**CIMARRON CORPORATION**

P.O. BOX 25861 • OKLAHOMA CITY, OKLAHOMA 73125

S. JESS LARSEN
VICE PRESIDENT

November 16, 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 No. SNM-928**
**Cimarron Corporation**
**Final Status Survey Plan for Sub-area "H"**

Dear Mr. Kalman:

Cimarron Corporation has recently completed the Final Status Survey for Sub-Area "H" in accordance with the previously approved Phase II Final Status Survey Plan. This submittal letter transmits the Final Status Survey Report for Sub-area "H".

Please find enclosed three (3) copies of the 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 Mr. Louis Carson with NRC Region IV.

Cimarron Corporation requests that Sub-area "H" be released from License No. SNM-928.

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

Sincerely,

Jess Larsen

Jess Larsen
Vice President
Enclosure

jl111698.le1

**CIMARRON CORPORATION**

P.O. BOX 25861 • OKLAHOMA CITY, OKLAHOMA 73125

S. JESS LARSEN
VICE PRESIDENT

April 6, 2000

Mr. Ken Kalman, Project Manager
Decommissioning Projects Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-001

**RE: Docket No. 70-925; License No. SNM-928**
**Cimarron Corporation**
**Response to NRC Comment on Phase II Subarea H**

Dear Mr. Kalman:

The purpose of this letter is to transmit Cimarron Corporation's response to the NRC staff comments dated March 20, 2000, pertaining to the "Final Status Survey Report (FSSR) for Phase II Subarea H." The two comments deal with the validity of a reported 59 pCi/g soil sample result and the rationale for including Table 5.10, in the FSSR. The NRC comments are included followed by Cimarron's response.

**NRC's Comments:**

1. Section 5.2.2, Table 5.2 indicated that, during characterization, a soil sample taken at 835N-33E had a total uranium concentration of 59 picoCuries per gram (pCi/g). However, as noted in Section 5.2.2, subsequent resampling was unable to produce the same measurement. Instead, subsequent samples ranged from 4 to 10 pCi/g and NRC staff is concerned with the disparity in these measurements. Please explain in more detail what methods were used to check this area, and, also explain what equipment was used to check the validity of the 59 pCi/g measurements taken during characterization. Were there errors in transferring data from field notes to final reports?

**Cimarron's Response:**

Based upon the NRC's comment, Cimarron personnel performed a complete review of the data package associated with the 59 pCi/g total uranium sample result to confirm the data was transferred correctly to the FSSR. The original soil sample was analyzed on the on-site sodium iodide multi-channel analyzer (MCA) which was calibrated in accordance with the facility

calibration procedures. The soil sample was not placed into archive storage; thus, this sample cannot be retrieved for further analyses.
Cimarron believes that a detailed explanation of how this area was addressed from drain line removal through final status survey will be helpful in understanding why Cimarron feels that the location in question has been adequately addressed.

In June 1985, the four-inch steel drain line from the closed Sanitary Lagoons to the Cimarron River was uncovered and removed. This drain line was approximately two feet below grade. A gamma scan survey was conducted of the entire excavation for the purpose of identifying elevated areas of residual contamination. Once the survey was completed, the excavation was subsequently backfilled with soil previously removed and stockpiled adjacent to the excavation.

In June 1994, the entire length of the area previously traversed by the drain line was cored at 10 meter intervals to a depth of four feet. It was during this sampling event that the 59 pCi/g total uranium sample result was recorded at the 3'-4' depth. After reviewing the 1994 data, Cimarron questioned the validity of the one location showing the total uranium concentration of 59 pCi/g. Soil sample results along the entire length of the backfilled excavation from the base of the hill to the Cimarron River ranged from 3 pCi/g to 17 pCi/g total uranium, all substantially below the 59 pCi/g result. Cimarron decided to address this location sometime in the future.

In December 1996, the location for the 59 pCi/g sample result, which was located midway along the excavation, was again sampled from 0-4' at one foot intervals. This sampling event showed a total uranium concentration of 9 pCi/g at the 3'-4' depth.

In September 1998, in an attempt to resolve the disparity between the 59 pCi/g and 9 pCi/g sample result, Cimarron decided to sample the location (i.e., 835N-33E) again and also included four 2 meter offset samplings down to 5 feet. A total of 30 soil samples were collected and analyzed on site. All results were below 10 pCi/g total uranium.

The numerous sampling and analyses have all been in accordance with Cimarron's aproved Quality Assurance Plans and Procedures. This program is an integral part of the overall site decommissioning program and ensures that samples are collected, controlled, and analyzed in accordance with applicable quality controls to provide confidence in the resulting data accuracy.

The original 1985 scan survey of the excavation did not identify elevated residual activity at the 835N-33E location. Additionally, the two subsequent sampling events in 1996 and 1998 did not replicate the 1994 sampling event. Cimarron believes that the 1994 data result (i.e., 59 pCi/g total uranium) is not representative of the soil present at this location.

**NRC Comment:**

2. As noted in our comments on other FSSR's that we have reviewed, we are concerned with the rationale for including Table 5.10. In its present form, the table is misleading by giving the impression that the data presented was taken from Subarea H. Based on the text provided in Section 5.3 of the FSSR, it appears that this table was included to provide an example of the success of Cimarron's quality assurance procedures by showing the agreement between

analyses from the on-site soil counter and those of independent laboratories. If this is so, then it should be stated in Section 5.3 and Table 5.1. NRC staff recommends that you correct this in the Subarea H FSSR, as well as in any future FSSR's, so we do not have to address it again.

**Cimarron's Response:**

We wish to note the existence of a typographical error in the NRC comment, as restated above. In the penultimate sentence of the NRC comment there is reference to Table 5.1. This reference should be to Table 5.10 as noted in the first sentence of the comment.

Cimarron did not intend to mislead the NRC staff by including in the FSSR the Table 5.10 soil data. The purpose of including Table 5.10 in the FSSR for Subarea H was, as stated in the NRC's March 20 letter, "to provide an example of the success of Cimarron's quality assurance procedures by showing the agreement between analyses from the on-site soil counter and those of independent laboratories."

The data that was included in Table 5.10 represented soil samples with activities in the ranges that apply to the Subarea H remediation surveys and final status surveys. It also includes some other samples from other similar areas collected during the time frame that the survey data for Subarea H was being generated. The majority of the data presented in Table 5.10 happened to be generated from samples collected within Subarea H. All samples were collected and analyzed on the on-site counter and then sent to Core Laboratories.

In reviewing the sample ID numbers in Table 5.10, we notice that sample SC-06 should have been labeled JC-06. The first letter designation (i.e., H or F for example) included in the sample number indicates the subarea where the samples were collected. The "MISC" designation meant that this sample was not directly related to a specific subarea. OWP and AO represent Uranium Waste Pond sample locations, which were located in Subarea "O".

For clarity, Section 5.3 and Table 5.10 have been modified per this response. The modified pages (i.e., pages iii, 42, 43, 44, and 45) for the FSSR for Subarea H are included with this letter for replacement in the original Report.

Like NRC, we would hope to avoid needing to again address this matter as it has been repetitive since it first was raised in the June 14, 1999, NRC comments on Subarea O – Surface. The final status survey reports for four subareas (L, O, H, and M) used similar presentations to show the QA/QC correlation between site produced data and independent laboratory results. These reports were submitted July 27, 1998, February 9, 1999, November 16, 1998, and December 31, 1998, respectively. All four of these reports were submitted prior to our first learning of your concerns on June 14, 1999. The issue has now been addressed in three of these reports, but it will also arise one more time during your review of the FSSR for Subarea M. The FSSR's issued after June 14, 1999, have implemented changes to avoid this matter recurring. We will agree in advance to provide modified pages for the FSSR for Subarea M to resolve this matter in that report.

We understand from your March 20 letter that these responses should resolve all outstanding issues pertaining to Subarea H with the exception of final confirmatory sampling. We request that upon completion of the confirmatory sampling and the acceptance of that confirmation by NRC, that NRC issue a letter expressing intent to release Subarea H from license.

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

Sincerely,

Jess Larsen

Jess Larsen
Vice President

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Activity"[46]. The uranium isotopic ratios were chosen to be the same as those used by the NRC for the "Environmental Assessment Associated with the BTP Option #2 Onsite Disposal Cell at Cimarron"[47], which were U-234 (79%), U-235 (1.7%), and U-238 (20%). The selected density for the concrete was 1.8 g/cc. The calculated area of the contaminated zone is 111 $m^2$, while the estimated thickness is 0.15m. The previously established erosion rate of 10 mm/150y (i.e., 6.7E-5 m/y) was utilized for the concerete[17].

The RESRAD computer code calculated maximum dose rate (all pathways) will occur immediately (i.e., at t = ∅ years) and will result in a maximum hypothetical annual dose to the resident of approximately 0.04 millirem per year. A calculation also was performed to conservatively determine an upper estimate of the dose due to inhalation of any resuspended material from the concrete. The extremely conservative RESRAD default mass loading variable of 200 $\mu g/m^3$ was utilized. In addition, an assumption was made that all of the radioactivity in the concrete was within the top 1/8 inch of the exposed surfaces. This assumption resulted in an average calculated concentration of 7.2 pCi/g in the uppermost 1/8 inch layer of concrete. This is equivalent to the average concentration previously calculated for the three inch layer of concrete rubble (i.e., 0.3 pCi/g) multiplied by a factor of 24 to account for the fact that all of the activity is concentrated in the uppermost layer. Based upon the above assumption, the RESRAD code calculated an inhalation dose of 0.7 mrem/y. A printout of the parameters used and results of the RESRAD calculations are provided in Appendix 6.

### 5.2.6 Survey Data – Cimarron River Sediments

Cimarron River sediment samples were collected upgradient from the site, at the outfalls from the former East and West pipeline runs, at the discharge of the two eastern drainages, and near the eastern site boundary. The sample locations are shown on Drawing No. 98POAHRV-0 included in Appendix 7. At the time the sediment samples were collected, the river elevation was below the former outfalls so sediment samples were collected out into the river channel at one meter intervals or greater. Samples were collected at the surface and at 6"- 1' and 1' - 2' depths. A total of eighteen locations were sampled, with seven locations at the outfalls from the former West pipeline and three locations from the former East pipeline outfall. Soil sample analytical results varied from 2.9 pCi/g to 7.8 pCi/g total uranium at the surface; 3.6 to 7.6 pCi/g total uranium at 6" to 1' in depth and 3.6 to 6.8 pCi/g total uranium at 1'- 2' depth. The results were indicative of background and there were no distinguishable differences between the upgradient results, outfall sample results, drainage results, or downstream results.

The data for this survey unit is tabulated and included in Appendix 7. The sample locations and survey results are shown on Drawing No. 98POAHRV-0.

## 5.3 QA/QC Procedures

Cimarron Corporation's Quality Assurance Plans and Procedures are an integral part of the overall site decommissioning program and include off-site independent isotopic analysis of split samples. Sample results for both on-site and off-site analyses for sixteen samples are listed in Table 5.10. The data that is included represents activity ranges that

apply to the Subarea H remediation surveys and to this final status survey and also for soil samples collected during the time frame that the survey data was being generated.

The purpose of including Table 5.10 in this report is to provide examples of the success of Cimarron's quality assurance procedures by showing agreement between analyses from the on-site soil counter and those of indepenent laboratories. The soil samples were first analyzed using the on-site counter prior to being packaged and sent off site for analysis at Core Laboratories. The majority of the data presented in this Table happened to be generated from samples collected within Subarea H. Cimarron also selected several representative samples from other areas on site for the comparison.

The first letter designation (i.e., H or F for example) included in the sample number indicates the subarea where the samples were collected. The "MISC" designation meant that this sample was not directly related to a specific subarea. OWP and AO represent Uranium Waste Pond sample locations, which were located in Subarea "O". These sample results show good agreement.

**TABLE 5.10**

| Sample ID No. | Off-Site Lab Results Core Lab (pCi/g U) | On-Site Results Cimarron (pCi/g U) |
|---|---|---|
| JC-06 | 1.5 ± 0.7 | 2.1 ± 1.7 |
| FA-542 | 1.0 ± 0.5 | 5.1 ± 1.4 |
| MISC-21 | 27.9 ± 4.0 | 31.6 ± 1.6 |
| MISC-29 | 17.7 ± 2.7 | 20.5 ± 1.9 |
| OWP-1-106 | 30.0 ± 4.4 | 29.8 ± 1.7 |
| AO-4026 | 42.0 ± 5.4 | 36.8 ± 1.9 |
| HD-45 | 50.1± 8.6 | 47.0 ± 5.0 |
| HD-52 | 64.2 ± 11.4 | 64.6 ± 5.0 |
| HD-99 | 11.4 ± 2.6 | 20.0 ± 6.0 |
| HU-08 | 4.8 ± 1.4 | 4.9 ± 2.8 |
| HU-26 | 3.1 ± 0.8 | 8.8 ± 6.8 |
| HA-1740 | 26.7 ± 6.5 | 21.4 ± 5.9 |
| HP-370 | 62.7 ± 11.1 | 52.3 ± 2.3 |
| HP-382 | 26.0 ± 5.5 | 29.0 ± 2.9 |
| HA-1437 | 80.8 ± 13.5 | 70.7 ± 3.0 |
| HA-1531 | 112.6 ± 15.9 | 124.0 ± 3.1 |
| HA-1532 | 105.2 ± 16.1 | 82.9 ± 2.7 |
| HC-1 | 2.0 ± 2.3 | 3.7 ± 1.8 |
| HC-6 | 3.1 ± 2.6 | 6.0 ± 1.7 |
| HC-9 | 5.1 ± 3.8 | 7.4 ± 1.4 |
| HU-70 | 15.1 ± 3.8 | 14.5 ± 1.9 |
| HU-73 | 15.1 ± 6.1 | 17.7 ± 1.9 |

## 6.0 SUMMARY

A Final Status Survey was performed in accordance with the approved Phase II FSSP and the SWP and WP approved by Cimarron Management for Subarea H. This report presents a comparison of the results of the Final Status Survey to the clean-up criteria (guideline values) for affected and unaffected areas at the Cimarron site. The comparison presented herein demonstrates that all guideline values have been met and thus Subarea H can now be released from License SNM-928. Therefore, this report is being submitted to the NRC in conjunction with a request to release Subarea H from License SNM-928.

## 7.0 APPENDICES

- Appendix 1 Drawing 95 MOST-RF3
- Appendix 2 Affected Areas - Data Tabulation Sheets, Statistical Analyses, and Drawings
- Appendix 3 East and West Pipeline Runs - Data Tabulation Sheets, Statistical Analyses, and Drawings
- Appendix 4 Drainage Areas - Data Tabulation Sheets, Statistical Analyses, and Drawings
- Appendix 5 Unaffected Areas - Data Tabulation Sheets, Statistical Analyses, and Drawings
- Appendix 6 Drawing for Concrete and RESRAD Pathway Analysis
- Appendix 7 River Sediments - Data Tabulation Sheets and Drawings

# FINAL STATUS SURVEY REPORT FOR SUBAREA H

for

Cimarron Corporation's Former
Nuclear Fuel Fabrication Facility
Crescent, Oklahoma

License Number: SNM-928

Prepared for:

Cimarron Corporation
Oklahoma City, Oklahoma

November 1998

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## REFERENCES


1. Cimarron Corporation Nuclear Materials License, SNM-928 Docket No. 70-0925, issued for possession only March 31, 1983; Amendment No. 14, issued April 23, 1996.

2. Cimarron Corporation Nuclear Materials License, SNM-1174, Docket No. 070-1193, terminated February 5, 1993.

3. Cimarron Corporation letter to USNRC, August 20, 1990.

4. USNRC letter from Mr. Richard E. Cunningham, Director, Division of Industrial and Medical Nuclear Safety to Dr. John Stauter, Director of Environmental Services, Cimarron Corporation, dated February 5, 1993.

5. Chase Environmental Group, Inc. "Radiological Characterization Report for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility, Crescent, Oklahoma", October 1994.

6. Chase Environmental Group, Inc. "Decommissioning Plan for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility, Crescent, Oklahoma", April 1995.

7. Chase Environmental Group, Inc. "Final Status Survey Plan for Unaffected Areas for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility, Crescent, Oklahoma", October 1994.

8. USNRC letter from Mr. Michael F. Weber, Chief Low-Level Waste and Decommissioning Project Branch, Division of Waste Management, to Mr. Jess Larsen, Vice President Kerr-McGee Corporation, dated May 1, 1995.

9. Cimarron Corporation Letter from Mr. Jess Larsen, Vice President, Cimarron Corporation to Mr. Michael F. Weber, Chief Low-Level Waste and Decommissioning Branch, Division of Waste Management, USNRC, dated November 13, 1995.

10. Cimarron Corporation, "Final Status Survey Report, Phase I Areas at the Cimarron Facility, License No. SNM-928", July 1995.

11. USNRC letter from Mr. R. A. Nelson Acting Chief Low-Level Waste and Decommissioning Project Branch, Division of Waste Management, to Mr. Jess Larsen, Vice President, Cimarron Corporation, dated April 23, 1996.

12. Chase Environmental Group, Inc., "Final Status Survey Plan for Phase II Areas for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility", Crescent, Oklahoma, July 1995.

13. USNRC letter from Mr. Kenneth L. Kalman, Project Manager, Low-Level Waste and Decommissioning Projects Branch, to Mr. Jess Larsen, Vice President, Cimarron Corporation, dated March 14, 1997.

14. USNRC letter from Mr. George M. McCann, Chief, Materials Licensing Section to Dr. John Stauter, Vice President, Kerr-McGee Corporation, dated December 30, 1992.

