FINAL RADIATION SURVEY PLAN FOR FOUR UNAFFECTED AREAS OF THE CUSHING REFINERY SITE

Kerr-McGee Corporation
Cushing, Oklahoma

prepared by
Morton Associates

June 7, 1994

KERR-McGEE CORPORATION
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TECHNOLOGY & ENGINEERING DIVISION

ROY R. SMITH
VICE PRESIDENT, ENVIRONMENTAL OPERATIONS

June 7, 1994

Dr. John H. Austin
Chief, Decommissioning and Regulatory Issues
Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Cushing Site Decommissioning Plan
Docket 70-3073, License SNM-1999

Dear Dr. Austin:

On April 27, 1994, Kerr-McGee Corporation submitted a plan to decommission its refinery site in Cushing, Oklahoma, including a final survey plan. To enable environmental restoration not involving radioactive material in four areas characterized as unaffected by licensed material, KMC is submitting herewith a final radiation survey plan covering those four unaffected areas. KMC needs NRC concurrence that the land and structures are not radioactively contaminated before starting the other activities.

While KMC wants to obtain recognition that the four areas are demonstrated by a final radioactivity survey to be free of contamination by licensed material, please note that KMC is not requesting that the four unaffected areas be deleted as authorized places of use after it has been determined that they are suitable for unrestricted use. We plan eventually to use a portion or portions of the unaffected areas to dispose of soil meeting the branch technical position[1] Option 1 specifications for unrestricted release and to site the engineered cell. Once the designated areas are recognized as such by the Commission, KMC would want to discontinue radiation monitoring until we begin placing licensed material in the engineered cell.

Kerr-McGee is interested in completing decommissioning at its Cushing site as soon as is practicable. To facilitate approval of the plan, we will provide whatever information is necessary to expedite approval of this plan.

Sincerely yours,

Roy Smith
Vice President, Environmental Operations

Enc.

cc: Bob Evans, NRC Region IV
Gene Smith, ODEQ
Scott Thompson, ODEQ
Rick Reiley, Cushing Citizens Oversight Committee

[1] W. J. Dircks, NRC, branch technical position on Disposal or Onsite Storage of Residual Thorium or Uranium from Past Operations, SECY 81-576 & 46 FR 52061, October 23, 1981.

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FINAL RADIOACTIVITY SURVEY PLAN FOR FOUR UNAFFECTED AREAS OF THE CUSHING REFINERY SITE

1. BACKGROUND INFORMATION

Kerr-McGee Corporation (KMC) used part of its Cushing site during 1962 through 1966 to process natural thorium and natural, depleted, and enriched uranium under two Atomic Energy Commission (AEC) licenses, SNM-695 and SMB-664. The site was released and the licenses terminated in 1966. As a result of subsequently determined contamination on the site, a new license, SNM-1999, was issued by the Nuclear Regulatory Commission (NRC) in 1992 for decommissioning the site for unrestricted use.

The site contains four large areas that were used for oil refining and storage during the years nuclear processing and disposal took place. KMC has no reason to suspect that radioactive materials were disposed of in any of these areas during subsequent decommissioning activities. These areas are therefore *unaffected* by licensed radioactive material. These *unaffected* areas are the subject of this final radioactivity survey plan. They are not the only *unaffected* areas on the property. KMC is performing a final survey on the areas subject to this plan in order to be able to perform other activities in those areas without needing radiation protection. Other *unaffected* areas not addressed in this plan are subject to the final survey plan in the Site Decommissioning Plan.

2. SITE INFORMATION

2.1 Site Description

The Cushing site is located in Payne County, Oklahoma, 2.5 miles NE of the City of Cushing, midway between Tulsa and Oklahoma City. Figure 1 shows the region surrounding the Cushing site. The terrain of the region is rolling, oil-producing pasture land. Skull Creek runs through the site before joining the Cimarron River 4 miles ENE at an elevation of 760 feet above mean sea level (MSL). The mean elevation of the site is 840 feet MSL. The locations of the four unaffected areas, including any distinguishing features and acreage, are shown in Figure 2. The total size of the four areas is approximately 200 acres.

2.2 Site Conditions at Time of Survey

In the opinion of Kerr-McGee, the four specified unaffected areas on the Cushing site satisfy current NRC guidelines for unrestricted use. The remainder of the Cushing site is not covered by this final radioactivity survey plan for unaffected areas; instead it is addressed by the Site Decommissioning Plan submitted in April 1994.

Affected areas are ones in which contamination has been identified or where historical information indicates the possible presence of radioactive contamination. Other areas where there is no reason to suspect contamination are considered *unaffected*.

Designated *unaffected* areas 1 through 4, identified on Figure 2, are not contaminated by licensed radioactive material because there is no known instance in which licensed radioactive material, including waste from licensed processing, was put in any of the designated areas. The characterization survey[1] has indicated that there is no radioactive contamination in either of these areas.

Kerr-McGee's intent, stated in its Site Decommissioning Plan, is to use portions of these unaffected areas in the future for disposition of soil meeting the specifications of NRC's BTP Option 1 and Option 2 for disposal of thorium or uranium wastes from past operations in an engineered cell.[2] KMC also plans to use portions of these areas for treatment and disposal of acidic hydrocarbon sludges, which are not radioactively contaminated unless separately confirmed to contain less activity than the BTP Option 1 limit.

3. RADIOACTIVITY SURVEY OVERVIEW

3.1 Survey Objectives

The purpose of the final radioactivity survey is to demonstrate that the radiological conditions in the four unaffected areas satisfy NRC criteria, and that the areas can be released for unrestricted use without radiological controls. The criteria that will apply to unrestricted release of the areas subject to this survey plan for unaffected areas are as follows.

A. In Buildings and on Structures
   1. Average surface contamination levels for each survey unit are within the acceptable levels specified in Table 1, Acceptable Surface Contamination Levels.
   2. Small areas of residual activity, *i.e.*, discrete areas up to 100 cm^2 , do not exceed three times the average value.
   3. The average activity level within a 1 m^2 area containing a discrete spot must be within the limit stated in Table 1.
   4. Exposure rate in every occupiable location is less than 10 µR/hr above background. Exposure rate is measured at 1 m from floor or lower wall surfaces and is averaged over floor areas, not to exceed a maximum of 10 m^2 or a small room.

