KERR-McGEE CORPORATION
CIMARRON FACILITY

RADIOLOGICAL CHARACTERIZATION REPORT FOR ASPHALT MATERIAL – URANIUM YARD AREA

LICENSE NO:SNM-928
DOCKET NO:70-0925

JANUARY, 1998

CIMARRON CORPORATION
OKLAHOMA CITY, OKLAHOMA

Radiological Characterization Report For Asphalt Material - Uranium Yard Area Review

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S. JESS LARSEN
VICE PRESIDENT

January 23, 1998

Mr. Ken Kalman, Project Manager
Facilities Decommissioning Section
Low-Level Waste & Decommissioning Projects Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: Docket No. 70-925; License SNM-928
Radiological Characterization report for Asphalt Material - Uranium Yard Area

Dear Mr. Kalman:

Your letter dated August 27, 1997 requested that Cimarron Corporation "...submit, for our approval, a final survey plan for the asphalt which is consistent with Draft NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination". Cimarron Corporation previously submitted this final survey plan for the asphalt titled "Radiological Characterization of Asphalt Material - Uranium Yard Area" via letter dated October 17, 1997.

*Your letter dated November 7, 1997 provided NRC staff comments to Cimarron Corporation regarding this final survey plan for the asphalt. Cimarron Corporation responded to the NRC staff comments in the letter dated December 24, 1997 and indicated that "The Radiological Characterization Report for Asphalt Material" would be submitted in the near future, after receipt of final laboratory confirmation sample results.

The purpose of this letter is to provide the above-referenced report to the NRC. Please find attached two (2) copies of this report for your review and approval. One(1) copy of this report has been submitted to the NRC Docket, and one(1) copy has been provided to Louis Carson at NRC, Region IV.

Please feel free to contact me if there are any additional questions or concerns.

Sincerely,

Jess Larsen

Jess Larsen
Vice President

Enclosures

* NRC did not specify number and location of samples

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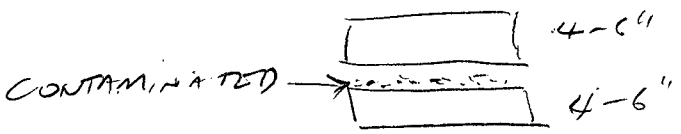

4-6"
CONTAMINATED
4'-6"

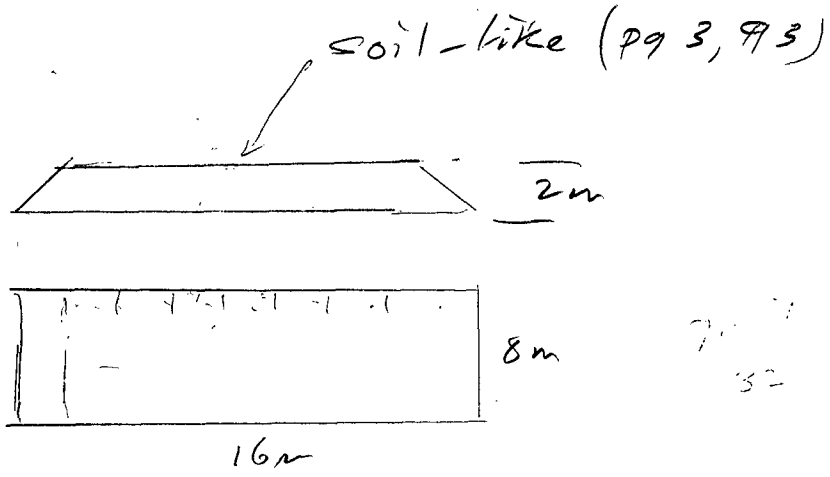
1.0 Introduction

The purpose of this report is to present the characterization data for the asphalt material stockpile as requested in the NRC staff letter dated August 27, 1997. Cimarron Corporation has characterized the Phase III U-Plant Yard stockpiled asphalt materials in accordance with the "impacted soils" guidance contained in Draft NUREG/CR-5849. This characterization approach has been utilized previously by Cimarron Corporation for characterizing stockpiles of BTP Option #2 soils (5-meter x 5-meter grid) prior to placement in the on-site disposal cell.

Cimarron Corporation has been stockpiling asphalt pavement in the Phase III, Sub-Area K, U-Plant Yard Area over the last 20 years. The majority of the asphalt pavement materials were placed in the asphalt stockpile prior to the issuance of Draft NUREG/CR-5849. The asphalt pavement surfaces were surveyed prior to their excavation and stockpiling as part of the facility's remediation and survey program.

Based upon these initial surface surveys, contaminated asphalt which did not meet the NRC's unconditional release criteria (Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source and Special Nuclear Material, July, 1982) was removed, packaged and shipped off-site to an authorized LLRW disposal facility. Asphalt pavement surfaces, which met the NRC's unconditional release criteria for surface contamination, were removed over this 20-year time period in order to gain access to contaminated soils located beneath the asphalt. As the asphalt materials were removed, they were stockpiled in one location within the Uranium Yard Area for future final characterization.

The excavated asphalt typically averaged approximately 4 to 6 inches in thickness at several locations on-site and consisted of multiple re-paving layers that were placed during facility operations. After the surface surveys were performed, the asphalt materials were excavated by bobcat and/or front-end loader. Subsequent surveys performed on the asphalt stockpile indicated that there was a potential for residual contamination to be located between the layers. Unsuccessful attempts were made to separate the layers such that surface surveys could be performed to accurately characterize the asphalt. Therefore, the asphalt stockpile was crushed into a soil-like material and was then characterized via sampling to depth utilizing a 2-meter x 2-meter grid that is consistent with Draft NUREG/CR-5849. The results of this characterization effort, as detailed in this report, demonstrate that the asphalt material meets the BTP Option #1 criteria (i.e. ≤ 30 pCi/g total uranium).



2 X 32, 2m x 4m
grid blocks

2.0 Description of Asphalt Stockpile

The crushed asphalt stockpile has a volume of approximately 8,000 cubic feet and is located in the Uranium Building Yard Area. The dimensions of the stockpile are approximately 16 meters by 8 meters with the center of the stockpile having a maximum depth of 2 meters. The side-slopes were tapered to allow for access and to prevent slumping.