15. Cimarron Corporation, "Final Status Survey Report, Phase II-Subarea J for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility, Crescent, Oklahoma", September 1997.

16. USNRC letter from Mr. Ken Kalman, Project Manager, Low-Level Waste and Decommissioning Project Branch, to Mr. Jess Larsen, Vice President, Cimarron Corporation, dated July 31, 1998.

17. Cimarron Corporation, "Final Status Survey Report for Concrete Rubble in Subarea F, Cimarron Corporation's Former Nuclear Fuel Fabrication Facility, Crescent, Oklahoma", March 1998.

18. Chase Environmental Group, Inc. "Final Status Survey Plan for Phase III Areas for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility", Crescent, Oklahoma, June 1997.

19. USNRC letter from Mr. Ken Kalman, Project Manager, Facilities Decommissioning Section to Mr. Jess Larsen, Vice President, Cimarron Corporation, dated September 11, 1998

20. Cimarron Corporation, "Final Status Survey Report, Phase III-Subarea L (Subsurface) for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility, Crescent, Oklahoma", May 1996.

21. USNRC letter from Mr. Ken Kalman, Project Manager, Facilities Decommissioning Section, to Mr. Jess Larsen, Vice President, Cimarron Corporation, dated August 16, 1996.

22. Cimarron Corporation letter from Mr. Jess Larsen, Vice President Cimarron Corporation, to Mr. Ken Kalman, Project Manager, Facilities Decommissioning Section, USNRC, dated September 9, 1996.

23. Cimarron Corporation letter from Mr. Jess Larsen, Vice President, Cimarron Corporation, to Mr. Ken Kalman, Project Manager, Facilities Decommissioning Section, USNRC, dated October 17, 1996.

24. Cimarron Corporation letter from Mr. Jess Larsen, Vice President Cimarron Corporation to Mr. Ken Kalman, Project Manager, Facilities Decommissioning Section, USNRC, dated November 4, 1996.

25. USNRC letter from Mr. Ken Kalman, Project Manager, Facilities Decommissioning Section, USNRC to Mr. Jess Larsen Vice President, Cimarron Corporation, dated November 8, 1996.

26. Cimarron Corporate letter from Mr. Jess Larsen, Vice President, Cimarron Corporation to Mr. Ken Kalman, Project Manager, Facilities Decommissioning Section, USNRC, dated July 27, 1998.

27. Cimarron Corporation, "Final Status Survey Report Phase III – Subarea "O" Subsurface for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility, Crescent, Oklahoma", dated March 1998.

28. Cimarron Corporation letter from Mr. Jess Larsen, Vice President, to Mr. Michael F. Weber, Chief Low-Level Waste and Decommission Projects Branch, Division of Waste Management, USNRC, dated June 21, 1995.

29. ORAU Final Report, "Confirmatory Survey of the Cimarron Corporation Mixed Oxide Fuel Fabrication Plant", January 1991.

30. USNRC, "Background as a Residual Radioactivity Criterion for Decommissioning", NUREG-1501, Draft Report, August 1994.

31. Eichholz, G.G., et.al., Radiation Exposure from Building Materials, in "Natural Radiation Environment III", US DOE CONF-780422, 1980.

32. Ingersoll, J.G., "A Survey of Radionuclide Contents and Radon Emanation Rates in Building Materials Used in the United States", University of California Lawrence Berkeley Laboratory Report LBL-11771, 1981.

33. Oak Ridge Associated Universities, "Confirmatory Radiological Survey of the Sanitary Lagoons at the Cimarron Corporation Facility, Crescent, Oklahoma", Smith, B.M., dated November 1991.

34. USNRC letter from Mr. George M. McCann, Chief, Materials Licensing Section, to Dr. John Stauter, Vice President, Kerr-McGee Corporation, dated December 30, 1992.

35. Cimarron Corporation letter from Dr. Edwin Still, Vice President, to Mr. Michael S. Houts, Solid Waste Management Service, Oklahoma State Department of Health, dated June 1, 1993.

36. Kerr-McGee Corporation, "Decommissioning Plan – Groundwater Evaluation Report for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility, Crescent, Oklahoma," July 1998.

37. J.D. Berger, "Manual for Conducting Radiological Surveys in Support of License Termination"; Draft Report for Comment, Oak Ridge Associated Universities, NUREG/CR-5849, June 1992.

38. USNRC, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for By-Product, Source, or Special Nuclear Material", August 1987.

39. USNRC, "Branch Technical Position on Disposal or On-site Storage of Residual Thorium and Uranium from Past Operations", FR. Vol. 46, No. 205, Page 52061, October 23, 1981.

40. American National Standards Institute, "Radiation Protection Instrumentation Test and Calibration", ANSI N323-1978, Institute of Electrical and Electronic Engineers, Inc. September 1977.

41. Cimarron Corporation, "Response to NRC Comments on Cimarron's Final Status Survey for Phase II, Subarea "J" for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility, Crescent, Oklahoma", dated May 13, 1998.

42. USNRC letter from Mr. Ross A. Scarano, Director Division of Nuclear Materials Safety to Mr. S. Jess Larsen, Vice President, Cimarron Corporation, dated July 31, 1997.

43. E.W. Abelquist, "Confirmatory Survey for the South Uranium Yard Remediation, Kerr-McGee Corporation, Cimarron Facility, Crescent, Oklahoma", Oak Ridge Institute for Science and Education, November 1995.

44. USNRC letter from Mr. Michael F. Weber, Chief, Low-Level Waste and Decommissioning Project Branch, Division of Waste Management to Mr. Jess Larsen, Vice President, Kerr-McGee Corporation, dated May 31, 1995.

45. American Society of Mechanical Engineers, "Quality Assurance Requirements for Nuclear Facility Applications" ASME NQA-I, 1994.

46. USNRC, "Scenarios for Assessing Potential; Doses Associated with Residual Activity", Policy Guidance PG8-08, May 1994

47. USNRC, Environmental Assessment Associated with BTP Option #2 Onsite Disposal Cell at Cimarron", November 1994.

# FINAL STATUS SURVEY REPORT FOR DECOMMISSIONING CIMARRON FACILITY SUBAREA H

## 1.0 PURPOSE

This Final Status Survey Report (FSSR) is being submitted by Cimarron Corporation to the Nuclear Regulatory Commission (NRC) for an area on the Cimarron site designated as Phase II Subarea H. This subarea is shown on Drawing No. 95MOST-RF3 which is included in Appendix 1, and includes both affected and unaffected areas that have been surveyed as part of the ongoing site decommissioning process. This report includes a discussion of the initial characterization survey performed to more precisely define the extent and magnitude of residual contamination present in soils located within Subarea H. The characterization data generated during the initial survey was utilized in designing the Final Status Survey (FSS) for this subarea which is included in the NRC approved Phase II Final Status Survey Plan (FSSP). Based upon the Phase II FSSP, the FSS was performed for the entire subarea to demonstrate that the established guideline values for unrestricted release had been met. The results of the Subarea H FSS are presented in this FSSR as justification for release of this Subarea from License SNM-928 for unrestricted use.

## 2.0 BACKGROUND

Cimarron Corporation, a subsidiary of Kerr-McGee Corporation, operated two plants near Crescent, Oklahoma, for the manufacture of enriched uranium and mixed oxide reactor fuels. The 840-acre Cimarron Facility site was originally licensed under two separate SNM Licenses. License SNM-928[1] was issued in 1965 for the Uranium Plant (U-Plant) and License SNM-1174[2] was issued in 1970 for the Mixed Oxide Fuel Fabrication (MOFF) Facility. Both facilities operated through 1975, at which time they were shut down and decommissioning work was initiated.

Decommissioning efforts at the MOFF Facility were completed in 1990 and Cimarron Corporation applied to the NRC on August 20, 1990[3] to terminate License SNM-1174. After confirmatory surveys, the NRC terminated the MOFF Facility License, SNM-1174, on February 5, 1993[4].

Decommissioning efforts at the Cimarron U-Plant facility involving characterization, decontamination and remediation were initiated in 1976 and are nearing completion. The goal of the decommissioning effort is to release the entire 840-acre site for unrestricted use.

Based upon historic knowledge of site operations and the characterization work completed to date, Cimarron Corporation completed and submitted the 1994 Cimarron Radiological Characterization Report[5]. As discussed in that report, the site was divided into affected and unaffected areas. The affected and unaffected areas are shown on Drawing No. 95MOST-RF3 which is included in Appendix 1. For the final status survey the entire 840-acre site was divided into three major areas containing both affected and unaffected areas. Each of these three major areas are shown on Drawing No. 95MOST-RF3 and are designated by Roman Numerals

I, II, and III (herein referenced as Phases I, II, and III). These three major areas were then further subdivided into smaller "subareas" (i.e., A, B, C, D, etc.).

## 2.1 Phase I Area

As presented in the Cimarron Decommissioning Plan[6], the FSSP's (Phases I, II and III) were discussed in general terms, with the understanding that each of these three phases would be submitted to the NRC under separate cover for approval. The FSSP for the first of these three phases (Phase I[7]) was approved by the NRC by letter dated May 1, 1995[8]. By letter dated November 13, 1995[9], Cimarron modified the southern boundary of two Phase I areas (i.e., Subareas C and E) and placed these portions of Subareas C and E into Phase II Subareas G and H. The FSSR[10] for Phase I was submitted to the NRC and confirmatory sampling for the Phase I Subarea was completed by the Oak Ridge Institute for Science and Education (ORISE). Cimarron Corporation received Amendment #13 which released all of the Phase I areas from License SNM-928; the amendment was forwarded by NRC letter dated April 23, 1996[11]. This amendment reduced the licensed facility acreage from 840 to approximately 152 acres.

## 2.2 Phase II Area

The area designated as Phase II on Drawing No. 95MOST-RF3 contains both affected and some contiguous unaffected areas and represents approximately 122 of the remaining licensed 152-acres. The FSSP for Phase II was submitted to the NRC in July 1995[12] and approved on March 14, 1997[13]. Phase II includes Subareas F, G, H, I and J. Included within Phase II are Burial Area #1 which was released in December 1992 by the NRC[14], subsequently backfilled with clean soil, and then seeded. Also included in Phase II are the East and West Sanitary Lagoons, the MOFF Plant Building exterior and yard area, the Emergency Building, the Warehouse Building (Building #4) and surrounding yard, and numerous drainage areas. The East and West Sanitary Lagoons, which also have been released by the NRC, are included in Subarea H and are discussed further in this report. Cimarron has essentially completed all remediation of each of the Phase II Subareas and final status surveys are currently being completed.

The FSSR for Subarea J was the first Phase II Subarea to be submitted to the NRC for final license release; it was submitted in September 1997[15]. This subarea is West of Highway #74, and represents approximately 7 of the 122 acres in Phase II. The FSSR for Subarea J has been approved by the NRC[16], and a confirmatory survey was performed by NRC staff during their site visit of September 21-23, 1998.

Subarea H is the second subarea included within Phase II where final status surveys have been completed. As discussed above, the East and West Sanitary Lagoons are included within this subarea. This subarea includes approximately 38.5 acres. The results of the FSS for Subarea H are presented in this Report. Concrete previously surveyed for releases and placed in a drainage way located within Subarea F has been surveyed in place with the results reported in the 1998 Concrete Rubble FSSR[17]. Final Status Survey Reports for Subareas F, G, and I are pending.

## 2.3 Phase III Area

The Phase III area survey includes the last areas for completing the final status survey for the entire Cimarron site, and represents approximately 30 acres. This area is designated as Phase III on Drawing No. 95MOST-RF3. The FSSP for release of this area from the site license, was submitted to the NRC for approval in June 1997[18]. Phase III includes the former Uranium Processing buildings and yard area, Burial Areas #2 and #3, New Sanitary Lagoon, the NRC approved BTP Option 2 On-site Disposal Cell (Burial Area #4), and the Five Former Waste Water Ponds, consisting of Uranium Waste Ponds #1 and #2, the Plutonium Waste Pond, the Uranium Emergency Pond, and the Plutonium Emergency Pond. By letter dated September 11, 1998[19], the NRC approved the Phase III Final Status Survey Plan. Thus, the Final Status Survey Plans for all three phases have been approved.

The FSSR for Subarea L (subsurface) was the first Phase III FSSR to be submitted to the NRC for final license release. The FSSR for Subarea L (subsurface) was submitted to the NRC on May 29, 1996[20]. The NRC, by letter dated August 16, 1996[21], sent Cimarron comments concerning the Subarea L FSSR. Cimarron responded to the NRC comments by letters dated September 9, 1996[22] and October 17, 1996[23]. Additionally, in order to resolve the NRC staffs concern pertaining to the potential presence of subsurface contamination, additional subsurface soil samples were collected for analysis within Subarea L. Cimarron provided the results for this additional subsurface sampling to the NRC by letter dated November 4, 1996[24]. Based upon the NRC staffs review of these submittals and the additional sampling data, Cimarron's request to backfill Subarea L was approved by letter dated November 8, 1996[25]. Subarea L has been backfilled and contoured. Subsequently, the FSS for the Subarea L surface soils has been completed and submitted to the NRC on July 27, 1998[26]. Also, the FSS for Subarea O (subsurface)[27] was submitted to the NRC in March 1998. Final survey reports for Subareas K, M, N and O (surface) are pending.

# 3.0 DECOMMISSIONING ACTIVITIES

The purpose of this section is to discuss briefly the status of the site decommissioning activities for Subarea H and to present the radiological criteria and guideline values utilized throughout the remediation and final status survey. Also, included in this section is a brief discussion of the results of the characterization and/or remediation work performed in Subarea H.

## 3.1 Identification of Contaminants

Based upon the knowledge of past site operations, the results of numerous characterization efforts to date, and other independent characterization efforts by regulatory agencies and their respective subcontractors, the radiological contaminants on the Cimarron site have been determined to consist of U-234, U-235 and U-238, with an average enrichment above the naturally occurring level of approximately 2.7 weight percent.

Thorium, although not considered the primary contaminant of concern for this subarea, has been included in the soil and sediment analyses and reported on the data summary sheets along with the total uranium sample results.

## 3.2 Site Background Levels

### 3.2.1 Soils

Natural background levels for uranium in soil have been established through numerous measurements by Cimarron personnel utilizing the on-site soil counter and through independent regulatory review and laboratory analysis. Analytical results from Cimarron Corporation's environmental sampling program are reported to the NRC annually in Environmental Monitoring Reports. These reports include 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 to further validate background levels. Total uranium ranged from 2.3 pCi/g to 6.6 pCi/g, with the average being 4.0 ± 2.6 ($2\sigma$) pCi/g. These values were obtained as a result of using the Cimarron on-site soil counter. This on-site soil counter 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 (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 2.9 pCi/g with an average of 1.8 ± 1.0 ($2\sigma$) pCi/g total uranium. Based upon these results, the average value of 4 pCi/g total uranium for background was adopted[28] and applied when the on-site soil counter sample analytical results were compared to guideline values.

### 3.2.2 Exposure Rate

Background exposure rates have been established at the Cimarron site by taking micro-R readings and pressurized ion chamber (PIC) readings at off-site sample locations in addition to Cimarron site areas which are unaffected by past operations. Exposure rates of approximately 7 to 10 μR/h have been observed in background areas by Cimarron personnel utilizing Ludlum micro-R survey meters. In addition, site background exposure rates were measured by ORAU (now ORISE) personnel utilizing a PIC[29], and were determined to be 9 to 10 μR/h. Based on the PIC measurements performed by ORISE, 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.

Cimarron personnel performed exposure rate measurements at background locations along the site boundary 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 3.1. The average background as measured using the micro-R

meter was 7.6 μR/h, and is about 15 percent less than the average for the PIC measurements of 9.0 μR/h. Cimarron has used 7 μR/h as representative of the average background exposure rate for micro-R measurements. Recently, Cimarron began sending their micro-R-meters off-site for calibration by the manufacturer. With this change in calibration procedure, measurements at background locations were taken for comparison to the PIC. This data also is presented in Table 3.1 and illustrates an increase in the average measured background of approximately 2 μR/h. Based upon this data, Cimarron will now use 9 μR/h as representative of background exposure rates for micro-R measurements taken with the off-site calibrated meters. The Table 3.1 comparison indicates good agreement between the micro-R measurements and the PIC measurements.

**TABLE 3.1**

| Sample ID No. | Grid Location | Micro-R Reading (μR/h) | PIC Reading (μR/h) | Micro-R Reading μR/h* |
|---|---|---|---|---|
| UAF-BKG-1 | 819W-81N | 9 | 9.8 | 10 |
| UAF-BKG-7 | 1600E-120N | 7 | 7.6 | 7.5 |
| UAF-BKG-11 | 840W-700S | 8 | 9.5 | 10 |
| UAF-BKG-13 | 840W-288S | 9 | 9.8 | 10.5 |
| UAF-BKG-16 | 808W-282N | 8 | 9.7 | 9.5 |
| UAF-BKG-19 | 640W-700S | 9 | 10.5 | 11 |
| UAF-BKG-23 | 1610E-300S | 5 | 7.8 | 7.5 |
| UAF-BKG-25 | 1610E-69N | 6 | 7.6 | 8 |
| UAF-BKG-27 | 1610E-469N | 7 | 7.8 | 8.5 |
| UAF-BKG-28 | 1610E-634N | 8 | 9.6 | 9.5 |
| | **AVERAGE** | **7.6 ± 2.7 (2σ)** | **9.0 ± 2.3 (2σ)** | **9.2 ± 2.8 (2σ)** |

*Background survey results taken with instruments now calibrated off-site by manufacturer.