Buildings in the unaffected areas include two pumphouses, a cable television service shed of recent construction, and an abandoned building once used as the refinery firehouse. In inhabitable structures, NRC guidance states that exposure rate should not exceed 5 µR/hr above background. Other than the service shed, these small buildings are slated for demolition; thus, future occupancy is not in question and the guideline for indoor occupancy would be unnecessarily restrictive. 10 µR/hr above background, the out-of-doors limit is therefore proposed for building interiors subject to this survey.

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1 Kerr-McGee, *Cushing Site Radiological Characterization*, May 4, 1991.

2 USNRC, Branch Technical Position, *Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations*, 46 FR 52601, October 23, 1981.

Table 1. Acceptable Surface Contamination Levels

Nuclides[a]	Average[b,d] (dpm/100 cm^2)	Maximum[c,d] (dpm/100 cm^2)	Removable[b,d] (dpm/100 cm^2)
uranium	5,000	15,000	1,000
thorium, nat.	1,000	3,000	200

a Including associated decay products.
b Average contamination may be averaged over as much as 1 m^2. If the area of an object is less than 1 m^2, average contamination over the object.
c Maximum contamination level applies to an area ≤ 100 cm^2
d dpm/100 cm^2 may be measured by either alpha or beta-gamma sensing instrument.
e Where both U and Th occur, the sum-of-fractions ≤ 1 formula may be employed.

These surface contamination criteria are based on *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material*.[3]

B. Soil and Building Materials

1. Average radionuclide concentrations are within the acceptable levels specified in Table 2, Option 1 Radioactivity Concentration Levels. Concentrations may be averaged over a 100 m^2 grid area.
2. At any discrete location, the maximum radionuclide concentration above background may not exceed 3 times the limit stated in Table 2.
3. Average exposure rate over a 100 m^2 grid area must not exceed 10 µR/hr above background at 1 m above the surface.
4. The maximum exposure rate over any discrete area of less than 100 m^2 may not exceed 20 µR/hr above background.

Table 2. Option 1 Radioactivity Concentration Limit

Kind of Material	Maximum Concentration (pCi/gm)
Thorium (Th^{232}+Th^{228}) if all daughters are present	10
Depleted Uranium	35
Enriched Uranium	30

3 Cunningham, R.E., USNRC:Div Ind & Med Nuc Saf, *Termination of Byproduct, Source, and Special Nuclear Material Licenses*, Policy And Guidance Directive FC 83-23, Nov. 4, 1983, rev. August 1987.

Material is in the Option 1 category when the combined radionuclide concentration, less background, is

$$\frac{U238}{35} + \frac{U235 + U234}{30} + \frac{Th232 + Th228}{10} \leq 1$$

These conditions will be demonstrated at a 95% confidence level for each survey unit as a whole. A *survey unit* is a land area, a building, or portion of a building having a common history, characteristics, and contamination potential.

3.2 Identity of Contaminants

Based on the knowledge of site operations and the results of a preliminary assessment, a characterization survey, and other measurements, the significant radiological contaminants on the site have been determined to be natural thorium and isotopes of uranium. The uranium is comprised of depleted, natural, and enriched forms, resulting in an average enrichment above the naturally occurring level. Although uranium with a wide range of U^{235} enrichment values was received, residual uranium enrichment is typically less than about 12% U^{235}. However, there is no suspicion or evidence of contamination in the four unaffected areas.

In addition to the radioactive contaminants, the site includes areas containing acidic hydrocarbon sludge, oils, and greases. These materials, as well as NORM materials, *e.g.*, radium-contaminated pipe scale, will be addressed in accordance with requirements of the State of Oklahoma. The *Cushing Refinery Site, Site Decommissioning Plan*, §2.2, Site Information, contains additional information about the origin and composition of radioactive contaminants on *affected* areas of the site.

4. ORGANIZATION AND ADMINISTRATION

4.1 Organization and Responsibilities

The final radioactivity survey of the unaffected areas will be performed by a team composed primarily of qualified personnel at the Cushing site, Cimarron Corporation, and KMC headquarters in Oklahoma City. Some contractor assistance may be required for certain, not now identified, services or tasks. The team organization for the survey is shown in Figure 3, Organization for Final Radioactivity Survey of Unaffected Areas, and it includes potential contractor assistance.

The team will operate under the general direction of the Site Coordinator. The Site Coordinator will have the authority to make appropriate adjustments deemed necessary to implement the survey plan (subject to the established QA/QC program) as the survey progresses.

Field measurements of radiological parameters and sample collection will be under the joint direction of the Site Coordinator and the Radiation Safety Officer. They will also oversee the activities of any field contractor assistance.

Laboratory activities for in-house analyses will be under the direction of the Radiation Safety Officer. He will also oversee the activities of any laboratory contractor assistance.

The KMC Technology and Engineering Division's Waste Management Department will provide expertise on spectrometry instrumentation and sample analysis.

4.2 Training

Kerr-McGee Corporation provides continuing training for its personnel and others who may be exposed to radioactive materials. Training varies according to the potential exposure and nature of employees' job duties. All members of the radioactivity survey team will attend an in-house training session at which radiation protection, survey procedures, and quality assurance activities will be reviewed. Special training will be provided on equipment, special techniques, and practices relative to the survey activities for those employees who will be involved in taking radiological measurements and samples and performing laboratory analyses.

4.3 Quality Assurance Program

The quality assurance (QA) emphasis at the Cushing site emphasizes quality control and assessment. The main objective of quality control (QC) is to help ensure reproducible measurements or execution of intended actions. The main aim of quality assessment is to evaluate performance and whether desired quality is achieved. Quality assurance depends on the competence of the staff, good practices, procedures for specific actions, audits and reviews, documentation, and training. During the unaffected area final survey of the Cushing site, quality of radiation and radioactivity measurements will receive particular emphasis.

4.3.1 Administration

Quality controls are integrated into calibration or survey procedures. Any changes or alterations to these procedures will be handled in the same manner as changes to survey procedures.

4.3.2 Radiation and Radioactivity Measurement

KMC's quality assurance program for measuring radiation and radioactivity addresses the following areas.

- Procedures
- Quality Control in Sampling
- Quality Control During Sample Handling
- Reference Standards
- Calibration
- Operability Checks
- Instrument Maintenance
- Laboratory Analytical Quality Control
- Data Management

Records
Audits

Regulatory Guide 4.15[4] was consulted during the development of the QA plan for measurements.