3.0 Characterization Data

3.1 Data Generation

The surface of the asphalt stockpile was leveled and the side-slopes were tapered in order to facilitate surveying and sampling. This stockpile was subdivided utilizing a 2-meter x 2-meter grid system, which was tied directly to an established survey reference point at the site. The asphalt stockpile was then surveyed using a micro-R survey meter at the surface and at a height of one meter above the surface. A 3" x 0.5" shielded NaI detector survey was also performed at the surface of the asphalt stockpile. Boreholes were then drilled on 2-meter x 2-meter grid intersect points to obtain core samples through the entire depth of the asphalt material which represented a maximum depth of 2 meters. Core samples of the asphalt material were collected and composited over each one-meter interval at each grid location throughout the depth of the stockpile. The composited (one-meter) core samples were then analyzed utilizing the Cimarron Soil Counting System. Split samples were also sent to an off-site independent laboratory for confirmatory analysis.

3.2 Data Evaluation

The surface survey and asphalt material sample data and the statistical data analyses and summaries resulting from the characterization effort are provided in Appendix 1. The diagrams depicting the asphalt material stockpile, along with the asphalt material sample analytical results for each grid intersect location, are provided in Appendix 2. A total of 57 asphalt material samples were analyzed for both total uranium and natural thorium. Total uranium concentrations ranged from 22.1 pCi/g to 46.6 pCi/g for the 57 samples with an average concentration of 29.7 pCi/g total uranium and 1 pCi/g total thorium, **including background**.

with the soil counter

The 57 asphalt material sample results were compared to the Option #1 criteria for soils from the 1981 BTP (Branch Technical Position on the Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations, Federal Register, October 23, 1981). Seven (7) samples exceeded 30 pCi/g total uranium after subtracting background and were therefore subjected to the hot-spot averaging criteria (i.e. $(100/A)^{1/2}$ contained in Draft NUREG/CR-5849 (Equation 8-10)).

The hot-spot evaluations for these seven (7) sample locations meet the required BTP Option #1 criteria and are provided in Appendix 3.

4.0 Cimarron Radiation Protection Program

The Cimarron Radiation Protection Program ensures that all employees, visitors and the general public are protected from radiological hazards, which may be present due to licensed activities conducted at the facility. Cimarron Corporation maintains a Radiation Protection Program which meets or exceeds all applicable regulatory requirements associated with the activities conducted under Special Nuclear Materials License SNM-928.

The Cimarron Radiation Protection Program currently in place for all decommissioning activities is administered through the use of the following documents:

- Cimarron Radiation Protection Program
- Cimarron Site Health and Safety Plan
- Cimarron Quality Assurance Plan and Procedures
- Cimarron Emergency Plan

Corporate audits for regulatory and internal requirements are conducted on a periodic basis and include the review of the Cimarron Radiation Protection Program and the associated elements. Assessments of program effectiveness are also performed periodically by the Cimarron Radiation Safety Officer/Health Physics Supervisor. Additionally, the program is inspected for compliance with applicable rules and regulations by NRC Region IV and NRC Headquarters.

4.1 Cimarron Quality Assurance Program

The Cimarron Corporation Quality Assurance Plan and Procedures are an integral part of the Cimarron Radiation Protection Program. A principal component of this program is to affirm the quality of project work performed during decommissioning by assuring that all tasks are performed in an organized manner by qualified personnel. The Program ensures that all samples are collected, controlled and analyzed in accordance with all applicable quality controls such that data accuracy and validity are verifiable. The data generated is compared to the criteria discussed in Sections 1.0 and 3.2 and managed in accordance with approved Cimarron procedures. Such quality controls allow for the independent verification of analysis results by third party review, thereby assuring that all characterization data is accurate and complete.

The Cimarron Quality Assurance Program is implemented and maintained in accordance with written policies, procedures, and instructions. This Quality

Assurance Program is administered under the direction of the Quality Assurance Manager. Periodic audits and reviews are conducted to ensure that all aspects of the Cimarron Quality Assurance Program are addressed. The Cimarron Quality Assurance Program incorporates the applicable requirements of 10 CFR 50, Appendix B and NQA-1.

4.1.1 Sample Chain of Custody

Field data are gathered and maintained in field logs for all samples in accordance with the Cimarron Quality Assurance Program. Necessary data are transferred to the laboratory sample log when the sample is brought to the on-site laboratory for analysis. The sample logs provide a record of sample collection and transport and are placed into the facility quality assurance files at appropriate intervals.

Samples shipped to off-site independent laboratories for analysis are accompanied by a chain of custody form in accordance with the Cimarron Quality Assurance Program. These forms provide documentation of sample handling and are maintained by the Quality Assurance Manager as permanent records.

4.1.2 Verification Samples

Off-site analysis of split samples is an integral part of the Cimarron QA Program. Four (4) samples were selected from the 57 asphalt material stockpile samples and one (1) composite sample representing background asphalt material was obtained (representing approximately 9% of the total number of samples) and sent to an off-site independent laboratory for analysis. These results are provided in Table 6.1.

5.0 Instrumentation

The instrumentation utilized to generate the characterization data discussed in this Report are calibrated and maintained at the Cimarron site in accordance with the associated Radiation Protection Program Procedures. These procedures utilize the guidance contained in ANSI N323-1978, "Radiation Protection Instrumentation Test and Calibration". Specific requirements for instrumentation include traceability of calibrations to NIST standards, field checks for operability, background radioactivity checks, operation of instruments within established environmental bounds (i.e. temperature and pressure), training of individuals, scheduled performance checks, calibration with isotopes of energies similar to those to be measured, quality assurance tests, review of data, and record keeping.

5.1 Survey Instrumentation

Portable survey instruments utilized during the survey (micro-R survey meters, α/β survey meters, dose rate instruments, scalers/ratemeters, etc.) are calibrated on a quarterly or semi-annual basis. All instrumentation utilized to perform final release surveys are calibrated with NIST traceable standards. Where applicable, activities of sources utilized for calibration are corrected for decay. In addition to the quarterly and/or semi-annual calibration requirements, source checks are also required for all instruments being utilized for characterization work on a daily basis. A calibrated electronic pulse generator is utilized for instrument scale linearity checks.