### 3.2.3 Natural Background Radioactivity of Concrete

Concrete background is addressed in detail in the "Final Status Survey Report for Concrete Rubble in Subarea F[17]". In that report, several independent sources were referenced including NUREG-1501[30], Eicholz[31], and Ingersoll[32]. In addition, a sample of concrete was collected by Cimarron to determine concrete background. The total uranium for background which will be used in this report is 1.5 pCi/g; this value is based upon the background sample collected at the facility and the literature which has been cited. A summary and justification for the above background value is presented in Section 6.2.1 of the FSS for Concrete Rubble in Subarea F[17]. Data utilized in the determination of background for gross alpha and gross beta-gamma surface activity are summarized in Table 3.2, which is reprinted from the "Final Status Survey Report for Concrete Rubble in Subarea F[17]".

**Table 3.2**
**Gross Alpha and Gross Beta Surface Activity Background Data**

| Location* | Ave. Alpha Dpm/100cm$^2$ | Max. Alpha dpm/100cm$^2$ | Ave. Beta dpm/100cm$^2$ | Max. Beta dpm/100cm$^2$ | Surface µR/h*** | 1m µR/h*** |
|---|---|---|---|---|---|---|
| Grid #6 | 10 | 40 | 1045 | 1650 | 7 | 8 |
| Grid #7 | 10 | 40 | 278 | 1584 | 7 | 6 |
| Grid #8 | 10 | 40 | 924 | 1397 | 7 | 7 |
| Grid #9 | 10 | 80 | 557 | 935 | 6 | 6 |
| Grid #21 | 50 | 80 | 1199 | 3212 | 6 | 6 |
| Grid #33 | 5 | 20 | 889 | 1386 | 7 | 7 |
| Grid #103 | 10 | 40 | 860 | 1353 | 7 | 7 |
| Representative "background"** | 60 | 60 | 649 | 649 | 5 | 5 |
| **Average** | **21** | **50** | **800** | **1520** | **6.5** | **6.5** |

* Grid locations represent grids for the concrete rubble in Subarea F.

** Sample measurements taken at the surface of the area to be cored prior to sampling. As this area is within a building over a concrete slab, the ambient background exposure rate was lower.

*** Exposure rate measurements include background contribution. All other measurements are net (instrument background subtracted).

Based upon Table 3.2, the average background for gross alpha surface activity was established as 21 dpm/100 cm$^2$. The gross alpha background activity is presented for reference purposes only. The data and evaluations presented in this report did not utilize the gross alpha background for subtraction due to the fact that this value was insignificant when compared to the overall conclusions made in the report. Thus, all data tables reflect the gross alpha activity, including background.

The average background for gross beta surface activity was established as 800 dpm/100 cm$^2$. The gross beta background was subtracted from the gross beta surface activity data prior to calculation of the volumetric activity concentration of total uranium. Additional information regarding the grid areas and methods utilized to determine these background values is presented in Section 6.2.2 of the Subarea F Concrete Rubble FSSR[17].

## 3.3 Characterization Data

Throughout the decommissioning process at the Cimarron site, a survey unit was characterized, remediated (if required), and then a final status survey was performed. The description of the decommissioning activities and final status survey data were then submitted to the NRC for review and approval (i.e., FSSR). After review of the FSSR, the NRC either released the unit or contracted with Oak Ridge Institute for Science and Education (ORISE was previously ORAU) to perform a confirmatory release survey. Based upon the ORISE confirmatory survey (if requested by the NRC), the NRC would either release the unit or require additional characterization and/or remediation.

For discussion and data presentation, Subarea H has been divided into survey units as follows:

- Affected area along ridge/cliff and a small area of the Cimarron River floodplain at the base of the cliff;
- Former East and West pipeline runs to the Cimarron River;
- Drainage areas, including supplemental data along a berm and drainage boundary;
- Unaffected areas;
- Concrete utilized for riprap within a drainage area; and
- Cimarron River sediment sample locations.

### 3.3.1 Affected Area Along Ridge/Cliff Above Cimarron River Floodplain

This unit includes the ridge and cliff just north of Subarea L and encompasses the former East and West Sanitary Lagoons and the small contiguous area surrounding three sides of Uranium Waste Pond #1 (Subarea O). Also included is a small portion of the floodplain just below the cliff.

The East and West Sanitary Lagoons initially received all liquid waste from the Uranium plant from 1966 to 1970. In 1970, all liquid process type wastes from the Uranium plant were diverted to other evaporation ponds located on-site. From 1970 until 1985 only septic tank drains and the site laundry, laboratory and floor drains discharged to the East and West Sanitary Lagoons. Both the East and West Sanitary Lagoons were isolated early in 1986, remediated and characterized as discussed below.

In 1990, soil samples were collected on a 5 meter grid to a depth of four feet within the perimeter of the two remediated Lagoons. Additionally, the areas surrounding the Lagoons were cored on a 10 meter grid to a depth of four feet for sample collection and analysis. This data was presented in Section 11.0 of the Cimarron Characterization Report[5]. All soil samples collected during this sampling event were below the BTP Option #1 limit of 30 pCi/g total uranium above background. Confirmatory surveys on the Lagoons were conducted by ORAU in 1990. Based upon these confirmatory radiological surveys by ORAU[33], the East and West Sanitary Lagoons were released for backfilling by the NRC with the issuance of Amendment #9 to Cimarron's License SNM-928 on December 28, 1992[34]. (NOTE: NRC's letter transmitting license was dated December 30, 1992.) This Amendment added a license condition (i.e., Condition #22) for final closure of the two Lagoons. It required a survey and analysis of the soils utilized for the cover. The survey was to include a walkover survey with a gamma scintillation instrument and an isotopic analysis of the soils. Also, soil analyses were to be performed to satisfy the Oklahoma State Department of Health requirements to demonstrate the absence of potentially toxic substances or any other nonradioactive constituents in the fill and cover soil.

As discussed in this FSSR, the surface area for these two Lagoons has been surveyed in accordance with License Condition #22 and the NRC approved Phase II FSSP. With approval of this FSSR, License Condition #22 would be satisfied. The Oklahoma

Department of Health's requirements for testing the cover soils were satisfied as discussed by Cimarron's letter[35] of June 1993 to the State. This entire survey unit, including the East and West Sanitary Lagoons, was surveyed in accordance with the Phase II FSSP. The FSS data for this unit is discussed in Section 5.2.1.

### 3.3.2 Former East and West Pipeline Runs to the Cimarron River

The West pipeline was a four-inch diameter steel drain line that was used for liquid effluent discharges from the Sanitary Lagoons to the Cimarron River during facility operations. This former pipeline is shown on Drawing No. 95MOST-RF3. The effluent was sampled prior to discharge to ensure that it met license effluent release limits. Both of the East and West Sanitary Lagoons were isolated in 1977 to prevent discharges to the Cimarron River from this West pipeline. This drain line was excavated and removed in June 1985. Surveys were performed on the excavated areas and soils at the time of removal prior to backfilling. These survey results are discussed further in Section 15.0 of the Characterization Report.

After backfilling, Cimarron personnel surveyed, cored, and sampled the length of the area previously traversed by this drain line. The surveys and soil samples were completed in late June 1994, and were taken at 10 m intervals throughout the entire length of the previously excavated and backfilled pipe run. Soil samples were collected at depths from 0 to 4 feet, at one foot intervals for analyses. This characterization data is presented in Section 15.0 of the Characterization Report. A total of 480 soil samples were collected and analyzed for total uranium. The average total uranium concentration for all soil samples was 8.7 pCi/g. Four samples exceeded the 30 pCi/g above background Option #1 limit and are listed below:

| Location | Depth Interval | Activity (pCi/g) |
|---|---|---|
| 395N-105E | 1' – 2' | 37 |
| 425N-104E | 1' – 2' | 52 |
| 455N-102E | 1' – 2' | 52 |
| 835N-33E | 3' – 4' | 59 |

These four areas, which were addressed prior to performing the final status survey for this survey unit, are discussed along with the West pipeline survey data in Section 5.2.2. Two of the three samples collected at the 1 to 2-foot depth between 395N and 455N are located in the drainage way at the base of the bluff.

The East pipeline was a six-inch diameter PVC drain line that was used for liquid effluent discharges from Waste Pond #1 to the Cimarron River. This drain line was utilized for only two discharges from Waste Pond #1 to the Cimarron River. A review of the records for these two discharges to the Cimarron River from Waste Pond #1 indicated that no liquids with concentrations greater than 1.0 MPC were released to the Cimarron River. One release consisted of approximately 1,600 gallons of water with a concentration of 0.9 MPC and the other release consisted of approximately 775 gallons of water with a concentration of 0.68 MPC.

Excavation and removal of the East pipeline was completed in June 1985 along with the associated 1-inch siphon drain line. A gamma survey was conducted within the excavation after the drain lines were removed. The survey was taken at the bottom, at the surface, and at one meter above the surface of the excavated area. These survey results are presented in Section 15.0 of the Characterization Report.

To verify the 1985 survey data, soil sampling of the former East pipeline traverses was completed in June 1994 with samples collected at 10 m intervals. Soil samples were collected at depths from 0 to 4 ft. A total of 74 locations were surveyed and 355 soil samples were collected and analyzed for total uranium and thorium. The soil samples all were less than 30 pCi/g total uranium above background, with the average being 8.4 pCi/g. The analytical results for total thorium were all within the range of 0 to 2 pCi/g. The soil sample results are discussed in Section 15.0 of the Characterization Report. The final status survey data for the East pipeline and siphon line are discussed in Section 5.2.2.

### 3.3.3 Drainage Areas

There are three affected drainages that discharge north and east from the former operating site area. These drainages flow through the adjoining cliffs and bluffs and then combine to flow north and east across the Cimarron River floodplain into Subarea G. These drainages were included in the 1979 site-wide random micro-R survey discussed in the Characterization Report. The limited micro-R survey results were representative of background. These drainages were included as affected areas because of their potential to receive run-off from the operating facility. Adjacent to the drainages are several areas that were designated as unaffected areas by Cimarron, but received more frequent surveying than required by NUREG/CR-5849. These areas were included within this survey unit and evaluated separately from the affected areas. Both the affected and unaffected final status survey data for these drainage areas are addressed in Section 5.2.3 of this Report.

### 3.3.4 Unaffected Areas

With the removal of the areas discussed previously in Section 3.3.1 through 3.3.3 all remaining areas within Subarea H were classified as unaffected and surveyed accordingly. Cimarron previously has not performed characterization surveys for these unaffected areas; though these areas were included in the site-wide micro-R survey that was completed in 1979. The limited micro-R survey results were representative of background. The final status survey data for the unaffected areas are discussed in Section 5.2.4.

### 3.3.5 Concrete Utilized for Riprap Within a Drainage Area

A small amount of the concrete surveyed and released from the Uranium Building was placed within Subarea H drainage area for erosion control. This concrete is located in the East Drainage at approximately 410N-380E, and covers an area of approximately 111 $m^2$ as shown on Drawing No. 98POAHCONC-0 included in Appendix 6. This concrete was

surveyed for gross alpha surface activity and met the applicable criteria for free release prior to being placed within the drainage area. This concrete is discussed further in Section 5.2.5.

### 3.3.6 Cimarron River Sediment Sample Locations

River sediment samples upgradient from the site, downgradient from the discharge point of the former East and West pipelines, from the two western site drainages, and at the western site boundary were collected for analysis as part of the final status survey of Subarea H. These sediments had not been characterized prior to this sampling event. The final status survey data collected for the River sediments are discussed in Section 5.2.6.

## 3.4 Environmental Monitoring Data

As previously discussed with the NRC's staff, Cimarron Corporation has committed to address groundwater for the site in a separate report. This report is titled, "Decommissioning Plan – Groundwater Evaluation Report", and was submitted to the NRC in July 1998[36]. This Groundwater Report evaluates the site environmental data, presents trending analyses and a dose assessment, and commits to a plan for resolving issues dealing with elevated areas of residual groundwater contamination. The monitoring wells which are located within Subarea H are Wells #1313, #1332, #1333, and #1334 (see Drawing No. 95MOST-RF3 for locations).

# 4.0 FINAL STATUS SURVEY PROCEDURE

The purpose of this section is to discuss the methodology utilized for the collection of the survey and soil sampling data presented as FSS data in this report. The methodology employed is similar to that utilized for the release of other subareas on site. The final status survey data were used to demonstrate that the applicable radiological parameters (guideline values) were satisfied for release of this subarea from License SNM-928. The guideline values utilized for comparison to the final status survey data are described in this section.

In general, for Phase II areas, Cimarron Corporation has committed to follow the methodology prescribed in NUREG/CR-5849[37] and as approved in the Phase II FSSP for performing the FSS. This report includes all necessary data to support the final status survey for the surface and subsurface soils contained within Subarea H and the unrestricted release of this subarea from License SNM-928.

## 4.1 Survey Method

In general, survey and soil sampling data were collected utilizing established methods that have been demonstrated through the release of other areas at the Cimarron site. The instrumentation available for use by site personnel as well as the minimum detectable activity (MDA) and typical efficiency for those instruments are listed in Table 4.1. The survey methods are discussed further below:

# TABLE 4.1

## RADIATION MONITORING INSTRUMENTS

| INSTRUMENT TYPE | NUMBER AVAILABLE | RADIATION DETECTED | SCALE RANGE | BKG | TYPICAL EFFICIENCY | TYPICAL MDA 95% CONFIDENCE LEVEL |
|---|---|---|---|---|---|---|
| Scintillation (Ludlum 2224)<br>Scaler/Ratemeter | 2 | Alpha<br>Beta | 0-500,000 cpm | < 10 cpm<br>< 300 cpm | 20%<br>19% | 100 dpm/100 $cm^2$<br>500 dpm/100$cm^2$ |
| Micro-R Meter (Ludlum 12 & 19)<br>1" x 1" Nal Detector | 3 | Gamma | 0 – 5,000 µR/h | 7 µR/h- 9 µR/h | N/A | 2 µR/h |
| Ion Chamber (Victoreen) | 1 | Gamma | 0.1 - 300 mR/h | <.0 1 mR/h | N/A | < 0.2 mR/h |
| 3" x 1/2" Nal Scintillation (43-82)<br>Digital Scaler (Ludlum 2220/2221) | 3 | Gamma | 0 - 500,000 cpm | 3,000 cpm avg shielded<br>9,000 cpm avg unshielded | N/A | 250 cpm<br>500 cpm |
| 100 $cm^2$ gas flow (43-68)<br>Digital Scaler (Ludlum 2220/2221) | 2 | Alpha | 0 - 500,000 cpm | <10 cpm | 20% | 100 dpm/100 $cm^2$ |
| 60 $cm^2$ gas flow (43-4)<br>Digital Scaler | 1 | Alpha | 0 - 500,000 cpm | <10 cpm | 25% | 200 dpm/100 $cm^2$ |
| 60 $cm^2$ Count Rate<br>Meter (PRM-6) | 7 | Alpha | 0 - 500,000 cpm | <100 cpm | 50% | 350 dpm/100 $cm^2$ |
| 50 $cm^2$ Personnel Room<br>Monitor (Ludlum 177) | 2 | Alpha | 0 - 500,000 cpm | <100 cpm | 50% | 500 dpm/100 $cm^2$ |
| Tennelec LB5100 Computer<br>Based Auto Sample Counter | 1 | Alpha<br>Beta | 0 - 99,999,999<br>cpm | <0.3 cpm<br>1.5 cpm | 38%<br>42% | 0.4 dpm<br>1.5 dpm |
| Soil Counter - Computer Linked<br>4" x 4" x16" Nal (Tl) Detector | 1 | Gamma | — | 4 pCi/g Total U<br>1.5 pCi/g Th (Nat) | 4%<br>15% | 5 pCi/g U (5 min. count)<br>0.6 pCi/g Th (Nat) (5 min. count)<br>3 pCi/g U (15 min. count)<br>0.3 pCi/g Th (Nat) (15 min. count) |
| 100 $cm^2$ gas flow (43-68)<br>Digital Scaler (Ludlum 2220/2221) | 2 | Beta, Gamma | 0 - 10,000 cpm | <300 cpm | 20 | 600 dpm/100 $cm^2$ |
| *Reuter-Stokes PIC Model RSS-112 | 1 | Gamma | 0 - 100 mR/h | 9 – 10 µR/h | N/A | 0.5 µR/h (10 min. count) |

*(Cushing Instrument available for Cimarron Use)

### 4.1.1 Grid Areas

Subarea H was subdivided into the 100 m x 100 m grid pattern shown on Drawing No 95MOST-RF3. The 100 m x 100 m grids were further subdivided for affected area surveys into 10 m x 10 m grids. For systematic surveys the 10 m grids were further subdivided into 5 m x 5 m grids. The 5 m x 5 m grids were utilized for locating survey and soil sampling points for this final status survey. Cimarron employs a Global Positioning Survey (GPS) unit to check pre-established grid points and to locate sample collection and survey positions in the field. This GPS unit is accurate to within less than ± 1 m. The 0.0 grid point is located just south and slightly west of the main Uranium Building. This grid point has been tied into a permanent marker for future reference.

### 4.1.2 Survey Locations (Open Land Areas)

In general, the affected subarea surfaces were 100% scanned utilizing a 3" x 1/2" unshielded NaI detector and the unaffected subarea surfaces were 10% scanned. The specific instruments used were selected by the RSO/Health Physics Supervisor.