4.4 General Survey Plan

The survey plan consists of systematic processes and procedures found to be acceptable by industry standards and the NRC. Activities have been defined and tasks within those activities have been described. Table 3, Overview of Unaffected Areas Survey Activities and Tasks, provides a breakdown of activities and tasks that currently comprise the final radioactivity survey plan. The tasks will be assigned to the appropriate team members as required. Subsequent sections provide information on the conduct of these tasks.

4.5 Schedule of Implementation

The first six of the major activities in the final radioactivity survey of unaffected areas depicted in Table 3 have been completed. The remaining activities will be completed within 60 days after submittal of this survey plan.

5. HEALTH AND SAFETY

KMC maintains a health and safety program in accordance with representations made in the license application made to the NRC for the Cushing site. While the unaffected areas subject to this plan have been demonstrated by a characterization survey to be free of contamination by licensed radioactive material, the KMC staff will exercise appropriate health and safety precautions, especially if contamination is discovered during the final survey.

6. SURVEY PLAN AND METHODS

6.1 General

Due to the location and nature of operations at the Cushing site, buildings and land areas in the four unaffected areas are considered non-contaminated. The location, type, and density of samples taken in these four areas will be based on the lack of potential for radioactivity above background. This lack of potential is based on a review of site history and a characterization survey, as discussed in §2.2 herein and in section 2 of the *Cushing Refinery Site, Site Decommissioning Plan*. To the extent that locations of measurements or sampling in support of characterization or other previous surveys have not been disturbed since those earlier surveys, and the radiological status would therefore be unchanged, data from those surveys may also be used as part of or in support of the final radioactivity survey of unaffected areas, depending on their quality.

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[4] USNRC, *Quality Assurance for Radiological Monitoring Programs - Effluent Streams and the Environment*, Regulatory Guide 4.15, 1979.

Table 3. Overview Of Unaffected Areas Survey Activities And Tasks

Activities	Tasks
Evaluate contamination potential	1. Review operating history with respect to site use, etc. 2. Review radioactivity data from scoping and characterization surveys. 3. Identify radionuclides of concern and determine guidelines 4. Classify areas that are *unaffected*
Establish grid reference system	1. Install grids 2. Prepare facility survey maps
Determine background levels	1. Measure indoor exposure rates and ambient beta-gamma radiation levels 2. Measure outdoor exposure rates 3. Collect and analyze background soil samples. 4. Measure background radionuclide concentration in soil.
Perform direct measurements	1. Conduct surface scans 2. Determine frequency and locations of measurements to meet criteria 3. Conduct surface activity measurements on structures 4. Measure exposure rates
Collect samples	1. Determine frequency and locations of sampling to meet criteria 2. Collect random samples
Analyze samples	1. Count smears and swabs. Analyze soil, residue, liquid, and other samples for uranium and thorium activity
Interpret data	1. Convert data to standard units 2. Calculate average levels 3. Compare data with criteria
Prepare report	1. Construct data tables and figures 2. Prepare text 3. Submit report to NRC.

Throughout this plan, the survey activities are generally described in the future tense. However, it should be understood that most activities have already been completed, although the verb tense remains future.

6.2 Instrumentation

Table 4, Instrumentation for Final Radioactivity Survey of Unaffected Areas, lists the instrumentation planned for use in the final radiological survey of unaffected areas, along with applications, typical parameters, and detection sensitivities for the instrumentation.

The minimum detectable activity (MDA) of an instrument is an *a priori* estimate of detection sensitivity. The basic equation for estimating instrument MDA is:

$$MDA = \frac{2.71 + 3.29 \cdot \sqrt{B \cdot (1/t_b + 1/t_s)}}{E \cdot A}$$

where

MDA	=	minimum detectable radioactivity
B	=	background or blank count rate (ct/min)
t_b	=	background count time (min)
t_s	=	sample or source count time (min)
E	=	overall detection efficiency
A	=	volume, mass, or area of sample measured

When $t_b = t_s$, this equation is equivalent to applications of this relationship to several practical radioactivity survey modes presented in NUREG/CR-5849, §5.2.

Sensitivities for field scanning applications are based on movement of the detector over the surface at about 1 detector width per second and the use of audible indicators to sense changes in instrument count rates. Calibration of field instruments will be maintained in accordance with established KMC procedures. Calibration will be appropriate for the radiation energies expected to be present at the site. Operational and background checks will be performed as specified by KMC procedures.

The objective MDA of instruments used to obtain final survey measurements is 25% or less of the stated limit for structures and less than 75% of the stated limit for land and outdoor pavement.

6.3 Survey Plan

6.3.1 Area Classification

For purposes of establishing the sampling and measurement frequency and pattern, each of the four unaffected areas will be considered a survey unit. These areas are also shown in Figure 2, a scale drawing of the site. Each building, remnant foundation, or oil storage tank within the four unaffected areas will also be a separate survey unit.

Certain surfaces will not be surveyed because there has been no opportunity for them to become contaminated with licensed radioactive material. While exterior surfaces of oil storage tanks will be

TABLE 4

RADIATION MONITORING INSTRUMENTS

INSTRUMENT TYPE	NUMBER AVAILABLE	RADIATION DETECTED	SCALE RANGE	MDA
Micro-R Meter	2	Gamma	1 - 5,000 μR/hr	2 μR/hr
Ion Chamber	1	Gamma	0.1 - 300 mR/hr	0.2 mR/hr
3" x 1/2"NaI Scintillator	2	Gamma	0 to 500,000 cpm	500 cpm
435 cm^2 Gas Flow Digital Scaler	1	Alpha-Beta, Gamma	0 - 500,000 cpm	30 dpm/100 cm^2
100 cm^2 Gas Flow Digital Scaler	1	Alpha-Beta, Gamma	0 - 500,000 cpm	150 dpm/100 cm^2
60 cm^2 Gas Flow Digital Scaler	1	Alpha-Beta, Gamma	0 - 500,000 cpm	300 dpm/100 cm^2
60 cm^2 Count Rate Meter	3	Alpha	0 - 500,000 cpm	350 dpm/100 cm^2
60 cm^2 Personnel Room Monitor	1	Alpha	0 - 50,000 cpm	350 dpm/100 cm^2
2" Slide Drawer Counter	1	Alpha	0 - 500,000 cpm	1 dpm
Pressurized Ion Chamber	1	Gamma	0 - 100 mR/hr	~ 3μR/hr Δ0.5 μR/hr @ 10 min count
Computer-Based Auto Sample Counter Tennelec LB5100W	1	Alpha-Beta	0 - 99,999,999 cpm	1 dpm
Computer-Based Multichannel Analyzer- NaI Well Counter	1	Gamma Spectrum		Being evaluated

surveyed, interior surfaces will not. Structures, including two caustic storage sheds and the cable television receiving station, that were constructed on the four unaffected areas within the past ten years, long after cessation of licensed material processing, have had no reasonable cause to be contaminated and thus will not be surveyed.