All calibration and source check records are completed, reviewed and retained in accordance with Cimarron Quality Assurance Plan and Procedure requirements.

A Special Work Permit (SWP) was written and approved, along with a work plan, prior to commencement of field work on the asphalt stockpile. The SWP specified the type of instrumentation (discussed further in sections 5.2 through 5.4) to be utilized in performing the surveys by site personnel.

5.2 Shielded 3" x 0.5" NaI Gamma Detector

The 3" x 0.5" detector is a sodium iodide (NaI) crystal gamma detector that is shielded with lead around the top socket and sides to improve the directional sensing capabilities of the equipment. This detector has a range of 0 – 500,000 cpm with a typical MDA (95% confidence level) of 250 cpm. The shielded detector is utilized with a portable scaler/ratemeter that has single channel analyzer capacity. This instrument is normally utilized in areas where background may be elevated, and is utilized for general scanning purposes to detect any potential areas which may require a more detailed or focused survey or sampling effort.

5.3 Micro-R Survey Meter

The Micro-R survey meter is a 1" x 1" NaI/Tl crystal gamma detector and measures exposure rates between 0 and 5,000 μR/h with a typical MDA (95% confidence level) of 7 μR/h. Background readings are obtained daily at a defined location prior to placing each instrument into service. This instrument is utilized, in general, for determination of exposure rates at both systematic and random locations, and at locations of elevated radiation as identified by area scans.

Quarterly comparisons and/or confirmatory measurements are obtained routinely to provide information concerning any measurement bias. These comparisons or confirmatory measurements are made using a pressurized ion chamber.

5.4 Cimarron Soil Counting System (Gamma Spectroscopy)

The Cimarron Soil Counting System consists of a 4" x 4" x 16" sodium iodide crystal housed in a shielded chamber which is computer linked to a multi-channel analyzer (MCA).

Data from the MCA is processed through an analysis program that, in turn, determines the uranium and thorium concentrations in samples. This system is utilized to determine the total uranium present in the sample by calculating the U-234 present from the U-235 value detected in the sample. Additionally, these two values are summed with the detected U-238 value for determining total uranium concentrations. Calibration of this counting system is performed annually and is traceable to NIST standards through contractor laboratory evaluations of the on-site standards.

The NRC has utilized ORISE for the verification of a majority of the decommissioning work completed to date at the Cimarron site. ORISE has conducted an evaluation of the Cimarron Soil Counting system's ability to accurately measure total uranium concentrations in samples. This was done by comparing ORISE sample analysis results obtained by alpha pulse height analysis and gamma spectroscopy with the results obtained from the use of the Cimarron Soil Counting System. ORISE and Cimarron analysis results compared favorably (i.e. Cimarron Soil Counting System results continue to be conservative as discussed in Section 6.0) at levels above background as demonstrated by the most recent confirmatory analysis performed for the On-Site Disposal Cell, Pit #3 (NRC approval letter dated July 31, 1997). NRC Inspection Report #70-925/97-02, which accompanied this letter, states that "no significant bias or statistical errors between the licensee's results and the NRC's results were identified". For uranium Additionally, the confirmatory analysis performed on select samples collected during ORISE's site visit to investigate the South U-Yard and DAP-3 stockpile previously verified that Cimarron's on-site Soil Counting system's results are statistically identical to ORISE's results.

Established quality assurance measures for the Cimarron Soil Counting System include Cesium-137 centroid checks, Chi-square tests, background determinations, and the counting of appropriate standards. All of these quality assurance controls are recorded on control charts and are trended on a continuing basis.

Standards used for calibration and quality assurance checks for the Cimarron Soil Counting System have been analyzed by outside laboratories and are NIST traceable through these analyses. Comparisons have been made between the standards as counted using the Cimarron Soil Counting System and two off-site, independent laboratories. The assigned values for the standards are the average of

the results obtained from the off-site laboratories, when the standards were analyzed by more than one laboratory. The standards range in concentration from 4.5 pCi/g total uranium to 292 pCi/g total uranium.

Cimarron personnel determine uranium and thorium activities based upon the evaluation of net counts from the Cimarron Soil Counting System. Activities are calculated through the use of efficiency and correction factors obtained using appropriate standards. Concentrations are calculated by dividing the net activity by the total mass. Masses are determined on a laboratory scale which is checked on a daily basis (when in use) utilizing NIST traceable standards, and are corrected for moisture content.

6.0 Independent Laboratory Analysis Data Comparison

B1, B2, B3

A

One (1) composite sample of the asphalt stockpile was obtained prior to gridding and sampling of the asphalt stockpile. Three (3) samples were selected from the 57 asphalt material stockpile grid area samples. One (1) background composite sample was also obtained from the Phase II Unaffected Parking Lot Area. These samples were sent to an off-site independent laboratory for comparison with the Cimarron Soil Counting System analysis results (representing greater than 8% of the total number of samples). Calibration standards used to check performance of the Cimarron Soil Counting System have also been analyzed by off-site independent laboratories. The independent laboratory analysis results for these five (5) samples (provided in Table 6.1 below) shows that the Cimarron Soil Counting System analysis results continue to be conservative.

Bckg

Conclusion:

Reported as

Table 6.1

	Asphalt Stockpile Sample Location	Asphalt Sample Depth	Independent Laboratory Results (pCi/g) U_E (Includes Background)	Soil Counting System Results (pCi/g) U_E (Includes Background)
			22.7 w/o enriched	2.7 w/o enriched
NO. of samples				
A	Asphalt Stockpile Composite Sample	0-2 Meters	27.9 ± 4.0	31.6 ± 1.6
B1	85 E - 100 N	0-1 Meters	47.6 ± 4.1	46.6 ± 1.6
B2	87 E - 100 N	0-1 Meters	30.2 ± 5.1	38.3 ± 1.5
B3	89 E - 100 N	1-2 Meters	19.4 ± 4.1	26.7 ± 1.6
	Asphalt	Asphalt BCKG	BCKG	
BCKG 5 Asphalt	Phase II Unaffected Parking Lot Area Composite Sample (Background Sample)	0-6 Inches	* 1.3 ± 0.8 * 2.5 ± 1.7 U_{NAT} (same sample counted twice)	6.0 ± 1.6 4.9 ± 1.6 U_{NAT} (same sample counted twice)

Uranium + BCKG Asphalt

+ BCKG Asphalt

7.0 Cimarron Site Background Levels

Soil BCKG! Natural background concentrations for uranium U_{NAT} in soil have been established through numerous measurements by Cimarron personnel utilizing the Cimarron Soil Counting System and through independent laboratory analysis. Analytical results from Cimarron Corporation's environmental sampling program are reported to the NRC annually in Environmental Reports. These reports provide sample analysis results for soil samples collected from numerous off-site locations which are representative of background in surrounding soils.