Where possible for affected areas, the 10 m x 10 m grids were surveyed by technicians by traversing back and forth within each grid area. Each traverse performed by the technician covered an area approximately 2 meters in width. In some cases, grid areas were less than ten (10) meters in width; thus requiring fewer traverses. The highest reading found within each 10 m x 10 m grid area or approximate ten (10) meter length was recorded. For an unaffected area, the technicians, in general, walked each 20 m north/south grid line surveying an area of approximately 2 meters. Survey performance, documentation, and record retention was performed in accordance with the Cimarron Radiation Protection Program. In the event that any of the survey readings exceeded the limits discussed in Section 4.2.3, their location was flagged for additional surveys and/or soil sampling. The survey procedures followed were specified in Cimarron's Special Work Permit(s) and Work Plan(s) for this subarea.

Additionally, within the affected subareas, at the intersect of each 5 m x 5 m grid location, a systematic survey was completed at ground surface and at 1 m above the surface for ambient radiation using a micro-R meter. Also, a gamma survey at the ground surface, using a shielded or unshielded 3" x 1/2" NaI detector was performed and documented. For unaffected areas each random soil sample location was surveyed as noted in Section 4.1.3.

### 4.1.3 Soil Sample Locations

The soil sampling frequency was specified in the Cimarron Special Work Permit(s) and Work Plan(s). For the unaffected area, a minimum of thirty surface soil samples (0 to 6 inches deep) were collected within the boundary of Subarea H. The samples from the designated unaffected area were selected from the 10 m x 10 m grid intersect points within the unaffected area utilizing a random number generator. All soil samples were analyzed for total uranium and natural thorium using the on-site soil counter.

Where practicable, for affected areas, surface soil samples were collected at each 5 m x 5 m intersect location and at 5 meter intervals along the length of drainage ways and pipeline runs when the width of such affected areas were less than 5 meters. Additionally, systematic and random subsurface soil sampling to a depth of 4 feet was performed at selected locations within the affected areas. Random subsurface samples were collected at a frequency of one (1) out of every twenty (20) 5 m x 5 m grid point located within this Subarea H open land affected area. One sample location out of every twenty (20) 5 m x 5 m grid areas equates to one (1) sample location for every 500 square meters. All soil samples collected were analyzed for total uranium and thorium using the on-site soil counter. Any locations found exceeding the soil guideline values discussed in Section 4.2.2 for either affected or unaffected areas were investigated further. The areas of the site formerly occupied by the East and West Sanitary Lagoons and the pipelines were previously sampled at depth and thus were not included in the final subsurface sampling event.

### 4.1.4 Concrete Survey Locations

A grid system was established for the concrete rubble so that each grid area could be easily located in the future for additional survey work and/or confirmatory surveys. The concrete grid system consists of irregular shaped grids which range from $3m^2$ to $7m^2$ in area. The width of each grid is 1m and the length of the grids range from 3m to 7m with the length determined by the amount of concrete riprap across the drainage area.

Each grid area was then 100% scanned over the accessible surfaces for gross beta-gamma activity to identify any elevated areas of activity. Any location within each grid that exceeded 5,000 dpm/100cm$^2$ was documented on survey forms. The 5,000 dpm/100cm$^2$ cut-off value was chosen as an action level for recording data because it represents the unconditional release surface activity criteria (average) for total uranium. (Note: There were no areas identified which exceeded 5,000 dpm/100cm$^2$). In addition, the final release of the concrete riprap is based upon the BTP Option 1 volumetric criteria, which is 30 pCi/g above background for total uranium.

Gross alpha scans to identify elevated locations were also performed, although gross alpha scanning over rough surfaces has not proven to be an effective method due to the effects of geometry (source to detector distance) and attenuation (shields the alpha particles before they are able to reach the detector). The survey data for areas containing elevated measurements of gross beta-gamma activity versus the gross alpha measurement results provides evidence of this (see Table 5.8).

In addition to gross alpha and gross beta-gamma measurements, exposure rate measurements were obtained at the surface of the concrete and at a height of one meter. The surveys performed on each grid section can be summarized as follows:

- The average gross beta-gamma dpm/100cm$^2$ was measured.
- The maximum gross beta-gamma dpm/100cm$^2$ was measured.
- The average gross alpha dpm/100cm$^2$ was measured.

- The maximum gross alpha dpm/100cm$^2$ was measured.
- A μR/hour reading at the surface and at one meter above the surface directly above the location with the highest gross beta-gamma activity was measured.

Surface activity measurements for gross beta-gamma were obtained using a Ludlum Model 2221 with a Model 43-68 gas proportional probe, or equivalent (e.g., Ludlum Model 43-89). Gross alpha surface scans were obtained using a Ludlum Model 2220/2221 with a Model 43-68 gas proportional probe. Micro-R measurements were obtained utilizing a Ludlum Model 19. The top surface and any other accessible concrete surfaces were surveyed. The intent of the survey was to be representative of the concrete rubble as a whole, through the use of standard survey techniques and the application of reasonable calculational assumptions.

Removable contamination measurements were not obtained due to the fact that the concrete has been in the drainage area for over 10 years. It was determined that any potentially removable contamination remaining would have been removed by environmental interactions. Monitoring of soils and sediments downstream of the concrete provided confirmation that removable contamination has not contributed to natural concentrations of uranium in downstream soils and sediment.

Exposure rate measurements were obtained at the surface of the concrete and at one meter above the concrete surface utilizing a sodium iodide based micro-R meter, or equivalent. These measurements support the position that the concrete rubble does not pose an external dose hazard and that exposures are similar to background.

An environmental thermoluminescent dosimeter (TLD) was placed near the concrete rubble to support the results of the exposure rate measurements and to demonstrate that there are not any seasonal or long-term upward trends in exposure rates. Data from the TLD are compared to site background area TLD measurements.

Nine soil/sediment samples were collected from the concrete rubble area to demonstrate that the concrete is not contributing to naturally occurring levels of uranium and thorium present in the sediment. One soil/sediment sample was collected up-gradient of the concrete, one sample immediately down-gradient in a location likely to collect sediments, and seven samples from soils and sediments beneath or within the concrete rubble. All samples were analyzed for total uranium and thorium activity utilizing the Cimarron soil counter. One upgradient sample, one downgradient sample, and one sample collected from within the concrete rubble were also sent to an independent off-site laboratory for analysis.

## 4.2 Radiological Guideline Values

The radiological guideline values discussed in this section were utilized for comparison with the final survey data in order to confirm that Subarea H can be released from License SNM-928.

### 4.2.1 Equipment and Materials

The release limits for contamination of all materials and equipment is in compliance with Facility License SNM-928 and is identical to the limits specified in Table 1 of the NRC's "Guidance for Decommissioning of Facilities and Equipment Prior to Release for Unrestricted Use"[38]. Subarea H contains no buildings or equipment and therefore these types of surveys were not applicable.

### 4.2.2 Volumetric Activity of Soil

For Subarea H, the guideline value for residual concentrations of total uranium which may remain in the soil is specified as BTP[39] Option #1 material. For enriched uranium, as specified in Table 2 of the BTP, the Option #1 limit is 30 pCi/g total uranium above background. The average uranium background has been established at 4 pCi/g. The maximum enriched uranium soil concentration within any 10 m x 10 m grid area may not exceed three times the BTP Option #1 limit (90 pCi/g total uranium above background). For affected areas, systematic soil sampling was performed within each 10 m x 10 m grid area to determine the average value for residual activity. This systematic sampling equates to four surface samples per 100 $m^2$ area; which is the same sample frequency as one sample collected at the intersect of each 5 m x 5 m grid. Areas of elevated activity were determined based upon discrete sampling within the grid or were assumed to have a constant value (e.g., 25 $m^2$ based upon 5 m x 5 m grid sampling frequency). The average value for the 10 m x 10 m grid then was compared to the BTP Option #1 guideline value of 30 pCi/g total uranium above background. Remediation or hot spot averaging was performed for each individual location which contained average total uranium concentrations in excess of 30 pCi/g above background as described in NUREG/CR-5849. Areas of elevated activity not remediated between one and three times the guideline value was tested to assure that the average concentration was less than $(100/A)^{1/2}$ times the guideline value, where "A" is the area of elevated activity in $m^2$.

The Option #1 guideline value for residual concentrations of thorium, which may remain in soil per Table 2 of the BTP, is up to 10 pCi/g above background. The average background for natural thorium has been determined to be 1.5 pCi/g for soil analyzed with the on-site counter.

For an unaffected area, NUREG/CR-5849 recommends reclassifying an area if any individual sample result exceeds 75% of the guideline value (i.e. 22.5 pCi/g total uranium above background for BTP Option #1 enriched uranium). Prior to reclassifying any unaffected area as an affected area, the NRC also recommends investigating any individual sample analysis result which exceeds 25% of the guideline value. The average total uranium concentration in background soil, as determined by the Cimarron soil counter (Counter #1) when calibrated for 2.7% enriched uranium, is approximately 4.0 pCi/g. The total uranium concentration corresponding to 25% of the guideline value of 30 pCi/g is 7.5 pCi/g. This value is then added to the average background value for the Cimarron site to derive the corresponding limit of 11.5 pCi/g total uranium. Therefore,

any soil samples in unaffected areas with total uranium concentrations greater than 11.5 pCi/g were investigated further.

### 4.2.3 Gamma Surface Survey (Open Land Areas)

Cimarron personnel utilize a shielded or unshielded 3" X 0.5" sodium iodide (NaI) detector as a final screening device for qualitative identification of residual contamination in soil. Prior to the commencement of site-wide remediation, Cimarron evaluated several portable survey instruments for performing scan surveys including the 2" x 2" NaI detector. Based upon recommendations from Ludlum Instruments, Inc. Cimarron decided to use an unshielded 3" x 0.5" NaI detector for general area scans. This system is one of the more sensitive detection systems available to Cimarron.

Since the inception of Cimarron site decommissioning, twice background has been used as the guideline for scan surveys when utilizing the 3" x 0.5" NaI detector. This guideline has been a standard in the nuclear industry for many years. With the submittal and approval by the NRC of numerous plans and reports, twice background also has become the accepted standard for the Cimarron Facility as a qualitative screening device. This qualitative guideline was included in the Phase I Final Status Survey Plan[7], Phase I Final Status Survey Report[10], and the Phase II Final Status Survey Plan[12] just to name a few of the documents where this guideline was addressed and approved by NRC staff for this site.

Twice background (as noted in Section 6.4.2 of NUREG/CR-5849) is at the lower end of the range discernable for scanning instrumentation. During the scan survey the technician upon noting a "discernable" difference in the audio output from the meter will stop and attempt to locate the elevated area. It is difficult to discriminate low levels of residual uranium contamination when other naturally occurring isotopes are present which affect the gross count rate of the scan instrument. However, this guideline value seems to provide a sufficient margin for technicians when conducting a scan to conclude that residual contamination may be present when a signal exceeds the twice background level (i.e., a discernable audible increase above background). This discernable audible response alerts the surveyor to momentarily stop moving the probe (i.e., 2 to 3 seconds) and to investigate the response. The survey instruments utilized at Cimarron indicate changes in radioactivity levels via either a higher or lower pitch. These changes in pitch are easier to detect rather than simply noting a change in the audible count rate.

Based upon data presented in the Phase I FSSR, Cimarron determined that background for the unshielded NaI detector varies across the site from approximately 5,230 CPM to 11,950 CPM. The average background is 8,580 CPM with a standard deviation of 1,614 CPM. Additionally, "daily" background surveys were taken prior to performing surveys within a survey unit. These average "daily" backgrounds are listed on the data tables and drawings and were used for comparison to the guideline (i.e., twice background).

The unshielded detector was utilized to perform the initial 100% surface scan survey for affected areas of Subarea H to identify regions or areas of slightly elevated activity. Either the shielded or unshielded detector was utilized for systematic surveys at grid

intersects to identify elevated areas. As stated above, these instruments are only utilized for qualitative measurements. Quantitative measurement of residual contamination levels in soil is performed with the Cimarron soil counter.

### 4.2.4 Exposure Rate Survey (Open Land Areas)

For Subarea H releases for unrestricted use, the average exposure rate may not exceed 10 μR/h above background, at 1 meter above the surface. Exposure rates may be averaged over a 100 $m^2$ grid area as described in NUREG/CR-5849. The maximum exposure rate at any discrete location within a 100 square meter area cannot exceed 20 μR/h above background. Any area with average exposure rates greater than 10 μR/h above background and any discrete location within a 100 square meter area with an exposure rate greater than 20 μR/h above background was delineated and remediated as required. Cimarron has in the past measured 7 μR/h as the average background exposure rate. However, as discussed in Section 3.2.2, since sending their micro-R meters off-site for calibration by the manufacturer, Cimarron has demonstrated that 9 μR/h is representative of the average background exposure rate for micro-R measurements. The tables and drawings included in the Appendices will list the average background for the micro-R meter used in developing the tabulated survey data.

### 4.2.5 Concrete Utilized for Riprap

#### 4.2.5.1 Relationship Between Surface Activity and Concentration

A special study was conducted to determine the depth profile of the contamination in the concrete and for the purpose of establishing a relationship between gross beta-gamma surface activity (measured in dpm/100$cm^2$) and uranium concentrations (measured in pCi/g). Full details of this study are provided in the Subarea F Concrete Rubble FSSR[17]. The results of the special study are presented in Section 5.2.5.6.

#### 4.2.5.2 Guideline Values

The radiological guideline values discussed in this section are utilized for comparison to the final survey data to verify that the concrete rubble in Subarea H can be released from License SNM-928.

NUREG/CR-5849[37], Section 2.2, states that "Volume concentration guideline values, which apply to soil, induced activity, and debris, are expressed in terms of activity per unit mass [typically picocuries per gram (pCi/g).]". Cimarron Corporation has established the release guideline values for concrete in Subarea H in accordance with the Branch Technical Position[38] (BTP) Option #1. The BTP Option #1 criteria is 30 pCi/g total uranium (enriched), above background.

The overall objective of the survey effort was to demonstrate that the release guideline values were complied with. Due to the nature of the sampling performed, the methods of NUREG/CR-5849 for "hot-spot" averaging were not directly utilized. Rather,

justification that the overall average concentration meets the release criteria (i.e., BTP Option #1 guideline value) is provided herein. This was determined to be appropriate based upon the characteristics of the concrete rubble and the low probability that a portion of the concrete rubble would be extracted and used in a manner that would result in inadvertent exposure.

## 4.3 Equipment Selection

Special Work Permits (SWP) and Work Plans (WP) were written and approved prior to commencement of the field work required for this final status survey. The SWP and/or WP for this project specified the type of instrumentation to be utilized in performing the site surveys. The instrumentation utilized by site personnel is discussed further below:

### 4.3.1 Equipment and Instrumentation

The instrumentation utilized to generate the final survey data discussed herein was calibrated and maintained by site personnel in accordance with the Cimarron Radiation Protection Program procedures. These procedures utilize the guidance contained in ANSI N323-1978[40], "Radiation Protection Instrumentation Test and Calibration". Specific requirements, as specified by the Cimarron procedures for instrumentation, include traceability of calibrations to NIST standards, field checks for operability, background radioactivity checks, operation of instruments within established environmental bounds, training of individuals, scheduled performance checks, calibration with isotopes of energies similar to those to be measured, quality assurance tests, data review, and recordkeeping. An explanation of how Cimarron's Radiation Protection Program procedures are implemented with respect to instrumentation was discussed in Cimarron's responses to the NRC dated May 13, 1998[41].

With the exception of the exposure rate instrumentation (ion chamber, PIC and micro-R meter), Cimarron health physics staff performs in-house calibration on each of the instruments listed in Table 4.1. These portable survey instruments are calibrated on a quarterly basis. The exposure rate instruments are sent off-site for vendor calibration on a semi-annual basis. Where applicable, activities of sources utilized for on-site calibration are corrected for decay. In addition to the periodic calibration requirements, source response checks are performed on a daily basis for all instruments being utilized during characterization, remediation and final status survey work.

All calibration and source check records are completed, reviewed, signed-off and retained in accordance with the Cimarron Quality Assurance Program. The instrumentation utilized by site personnel is discussed below.

#### 4.3.1.1 Unshielded 3" x 0.5" NaI Gamma Detector

The 3" x 0.5" detector is a sodium iodide (NaI) crystal gamma detector which is unshielded around the sides. The NaI detector is utilized with a portable scaler/ratemeter that has single channel analyzer capability. Americium-241, Uranium-235, and Natural Thorium sources are utilized to set the instrumentation window and threshold to detect

gamma energies in the range of 50 to 250 keV. This energy range corresponds to the energies of interest when surveying for uranium and natural thorium contamination. The instrument is normally operated in the window "out" mode, meaning that the instrument response is for the entire range of detectable energies.

4.3.1.2 Shielded 3" x 0.5" NaI Gamma Detector

The 3" x 0.5" detector is a NaI crystal gamma detector which is shielded with lead around the top socket and sides to improve the directional sensing capabilities of the equipment. Similar to the unshielded detector, the shielded detector is utilized with a portable scaler/rate meter that has single channel analyzer capacity. This instrument is normally utilized in areas where background may be elevated.

4.3.1.3 Micro-R Meters

The micro-R meter is a 1" x 1" NaI crystal gamma detector which measures exposure rates between 0 and 5,000 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 identified by area scans.

Confirmatory measurements are obtained routinely to provide information concerning any measurement bias. These comparisons or confirmatory measurements are made using a pressurized ion chamber. Confirmatory measurements for site background are included in Table 3.

4.3.1.4 Soil Counter (Gamma Spectroscopy)

The Cimarron Soil Counter 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). Cimarron's counting system is programmed to determine the total uranium present in the soil sample by calculating the U-234 activity based upon the U-235 activity measured in the soil sample. The U-234 and U-235 activities are summed with the detected U-238 activity to obtain the total U activity. The counter also adjusts for system background. Calibration of this counting system is performed annually and is traceable to NIST standards through contractor laboratory evaluations of the on-site standards.