6.3.2 Reference Grids

Outdoor area grids will be established for the purpose of referencing locations for measurements and sampling. Building surfaces will not be gridded; measurements of these surfaces will be referenced to other grid systems or to prominent building features.

Outdoor areas will be gridded at 10 m intervals. The grid system is identical to the one used during the characterization survey for the entire site. Where necessary, the previous grid system will be reestablished, expanded, subdivided, or otherwise modified to meet specific topographic conditions and survey requirements.

The four unaffected areas, each of which comprises a survey unit, are of a size to assure a minimum of 30 measurement locations each for outside areas. Each building in an unaffected area will be considered a separate survey unit, independent of the unaffected outside area in which it is located.

In the event a discrete location in an unaffected area is confirmed by scans, direct measurements, or sampling as exceeding 0.75 of the stated limit, four or more contiguous grid elements incorporating the discrete location,[5] but not exceeding the survey unit in area, will be reclassified as an *affected area*. Any such *affected* area would be excluded from unrestricted release under this plan and would become subject to the *Site Decommissioning Plan*.

6.3.3 Surface Scans

Scanning of surfaces will be performed according to the following protocol:

Unaffected Area Surfaces:

- Building interior: at least 10% of floor and wall surfaces up to 2 m above the floor (none on interior building surfaces more than 2 m above the floor) will be scanned for alpha and or beta-gamma radiations.
- Building exterior: at least 10% of wall surfaces up to 2 m above the ground will be scanned for alpha and or beta-gamma radiation.
- Pavement: at least 10% of the surface will be scanned for beta-gamma radiation.
- Land: at least 10% of the surface will be scanned for gamma radiation.

Instrumentation for scanning is listed in Table 4. The instruments having the greatest detection sensitivity will be used for scanning as physical surface conditions and measurement locations permit.

Scanning speeds will be approximately 1 detector width per second for alpha and beta detection instruments, and about 0.5 m per second for gamma detection instruments. When appropriate to use,

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5 10 x 10 m for an outdoor area; 1 m^2 on a building surface; or 10 m^2 for indoor exposure rate.

audible indicators, either headphones or speakers, will be used to identify locations having levels of direct radiation more than about 2 times higher than ambient. All scanning results will be noted on standard field record forms; locations of higher than ambient radiation will be identified for subsequent investigation.

6.3.4 Surface Contamination Measurements

Direct Measurements. Direct measurements of alpha and or beta-gamma surface contamination will be performed at selected locations using instrumentation described in Table 4. The instrument type having the greatest detection sensitivity will be used for surface contamination measurements as physical surface conditions and measurement locations permit. For instruments so equipped and calibrated, measurements will be conducted by integrating counts over a 1 minute period. When a ratemeter type of instrument is used, the count averaging time should be about twice the time constant of the instrument.

On building surfaces and pavement in unaffected areas, 30 random or systematic measurements will be performed for each survey unit. On the small buildings involved, this is much greater than an average of 1 measurement location per 50 m^2 of surface area. These locations will include all building surfaces up to 2 m above the floor.

Removable Contamination Measurements. Smears to detect removable surface contamination will be collected at locations in buildings where direct measurements are performed.

5.3.5 Exposure Rate Measurements

Gamma radiation exposure rates will be measured at 1 m above ground and floor surfaces using a pressurized ion chamber instrument, or a gamma scintillation instrument or micro-R meter calibrated against the pressurized ion chamber instrument. Measurements will be spaced according to the following protocol:

Building Interiors

Unaffected Areas: $\geq$ 1 measurement per 200 m^2

Outside Areas

Unaffected Areas: $\geq$ 30 measurements at randomly selected locations in each of the four land area survey units.

6.3.6 Soil Sampling

Surface. At least 30 samples of surface soil, about 0 to 15 cm deep, will be obtained from random locations on land in each survey unit of unaffected areas. Random locations may be randomly chosen nodes of a 10 x 10 m grid.

6.4 Background Level Determinations

Background radiation exposure rates and concentrations of uranium and thorium in soil will be determined for outdoor areas by taking a minimum of 10 measurements and samples at appropriate locations within a 2 km radius of the site. Background radiation exposure rates will be determined for

building interiors by taking a minimum of 10 measurements at locations of similar construction, when available. Gamma radiation exposure rates will be measured at 1 m above ground and floor surfaces using a pressurized ion chamber instrument, or a gamma scintillation instrument or micro-R meter calibrated against the pressurized ion chamber instrument.

Results of background radiation exposure rates and concentrations of uranium and thorium in soil will be evaluated to assure that the averages determined are representative of the true averages. The background data will be tested to assure that the average represents the true mean to within ±20% at the 95% confidence level. If necessary, additional measurements or sampling will be performed to satisfy the criteria. The total number of background measurements needed to satisfy the objective will be calculated by:

$$n_b = [(t_{95.5\%,df} \cdot s_x) \div (0.2 \cdot x_b)]^2$$

where n_b = number of background measurements required
x_b = mean of initial background measurements
s_x = standard deviation of initial background measurements
$t_{95\%,df}$ = t statistic for 95% confidence at df = n-1 degrees of freedom, where n is the number of initial background data points

Table 5 contains a list of values for the $t_{95\%}$ statistic at various degrees of freedom.[6] Subtracting the number of data points already collected (n) from the total calculated number (n_b) will determine the number of additional measurements or samples that will be required to demonstrate the desired confidence of the data. If this calculation indicates that additional background data are needed, they will be collected using the same sampling or measurement protocol as that used for the original sampling or measurement. The average background will then be recalculated using all data points.