Cimarron personnel collected and analyzed 30 surface soil samples from the perimeter of the Cimarron site during the first quarter of 1995 (IN 1995) to further validate background levels. These results are discussed in Cimarron Corporation's response to the NRC dated June 21, 1995., which was related to the release of the South U-Yard Area for backfill. Total uranium ranged from 2.3 pCi/g to 6.6 pCi/g, with the average being * 4.0 ± 2.6 (2σ) pCi/g. U_E These values were obtained using the Cimarron Soil Counting System. The Cimarron Soil Counting System is calibrated to assume an enrichment of 2.7 weight percent as this is the average enrichment found throughout the site. When a correction factor of (0.67/1.5) is applied to these results to convert the values from an assumed 2.7 weight percent enrichment to a natural enrichment, the converted results ranged from 1.0 pCi/g to

Soil counter reads: 4.0 pCi/gm | 2.7 w/o enriched

or

$4.0 \times \frac{0.67\ U_{nat}}{1.5\ U_{2.7}}$ 1.8 pCi/gm | equivalent of Unatural

equivalent

2.9 pCi/g, with an average of 1.8 ± 1.0 (2σ) pCi/g total Natural uranium. Based upon these results, the average value of 4 pCi/g total uranium for background was used when the soil sample analytical results were compared to guideline values. For enriched U

2.7% enriched

Asphalt Bckg

Results for the Phase II Unaffected Parking Lot Area Composite Asphalt Sample — IN 1998 (provided in Table 6.1 above) reveal similar concentrations as compared to background soil concentrations found at the Cimarron site. The average background value of 4 pCi/g total uranium [for soil (as determined by the Cimarron Soil Counting System)] is conservative as compared to the soil counter range of 4.9-6.0 pCi/g total uranium [for the Phase II Unaffected Parking Lot Area Composite Sample.] Therefore, the value of 4 pCi/g total uranium was also utilized as the background value for the asphalt material. Asphalt

IN soil

WR Soil

Background exposure rates have been established at the Cimarron site by taking micro-R and pressurized ion chamber (PIC) readings at off-site sample locations in addition to Cimarron site areas which are unaffected by past operations. Site background exposure rates of approximately 7 μR/h have been observed in background areas by Cimarron personnel using a Ludlum micro-R survey meter, and have been used in past reports to the NRC. Site background exposure rates of approximately 7 μR/h have also been determined by ORISE personnel utilizing similar instrumentation. In addition, site background exposure rates were measured in 1991 by ORAU (now ORISE) personnel utilizing a PIC, and were determined to be 9 to 10 μR/h (ORAU Final Report, "Confirmatory Survey of the Cimarron Corporation Mixed Oxide Fuel Fabrication Plant", January, 1991). Based on the PIC measurements, the site background was determined to be approximately 10 μR/h. Thus, depending upon instrumentation utilized, the background exposure rate at the Cimarron site ranges from 7 to 10 μR/h. As Cimarron utilizes a Ludlum micro-R survey meter, 7 μR/h represents average background.

Cimarron personnel performed exposure rate measurements at background locations in Subarea "F" in 1995 using a Micro-R meter. Confirmatory measurements were obtained at the same locations in 1997 using a Reuter-Stokes PIC. These data are tabulated below in Table 7.1. The average background as measured using the Micro-R meter was 7.6 ± 1.3 μR/h (2σ), and is about 15 percent less than the average for the PIC measurements of 9.0 ± 1.1 μR/h (2σ). These differences are not significant and indicate good agreement between the micro-R measurements and the PIC measurements. Cimarron will continue the use of 7 μR/h as representative of background exposure rates for micro-R measurements in accordance with previous reports.

Soil counter values:

1998 Asphalt Bckg: 5 - 9 $\frac{pCi}{g_{asphalt}}$

1995 Soil Bckg: 4 $\frac{pCi}{g_{soil}}$ | equivalent 1.8 $\frac{pCi}{g_{soil}}$ U_{NAT}

Soil counter

Table 7.1

Sample ID No.	Grid Location	Micro-R Reading (μR/h)	PIC Reading (μR/h)
UAF-BKG-1	819W-81N	9	9.8
UAF-BKG-7	1600E-120N	7	7.6
UAF-BKG-11	840W-700S	8	9.5
UAF-BKG-13	840W-288S	9	9.8
UAF-BKG-16	808W-282S	8	9.7
UAF-BKG-19	640W-700S	9	10.5
UAF-BKG-23	1610E-300S	5	7.8
UAF-BKG-25	1610E-69N	6	7.6
UAF-BKG-27	1610E-469N	7	7.8
UAF-BKG-28	1610E-634N	8	9.6
	Average	7.6 ± 1.3	9.0 ± 1.1

8.0 Training

Cimarron Corporation provides continuing training for all Cimarron personnel and any other personnel (i.e., contractors, visitors, etc.) who are allowed access to the Cimarron site. All personnel associated with the characterization of the asphalt stockpile were trained on the project work plan and the associated special work permit(s), which included all survey and sampling procedures, as well as all the associated quality assurance requirements.

9.0 Conclusion

Cimarron Corporation performed and completed the characterization of the asphalt material stockpile in accordance with Draft NUREG/CR-5849. This characterization effort was very similar to the characterization performed on numerous stockpiles of Option 2 materials which were approved for on-site disposal by the NRC.

However, Cimarron Corporation performed the characterization of the asphalt material stockpile on a 2-meter x 2-meter grid system, which is much more conservative than a 5-meter x 5-meter grid system as recommended by Draft NUREG/CR-5849.