Established quality assurance measures for the soil counter include Cesium-137 centroid checks, Chi-square tests, background determinations, and the counting of soil 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 soil counter have been analyzed by outside laboratories and are NIST traceable through these analyses. Comparisons have been made between the standards as counted using the soil counter and two off-site 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. Additional information pertaining to these standards and typical MDA calculations for the counting system were included in Cimarron's responses to the NRC's comments on Subarea J[41].

Cimarron personnel determine uranium and thorium activities based upon the evaluation of net counts from the soil counter. Activities are calculated through the use of efficiency and correction factors obtained using appropriate standards. Soil concentrations are calculated by dividing the net activity by the soil mass. Soil masses are determined on a laboratory scale which is checked on a daily basis (when in use) utilizing NIST traceable standards. Corrections for soil moisture content are also made as necessary.

ORISE has been used by the NRC for 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 measure accurately total uranium concentrations in soil 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 Counter. ORISE and Cimarron analysis results compared favorably at levels above background as demonstrated by the confirmatory analysis performed for the On-Site Disposal Cell, Pit #3 (NRC cover letter dated July 31, 1997)[42]. NRC inspection Report #70-925/97-02, which accompanied this letter, states that "no significant bias or statistical errors between the license's soil results and the NRC's results were identified". Additionally, the confirmatory analysis performed on select soil samples collected during ORISE's site visit to investigate the South U-Yard[43], and DAP-3 stockpile[44] verified previously that Cimarron's on-site counter results are statistically identical to ORISE's results.

## 4.4 Procedures/Plans

As discussed in Section 4.3, SWPs and WPs were written and approved prior to commencement of field work required for this final status survey. These SWPs and WPs are an integral part of this site's radiation protection and quality assurance program. Project organization and responsibilities, which are a part of the site's quality assurance program, are discussed in this section.

### 4.4.1 Organization

The Subarea H final status survey was performed by a survey team consisting of qualified personnel from the Cimarron site. The final survey team operated under the general direction of a Project Manager who reports directly to the Site Manager at the Cimarron Facility.

The selection of field measurement equipment and sample collection techniques was under the direction of the RSO/Health Physics Supervisor who reports to the Cimarron Site Manager. Actual field measurements and sample collection were under the direction of the Project Manager. The Project Manager was responsible for developing the SWP

and WP for this subarea with input from the RSO/Health Physics Supervisor. The SWP and WP were reviewed and approved by the Cimarron Site Manager.

### 4.4.2 Training

Cimarron Corporation provides continuing training to Cimarron personnel and any other personnel (i.e., contractors, visitors, etc.) who are allowed access to the site. All members of the final survey team attended an in-house training session on the SWP and WP prior to commencement of work under the final status survey plan. All survey procedures and quality assurance requirements were reviewed during this training session.

### 4.4.3 Radiation Protection Program

Cimarron Corporation maintains a radiation protection program that meets and/or exceeds all of the applicable regulatory requirements associated with 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 Procedures
- Cimarron Site Health and Safety Plan
- Cimarron Quality Assurance Plan and Procedures
- Cimarron Emergency Plan

It is the policy of Cimarron Corporation to perform all work in strict compliance with applicable regulatory and internal requirements. The goal of the Cimarron decommissioning effort is to conduct all operations at a level of excellence that exceeds regulatory requirements. Cimarron staff will continue to exercise appropriate radiation protection precautions throughout the remaining decommissioning work and final survey process.

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

### 4.4.4 Cimarron Quality Assurance Program (QAP)

The Cimarron Corporation QAP is an integral part of the Cimarron Radiation Protection Program. A principal component of the QAP is the confirmation of the quality of project work performed during decommissioning by assuring that all tasks are performed in a quality manner by qualified personnel. The Program ensures that samples are collected, controlled, and analyzed in accordance with applicable quality controls to provide confidence in the resulting data accuracy and validity. Cimarron's QA/QC program is

structured to generate data that can be verified by a third party review should they desire to perform an audit of the data.

The Cimarron QAP is implemented and maintained in accordance with written policies, procedures, and instructions. This Program is administered under the direction of the Quality Assurance Manager. Periodic surveillance and reviews are conducted to ensure that all aspects of the Program are addressed. The Cimarron QAP satisfies the applicable requirements of ASME NQA-1[45].

Written procedures designated as SWPs and WPs, are prepared, reviewed and approved for activities involved in carrying out the decommissioning process. The Subarea H Survey SWP and WP were written in accordance with the Cimarron QAP. These documents designate the type of surveys to be performed, samples to be collected, frequency of sample collection, and the type of field instrumentation required for the tasks required.

Selection, calibration and use of radiation detection instrumentation used for final status survey release at Cimarron are directed by the Radiation Safety Officer (RSO). The RSO is responsible for the calibration performed by Cimarron Health Physics staff or by contract services. The RSO maintains a file for each technician on staff as to their qualifications and training.

The facility performs its own radiological soil analysis in accordance with written procedures and QA/QC protocols. Field data are gathered and maintained in logs for all samples in accordance with the Cimarron QAP. Necessary data are transferred to the on-site 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 (chain of custody) and are incorporated into the facility quality assurance records.

In addition, off-site independent radiological analysis of split samples (samples are first counted on site and then sent to an off-site independent laboratory) is an integral part of the Cimarron QAP. Samples sent to an off-site independent laboratory for analysis are accompanied by a chain of custody form in accordance with the Cimarron QAP. These forms provide documentation for all aspects of sample control and are maintained by the Quality Assurance Manager as permanent records.

Sample and survey data are reviewed by the Health Physics Department for accuracy and consistency and to determine if further characterization or remediation is required or if the data is acceptable. Additionally, the data are compared to the guideline values. The data review process is to verify that approved QA/QC procedures have been followed. Reviews are performed on a regular basis. When identified, corrections to recognized deficiencies are performed.

## 5.0 SURVEY FINDINGS

As discussed in Section 1.0, final status survey data were generated for Subarea H to justify release of the area from License SNM-928. The survey findings, including the statistical methodology employed to evaluate the data for Subarea H, are discussed in this section. The survey data is discussed, evaluated and presented for the survey units outlined in Section 3.3.

### 5.1 Data Evaluation

As discussed in NUREG/CR-5849, the guideline values for soil activity concentrations and exposure rates are average values (above background) established for areas of survey units. In order to compare the analytical and survey data developed for the final status survey with guideline values; data at each individual survey grid location was compared to the respective guideline value. The guideline value for leaving soil in place is Option #1 material (up to and including 30 pCi/g total uranium above background).

For an affected area, if an individual soil activity measurement (representing $25m^2$) exceeded the applicable guideline value, then the average was determined for the survey unit (100 square meters). Areas of residual activity exceeding the guideline value, known as elevated areas, were acceptable provided they did not exceed the guideline value by greater than a factor of $(100/A)^{1/2}$, where A was the area of residual activity in $m^2$, and provided the activity level at any location did not exceed three times the guideline value. The average for the survey unit was then compared to the guideline value. If the average was below the guideline plus background, further remediation was not required and the data was presented as final status survey data.

For the unaffected areas, soil samples which exceeded 11.5 pCi/g (25% of guideline plus background) were further investigated. An unaffected area containing a soil sample with an activity greater than 26.5 pCi/g (75% of the guideline plus background) was reclassified as an affected area and surveyed as an affected area. The extent of the re-classification was based upon the accumulated survey data.

### 5.2 Comparison With Guideline Values

The data for each of the survey units for Subarea H were compared to the guideline value criteria and are discussed separately in the following section. Also, areas reclassified affected from unaffected are discussed.

#### 5.2.1 Survey Data - Affected Areas Along Ridge and Cliff

This section evaluates the data collected from both the 100% scan and the systematic survey performed at the grid intersects for this subarea survey unit which is shown on Drawing No. 98POAHASSS-O (Appendix 2). The data includes analytical soil sample results, systematic survey readings for the 5 m x 5 m grid intersects, and initial survey results from the 100% scan performed. Based upon the initial scan and preliminary soil analytical analyses, an area within Subarea H was added to this survey unit and reclassified affected from unaffected.

This unit includes the area along the ridge and cliff above and the Cimarron River floodplain and an area at the base of the cliff within the River floodplain. This area includes the former East and West Sanitary Lagoons and a large area that was reclassified affected from unaffected just north of the 335N gridline. The triangular shaped area that was reclassified consisted of approximately 1.3 acres spanning 70E to 120E and 335N to 440N. The initial scoping survey identified several areas containing residual activity above the guideline value for unaffected areas. Thus, Cimarron decided to reclassify this area as an affected area for final status surveying and added it to this survey unit.

The initial scan and soil sampling event identified twenty-one locations within this survey unit that showed soil locations exceeding the total uranium guideline values (i.e., 30 pCi/g total uranium above background which is 34 pCi/g). These locations are tabulated below (i.e., Table 5.1) and were subsequently remediated with the removal of impacted soils that were above the guideline value. The locations were again surveyed and if found to be acceptable the data was included with the final status survey data for this unit.

**Table 5.1**
**Affected Area Locations Remediated**
**(Background Included)**

| Grid Location | Depth | Total - U Original pCi/g | Corrective Action | Final Status pCi/g |
|---|---|---|---|---|
| 65E-335N | 0-6" | 35 | Remediated | 8 |
| 89E-390N | 0-6" | 49 | Remediated | 12 |
| 90E-389N | 0-6" | 92 | Remediated | 15 |
| 90E-390N | 0-6" | 72 | Remediated | 6 |
| 90E-391N | 0-6" | 42 | Remediated | 13 |
| 95E-429N | 0-6" | 62 | Remediated | 23 |
| 95E-430N | 0-6" | 38 | Remediated | 23 |
| 95E-431N | 0-6" | 35 | Remediated | 17 |
| 100E-371N | 0-6" | 36 | Remediated | 12 |
| 100E-435N | 0-6" | 63 | Remediated | 24 |
| 101E-370N | 0-6" | 88 | Remediated | 11 |
| 104E-370N | 0-6" | 42 | Remediated | 21 |
| 105E-370N | 0-6" | 40 | Remediated | 8 |
| 148.3E-316N | 0-6" | 48 | Remediated | 15 |
| 290E-250N | 0-6" | 53 | Remediated | 18 |
| 291E-250N | 0-6" | 35 | Remediated | 21 |
| 304E-465N | 0-6" | 58 | Remediated | 12 |
| 305E-464N | 0-6" | 56 | Remediated | 8 |
| 305E-465N | 0-6" | 45 | Remediated | 11 |
| 89E-387N | 0-6" | 650 | Remediated | 7 |
| 89E-389N | 0-6" | 284 | Remediated | 27 |

With the locations above remediated, a 100% scan was performed with the unshielded NaI detector prior to the systematic survey; no locations were identified that exceeded twice background. For this survey unit a "daily" average background was determined for use when comparing either scan or systematic survey results to the guideline value. The average background value is listed in the data tables and on the drawings.

For the surface sampling event, after the twenty-one locations discussed above were remediated, all soil sample analytical results for this unit were below the total uranium guideline value (i.e. 34 pCi/g total uranium including background). The soil sample analytical results for each 5 m x 5 m grid location are tabulated in tables included in Appendix 2. The soil sample locations and analytical results for total uranium are shown on Drawing No. 98POAHASSS-0. This drawing is also included in Appendix 2.

A total of 1,392 final status survey soil samples were collected at the surface for analysis; the soil analytical results ranged from 1 to 30 pCi/g total uranium. The mean value for all surface sample locations was 8.3 pCi/g total uranium, with a standard deviation of 3.8 pCi/g. The 95% confidence level value was 8.4 pCi/g, which is below the guideline values for total uranium. Also, the soil sample analytical results for this unit showed natural thorium varying from 3 pCi/g down to 1 pCi/g. The mean value was 1.5 pCi/g natural thorium, with a standard deviation of 0.5 pCi/g thorium. The statistical analyses for the soil sample data and systematic survey data are included in Appendix 2.

The systematic surveys performed for the final status survey at the grid intersects with 3" x 0.5" unshielded and shielded NaI detectors and the μR meter were all within guideline values. The exposure rates at the surface and at one meter above the surface as measured using a μR/h meter ranged from 5 to 14 μR/h, with the mean being 8 μR/h. All measured exposure rates were below the guideline value of 17 μR/h (i.e., 10 μR/h above the average background of 7 μR/h). The exposure rates are presented on Drawing Nos. 98POAHASUR-0 and 98POAHASUR-1. These drawings are included in Appendix 2. The ground level unshielded NaI detector survey results for the grid intersect sample locations ranged from 3,758 to 10,990 CPM. At seventeen locations a shielded NaI detector was used to perform the survey with readings ranging from 4,520 to 5,440 CPM. All survey results were less than twice background. The survey results are presented on Drawing No. 98POAHAS3D-0 included in Appendix 2.

Subsurface soil samples also were collected within this affected area. At seventy-two locations, shown on Drawing No. 98POAHADSS-0, samples were collected and composited at intervals of 0-6", 6"-1', 1'-2', 2'-3' and 3'-4' or to rock. These samples were collected to satisfy the Phase II FSSP requirement that area subsurface samples be collected at 500 $m^2$ intervals or less if not previously surveyed, and also to further investigate several surface sample locations. Subsurface soil samples were not collected within the perimeter of the East and West Sanitary Lagoons as they were previously sampled and decommissioned per NRC approval in December 1992[34].

A total of 307 subsurface soil samples were collected for analysis, the soil analytical results ranged from 1 to 33 pCi/g total uranium. The mean value for all sample locations

was 9.1 pCi/g total uranium, with a standard deviation of 3.7 pCi/g. The 95% confidence level value was 9.4 pCi/g, which is below the guideline values for total uranium. Also, the soil sample analytical results for this data set showed natural thorium varying from 2 pCi/g down to 1 pCi/g. The mean value was 1.5 pCi/g natural thorium, with a standard deviation of 0.5 pCi/g thorium.

The subsurface sampling included one location that was remediated, 305E-465N. This general location was sampled extensively on a 5 m grid to depth as shown on Drawing No. 98POAHADSS-0. This sampling was performed after the area was remediated. A total of eighteen locations were sampled as shown on the referenced drawing. In addition, the subsurface sampling event included off-set samples collected and analyzed around one location which showed a 33 pCi/g total uranium at a depth of 1'-2'. The sample location (i.e., E120-N318) and analytical results are shown on Drawing No. 98POAHADSS-0. The off-set sampling was performed for further investigation even though the 33 pCi/g was below the guideline value of 30 pCi/g above background.

Drawing No. 98POAHADSS-0 illustrates that rock was encountered at varying depths as subsurface samples were collected. This drawing and the data tabulation sheets and statistical analyses are included in Appendix 2. All final status sample analytical results were less than the guideline value of 30 pCi/g total uranium above background. All sample results are presented as total uranium and include background.

### 5.2.2 Survey Data – East and West Pipeline Runs

This section evaluates the data collected from both the 100% scan and the systematic survey performed at the grid locations for this affected subarea unit which is shown on Drawing No. 98POAHPLSS-0. The data includes analytical soil sample results, systematic survey readings for the 5 m linear grids, and initial survey results from the 100% scan performed. The data were evaluated in two data sets, the East pipeline run to the River and the West pipeline run to the River.

As discussed in Section 3.3.2, four locations were identified during the characterization survey that exceeded the 30 pCi/g above background guideline for total uranium. The four locations are tabulated below in Table 5.2.

**TABLE 5.2**
**SURVEY LOCATIONS**

| Grid Locations | Total –U Original (pCi/g) | Corrective Action |
|---|---|---|
| 395N-105E | 37 | Remediated to rock |
| 425N-104E | 52 | Remediated to 10 pCi/g |
| 455N-102E | 52 | Remediated to 4 pCi/g |
| 835N-33E | 59 | Resampled/not found |

Three of the locations were remediated by the removal of surface and subsurface soil. Remediation depths varied from the surface down to approximately two feet. The

location at 835N was resampled to a depth of 5' in sample increments of one foot. The five samples ranged from 4 pCi/g total uranium to 10 pCi/g, and averaged 6.8 pCi/g total uranium. The location also was off-set sampled at 2 meter intervals to a depth of 5 feet with similar results. Since the previous sample result could not be duplicated; no further action was taken for this location.

The 100% scan that was performed on both former East and West pipeline runs with the unshielded NaI detector prior to the systematic survey identified no locations that exceeded twice background.

For both the East pipeline and West pipeline sampling events surface samples were collected at 5 m intervals. The survey results show that all soil sample analytical results for these two data sets were below the total uranium guideline value (i.e. 34 pCi/g total uranium including background). The soil sample analytical results for each 5 m grid location are tabulated in tables included in Appendix 3. The soil sample locations and analytical results for total uranium are shown on Drawing No. 98POAHPLSS-0. This drawing also is included in Appendix 3.

For the West pipeline, a total of 193 surface samples were collected at 5 meter intervals along the length of the former pipeline run for analysis. The soil sample analytical results ranged from 3 to 32 pCi/g total uranium. The mean value for all sample locations was 8.7 pCi/g total uranium, with a standard deviation of 4.2 pCi/g. The 95% confidence level value was 9.2 pCi/g which is below the affected area guideline value for total uranium. Also, the soil sample analytical results for this data set showed natural thorium varying from 2 pCi/g down to 1 pCi/g. The mean value was 1.1 pCi/g natural thorium, with a standard deviation of 0.3 pCi/g thorium. The statistical analyses for the soil sample data and systematic survey data are included in Appendix 3.