6.5 Sample Analysis

Smears and swabs collected for removable contamination will be analyzed for gross alpha and gross beta activity. Soil and other large volume samples will be analyzed for thorium, U^{235}, and U^{238} by gamma spectrometry; total uranium will be calculated on the basis of previously determined average specific activity ratios for the site.

Laboratory chain-of-custody procedures will be observed for all samples analyzed.

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6 NUREG/CR-5849, Table B-1.

Table 5. T-test Factors for Comparing a Survey Data Set and Its Limit

Degrees of Freedom	t_{95}	Degrees of Freedom	t_{95}
1	6.314	19	1.729
2	2.920	20	1.725
3	2.353	21	1.721
4	2.132	22	1.717
5	2.015	23	1.714
6	1.943	24	1.711
7	1.895	25	1.708
8	1.860	26	1.706
9	1.833	27	1.703
10	1.812	28	1.701
11	1.796	29	1.699
12	1.782	30	1.697
13	1.771	40	1.684
14	1.761	60	1.671
15	1.753	120	1.658
16	1.746	400	1.649
17	1.740	∞	1.645
18	1.734		

Degrees of freedom is the number of items of data minus 1. For values of degrees of freedom not in the table, interpolate between values listed.

7. DATA INTERPRETATION

Measurement data will be converted to units of dpm/100 cm^2 (surface contamination), µR/hr (radiation exposure rates), and pCi/g (soil concentrations) for comparison with release limits. Net measurements, i.e., after subtraction of background, will be used for the comparisons.

Individual measurements and soil sample concentrations will be compared with discrete-spot criteria.

In the event radioactivity elevated above the stated release limit is measured, weighted average values for surface contamination, radiation exposure rates, and soil concentrations will be determined using the following equation:[7]

[7] In the event a data set obeys the lognormal distribution, lognormal statistics may be invoked for statistical analysis.

$$x_w = \frac{1}{n_s} \frac{\sum A_i \cdot x_i}{\sum A_i}$$

where x_w = weighted mean including elevated area(s)

x_i = activity represented by systematic and random measurements in both elevated and non-elevated area portions of the total measurement area

A_i = area *i* associated with measurement *i*

n_s = number of systematic and random measurements

This is equivalent to equation 8-16 in report NUREG/CR-5849.

When averaged over a survey unit, values for surface contamination, radiation exposure rates, or soil concentrations, as specified in Section 3.1, Survey Objectives, the average will be determined using the following equation:

$$x_w = \frac{\sum x_i}{n_s}$$

The averages will be tested to determine whether the data for each survey unit provide a 95% confidence that the true mean levels meet the stated limits. The data will be tested using the following equation:

$$\mu_\alpha = x_w + t_{1-\alpha,df} \cdot \frac{s_x}{\sqrt{n}}$$

where $t_{1-\alpha,df}$ = 95% confidence level factor obtained from Table 5; df is n-1; α is the false probability (the probability that μ_α is less than the stated limit if the true mean activity level is equal to the guideline level)

x_w = calculated mean

s_x = standard deviation

n = number of individual points used to determine x and s_x

The value of μ_α will be compared to the stated limit. If μ_α is less than the stated limit, the data being tested meet the guideline at a 95% confidence level.

In the event remediation and/or further sampling and measurement is performed where a stated limit was not met or was not demonstrated to the specified level of confidence, computations and comparisons will be repeated as necessary.

8. REPORT

A report describing the findings of the final radioactivity survey of the unaffected areas will be prepared and submitted to the NRC. Report format and content will generally follow the recommendations contained in the NRC's *Manual for Conducting Radiological Surveys in Support of*

License Termination.[8] Data will be summarized in tables and figures. Measurement and sampling locations will be shown on scale drawings.

All field and analytical data, including procedures and instrument calibration certificates used in the survey, will be archived by Kerr-McGee Corporation until such time as the NRC agrees that they may be disposed of or until the license is terminated.

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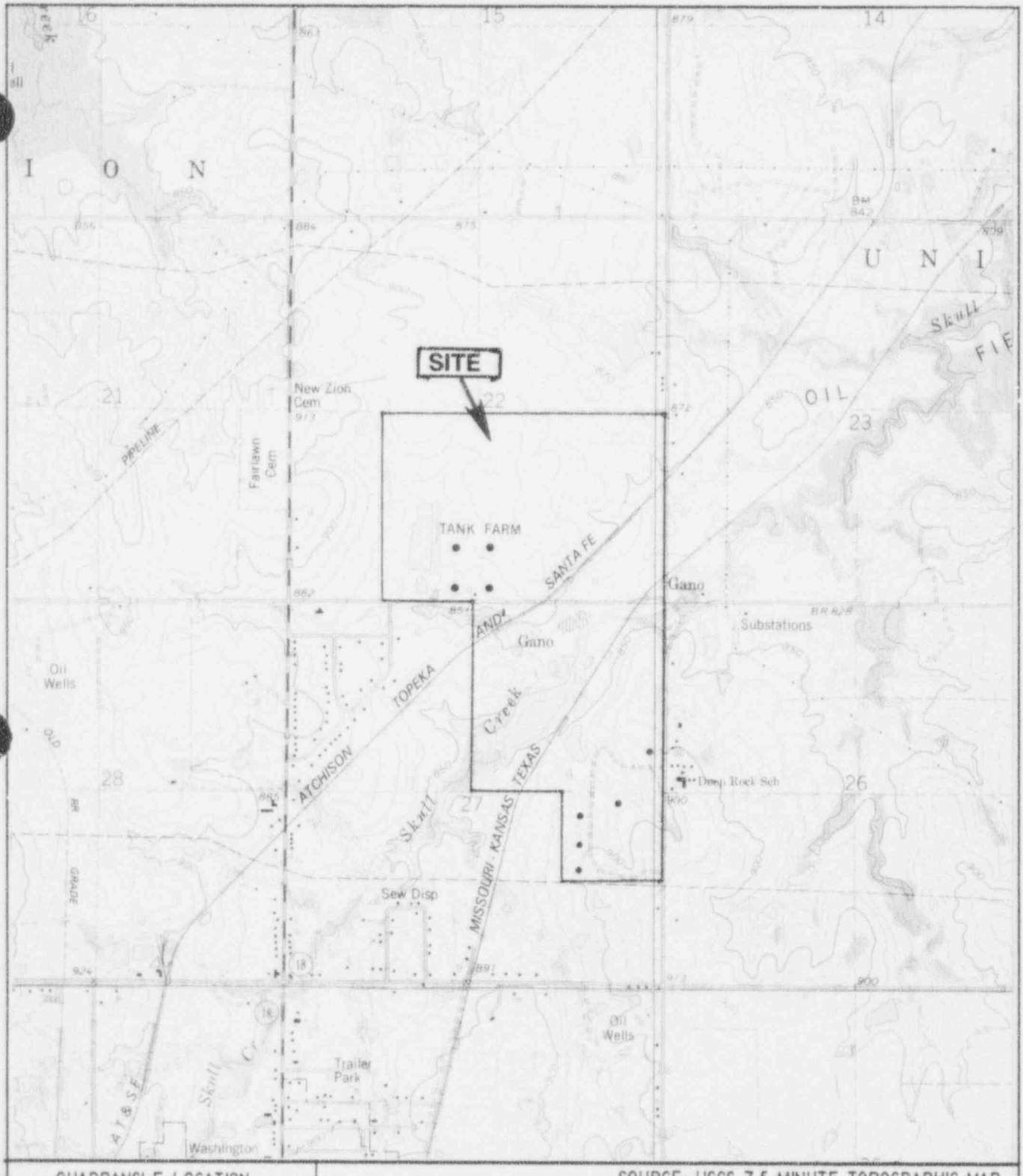
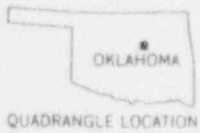
8 NUREG/CR-5849.



