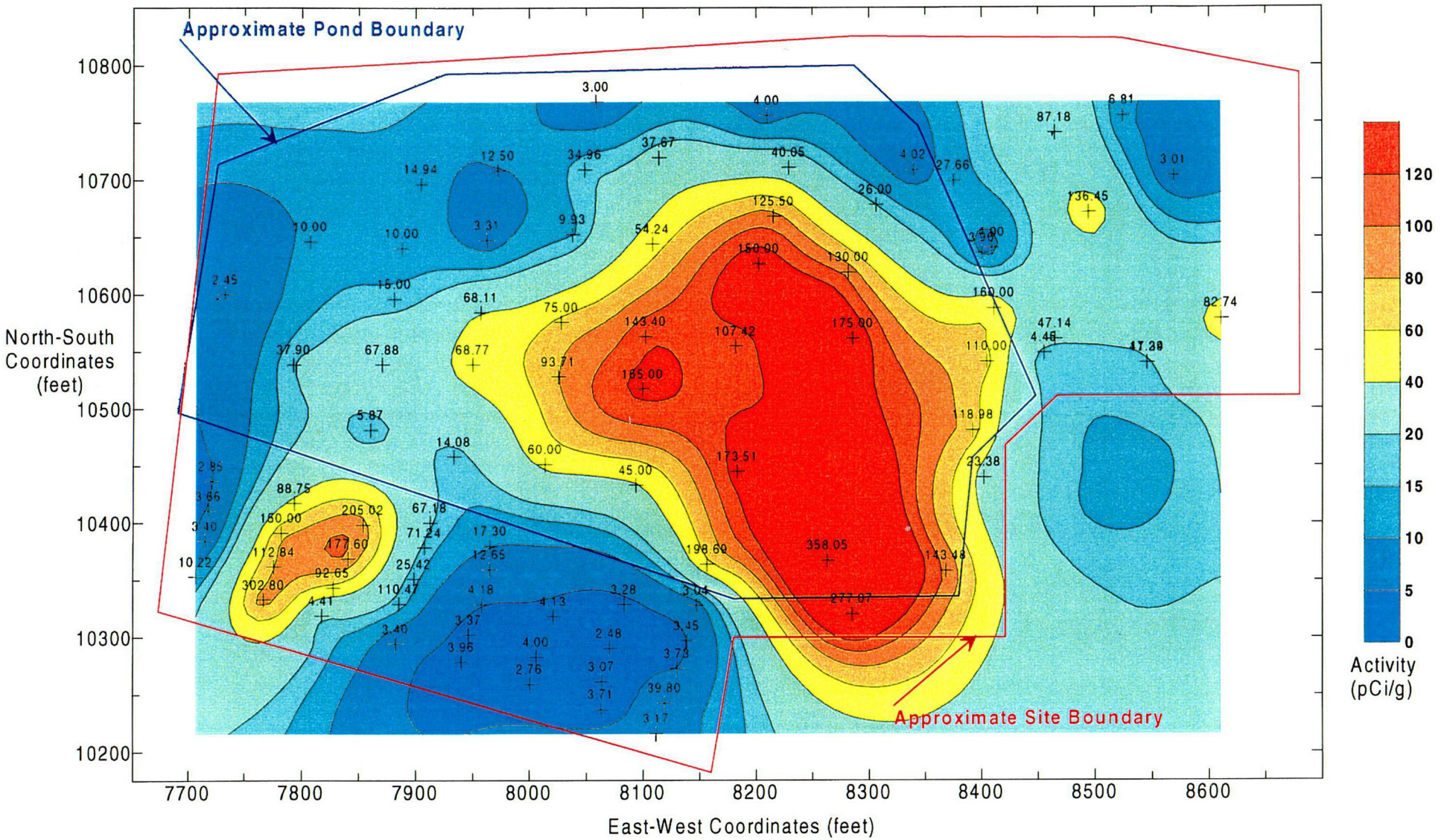
Figures

Figure A-1
Concentration Distributions, Kriging Method,
0 - 2 ft Depth
Kaiser Aluminum, Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana



C01

Figure A-2
Concentration Distributions, Kriging Method,
2 - 4 ft Depth
Kaiser Aluminum, Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana



C02

Figure A-3
Concentration Distributions, Kriging Method,
5 - 10 ft Depth
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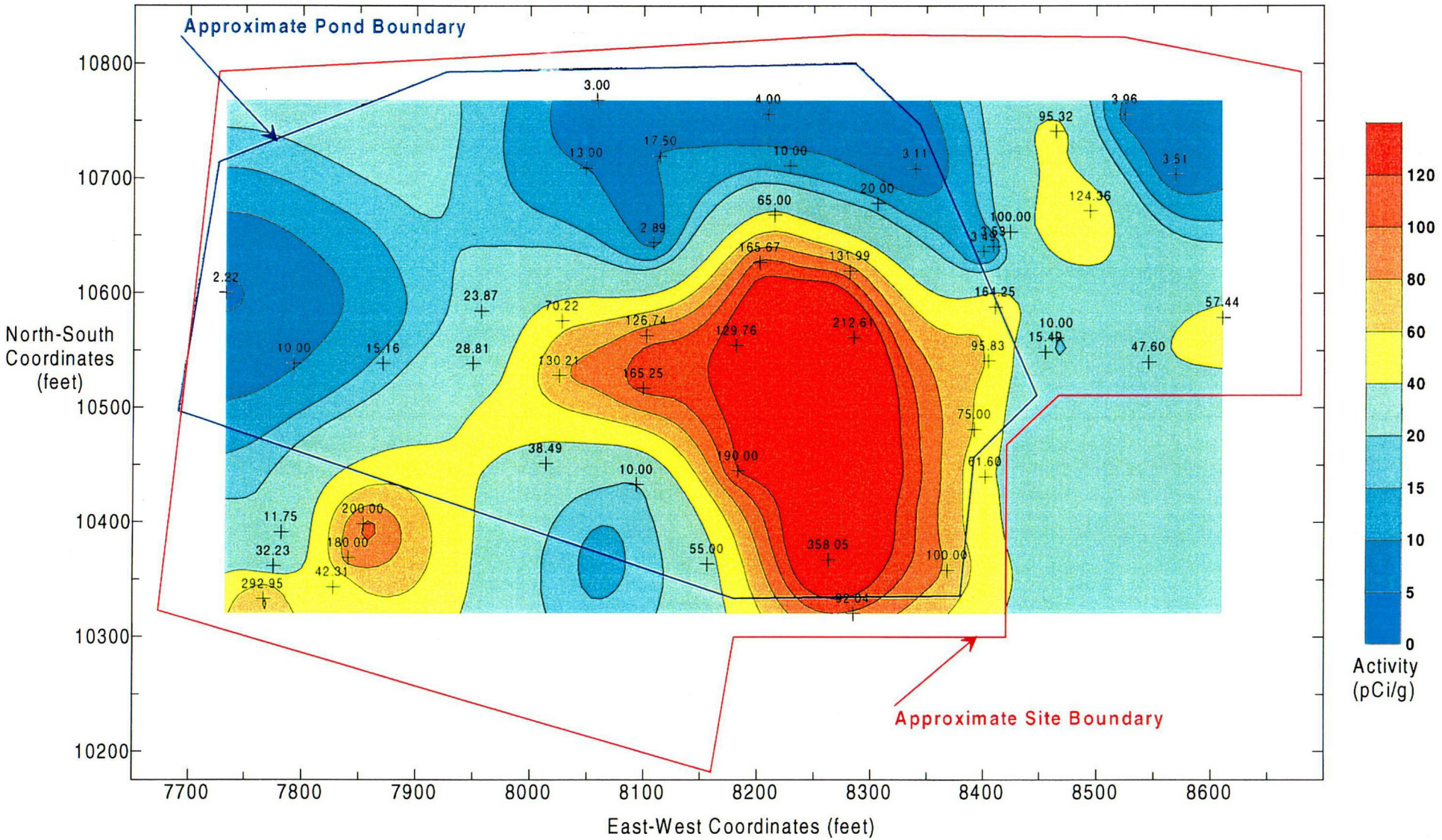
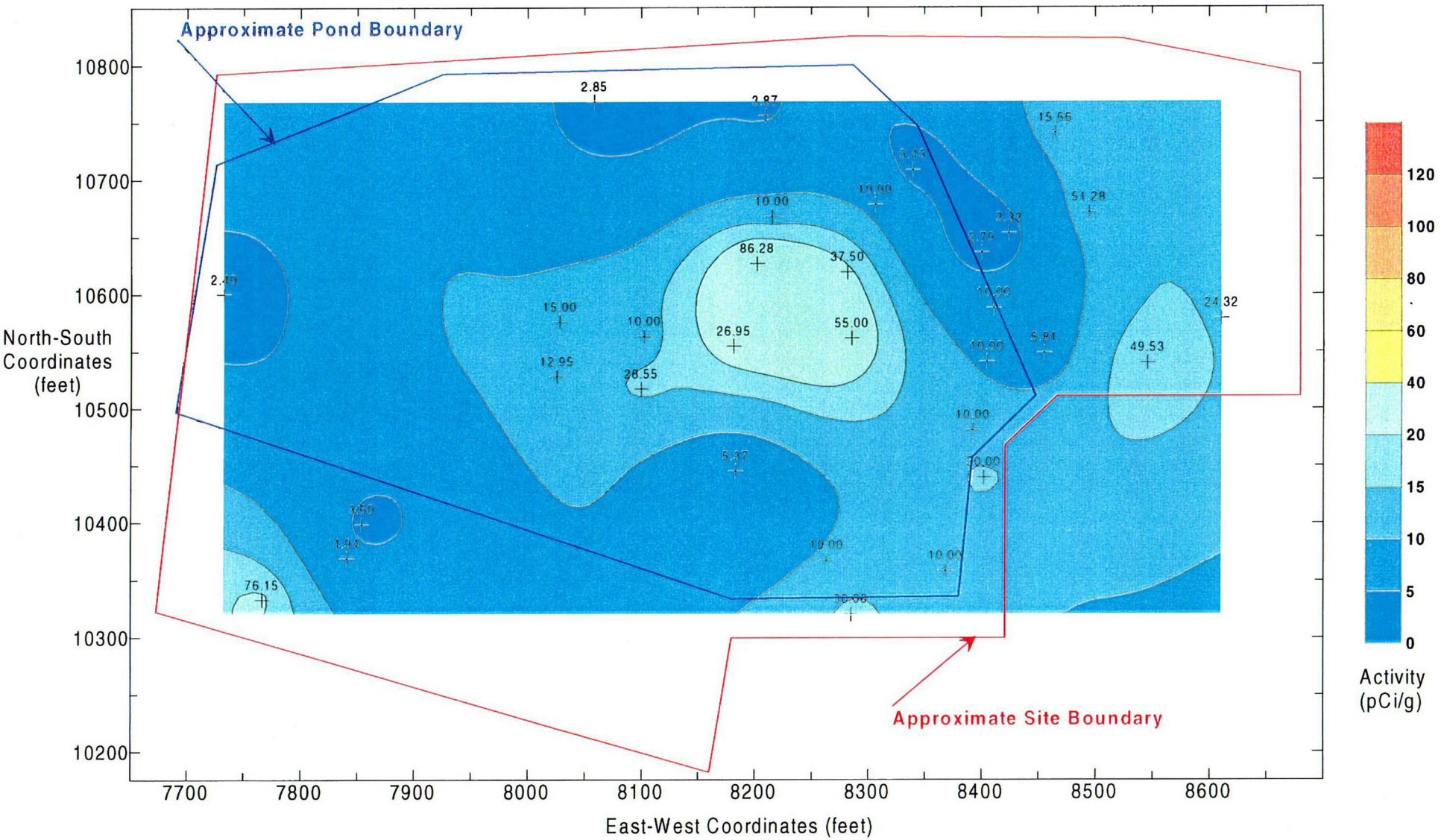
Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana



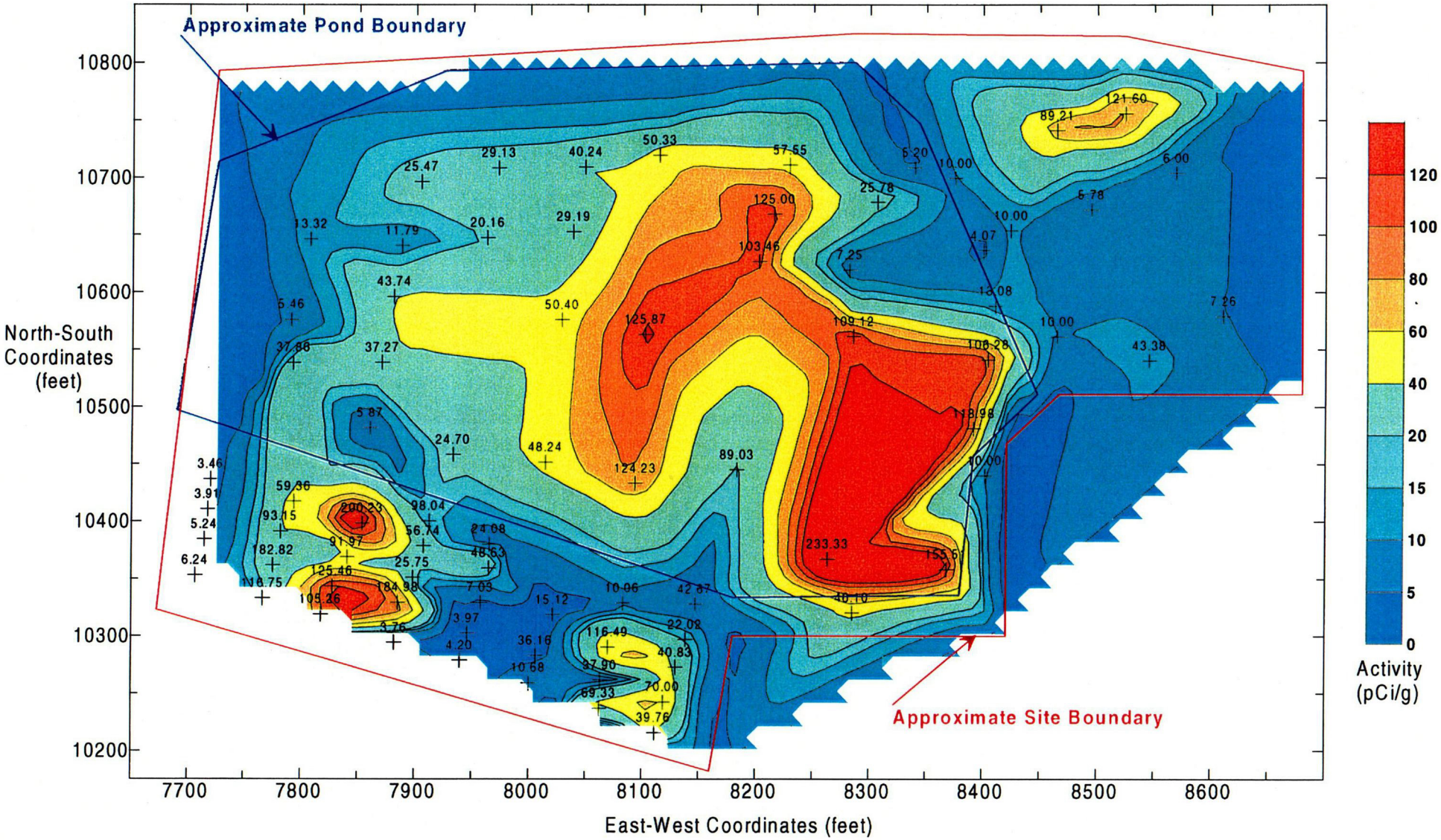
C03

Figure A-4
Concentration Distributions, Kriging Method,
10 - 15 ft Depth
Kaiser Aluminum, Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana



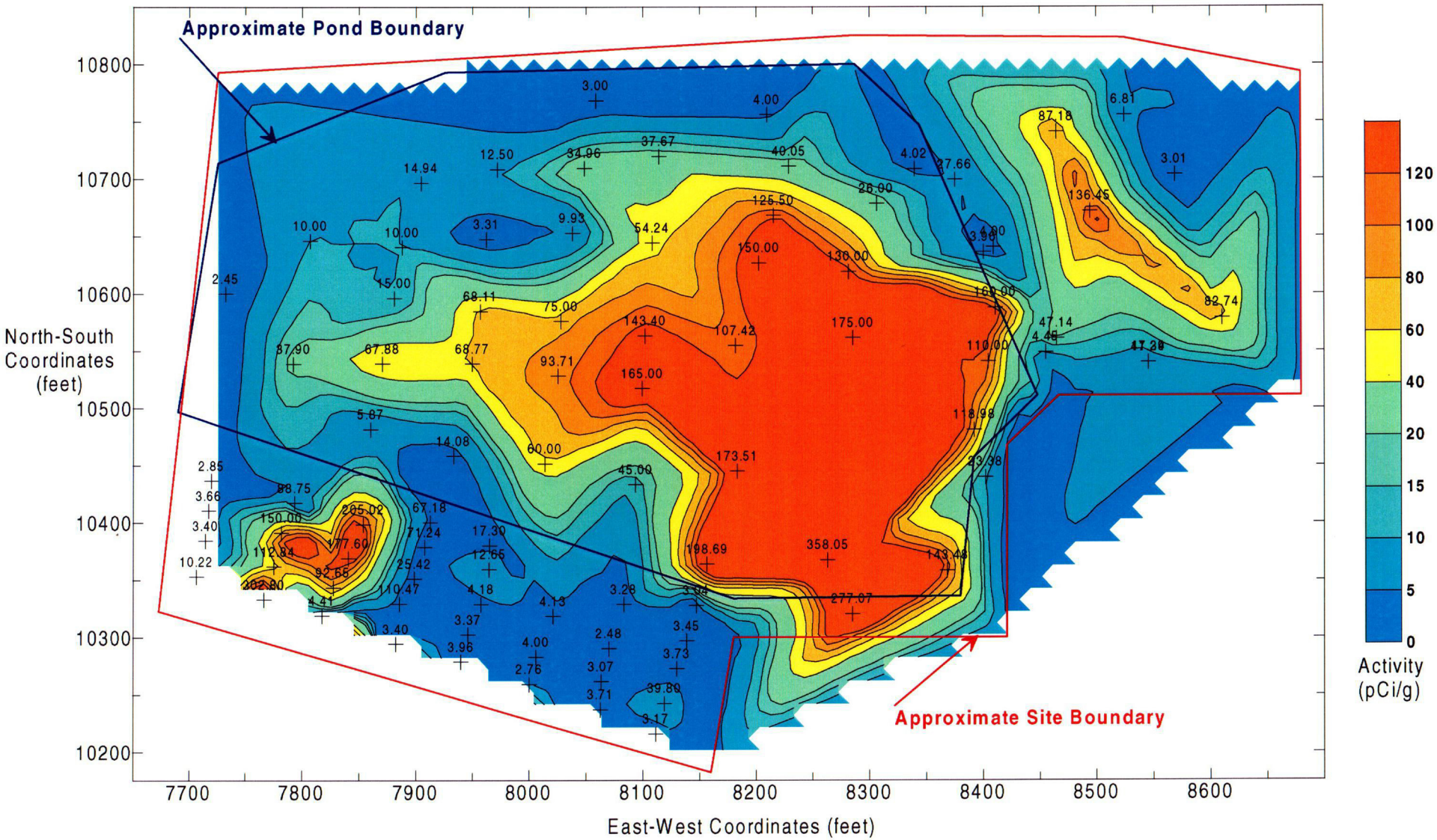
C04

Figure A-5
Concentration Distributions, Triangulation Method,
0 - 2 ft Depth
Kaiser Aluminum, Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana



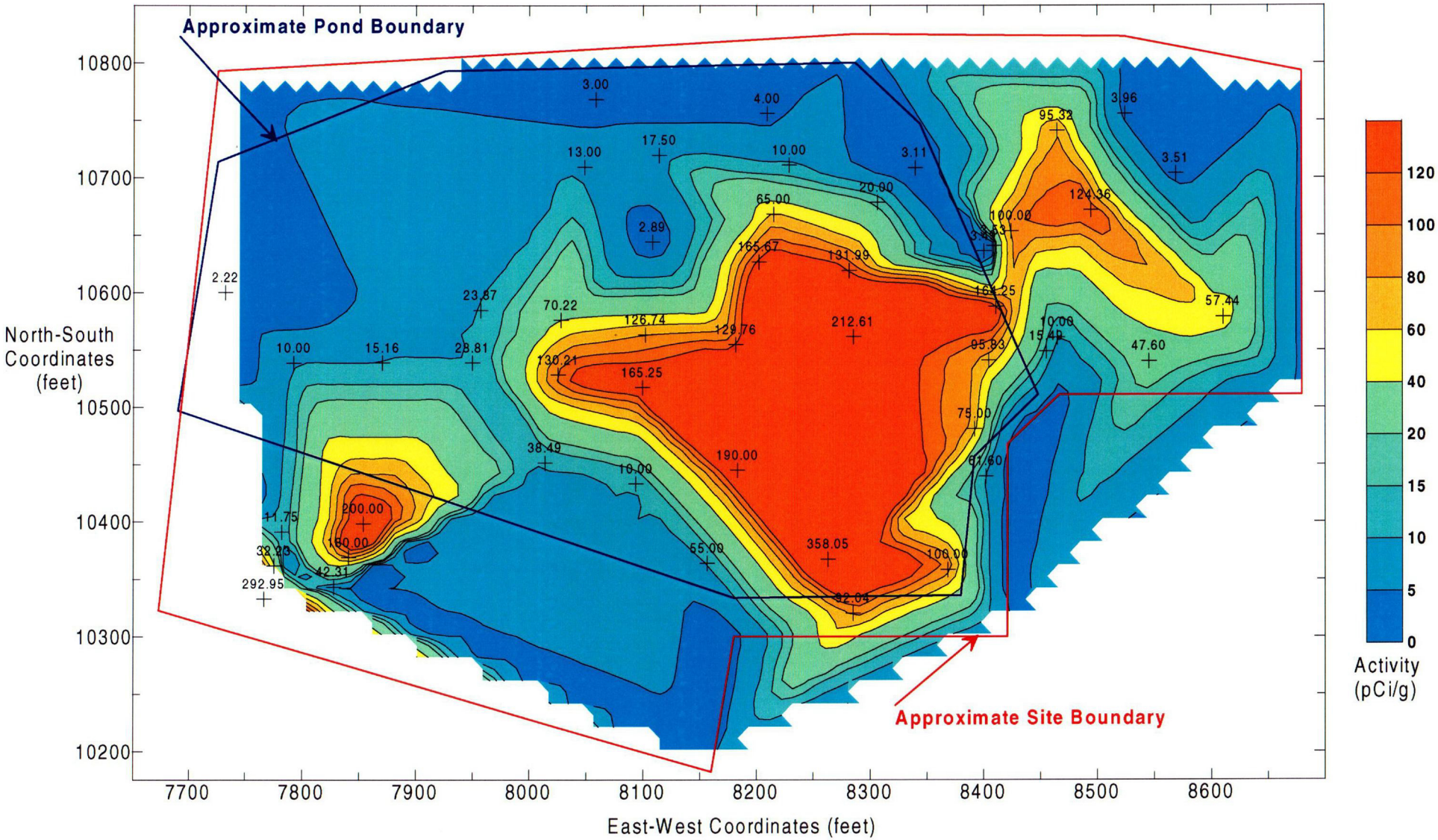
C05

Figure A-6
Concentration Distributions, Triangulation Method,
2 - 4 ft Depth
Kaiser Aluminum, Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana



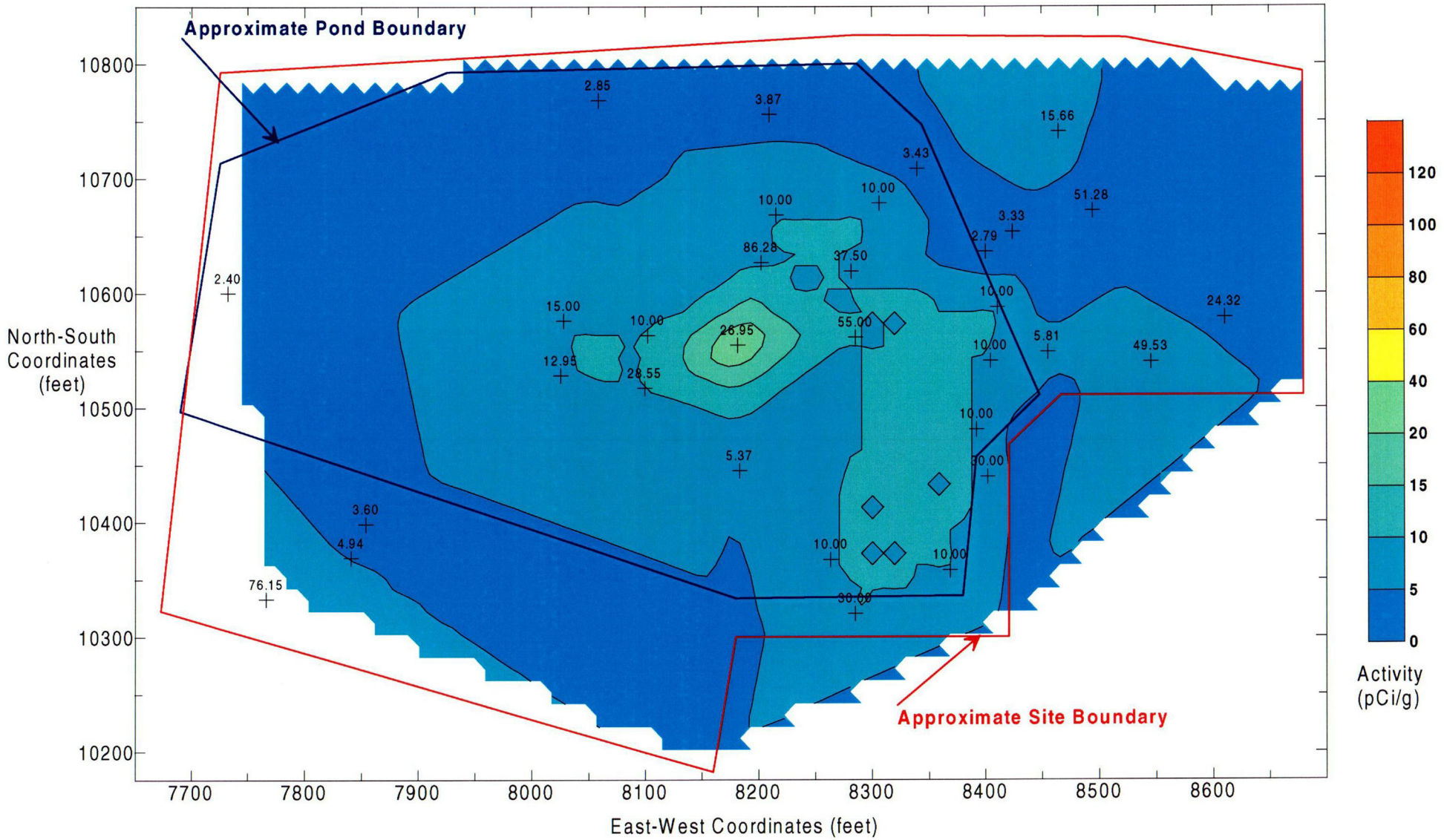
C06

Figure A-7
Concentration Distributions, Triangulation Method,
5 - 10 ft Depth
Kaiser Aluminum, Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana



C07

Figure A-8
Concentration Distributions, Triangulation Method,
10 - 15 ft Depth
Kaiser Aluminum, Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana



C08