The systematic surveys performed at the grid intersects with 3" x 0.5" shielded and unshielded NaI detectors and the micro-R meter were all within guideline values. The exposure rates at the surface and at one meter above the surface as measured using a μR/h meter ranged from 5 to 15 μR/h and from 4 to 15 μR/h respectively, with the mean being 8 μR/h at the surface and 7 μR/h at 1 m above the surface. All measured exposure rates were below the guideline value of 17 μR/h (i.e., 10 μR/h above the average background of 7 μR/h). The exposure rates are presented on Drawing Nos. 98POAHPLUR-0 and 98POAHPLUR-1. These drawings are included in Appendix 3. The ground level NaI detector survey results for the grid intersect sample locations ranged from 4,268 to 8,988 CPM for the unshielded detector, and from 3,950 CPM to 4,930 CPM for the eleven locations surveyed with the shielded detector. All survey results were less than twice background. The survey results are presented on Drawing No. 98POAHPL3D-0 which is included in Appendix 3.

For the East pipeline, a total of 177 surface samples were collected at 5 meter intervals along the length of the former pipeline run for analysis. The soil analytical results ranged from 3 to 23 pCi/g total uranium. The mean value for all sample locations was 8.3 pCi/g total uranium, with a standard deviation of 2.6 pCi/g. The 95% confidence level value

was 8.7 pCi/g which is below the guideline values for total uranium. Also, the soil sample analytical results for this data set showed natural thorium varying from 1 pCi/g to 3 pCi/g. The mean value was 1.3 pCi/g natural thorium, with a standard deviation of 0.5 pCi/g thorium. The statistical analyses for the soil sample data and systematic survey data are included in Appendix 3.

The systematic surveys performed at the grid intersects with 3" x 0.5" unshielded and shielded NaI detectors and the μR meter were all within guideline values. The exposure rates at the surface and at one meter above the surface as measured using a micro-R meter ranged from 6 to 13 μR/h and from 7 to 13 μR/h respectively, with the mean being 9 μR/h for both the surface and the one meter above the surface surveys. All measured exposure rates were below the guideline value of 17 μR/h (i.e., 10 μR/h above the average background of 7 μR/h). The exposure rates are presented on Drawing Nos. 98POAHPLUR-0 and 98POAHPLUR-1. These drawings are included in Appendix 3. The ground level NaI detector survey results for the grid intersect sample locations ranged from 6,220 to 10,116 CPM. At twenty-nine locations, a shielded NaI detector was used to perform the survey with readings ranging from 2,914 to 5,232 CPM. All survey results were less than twice background. The survey results are presented on Drawing No. 98POAHPL3D-0 included in Appendix 3.

### 5.2.3 Survey Data – Drainage Areas

This section evaluates the data collected from both the 100% scan and the systematic survey performed at the affected area grid intersects for this unit which is shown on Drawing No. 98POAHDSSS-0. Additionally, supplemental survey data was gathered for both affected and unaffected areas along the drainage boundary and a berm located adjacent to the drainage area. These supplemental areas are noted on Drawing No. 98POAHDBSS-0. The data sets include analytical soil sample results, systematic survey readings for the grid intersects, and initial survey results from the 100% scan performed. Although this unit was surveyed during a dry period, standing water was present at several drainage locations. These locations were not surveyed with portable instruments but were soil sampled. For discussion purposes, the drainage areas and the supplemental data along the berm and drainage boundary were divided as follows:

- Main Drainage Survey Data
- Middle Drainage Survey Data
- East Drainage Survey Data
- Drainage/Boundary Supplemental Survey Data

For data evaluation purposes the main, middle and east drainage survey data were evaluated as one data set, with the supplemental survey data evaluated as a separate data set. The supplemental data set includes analytical results for both affected and unaffected areas which were evaluated separately.

The initial scan and soil sampling event identified seventeen locations within this survey unit that showed soils at or exceeding the total uranium guideline value (i.e., 30 pCi/g

total uranium above background which is 34 pCi/g). These location are listed in Table 5.3. The elevated samples in general represented nine areas which were subsequently remediated with the removal of impacted soils from depths varying from the surface down to approximately two feet. The areas remediated included small isolated locations up to planar areas of several square meters. The surface locations at 90E-444N, for example, required approximately one-half cubic meter of soil be removed. The soils at the locations listed in Table 5.3 were remediated to below the BTP Option #1 guideline value for total uranium. The locations again were surveyed with the data being included with the final status survey data for this survey area. Also, portions of the originally designated unaffected area were reclassified as affected and included within both the drainage and the drainage/ boundary supplemental survey data base for final status survey evaluation. These reclassified areas are discussed in the following sections.

**Table 5.3**
**Locations Remediated**
**Subarea H Drainage (Background Included)**

| Grid Location | Depth | Total – U Original (pCi/g) | Corrective Action | Final Survey Data (pCi/g) |
|---|---|---|---|---|
| 69E-435N | 0-6" | 38 | Remediated | 30 |
| 70E-435N | 0-6" | 34 | Remediated | 16 |
| 70E-436N | 0-6" | 36 | Remediated | 17 |
| 90E-444N | 0-6" | 1888 | Remediated | 28 |
| 90E-440N | 6"-1" | 37 | Remediated | 19 |
| 95E-445N | 0-6" | 34 | Remediated | 26 |
| 155E-510N | 0-6" | 47 | Remediated | 18 |
| 155E-509N | 6"-1' | 86 | Remediated | 15 |
| 155E-511N | 6"-1' | 35 | Remediated | 16 |
| 156E-510N | 6"-1' | 46 | Remediated | 15 |
| 165E-515N | 0-6" | 58 | Remediated | 15 |
| 166E-515N | 0-6" | 42 | Remediated | 11 |
| 166E-515N | 6"-1' | 55 | Remediated | 14 |
| 166E-516N | 6"-1' | 63 | Remediated | 6 |
| 215E-360N | 1'-2' | 42 | Remediated | 15 |
| 370E-688N | 1'-2' | 85 | Remediated | 26 |
| 370E-690N | 1'-2' | 75 | Remediated | 10 |

5.2.3.1 Main, Middle and East Drainages

The Main drainage runs from north of Subarea L to the base of the bluff, then east to the boundary of Subarea G, and then turns north paralleling the boundary to Subarea G (See Drawing No. 98POAHDSSS-0, Appendix 4 for location). Two unaffected area locations were reclassified affected and added to this survey unit. These areas included the main drainage which was expanded to reflect actual field conditions with respect to drainage width between 140E and 350E. Also, the main drainage channel was expanded in width and expanded further north between N600 and N750 to reflect the fact that the actual

drainage channel flows north and then west into Subarea G as opposed to north-east directly into Subarea G.

The Middle drainage runs from the southwest boundary of Subarea M (i.e., 175N-310E) north-northwest and intersects the main drainage at approximately 450N-120E. A small unaffected area location was reclassified affected and added to this survey unit. The drainage was expanded in width at the approximate location of 350N-220E to reflect actual site conditions. The East drainage runs from south of Subarea N's boundary (i.e., 400N-390E) north to intersect the Main drainage at approximately 590N-360E.

With the locations listed in Table 5.3 remediated, the 100% scan that was performed on this survey unit with the unshielded NaI detector prior to the systematic survey identified no locations that exceeded twice background.

For the final status surface sampling all soil samples analytical results for this unit were below the total uranium guideline value (i.e., 34 pCi/g total uranium including background). The soil sample analytical results for each 5 m x 5 m grid location are tabulated in tables included in Appendix 4. The soil sample locations and analytical results for total uranium are shown on Drawing No. 98POAHDSSS-0. This drawing is included in Appendix 4.

A total of 319 samples were collected for analysis, the soil analytical results ranged from 1 to 32 pCi/g total uranium. The mean value for all surface sample locations was 11.8 pCi/g total uranium, with a standard deviation of 5.0 pCi/g. The 95% confidence level value was 12.2 pCi/g which is below the guideline value for total uranium. Also, the soil sample analytical results for this data set showed natural thorium varying from 3 pCi/g down to 1 pCi/g. The mean value was 1.4 pCi/g natural thorium, with a standard deviation of 0.5 pCi/g thorium. The statistical analyses for the soil sample data and systematic survey data are included in Appendix 4.

The systematic surveys performed at the grid intersects with the 3" x 0.5" unshielded NaI detector and the μR meter were all within guideline values. The exposure rates at the surface and at one meter above the surface as measured using a μR/h meter ranged from 5 to 12 μR/h, with the mean being 9 μR/h. All measured exposure rates were below the guideline value of 17 μR/h (i.e., 10 μR/h above the average background of 7 μR/h) or 19 μR/h (i.e., for data collected using the μR meters calibrated off-site). The exposure rates are presented on Drawing Nos. 98POAHDSUR-0 and 98POAHDSUR-1. These drawings are included in Appendix 4. The ground level NaI detector survey results for the grid intersect sample locations ranged from 4,952 to 12,620 CPM. All survey results were less than twice background with the exception of location 200E-377N which showed a survey result of 12,620 CPM. Follow-up soil sample analytical results for this location did not indicate the presence of elevated residual total uranium or thorium. The 3" NaI survey results are presented on Drawing No. 98POAHDS3D-0 included in Appendix 4.

Subsurface soil samples were collected within this affected area in accordance with the approved Phase II FSSP at a frequency of one sample location (or greater) for each 100 meters in length of a drainage area. In accordance with this requirement, a total of 324 samples were collected at depths of 0-6", 6"-1', 1'-2', 2'-3' and 3'-4'. Included with these subsurface samples were, off-set samples collected and analyzed around several locations for further investigation. The analytical results for these subsurface samples ranged from 2 pCi/g to 34 pCi/g total uranium with a mean value of 10.7 pCi/g total uranium for the data set. The standard deviation was 5.0 pCi/g total uranium with a 95% confidence level value of 11.2 pCi/g total uranium. Also, the soil samples analytical results showed natural thorium varying from 1 to 3 pCi/g. The mean value was 1.2 pCi/g natural thorium with a standard deviation of 0.5 pCi/g thorium. The sample locations and analytical results are shown on Drawing No. 98POAHDDSS-0. This drawing and the data tabulation sheets are included in Appendix 4. All sample analytical results were at or below the guideline value of 30 pCi/g total uranium above background with background established at 4 pCi/g.

5.2.3.4 Supplemental Data

This data set includes all survey data gathered as supplemental data to the drainage areas discussed in Section 5.2.3.3. These areas are classified as affected and unaffected areas and include the berm and contiguous areas north and west of the Main drainage. Also included in this data set are six cross sections representing soil samples (analyzed for total uranium and thorium) collected at the surface and to depth across the main drainage traverse. The supplemental data was collected to verify that the potential impacted width of the main drainage area has been identified and to further characterize the unaffected areas north and east of the Main drainage.

The affected area data set includes the soil samples collected across the Main drainage traverses at the six locations shown on Drawing No. 98POAHDBSS-0 plus the samples collected along the grid intersects (including off-set locations) from N600 to N745 along both the E370 and E375 grid lines.

A total of 466 surface and subsurface soil samples were collected for analysis for this data set, the soil analytical results ranged from 1 to 32 pCi/g total uranium. The mean value for all sample locations was 8.8 pCi/g total uranium, with a standard deviation of 3.8 pCi/g. The 95% confidence level value was 9.1 pCi/g which is below the affected guideline value for total uranium. Also, the soil sample analytical results for this data set showed natural thorium varying from 2 pCi/g down to 0.5 pCi/g. The mean value was 1.1 pCi/g natural thorium, with a standard deviation of 0.3 pCi/g thorium. The soil sample locations and analytical results for total uranium are shown on Drawing Nos. 98POAHDBSS-0 and 98POAHDBSS-1. These drawings and the statistical analyses for the soil sample data and systematic survey data are included in Appendix 4.

The systematic surveys performed at the affected area grid intersects with both 3" x 0.5" shielded or unshielded NaI detectors and the μR meter were all within guideline values. The exposure rates at the surface and at one meter above the surface as measured using a μR/h meter ranged from 6 to 15 μR/h, with the mean being 12 μR/h at the surface and 11

μR/h at one meter above the surface. All measured exposure rates were below the guideline value of 17 μR/h (i.e., 10 μR/h above the average background of 7 μR/h) or 19 μR/h (i.e., for data collected using the μR meters calibrated off-site). The exposure rates are presented on Drawing Nos. 98POAHDBUR-0 and 98POAHDRUB-1. The ground level unshielded NaI detector survey results for the grid intersect sample locations ranged from 4,920 to 9,780 CPM. Ground level NaI shielded survey results for the grid intersect locations range from 2,770 CPM to 5,970 CPM. All survey results were less than twice background. The survey results are presented on Drawing No. 98POAHDB3D-0 included in Appendix 4.

The unaffected area data set includes surface and limited subsurface soil samples collected along the southern boundary between Subarea D and Subarea H, along the berm and fence line just north of the Main drainage traverses, and along the border between Subarea G and H from N600 to N755. This data set was expanded during the final status survey because several locations were found to exceed the 11.5 pCi/g total uranium guideline value for unaffected areas which require further investigation. The further investigation included collecting soil samples at 5 meter intervals along the fence line adjacent to the berm from E120 to E350. Additionally, soil samples were collected at 5 meter intervals along the southern border of Subarea D from E125 to E350. Five locations also were sampled to a depth of three feet.

A total of 157 surface and subsurface soil samples were collected for analysis for this data set, the soil analytical results ranged from 2 to 20 pCi/g total uranium. The mean value for all surface sample locations was 8.1 pCi/g total uranium, with a standard deviation of 2.9 pCi/g. The 95% confidence level value was 8.5pCi/g which is below the unaffected guideline value for total uranium (i.e., 11.5 pCi/g). Also, the soil sample analytical results for this data set showed natural thorium varying from 1.6 pCi/g down to 0.7 pCi/g. The mean value was 1.0 pCi/g natural thorium, with a standard deviation of 0.2 pCi/g thorium. The soil sample locations and analytical results for total uranium are shown on Drawing Nos. 98POAHDBSS-0 and 98POAHDBSS-1. These drawings and the statistical analyses for the soil sample data and systematic survey data are included in Appendix 4.

The systematic surveys performed at the grid intersects with both the 3" x 0.5" shielded and unshielded NaI detectors and the μR meter were all within guideline values. The exposure rates at the surface and at one meter above the surface as measured using a μR/h meter ranged from 6 to 15 μR/h and from 6 to 16 μR/h respectively, with the mean being 12 μR/h for both data sets. All measured exposure rates were below the guideline value of 17 μR/h (i.e., 10 μR/h above the average background of 7 μR/h) or 19 μR/h (i.e., for data collected using the μR-meters calibrated off-site). The exposure rates are presented on Drawing Nos. 98POAHUDUR-0 and 98POAHDBUR-1. These drawings are included in Appendix 4. The ground level unshielded NaI detector survey results for the grid intersect sample locations ranged from 6,342 to 9,600 CPM. Ground level NaI shielded detector survey results for the grid intersect locations ranged from 3,010 to 5,410 CPM. All survey results were less than twice background. The survey results are presented on Drawing No. 98POAHD3D-0 included in Appendix 4.

### 5.2.4 Survey Data – Unaffected Areas

This section evaluates the data collected from the 10% scan of the unaffected area, the systematic survey performed at the random grid intersect locations, and the soil samples collected at the random grid locations. This unaffected area is shown on Drawing No. 98POAHUASS-0. A total of 32 random surface soil samples were collected from the unaffected area at the locations noted on Drawing No. 98POAHUASS-0. This drawing is located in Appendix 5. The soil sample analytical results all were below the total uranium guideline values (i.e., 11.5 pCi/g which requires further evaluation or 26.5 pCi/g which requires that an unaffected area be reclassified as an affected area) with the exception of location 80E-500N with a recorded total uranium concentration of 12.1 pCi/g. This location was further evaluated as discussed below.

Off-set and depth samples (i.e., down to two feet) were collected around the one location that exceeded the 11.5 pCi/g guideline value for unaffected areas (i.e., 80E-500N). The twenty-six additional soil sample results are included in Appendix 5 and shown on Drawing Nos. 98POAHUASS-0 thru – 2. The data shows an average total uranium activity at 0'-6" of 10.6 pCi/g; at 6"-1' of 7.7 pCi/g; and at 1'-2' of 7.2 pCi/g. With the additional sampling, a total of 58 samples were collected and analyzed for total uranium for the entire unaffected area. The soil analytical results varying from 3.9 to 13.5 pCi/g total uranium, with a mean of 8.0 pCi/g. The standard deviation for this data set was 1.9 pCi/g total uranium with a 95% confidence level value of 8.4 pCi/g total uranium. Also, the soil sample analytical results showed natural thorium varying from 0.3 to 1.7 pCi/g. The mean value was 1.2 pCi/g natural thorium with a standard deviation of 0.3 pCi/g thorium.

The 10% NaI scan that was performed prior to the systematic surveys did not identify any locations that exceeded twice background. The scan results ranged from 5,482 CPM to 9,924 CPM. The systematic surveys performed with both the shielded and unshielded NaI detector, and the μR meter were all within guideline values. The dose rates at the surface and at one meter above the surface ranged from 6 to 14 μR/h, with a mean of 9.0 μR/h. The exposure rates are presented on Drawing Nos. 98POAHUAUR-0 and 98POAHUAUR-1. The tabulation for all values collected and drawings showing survey locations are included in Appendix 5. The unshielded NaI detector survey results for the 36 grid intersect soil sample locations ranged from 5,482 CPM to 9,008 CPM with a mean value of 7,796 CPM. Ground level NaI shielded detector survey results for four locations ranged from 2,860 to 5,300 CPM. Survey locations and results are plotted on Drawing No. 98POAHUA3D-0 included in Appendix 5.