QUADRANGLE LOCATION



QUADRANGLE LOCATION

LEGEND

N

0 2000 FT

SCALE

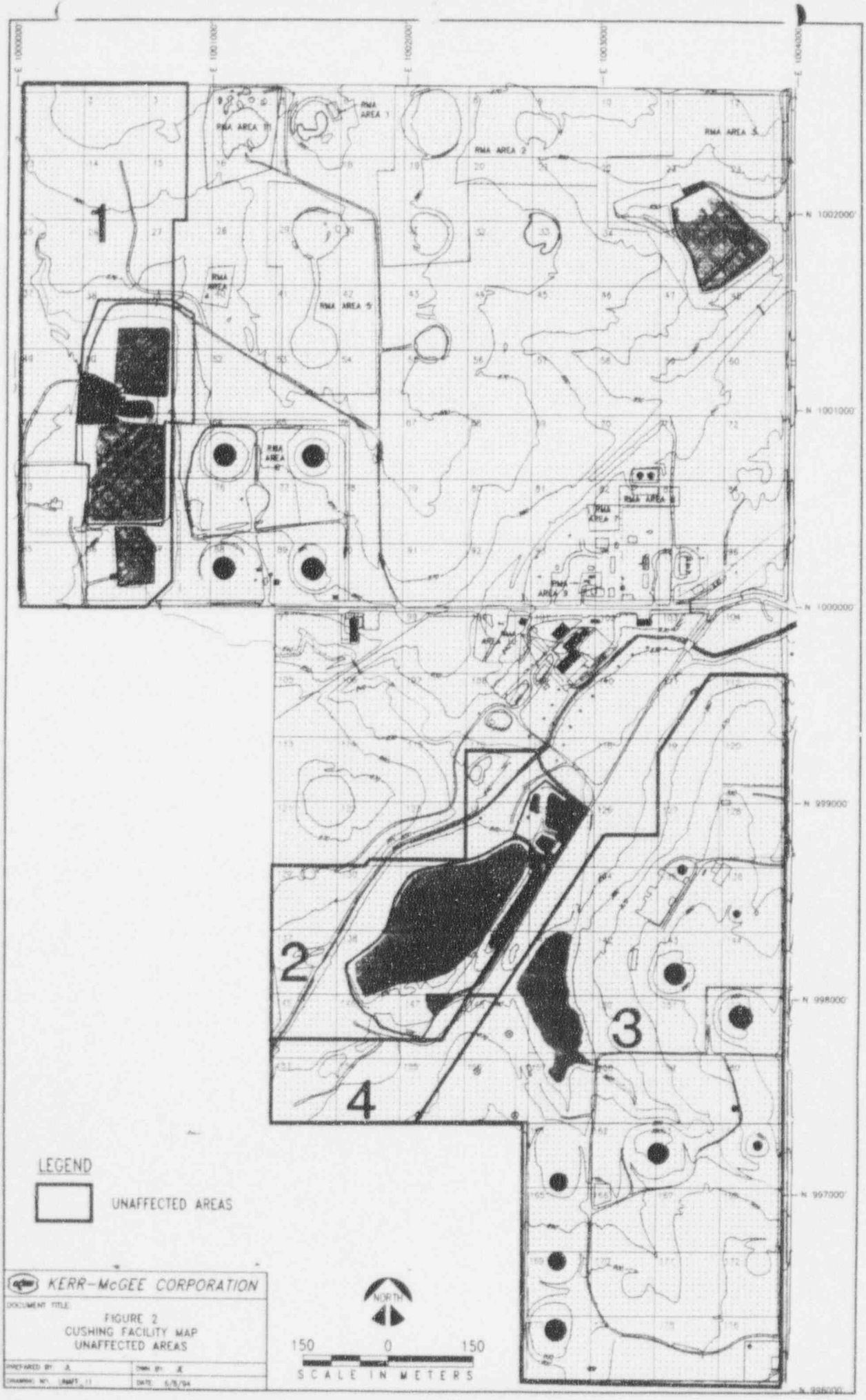
SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC MAP

FIGURE 1: GEOGRAPHY IN THE VICINITY OF THE CUSHING SITE

KERR-McGEE CORP. HYDROLOGY DEPT.