The average asphalt concentration after subtraction of background was 25.7 pCi/g total uranium. However, after subtracting background, seven (7) asphalt samples

out of a total of 57 asphalt samples exceeded 30 pCi/g total uranium. These seven (7) asphalt samples were therefore subjected to the "hot-spot" averaging criteria evaluation (i.e. $(100/A)^{1/2}$ contained in Draft NUREG/CR-5849 (Equation 8-10)) and all seven (7) asphalt samples met the "hot-spot" averaging criteria (see Appendix 3). Therefore, the characterization of the asphalt material stockpile in accordance with Draft NUREG/CR-5849 demonstrates that the asphalt material contained within the stockpile meets the BTP Option #1 criteria for unrestricted release (i.e. ≤ 30 pCi/g total uranium above background).

No restrictions on burial methods exist for BTP Option #1 concentrations as stated in the 1981 BTP: "1. Disposal of acceptably low concentrations (which meet EPA cleanup standards) of natural thorium, with daughters in secular equilibrium, depleted or enriched uranium, and uranium ores with daughters in secular equilibrium with no restriction on burial method." Therefore, the asphalt materials could be utilized on-site for road construction and/or surface fill.

However, Cimarron Corporation believes it is prudent and conservative to place this asphalt material in the access ramp to the approved Option #2 Disposal Cell. Prior to closure, the ramp area will be separated from the Option #2 Disposal Cell by a compacted clay dike, and then this asphalt material will be placed as backfill material outside of the Option #2 burial area, behind the dike. The asphalt material will then be covered with soil and contoured to the surrounding terrain.

BTP OPTION 1

CIMARRON CORPORATION
CIMARRON FACILITY
ASPHALT STOCKPILE (U-YARD)

Soil counter measures Th(Nat) U enriched in Asphalt

DATE: 1/15/98

LN #	GRID NUMBER	3" DETECT C.P.M.	MICRO R' SURF	MICRO R' 1 METER	0 - 1m Depth Total-U	0 - 1m Depth Th (Nat)	1 - 2m Depth Total-U	1 - 2m Depth Th (Nat)
1	85 E - 100 N	3134	6	6	MAX 46.6	0.5		
2	85 E - 102 N	2806	7	7	34.9	0.5		
3	85 E - 104 N	3100	7	7	33.9	0.5		
4	87 E - 98 N	3354	7	6	26.8	0.4		
5	87 E - 100 N	2742	7	6	38.3	0.5	25.1	0.2
6	87 E - 102 N	2788	7	5	33.5	0.5	29.9	0.4
7	87 E - 104 N	2816	6	6	33.5	0.3	30.4	0.3
8	87 E - 106 N	3306	7	7	26.6	0.2		
9	89 E - 98 N	3248	6	7	24.0	0.4		
10	89 E - 100 N	2830	6	7	36.5	0.7	26.7	0.3
11	89 E - 102 N	3320	6	4	32.9	0.6	23.8	0.5
12	89 E - 104 N	2760	6	5	34.0	0.5	32.2	0.3
13	89 E - 106 N	3268	7	5	26.0	0.2		
14	91 E - 98 N	3100	7	7	MIN 22.1	0.2		
15	91 E - 100 N	2870	5	7	24.9	0.5	32.2	0.3
16	91 E - 102 N	2740	5	5	30.9	0.4	25.7	0.3
17	91 E - 104 N	2630	5	5	33.1	0.5	27.8	0.3
18	91 E - 106 N	3200	7	7	26.7	0.4		
19	93 E - 98 N	3122	7	7	28.5	0.5		
20	93 E - 100 N	2840	6	7	31.3	0.4	22.9	0.2

Sample # 4 pCi/gm U — Th is NOT in Equilibrium — Table is wrong — Karen Morgan 7/19/98

INSTRUMENTS:	RESULTS IN:	BACKGROUND	MDA
LUDLUM MICRO 'R' METER - MODEL 19 S/N 111299	μR/hr	7	7
LUDLUM 2221, SHIELDED 3" X 1/2" NaI DETECTOR S/N 48395	CPM	2750	250
CIMMARON SOIL COUNTER 4" X 4" X 16" NaI DETECTOR	pCi/g	Total U 4.0 / Th(Nat) 1.5	3 / 0.4

Bckg measured w/ soil counter

BACKGROUND NOT SUBTRACTED
PAGE 1
FILE: ASPHSPUY

Karen Morgan

DATE: 1/15/98

Bckg IN asphalt should be used to calculate pCi/gm U in Asphalt

CIMARRON CORPORATION
CIMARRON FACILITY
ASPHALT STOCKPILE (U-YARD)

DATE: 1/15/98

LN #	GRID NUMBER	3" DETECT C.P.M.	MICRO R' SURF	MICRO R' 1 METER	0 - 1m Depth Total-U	0 - 1m Depth Th (Nat)	1 - 2m Depth Total-U	1 - 2m Depth Th (Nat)
1	93 E - 102 N	2880	6	6	29.0	0.4	31.0	0.4
2	93 E - 104 N	2810	5	5	33.4	0.3	26.9	0.3
3	93 E - 106 N	3010	7	6	35.8	0.5		
4	95 E - 98 N	2908	6	7	26.6	0.3		
5	95 E - 100 N	2750	6	6	28.9	0.5	25.8	0.2
6	95 E - 102 N	2680	6	7	30.2	0.2	26.7	0.2
7	95 E - 104 N	2830	7	7	26.1	0.5	29.1	0.3
8	95 E - 106 N	2844	6	6	29.0	0.5		
9	97 E - 98 N	2882	5	7	30.3	0.4		
10	97 E - 100 N	2650	6	6	32.8	0.3	26.8	0.2
11	97 E - 102 N	2720	5	5	29.9	0.4	27.2	0.3
12	97 E - 104 N	2840	5	6	32.8	0.6	31.8	0.1
13	97 E - 106 N	2984	6	6	34.1	0.6		
14	99 E - 100 N	2740	6	6	32.4	0.4		
15	99 E - 102 N	2730	6	7	31.9	0.3		
16	99 E - 104 N	2798	7	7	25.8	0.2		
17	101 E - 100 N	2694	6	7	27.6	0.3		
18	101 E - 102 N	2874	6	6	25.1	0.3		
19	101 E - 104 N	2626	7	6	27.1	0.3		
20								