### 5.2.5 Survey Data and Calculations - Concrete Riprap

Final Status Survey data was generated for the concrete rubble located in Subarea H in order to demonstrate that this concrete rubble could be unconditionally released. The survey findings, including the methodology employed to evaluate the data, are described in this section.

5.2.5.1 Thermoluminescent Dosimeter (TLD) Exposure Rate Data

A thermoluminescent dosimeter was placed at one location (#AM018) just above the concrete rubble. TLD data for 1996, 1997, and 1998 are provided in Tables 5.4 through 5.6, along with data for TLD location #AM014, which is located approximately one half mile south of the facility near the junction of Highways #33 and #74. Location #AM014 represents background. All TLDs were placed at a height of approximately one meter above the ground or concrete surface, and were oriented to face the area to be monitored. Drawing No. 98POAHCONC-0 included in Appendix 6 shows the TLD location within Subarea H.

**Table 5.4**
**TLD Exposure Rate Measurements-1996**

| TLD# | Description | 1Q96 µR/h | 2Q96 µR/h | 3Q96 µR/h | 4Q96 µR/h | 96 Ave. µR/h |
|---|---|---|---|---|---|---|
| AM014 | Junction of Highways 33 & 74 (Background) | 7.6 | 8.3 | 5.6 | 7.0 | 7.1 |
| AM018 | Subarea H Concrete | 10.0 | 7.7 | 5.6 | 6.9 | 7.6 |

**Table 5.5**
**TLD Exposure Rate Measurements-1997**

| TLD# | Description | 1Q97 µR/h | 2Q97 µR/h | 3Q97 µR/h | 4Q97 µR/h | 97 Ave. µR/h |
|---|---|---|---|---|---|---|
| AM014 | Junction of Highways 33 & 74 (Background) | 9.2 | 6.9 | 8.8 | 11.3 | 9.1 |
| AM018 | Subarea H Concrete | 5.7 | 4.9 | 6.4 | 9.9 | 6.7 |

**Table 5.6**
**TLD Exposure Rate Measurements-1998***

| TLD# | Description | 1Q98 µR/h | 2Q98 µR/h | 98 Ave.* µR/h |
|---|---|---|---|---|
| AM014 | Junction of Highways 33 & 74 (Background) | 7.4 | 8.0 | 7.7 |
| AM018 | Subarea H Concrete | 4.8 | Lost Badge | 4.8 |

* Data not available for third and fourth quarters

During 1996, the exposure rate near the concrete averaged 7.6 μR/h at the indicator location (#AM018), and averaged 7.1 μR/h at the background location (#AM014). The average exposure rates during 1997 were similar, averaging 6.7 μR/h at the indicator location, and 9.1 μR/h at the background location. During 1998, the indicator location averaged 4.8 μR/h, while the background location averaged 7.7 μR/h. Data for the third quarter of 1998 has not been received from the contractor and are therefore not available.

The TLD exposure data does not indicate any elevated exposures occurring as a result of the concrete surface contamination. The TLD data also supports the measurements obtained with micro-R meters. The TLD data indicates that the guideline value of 10 micro-R above background is met at each TLD location during 1996, 1997, and 1998 to date.

5.2.5.2 Soil/Sediment Samples

One soil/sediment surface sample (6" depth) was collected from the area upgradient of the concrete rubble, seven surface soil samples from areas within and beneath the concrete, and one surface soil sample from an area downgradient of the concrete. The sampling locations and sample results are summarized in Table 5.7. The locations where each soil/sediment sample was collected are shown on Drawing No. 98POAHCONC-0 (Appendix 6). Sample results do not indicate any samples above the BTP Option #1 guideline concentration of 30 pCi/g, above background. Concentrations of total uranium ranged from 3.7 to 8.6 pCi/g, while total thorium ranged from 0.6 to 1.3 pCi/g, including natural background. The concentrations in these soil and sediment samples are similar to those found in unaffected areas.

**Table 5.7**
**Soil/Sediment Samples Collected Around Concrete**

| Sample Number | Grid Location | Total U* (pCi/g) | Total Th* (pCi/g) |
|---|---|---|---|
| HC-1 (upgradient) | 395E-396N | 3.7 | 1.0 |
| HC-2 | 391E-399N | 4.6 | 0.8 |
| HC-3 | 392E-403N | 6.4 | 1.3 |
| HC-4 | 392E-407N | 4.0 | 0.7 |
| HC-5 | 390E-411N | 4.0 | 1.1 |
| HC-6 | 391E-415N | 6.0 | 0.6 |
| HC-7 | 390E-419N | 8.6 | 1.0 |
| HC-8 | 391E-422N | 5.2 | 0.9 |
| HC-9 (downgradient) | 391E-424N | 7.4 | 0.8 |

*Reported measurements include the contribution from natural background (4 pCi/g total U; 1.5 pCi/g Th) and assumes 2.7 weight % U enrichment.

5.2.5.3 Micro-R Measurements

A tabular summary of micro-R meter surveys for the concrete grids is provided in Table 5.8 (see right hand columns). The maximum exposure rate over any grid area ranged from 8 μR/h to 10 μR/h at one meter from the surface, including background. The overall average exposure rate for the concrete grids was 9.3 μR/h at one meter from the surface, and 9.8 μR/h at the surface, including background. Using a background of 9 μR/h, the net exposure rate due to the concrete averaged 0.3 μR/h at one meter above the surface and 0.8 μR/h at the surface.

The concrete in Subarea H was evaluated to determine any significance with respect to exposure of the general public. Under normal circumstances, it is unlikely that any additional exposure would occur to members of the public as the concrete is within a drainage area, and is on land owned by Cimarron Corporation. The possible exposure scenarios evaluated included hunting the land or an intruder inadvertently remaining in the area for a period of time. Assuming that the intruder is exposed for ten hours per year, the hypothetical individual could potentially receive a net annual dose of 30 μrem (i.e., 12 μR/h – 9 μR/h) x 10 h/y)) to the portion of the skin of the whole body or to any organs situated directly in contact with the concrete with the highest measured exposure rate. A more likely scenario is from a person standing in the area for a period of several hours per year. The net annual dose rate above background from this hypothetical activity would be approximately 3 μrem/y ((i.e., 10 μR/hr – 9 μR/h) x 3 h/y)) to the whole body, based upon the net measured exposure rate at a height of one meter and an exposure time of three hours. Both of the above dose scenarios are unlikely, in that the concrete rubble is not in an area where it would be desirable to spend any amount of time. In comparison to the exposure that an individual receives from natural background radiation (≈300 mrem/y), the calculated hypothetical doses of 30 μrem/y (0.03 mrem/y) and 3 μrem/y (0.003 mrem/y) are insignificant.

5.2.5.4 Gross Alpha and Gross Beta-Gamma Surface Activity Data

Gross beta-gamma and gross alpha scans were performed over the entire surface of concrete grids to determine the nature and extent of the activity. Gross alpha and gross beta-gamma surface activity data are summarized in Table 5.8. Background subtraction was performed on the gross beta-gamma data to obtain the expected increase that is due to residual activity from facility operations. The minimum, maximum, average, and weighted average activity (dpm per 100 $cm^2$) was calculated for each of the grids containing concrete. The average volumetric concentration over the grids was then calculated using the relationship between gross beta-gamma surface activity and volumetric concentration that is presented in Section 5.2.5.6.

## TABLE 5.8
## SUB-AREA "H" CONCRETE DEBRIS RESULTS SUMMARY

| GRID # | AREA (m^2) | GROSS BETA-GAMMA NET READING (dpm/100cm2) AVE | MAX | GROSS BETA-GAMMA (background subtracted) (dpm/100cm2) AVE | MAX | WT. AVE. | CONCENTRATION (pCi/g) AVE. OVER 3" | WT. AVE. | GROSS ALPHA (dpm/100cm2) AVE | MAX | WT. AVE. | EXPOSURE RATE (uR/h) SURFACE | 1 METER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.5 | 1,500 | 1,800 | 700 | 1,000 | 28 | 2.0 | 0.1 | 500 | 800 | 20 | 9 | 10 |
| 2 | 4.0 | 900 | 3,160 | 100 | 2,360 | 4 | 0.3 | 0.0 | 100 | 198 | 4 | 10 | 9 |
| 3 | 4.0 | 700 | 1,450 | (100) | 650 | (4) | -0.3 | -0.0 | 63 | 234 | 2 | 9 | 9 |
| 4 | 4.5 | 950 | 4,380 | 150 | 3,580 | 6 | 0.4 | 0.0 | 36 | 63 | 1 | 9 | 9 |
| 5 | 4.0 | 400 | 840 | (400) | 40 | (14) | -1.2 | -0.0 | 27 | 72 | 1 | 12 | 9 |
| 6 | 4.0 | 600 | 1,330 | (200) | 530 | (7) | -0.6 | -0.0 | 45 | 72 | 2 | 11 | 9 |
| 7 | 4.0 | 600 | 800 | (200) | 0 | (7) | -0.6 | -0.0 | 0 | 36 | 0 | 11 | 10 |
| 8 | 3.0 | 700 | 3,170 | (100) | 2,370 | (3) | -0.3 | -0.0 | 300 | 1,017 | 8 | 11 | 10 |
| 9 | 4.0 | 850 | 1,510 | 50 | 710 | 2 | 0.1 | 0.0 | 50 | 54 | 2 | 9 | 9 |
| 10 | 4.0 | 800 | 2,940 | 0 | 2,140 | 0 | 0.0 | 0.0 | 40 | 162 | 1 | 11 | 10 |
| 11 | 4.0 | 500 | 1,340 | (300) | 540 | (11) | -0.9 | -0.0 | 0 | 27 | 0 | 10 | 10 |
| 12 | 3.5 | 1,200 | 3,150 | 400 | 2,350 | 13 | 1.2 | 0.0 | 50 | 216 | 2 | 10 | 10 |
| 13 | 3.0 | 900 | 1,970 | 100 | 1,170 | 3 | 0.3 | 0.0 | 0 | 0 | 0 | 10 | 10 |
| 14 | 3.0 | 1,000 | 2,840 | 200 | 2,040 | 5 | 0.6 | 0.0 | 100 | 495 | 3 | 11 | 8 |
| 15 | 3.5 | 1,300 | 3,150 | 500 | 2,350 | 16 | 1.4 | 0.0 | 150 | 909 | 5 | 10 | 10 |
| 16 | 4.0 | 1,600 | 4,770 | 800 | 3,970 | 29 | 2.3 | 0.1 | 0 | 18 | 0 | 9 | 9 |
| 17 | 4.0 | 950 | 1,430 | 150 | 630 | 5 | 0.4 | 0.0 | 0 | 0 | 0 | 10 | 9 |
| 18 | 4.0 | 800 | 1,600 | 0 | 800 | 0 | 0.0 | 0.0 | 0 | 0 | 0 | 10 | 10 |
| 19 | 5.0 | 600 | 800 | (200) | 0 | (9) | -0.6 | -0.0 | 0 | 0 | 0 | 9 | 9 |
| 20 | 6.0 | 800 | 1,660 | 0 | 860 | 0 | 0.0 | 0.0 | 0 | 0 | 0 | 9 | 9 |
| 21 | 6.0 | 900 | 1,590 | 100 | 790 | 5 | 0.3 | 0.0 | 50 | 90 | 3 | 8 | 9 |
| 22 | 6.0 | 950 | 3,990 | 150 | 3,190 | 8 | 0.4 | 0.0 | 100 | 675 | 5 | 9 | 9 |
| 23 | 7.0 | 1,500 | 3,760 | 700 | 2,960 | 44 | 2.0 | 0.1 | 200 | 711 | 13 | 10 | 9 |
| 24 | 5.0 | 1,000 | 4,260 | 200 | 3,460 | 9 | 0.6 | 0.0 | 200 | 873 | 9 | 9 | 9 |
| 25 | 4.0 | 850 | 4,610 | 50 | 3,810 | 2 | 0.1 | 0.0 | 200 | 1,206 | 7 | 10 | 9 |
| 26 | 3.0 | 700 | 1,320 | (100) | 520 | (3) | -0.3 | -0.0 | 0 | 9 | 0 | 10 | 9 |

**DATA SUMMARY**

| | | | Gross beta-gamma (background subtracted) Minimum | Maximum | Overall Ave. | WT. AVE. |
|---|---|---|---|---|---|---|
| Total # of Grids: | 26 | | | | | |
| Total Area (m^2): | 111 | dpm/100cm2: | (400) | 3,970 | 106 | 121.4 |
| Est. Volume (m^3): | 16.65 | pCi/g U (3" ave.): | -1.2 | 2.3 | 0.3 | 0.3 |

| | Gross alpha Minimum | Maximum | Overall Ave. | WT. AVE. |
|---|---|---|---|---|
| dpm/100cm2: | 0 | 1,206 | 85 | 87.5 |

| | Exposure Rate (uR/h) Minimum | Maximum |
|---|---|---|
| Surface: | 8 | 12 |
| 1 meter: | 8 | 10 |

NOTES:

1. Gross beta background for concrete = 800 dpm/100cm^2 (net).
2. Results reported in units of dpm/100cm2 unless otherwise indicated.
3. The thickness of the concrete was estimated by field personnel as 15 cm.
4. Numbers in ( ) are negative (i.e., net result was less than zero after background subtraction).
5. Background not subtracted from gross alpha results and exposure rate results.
6. Gross alpha background for concrete = 21 dpm/100cm^2 (net).
7. Exposure rate background = 9 uR/h.

The volumetric concentration calculation assumes that the average gross beta-gamma surface activity is representative of the grid area as a whole, and that there is equal probability of measurement of the residual activity on the most elevated side of the concrete as there is for measurement on the least elevated side, since the small pieces of rubble were placed into the drainage area in a random manner. In order to account for the probability for residual activity to exist on both the top and bottom sides of each concrete slab, the average thickness for the concrete was divided by two. Therefore, since the average thickness of the concrete was estimated to be six inches, the volumetric concentration was calculated over a thickness of three inches.

The maximum gross beta-gamma surface activity (concrete background subtracted) was found within concrete grid #16. This location measured 3,970 dpm/100 $cm^2$. Using the conversion to volumetric concentration, this equates to 11.4 pCi/g average total uranium concentration over the 100 $cm^2$ area. This concentration is well below the BTP Option #1 guideline value. The overall average volumetric concentration calculated for the concrete was 0.3 pCi/g. Although, the average concentration is slightly above typical background levels for concrete, these concentrations are similar to those found in uncontaminated concrete and natural soils, and are well below the BTP Option #1 criteria. Therefore, the health and safety significance of leaving the concrete in place is similar to the health and safety considerations for natural soils. The potential future uses of the concrete are limited by its portability and by the difficulty that would be experienced through attempts to remove it from the drainage areas. Therefore, it is anticipated that the any exposures to the concrete would be from casual contact or from its gradual erosion over time due to environmental forces.

Gross alpha survey data are also presented in Table 5.8. Data indicate that the concrete rubble would meet the current gross alpha guideline criteria of 5,000 dpm/100 $cm^2$ (average) and 15,000 dpm/100 $cm^2$ (maximum) for unconditional release (assuming that it was being applied). The gross alpha measurements indicate that the most elevated location had an activity of 1,206 dpm/100 $cm^2$, which is well below the unconditional release criteria for surface contamination.

The criteria proposed for release of the concrete is based upon volumetric concentration. The concrete rubble does not have any smearable contamination and the activity would have to be removed through mechanical or physical forces. While it is probable that environmental forces will eventually act to disperse the radioactivity remaining in the concrete this will result in insignificant quantities available for ingestion or inhalation.

5.2.5.5 Estimation of Average Concrete Thickness and Volume

Based upon visual observations in the field, the average thickness of the concrete was estimated to be 6 inches (15 cm). The area of the concrete is 111 $m^2$ (see Table 5.8). Therefore, the volume of the concrete is estimated to be 16.7 $m^3$ (i.e., 111 $m^2$ x 0.15 m).

5.2.5.6 Volumetric Concentration Conversion Factor

A special study was performed as described in Section 4.5.2.1 and in the FSSR for concrete rubble in Subarea F[17] to determine a relationship between gross beta-gamma surface activity on the concrete (measured in dpm/100cm$^2$) and the volumetric concentration (measured in pCi/g) of total uranium. The solution to this problem is complicated due to the natural presence of beta and gamma emitters in concrete, including uranium. In addition, the low energy of the beta emitters associated with enriched uranium and the variability in depth of the contaminated layer hinder the determination of a single conversion factor for this purpose. However, the data presented for the two slabs studied indicate a reasonable agreement between the data. Using the method of Reference #17 and the data presented in Table 5.9, the conversion factor from surface activity to concentration was calculated as follows:

Slab #1

Volumetric average conversion factor (dpm/100 cm$^2$ gross beta-gamma per pCi/g total U) =

(17,697 dpm/100 cm$^2$) ÷ {[814.7 pCi/g + 102.7 pCi/g + (1.5 pCi/g x 22)] ÷ 24} =

**446.9 dpm/100 cm$^2$ gross beta-gamma per pCi/g total U.**

Slab #2

Volumetric average conversion factor (dpm/100 cm$^2$ gross beta-gamma per pCi/g total U) =

(4,496 dpm/100 cm$^2$) ÷ {[313 pCi/g + 74.9 pCi/g + 17.7 pCi/g + (1.5 pCi/g x 21)] ÷ 24} =

**246.9 dpm/100 cm$^2$ gross beta-gamma per pCi/g total U.**

In the above calculations, each scabbled layer is assigned a thickness of 1/8 inch, which corresponds to the measured concentration of the concrete. It follows that there are 24, 1/8 inch layers in a three inch slab of concrete. Each background layer is assumed to have a total uranium concentration of 1.5 pCi/g, as discussed in Section 3.2.3. The numerator in the above equations is the measured gross beta-gamma surface activity on the top layer. This data is readily available and was obtained during the surveys of the concrete rubble surface. The two slabs studied in this special project indicate that the conversion factor is in the range of 247 to 447 dpm/100 cm$^2$ gross beta-gamma per pCi/g total U. The two samples resulted in calculated conversion factors that were within a factor of two, which is good agreement considering the numerous areas of uncertainty.