KERR-McGEE CORPORATION
CUSHING, OK

MAP DATE: 6/94 | DRAWN BY: KB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E 1002000'
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N 1001000'
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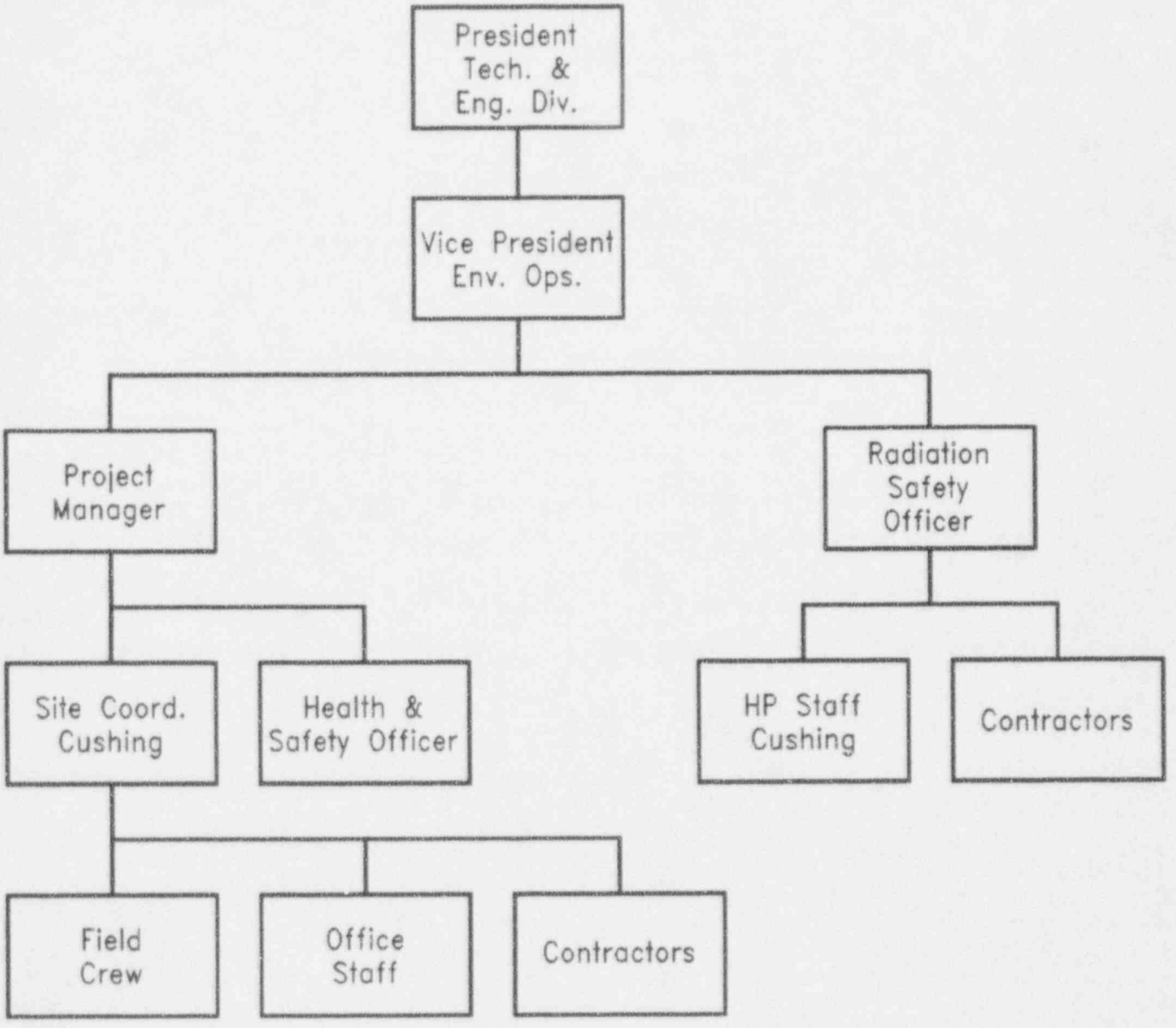
N 999000'
N 998000'
N 997000'
RMA AREA 1
RMA AREA 2
RMA AREA 3
RMA AREA 4
RMA AREA 5
RMA AREA 6
RMA AREA 7
RMA AREA 8
RMA AREA 9
RMA AREA 10
1
2
3
4
LEGEND
UNAFFECTED AREAS
KERR-McGEE CORPORATION
DOCUMENT TITLE:
FIGURE 2
CUSHING FACILITY MAP
UNAFFECTED AREAS
PREPARED BY: JK
DRWN BY: JK
DRAWING NO.: RMAP_11
DATE: 5/5/94
NORTH
150 0 150
SCALE IN METERS