INSTRUMENTS:	RESULTS IN:	BACKGROUND	MDA
LUDLUM MICRO 'R' METER - MODEL 19 S/N 111299	µR/hr	7	7
LUDLUM 2221, SHIELDED 3" X 1/2" NaI DETECTOR S/N 48395	CPM	2750	250
CIMMARON SOIL COUNTER 4" X 4" X 16" NaI DETECTOR	pCi/g	Total U 4.0 Th(Nat) 1.5	3 0.4

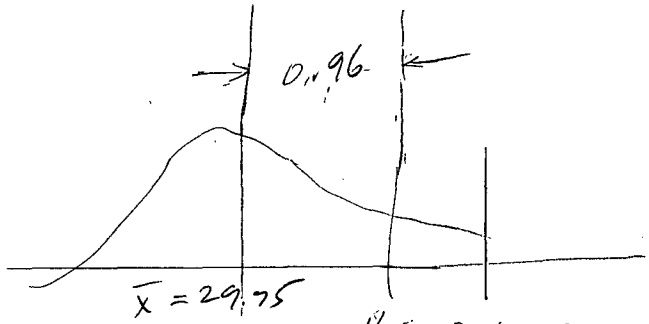
BACKGROUND NOT SUBTRACTED

PAGE 2

FILE: ASPHSPUY

Karen Morgan

DATE: 1/15/98



(sample + Asphalt Bckg)

$$U_\alpha = 29.75 + \underbrace{\left[1.645 \cdot \frac{4.33}{\sqrt{57}}\right]}_{0.96} = 30.71$$

2/23 Kulkarni wants to know:

1. Reasonable?
2. NUREG-5849 approach
3. move to opt #2 Cell

CIMARRON CORPORATION - CIMARRON FACILITY

TRUE MEAN ACTIVITY VS. GUIDELINE VALUE AT 95% CONFIDENCE For enriched URANIUM IN SOIL

ASPHALT STOCKPILE (U - YARD) = U^{E} Asphalt + U^{NAT} Bckg in Asphalt

n = pCi/g TOTAL U

Number	n	(n-N)	(n-N)²
1	46.6	16.85	283.89
2	34.9	5.15	26.51
3	33.9	4.15	17.22
4	26.8	-2.95	8.71
5	38.3	8.55	73.09
6	33.5	3.75	14.06
7	33.5	3.75	14.06
8	26.6	-3.15	9.93
9	24.0	-5.75	33.07
10	36.5	6.75	45.55
11	32.9	3.15	9.92
12	34.0	4.25	18.06
13	26.0	-3.75	14.07
14	22.1	-7.65	58.54
15	24.9	-4.85	23.53
16	30.9	1.15	1.32
17	33.1	3.35	11.22
18	26.7	-3.05	9.31
19	28.5	-1.25	1.56
20	31.3	1.55	2.40
21	29.0	-0.75	0.56
22	33.4	3.65	13.32
23	35.8	6.05	36.59
24	26.6	-3.15	9.93
25	28.9	-0.85	0.72
26	30.2	0.45	0.20
27	26.1	-3.65	13.33
28	29.0	-0.75	0.56
29	30.3	0.55	0.30
30	32.8	3.05	9.30
31	29.9	0.15	0.02
32	32.8	3.05	9.30
33	34.1	4.35	18.91
34	32.4	2.65	7.02
35	31.9	2.15	4.62
36	25.8	-3.95	15.61
37	27.6	-2.15	4.63
38	25.1	-4.65	21.63
39	27.1	-2.65	7.03
40	25.1	-4.65	21.63
41	29.9	0.15	0.02
42	30.4	0.65	0.42
43	26.7	-3.05	9.31
44	23.8	-5.95	35.41
45	32.2	2.45	6.00
46	32.2	2.45	6.00
47	25.7	-4.05	16.41
48	27.8	-1.95	3.81
49	22.9	-6.85	46.93
50	31.0	1.25	1.56
51	26.9	-2.85	8.13
52	25.8	-3.95	15.61
53	26.7	-3.05	9.31
54	29.1	-0.65	0.42
55	26.8	-2.95	8.71
56	27.2	-2.55	6.51
57	31.8	2.05	4.20
	1695.8		1050.0
	Sum(n)		Sum(n-N)²

Q why 39 values in App E but 57 here?

No. of Samples (x) : **57**

COUNT TIME: 15 MINUTES

Sample Mean (N) = Sum(n) ÷ (x)

Sample Mean (N) : **29.75**

Standard Deviation (Sd) = SQRT [(n-N)² ÷ (x - 1)]

Standard Deviation: **4.33** N ÷ 16

2 Std Deviations: **8.66** N ÷ 26 *

Degree of Freedom(df) = (x) - 1 Data listed below on Table B-1

(df) = **1.674**

Area's Average Level (Aμ) = (N) + (df) x [(Sd)/SQRT(x)] 0.96

U_{α} : Asphalt

(Aμ) + BACKGROUND = **30.71** pCi/gU TOTAL U (29.75 + 0.96) includes Bckg soil

GUIDELINE VALUE + BACKGROUND: **34.0** pCi/gU TOTAL U = (30 + 4) pCi U_{Nat} / gram soil

U_E + Asphalt

TABLE B - 1

Factors for Comparision of Survey Data with Guidelines

(df)	95%	97.5%	(df)	95%	97.5%
1	6.314	12.706	19	1.729	2.093
2	2.92	4.303	20	1.725	2.086
3	2.353	3.182	21	1.721	2.08
4	2.132	2.776	22	1.717	2.074
5	2.015	2.571	23	1.714	2.069
6	1.943	2.447	24	1.711	2.064
7	1.895	2.365	25	1.708	2.06
8	1.86	2.306	26	1.706	2.056
9	1.833	2.262	27	1.703	2.052
10	1.812	2.228	28	1.701	2.048
11	1.796	2.201	29	1.699	2.045
12	1.782	2.179	30	1.697	2.042
13	1.771	2.16	40	1.684	2.021
14	1.761	2.145	60	1.671	2
15	1.753	2.131	120	1.658	1.98
16	1.746	2.12	400	1.649	1.966
17	1.74	2.11	Infinite	1.645	1.96
18	1.734	2.101			

For values of Degrees of Freedom not listed:

Interpolate between the listed values.