The average of the two measurements, which is 347 dpm/100 cm$^2$ gross beta-gamma per pCi/g total U, was utilized to estimate the average volumetric concentration of residual activity present in the concrete. This conversion factor was also used to calculate average total uranium concentrations.

## TABLE 5.9

### Survey Data for Concrete Rubble Slabs Used to Determine the Volumetric Concentration Conversion Factor

| | Gross Alpha dpm/100cm$^2$ (ave) | Gross Alpha dpm/100cm$^2$ (max) | Gross Beta dpm/100cm$^2$ (ave) | Gross Beta Dpm/100cm$^2$ (max) | Slab Surface µR/h | Slab 1m µR/h | Hot Surface µR/h | Spot 1m µR/h | Total U Conc. (pCi/g) |
|---|---|---|---|---|---|---|---|---|---|
| Slab #1 | | | | | | | | | |
| Initial Measurement | 1251 | 4800 | 17,697 | 44,540 | 9 | 7 | 11 | 7 | 814.7 |
| After 1st Scabbling | 157 | 480 | 2411 | 8330 | 6 | 6 | 6 | 6 | 102.7 |
| After 2nd Scabbling | 24 | 160 | 0 | 1310 | 6 | 6 | 6 | 6 | |
| | | | | | | | | | |
| **Slab #2** | | | | | | | | | |
| Initial Measurement | 329 | 1280 | 4496 | 24,390 | 6 | 6 | 9 | 8 | 313 |
| After 1st Scabbling | 115 | 480 | 935 | 13,370 | 5 | 6 | 8 | 6 | 74.9 |
| After 2nd Scabbling | 116 | 400 | 0 | 4,950 | 6 | 6 | 6 | 6 | 17.7 |
| After 3rd Scabbling | <350 | <350 | 0 | 230 | 9 | 9 | 9 | 9 | |

Notes:
1) Concrete gross beta-gamma background (800 dpm/100cm$^2$) subtracted from beta-gamma measurements.
2) No background subtraction performed for all other measurements.
3) Measurements less than 0 after background subtraction were recorded as 0.
4) Total U concentration assumed as 1.5 pCi/g when all residual gross beta-gamma activity was determined to be removed by scabbling.

5.2.5.7 Volumetric Concentration Calculations

Calculation of the estimated volumetric concentration (in pCi/g total U) was performed by multiplying the conversion factor described in Section 5.2.5.6 times the measured gross beta-gamma surface contamination measurement (with background subtracted). These calculations, which are summarized in Table 5.8, resulted in average grid total uranium concentrations (after background subtraction) ranging from -1.2 pCi/g to 2.3 pCi/g. The negative results indicate that the grid average was less than 1.5 pCi/g (background). In these cases subtraction of the 800 dpm/100cm$^2$ concrete background thus resulted in a value that was less than average background. Assuming a normal distribution of a background distribution, one half of the samples collected would be expected to be less than background.

The maximum grid average total uranium concentration was 2.3 pCi/g (grid #16). This concentration is less than 8% of the guideline value of 30 pCi/g above background. The average total uranium concentration for the concrete sample was 0.3 pCi/g, which is 1% of the guideline value for enriched uranium (30 pCi/g). A "weighted average" concentration also was calculated to normalize the data in order to account for the volume differences between grids. The weighted average concentration was also 0.3 pCi/g. Therefore, the data indicate that the concrete in Subarea H falls well within the guideline value.

5.2.5.8 Source Term Calculation

The average and weighted average volumetric concentration for the random sample was calculated to be 0.3 pCi/g. Since the volume of concrete is known, an estimate of the total activity of uranium present in the concrete can be calculated as follows:

Total activity = (0.3 pCi/g-concrete) x (1.8 g-concrete/cm$^3$) x $10^6$ cm$^3$/m$^3$ x 16.7m$^3$ concrete

= 9E+6 pCi = **9 E–6 Ci Total Uranium.**

5.2.5.9 Pathway Analysis

The RESRAD computer code was used to evaluate the potential dose due to leaving the concrete in place. The RESRAD code considers direct radiation, inhalation of resuspended radioactivity, ingestion of groundwater and foodstuffs grown in contaminated soils, or in soils irrigated with contaminated surface or ground water, and all other credible pathways. The RESRAD model generally will predict a more conservative dose (i.e., a higher dose) than that which could potentially be received, as it generally utilizes conservative assumptions and includes scenarios for use of the land area that are generally not consistent with the expected uses for concrete rubble.

The input parameters for RESRAD include those defined in NRC's Policy and Guidance Directive (PG) 8-08, "Scenarios for Assessing Potential Doses Associated with Residual

Activity"[46]. The uranium isotopic ratios were chosen to be the same as those used by the NRC for the "Environmental Assessment Associated with the BTP Option #2 Onsite Disposal Cell at Cimarron"[47], which were U-234 (79%), U-235 (1.7%), and U-238 (20%). The selected density for the concrete was 1.8 g/cc. The calculated area of the contaminated zone is 111 $m^2$, while the estimated thickness is 0.15m. The previously established erosion rate of 10 mm/150y (i.e., 6.7E-5 m/y) was utilized for the concerete[17].

The RESRAD computer code calculated maximum dose rate (all pathways) will occur immediately (i.e., at t = ∅ years) and will result in a maximum hypothetical annual dose to the resident of approximately 0.04 millirem per year. A calculation also was performed to conservatively determine an upper estimate of the dose due to inhalation of any resuspended material from the concrete. The extremely conservative RESRAD default mass loading variable of 200 $\mu g/m^3$ was utilized. In addition, an assumption was made that all of the radioactivity in the concrete was within the top 1/8 inch of the exposed surfaces. This assumption resulted in an average calculated concentration of 7.2 pCi/g in the uppermost 1/8 inch layer of concrete. This is equivalent to the average concentration previously calculated for the three inch layer of concrete rubble (i.e., 0.3 pCi/g) multiplied by a factor of 24 to account for the fact that all of the activity is concentrated in the uppermost layer. Based upon the above assumption, the RESRAD code calculated an inhalation dose of 0.7 mrem/y. A printout of the parameters used and results of the RESRAD calculations are provided in Appendix 6.

### 5.2.6 Survey Data – Cimarron River Sediments

Cimarron River sediment samples were collected upgradient from the site, at the outfalls from the former East and West pipeline runs, at the discharge of the two eastern drainages, and near the eastern site boundary. The sample locations are shown on Drawing No. 98POAHRV-0 included in Appendix 7. At the time the sediment samples were collected, the river elevation was below the former outfalls so sediment samples were collected out into the river channel at one meter intervals or greater. Samples were collected at the surface and at 6"- 1' and 1' - 2' depths. A total of eighteen locations were sampled, with seven locations at the outfalls from the former West pipeline and three locations from the former East pipeline outfall. Soil sample analytical results varied from 2.9 pCi/g to 7.8 pCi/g total uranium at the surface; 3.6 to 7.6 pCi/g total uranium at 6" to 1' in depth and 3.6 to 6.8 pCi/g total uranium at 1'- 2' depth. The results were indicative of background and there were no distinguishable differences between the upgradient results, outfall sample results, drainage results, or downstream results.

The data for this survey unit is tabulated and included in Appendix 7. The sample locations and survey results are shown on Drawing No. 98POAHRV-0.

## 5.3 QA/QC Procedures

Cimarron Corporation's Quality Assurance Plans and Procedures are an integral part of the overall site decommissioning program and include off-site independent isotopic analysis of split samples. For the soil activity ranges that apply to this final status survey and for soil samples collected during the time frame that the survey data was being

generated, a total of sixteen soil samples were split and sent off-site for analysis. The soil samples were first analyzed using the on-site counter prior to being packaged and sent off site for analysis at an independent laboratory. The independent laboratory was Core Laboratories and they do participate in a national inter-comparison. The results for both off-site and on-site analysis are listed in Table 5.10. These sample results show good agreement.

**TABLE 5.10**

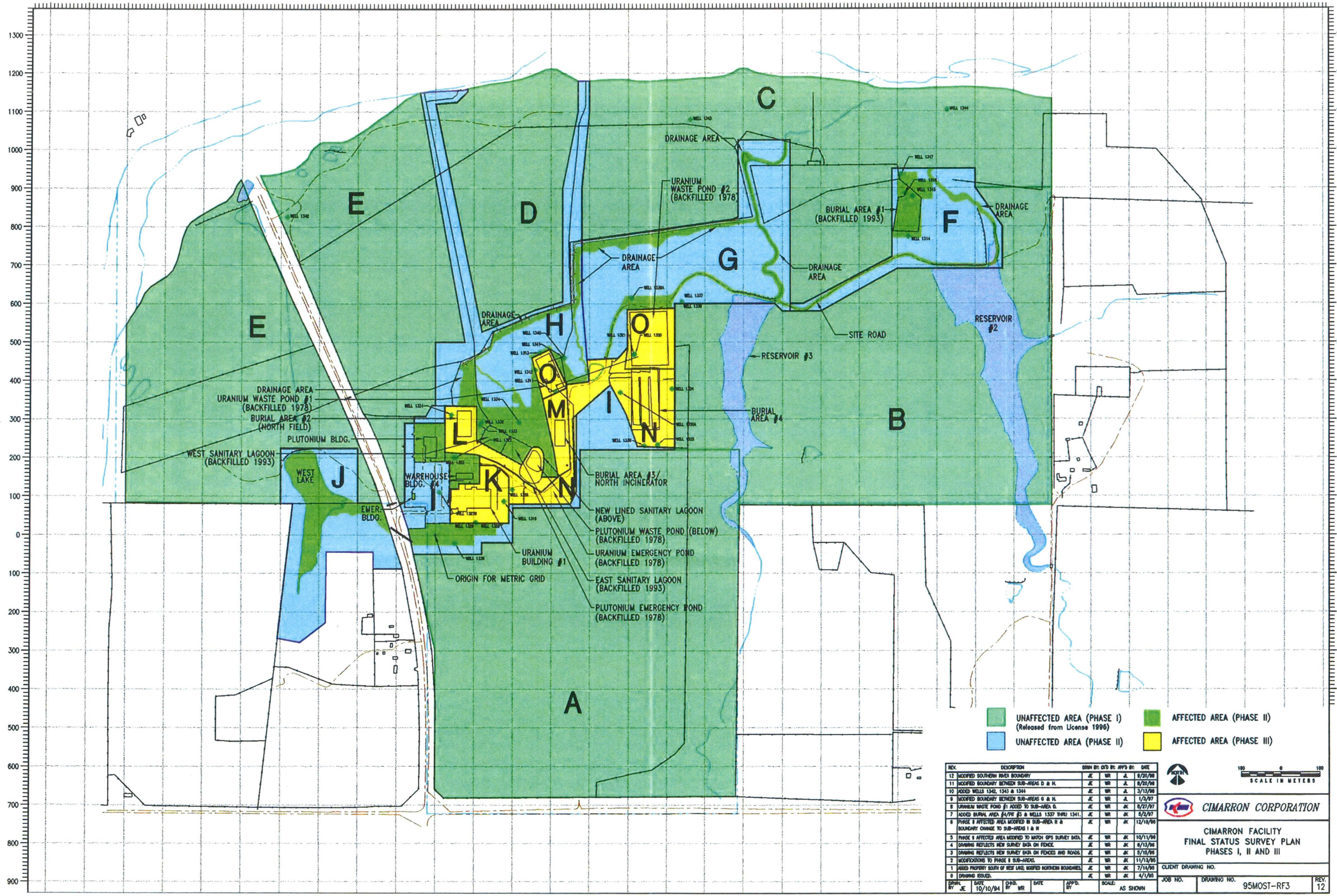
| Sample ID No. | Off-Site Lab Results Core Lab (pCi/g U) | On-Site Results Cimarron (pCi/g U) |
|---|---|---|
| SC-06 | 1.5 ± 0.7 | 2.1 ± 1.7 |
| FA-542 | 1.0 ± 0.5 | 5.1 ± 1.4 |
| MISC-21 | 27.9 ± 4.0 | 31.6 ± 1.6 |
| MISC-29 | 17.7 ± 2.7 | 20.5 ± 1.9 |
| OWP-1-106 | 30.0 ± 4.4 | 29.8 ± 1.7 |
| AO-4026 | 42.0 ± 5.4 | 36.8 ± 1.9 |
| HD | 50.1± 8.6 | 47.0 ± 5.0 |
| HD | 4.2 ± 11.4 | 64.6 ± 5.0 |
| HI | 11.4 ± 2.6 | 20.0 ± 6.0 |
| HI SC-06 | 4.8 ± 1.4 | 4.9 ± 2.8 |
| HI should | 3.1 ± 0.8 | 8.8 ± 6.8 |
| HA be | 26.7 ± 6.5 | 21.4 ± 5.9 |
| H SC-06 | 62.7 ± 11.1 | 52.3 ± 2.3 |
| H | 26.0 ± 5.5 | 29.0 ± 2.9 |
| H | 80.8 ± 13.5 | 70.7 ± 3.0 |
| H | 112.6 ± 15.9 | 124.0 ± 3.1 |
| HA-1532 | 105.2 ± 16.1 | 82.9 ± 2.7 |
| HC-1 | 2.0 ± 2.3 | 3.7 ± 1.8 |
| HC-6 | 3.1 ± 2.6 | 6.0 ± 1.7 |
| HC-9 | 5.1 ± 3.8 | 7.4 ± 1.4 |
| HU-70 | 15.1 ± 3.8 | 14.5 ± 1.9 |
| HU-73 | 15.1 ± 6.1 | 17.7 ± 1.9 |

## 6.0 SUMMARY

A Final Status Survey was performed in accordance with the approved Phase II FSSP and the SWP and WP approved by Cimarron Management for Subarea H. This report presents a comparison of the results of the Final Status Survey to the clean-up criteria (guideline values) for affected and unaffected areas at the Cimarron site. The comparison presented herein demonstrates that all guideline values have been met and thus Subarea H can now be released from License SNM-928. Therefore, this report is being submitted to the NRC in conjunction with a request to release Subarea H from License SNM-928.

## 7.0 APPENDICES

- Appendix 1 — Drawing 95 MOST-RF3
- Appendix 2 — Affected Areas - Data Tabulation Sheets, Statistical Analyses, and Drawings
- Appendix 3 — East and West Pipeline Runs - Data Tabulation Sheets, Statistical Analyses, and Drawings
- Appendix 4 — Drainage Areas - Data Tabulation Sheets, Statistical Analyses, and Drawings
- Appendix 5 — Unaffected Areas - Data Tabulation Sheets, Statistical Analyses, and Drawings
- Appendix 6 — Drawing for Concrete and RESRAD Pathway Analysis
- Appendix 7 — River Sediments - Data Tabulation Sheets and Drawings




| REV. | DESCRIPTION | DRWN BY: | CK'D BY: | APP'D BY: | DATE |
|---|---|---|---|---|---|
| 12 | MODIFIED SOUTHERN RIVER BOUNDRY | JE | WR | JL | 9/20/98 |
| 11 | MODIFIED BOUNDARY BETWEEN SUB-AREAS D & H. | JE | WR | JL | 8/20/98 |
| 10 | ADDED WELLS 1342, 1343 & 1344 | JE | WR | JL | 3/13/98 |
| 9 | MODIFIED BOUNDARY BETWEEN SUB-AREAS G & H. | JE | WR | JL | 1/3/97 |
| 8 | URANIUM WASTE POND #1 ADDED TO SUB-AREA D. | JE | WR | JK | 8/27/97 |
| 7 | ADDED BURIAL AREA #4/PIT #3 & WELLS 1337 THRU 1341. | JE | WR | JK | 5/2/97 |
| 6 | PHASE II AFFECTED AREA MODIFIED IN SUB-AREA H & BOUNDARY CHANGE TO SUB-AREAS I & N | JE | WR | JK | 12/19/96 |
| 5 | PHASE II AFFECTED AREA MODIFIED TO MATCH GPS SURVEY DATA. | JE | WR | JK | 10/11/96 |
| 4 | DRAWING REFLECTS NEW SURVEY DATA ON FENCE. | JE | WR | JK | 6/13/96 |
| 3 | DRAWING REFLECTS NEW SURVEY DATA ON FENCES AND ROADS. | JE | WR | JK | 5/15/96 |
| 2 | MODIFICATIONS TO PHASE II SUB-AREAS. | JE | WR | JK | 11/13/95 |
| 1 | ADDED PROPERTY SOUTH OF WEST LAKE; MODIFIED NORTHERN BOUNDARY. | JE | WR | JK | 7/14/95 |
| 0 | DRAWING ISSUED. | JE | WR | JK | 4/1/95 |

| DRWN. BY | DATE | CK'D. BY | DATE | APP'D. BY | SCALE: |
|---|---|---|---|---|---|
| JE | 10/10/94 | WR | | | AS SHOWN |

CLIENT DRAWING NO.

| JOB NO. | DRAWING NO. | REV. |
|---|---|---|
| | 95MOST-RF3 | 12 |