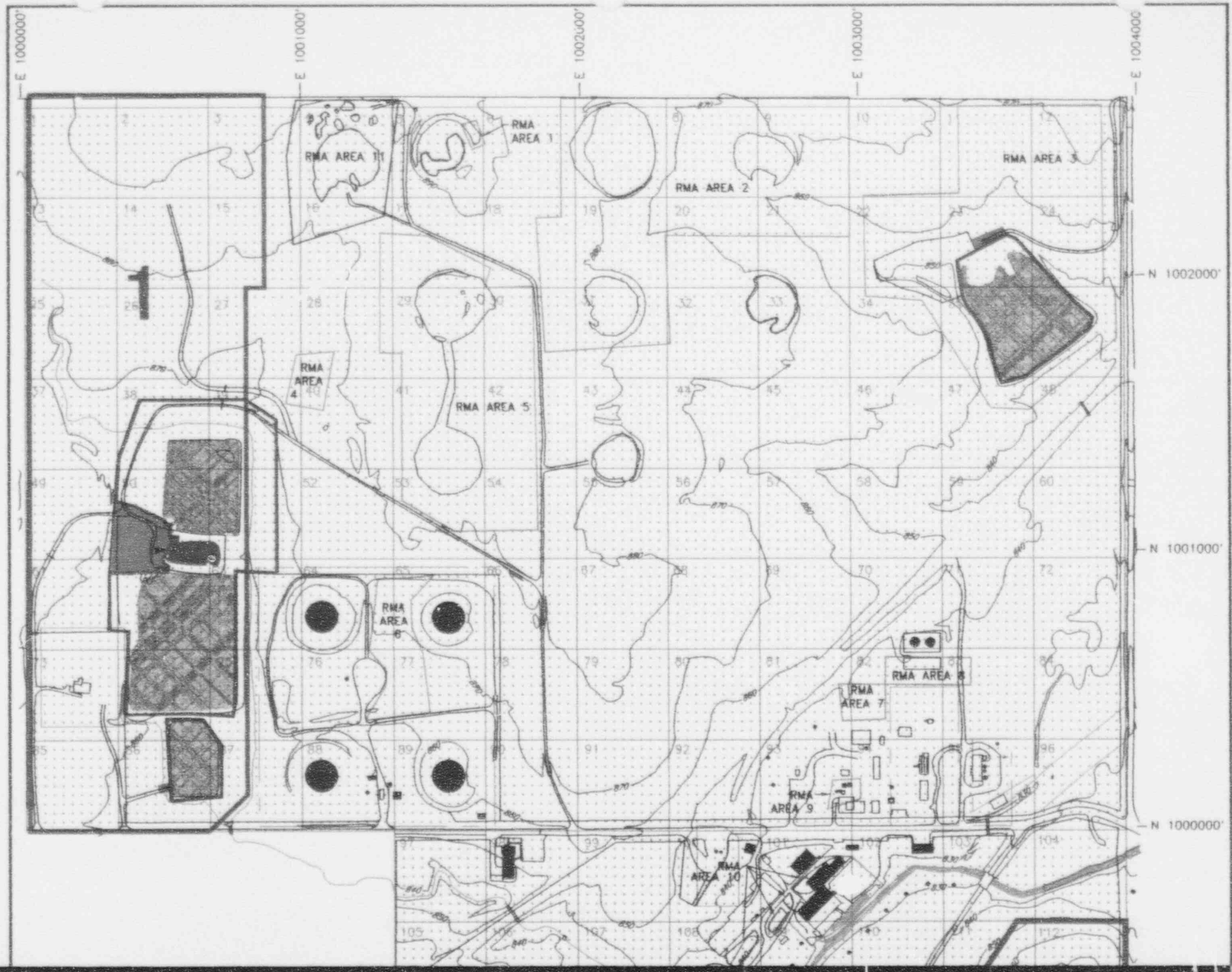


KERR-McGEE CORPORATION

DOCUMENT TITLE:

FIGURE 3
CUSHING REFINERY SITE
DECOMMISSIONING PLAN
ORGANIZATIONAL CHART

PREPARED BY: JL	DWN BY: JE
DRAWING NO. ORG_CHT	DATE: 6/8/94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E 1001000'
E 1002000'
E 1003000'
E 1004000'
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RMA AREA 1
RMA AREA 11
RMA AREA 2
RMA AREA 3
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RMA AREA 5
RMA AREA 6
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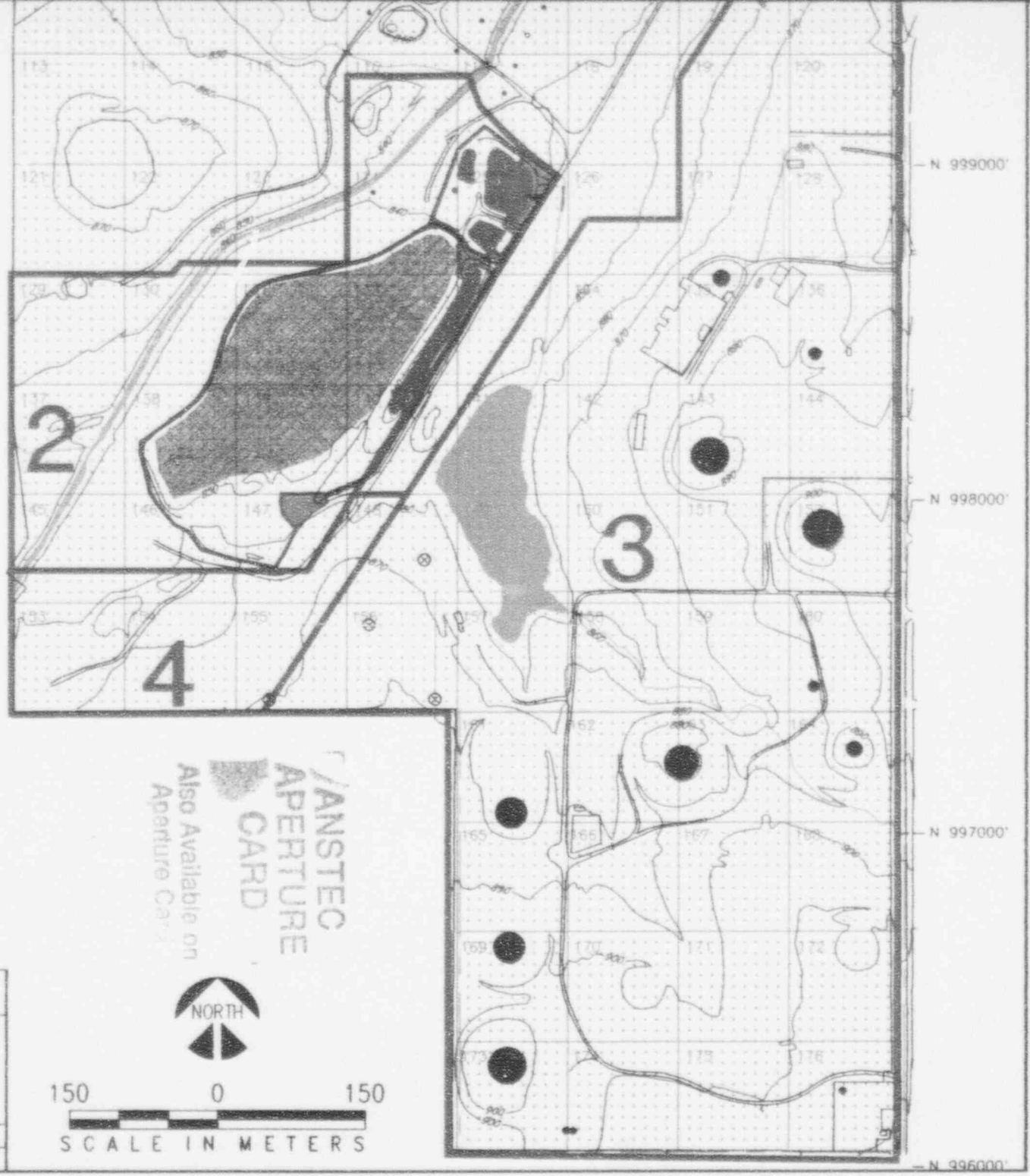
1



LEGEND

UNAFFECTED AREAS

NORTH

150 0 150

SCALE IN METERS

KERR-McGEE CORPORATION

DOCUMENT TITLE:

FIGURE 2
CUSHING FACILITY MAP
UNAFFECTED AREAS

PREPARED BY: JL	DWN BY: JE
DRAWING NO: UNAFF_11	DATE: 6/8/94