(df) high value(Z)	60	is (B)	1.671	95%
(df) low value(Y)	40	is (A)	1.684	95%
Desired value(df) (X)	56	is calculated as follow:		

EXP[((Ln(B)-Ln(A)) ÷ (Z-Y)) (X-Y) + Ln(A)]

* The (df) value for (X)	56	1.674	95%

3/12/98 Method will be changed to reflect practice in NUREG-5849 where U_{α} is calc with Bckg sub prorated from all sample values + compared to guidelines.

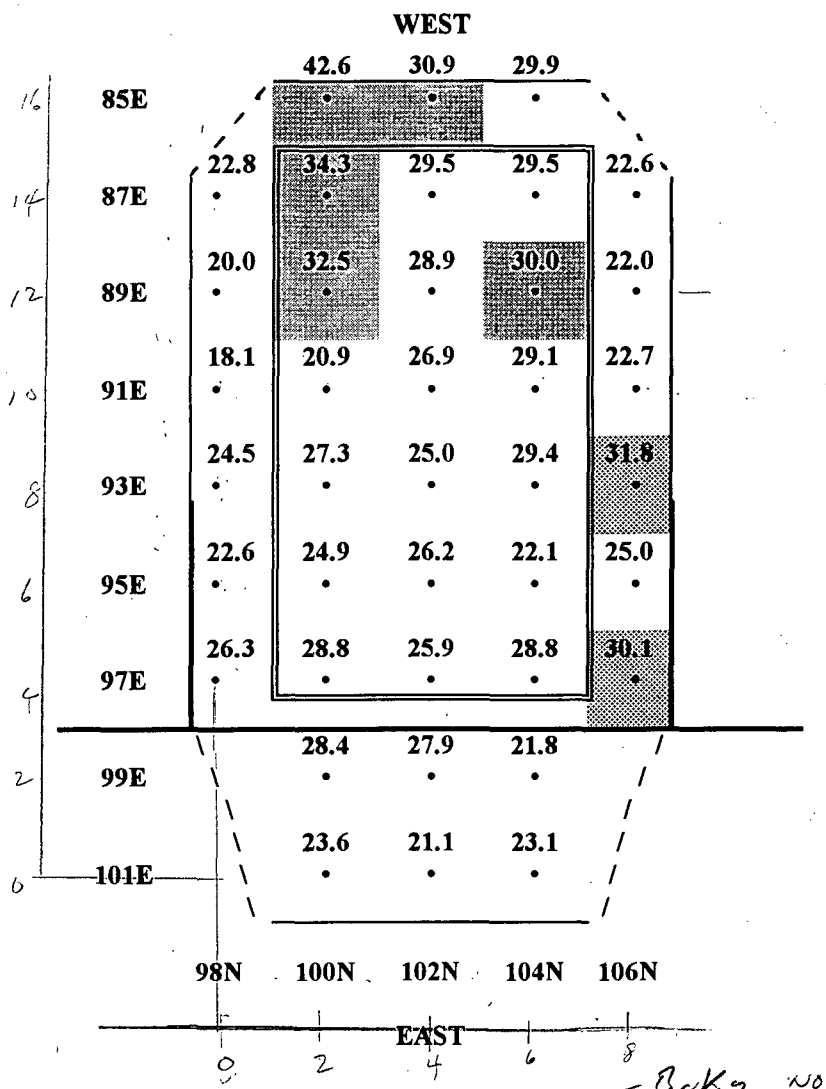
PERFORMED BY: E. Powell DATE: 1-15-98

REVIEWED BY: K. Morgan DATE: 1-15-98

APPENDIX 3

CIMARRON FACILITY
ASPHALT STOCK PILE (U - YARD)
HOT SPOT EVALUATION (0 TO 1 METER)

SAMPLE RESULTS ARE RECORDED IN " pCi /g of U "
APPROXIMATELY 16 METERS X 8 METERS GRID × 2 m deep
(APPROXIMATELY 128 SQUARE METERS)
BACKGROUND (4 pCi / g U) SUBTRACTED



39 SAMPLE POINTS 7 ELEVATED SAMPLES — Bdy not included

AREAS (> OR = TO) 30 pCi /gU REPRESENT APPROXIMATELY 24 % OF ASPHALT STOCKPILE. 100 m² AREA **AVERAGE = 33.2 pCi /gU**

AREAS LESS THAN 30 pCi /gU REPRESENT APPROXIMATELY 76 % OF ASPHALT STOCKPILE. 100 m² AREA **AVERAGE = 25.4 pCi /gU**

76% 76% 24%

Xw = 25.4 [1 - 24/100] + 33.2 [24/100] = 19.3 + 7.97 = 27.27 pCi/g U

SQRT (100/A) = SQRT (100/24) = 2.0 X 30 pCi /g U = 61.4 pCi /g U

42.6 pCi /g U (MAXIMUM) < 61.4 pCi /g U CRITERIA IS SATISFIED.

CIMARRON CORPORATION
CIMARRON FACILITY
ASPHALT STOCK PILE (U - YARD)

SAMPLE RESULTS ARE RECORDED IN " pCi /g of U " (0 TO 1 METER)
APPROXIMATELY 16 METERS X 8 METERS GRID × 2 m deep
(APPROXIMATELY 128 SQUARE METERS)
BACKGROUND (4 pCi / g U) INCLUDED

WEST

	98N	100N	102N	104N	106N
85E		46.6	34.9	33.9	
87E	26.8	38.3	33.5	33.5	26.6
89E	24.0	36.5	32.9	34.0	26.0
91E	22.1	24.9	30.9	33.1	26.7
93E	28.5	31.3	29.0	33.4	35.8
95E	26.6	28.9	30.2	26.1	29.0
97E	30.3	32.8	29.9	32.8	34.1
99E		32.4	31.9	25.8	
101E		27.6	25.1	27.1	

EAST

39 SAMPLE POINTS 21 ELEVATED SAMPLES – Bckg included

AREAS (> OR = TO) 30 pCi /gU REPRESENT 54 % OF ASPHALT STOCK PILE
AVERAGE = 32.4 pCi /gU

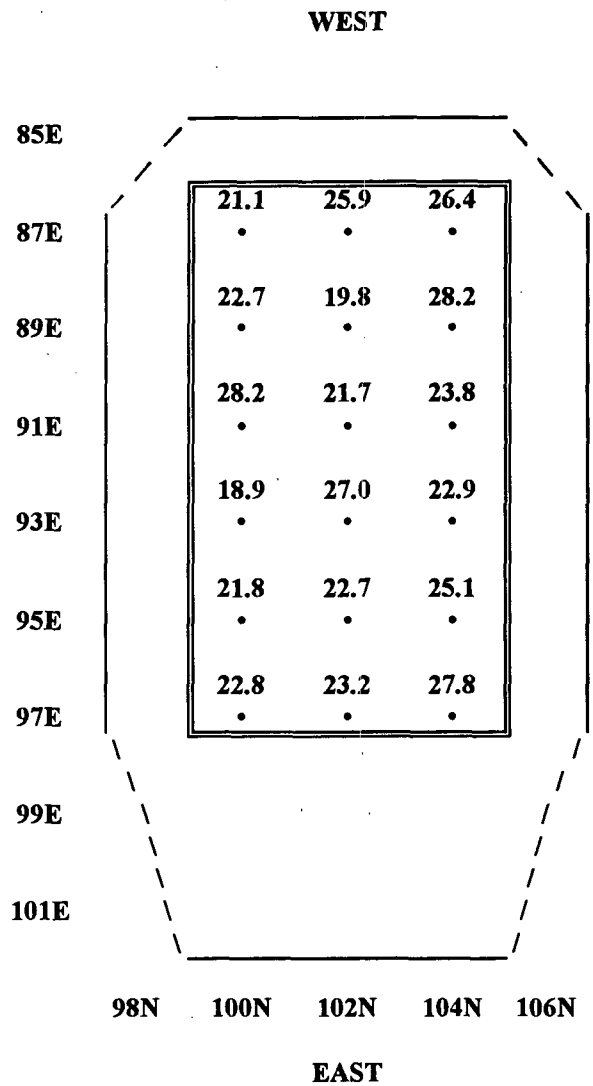
AREAS LESS THAN 30 pCi /gU REPRESENT 46 % OF ASPHALT STOCK PILE
AVERAGE = 26.7 pCi /gU

Xw = 26.7 [1 - 54/100 } + 32.4 [54/100] = 12.28 + 17.49 = 29.77 pCi/g U

Appendix 3

CIMARRON CORPORATION
CIMARRON FACILITY
ASPHALT STOCK PILE (U - YARD)
HOT SPOT EVALUATION (1 TO 2 METERS)

SAMPLE RESULTS ARE RECORDED IN " pCi /g of U "
12 METERS X 6 METERS GRID (72 SQUARE METERS)
BACKGROUND (4 pCi / g U) SUBTRACTED

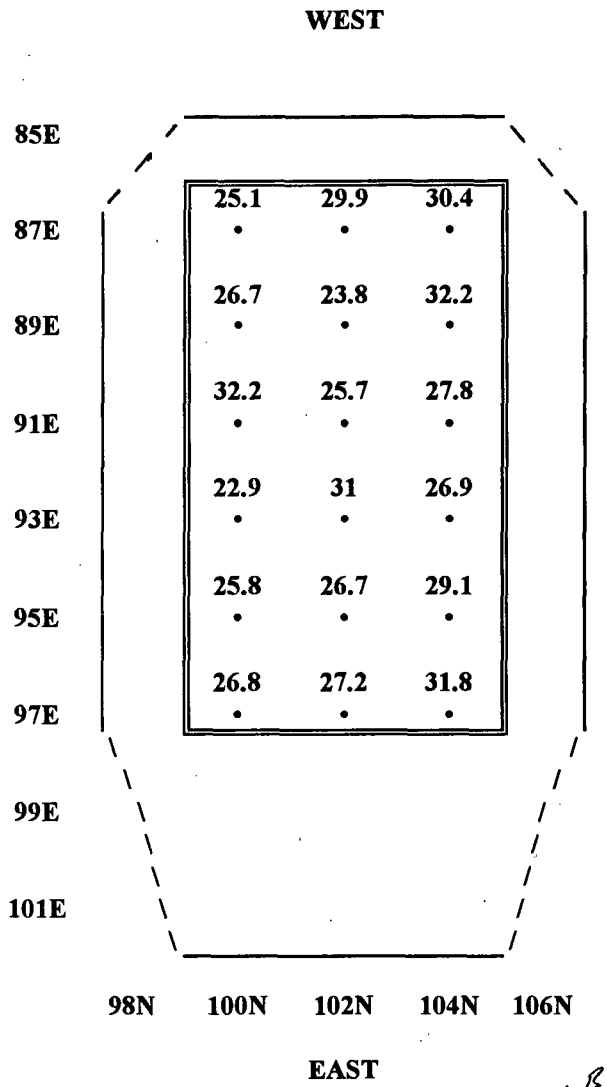


18 SAMPLE POINTS NO ELEVATED SAMPLES Bckg not included

AVERAGE CONCENTRATION OF SAMPLES = 23.9

CIMARRON CORPORATION
CIMARRON FACILITY
ASPHALT STOCK PILE (U - YARD)

SAMPLE RESULTS ARE RECORDED IN " pCi /g of U " (1 TO 2 METER)
12 METERS X 6 METERS GRID (72 SQUARE METERS)
BACKGROUND (4 pCi / g U) INCLUDED



BKG included

18 SAMPLE POINTS 5 ELEVATED SAMPLES 5 ÷ 18 = .28 OR 28 %

AREAS (> OR = TO) 30 pCi /gU REPRESENT 28 % OF ASPHALT STOCK PILE
AVERAGE = 31.5 pCi /gU

AREAS LESS THAN 30 pCi /gU REPRESENT 72 % OF ASPHALT STOCK PILE
AVERAGE = 26.5 pCi /gU

Xw = 26.5 [1 - 28/100 } + 31.5 [28/100] = 19.08 + 8.82 = 27.9 pCi/g U