# CIMARRON ENVIRONMENTAL RESPONSE TRUST

# FACILITY DECOMMISSIONING PLAN – REV 3

**Prepared by**

**Environmental Properties Management LLC**

**With Consultants**

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**DRAFT – TO BE FINALIZED AFTER NRC REVIEW**

environmental
properties management, LLC

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| Acronym/Abbreviation | Term/Phrase/Name |
|---|---|
| % | percent |
| µg | micrograms |
| µg/L | micrograms per liter |
| µR/hr | microroentgen/hour |
| ALARA | As Low As Reasonably Achievable |
| amsl | above mean sea level |
| APF | assigned protection factor |
| BA1 | Burial Area #1 |
| BA2 | Burial Area #2 |
| BA3 | Burial Area #3 |
| BA4 | Burial Area #4 |
| BARF | BA1 Remediation Facility |
| BFE | Base Flood Elevation |
| bgs | below ground surface |
| BMP | Best Management Practice |
| Bq/g | becquerel per gram |
| Bq/L | becquerel per liter |
| BTP | Branch Technical Position |
| CERT | Cimarron Environmental Response Trust |
| cfs | cubic feet per second |
| cm | centimeter |
| cm/s | centimeters per second |
| $cm^2$ | square centimeter |
| CAM | constant air monitors |
| COC | contaminant of concern |
| DAP-1 | North Stockpile |
| DAP-2 | East Stockpile |
| DAW | dry active waste |
| DCE | decommissioning cost estimate |
| DCGL | Derived Concentration Goal Level |
| DCL | derived concentration limit |
| DEQ | Oklahoma Department of Environmental Quality |
| DOT | U. S. Department of Transportation |
| dpm | disintegrations per minute |
| DPW | declared pregnant woman |
| EPA | U. S. Environmental Protection Agency |
| EPC | engineering, procurement, and construction |
| EPM | Environmental Project Management LLC |
| FEMA | Federal Emergency Management Agency |
| $Fe(OH)_3$ | ferric hydroxide |
| FIRM | Flood Insurance Rate Map |
| FSSR | Final Status Survey Report |
| ft | foot/feet |
| $ft^2$ | square foot/square feet |
| $ft^2/d$ | square feet per day |
| $ft^3$ | cubic foot/cubic feet |
| GE | Groundwater Extraction |

| **Acronym/Abbreviation** | **Term/Phrase/Name** |
|---|---|
| GETR | Groundwater Extraction Trench |
| gpm | gallons per minute |
| GWI | Groundwater Injection |
| HDPE | high-density polyethylene |
| HUC | Hydrologic Unit Code |
| ICP-MS | inductively coupled plasma – mass spectroscopy |
| ICRP | International Commission on Radiological Protection |
| in/yr | inches per year |
| $in^2$ | square inch |
| $K_d$ | distribution coefficient |
| kg | kilogram |
| KMNC | Kerr-McGee Nuclear Corporation |
| L/kg | Liters per kilogram |
| LLRW | low-level radioactive waste |
| m | meter |
| $m^2$ | square meter |
| $m^3$ | cubic meters |
| MCL | Maximum Contaminant Level |
| MDA | minimum detectable activity |
| MDC | minimum detectable concentration |
| mEq | milliequivalent |
| mg/L | milligrams per liter |
| mL/g | milliliters per gram |
| MNA | monitored natural attenuation |
| MOFF | Mixed Oxide Fuel Fabrication |
| mrem/yr | millirem per year |
| ng/L | nanograms per liter |
| NOAA | National Oceanic and Atmospheric Administration |
| NRC | Nuclear Regulatory Commission |
| ODEQ | Oklahoma Department of Environmental Quality |
| OGS | Oklahoma Geological Survey |
| OPDES | Oklahoma Pollution Discharge Elimination System |
| ORAU | Oak Ridge Associated Universities |
| ORISE | Oak Ridge Institute for Science and Education |
| OWRB | Oklahoma Water Resources Board |
| pC/kg | picoCuries per kilogram |
| pCi/g | picoCuries per gram |
| pCi/L | picoCuries per liter |
| PHMSA | Pipeline and Hazardous Materials Safety Administration |
| PM | Project Manager |
| POV | personally owned vehicles |
| PVC | polyvinyl chloride |
| QAC | Quality Assurance Coordinator |
| QAPP | Quality Assurance Program Plan |
| RAI | Request for Additional Information |
| RP | radiation protection |
| RPP | Radiation Protection Program |
| RSO | Radiation Safety Officer |
| SFC | Sequoyah Fuels Corporation |

| **Acronym/Abbreviation** | **Term/Phrase/Name** |
|---|---|
| SNM | Special Nuclear Material |
| SWPPP | Stormwater Pollution Prevention Plan |
| Tc-99 | Technetium-99 |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TEDE | total effective dose equivalent |
| TODE | total organ dose equivalent |
| $U_3O_8$ | uranium octaoxide |
| $UF_4$ | uranium tetrafluoride |
| $UF_6$ | uranium hexafluoride |
| UIC | Underground Injection Control |
| UIX | Uranium Ion Exchange |
| $UO_2$ | uranium dioxide |
| USACE | U. S. Army Corps of Engineers |
| USFWS | U. S. Fish and Wildlife Service |
| USGS | U. S. Geological Survey |
| WAA | Western Alluvial Area |
| WATF | Western Area Treatment Facility |
| WAC | Waste Acceptance Criteria |
| wt. % | weight percent |
| WU | Western Upland |
| 95% UCL | 95 percent upper confidence level |

# EXECUTIVE SUMMARY

Solely as Trustee for the Cimarron Environmental Response Trust (CERT), Environmental Properties Management LLC (EPM) submits this Decommissioning Plan (this Plan) for the Cimarron Site (the Site), located at 100 N. Highway 74, Guthrie, OK. On February 14, 2011, License SNM-928 was transferred to the Trust, with offices at 9400 Ward Parkway, Kansas City, MO 64114.

In the 1960s and early 1970s, Kerr-McGee Nuclear Corporation (KMNC) purchased nearly 800 acres of property located at the intersection of Highways 74 and 33, approximately seven miles south of Crescent, OK, as shown in Figure 1-1. KMNC manufactured nuclear fuel under two Nuclear Regulatory Commission (NRC) licenses. Uranium fuel was produced under NRC Special Nuclear Material (SNM) License SNM-928, and mixed oxide fuel was produced under NRC License SNM-1174. Waste was buried in three locations, and wastewater containing licensed material was stored in impoundments and discharged to the Cimarron River in accordance with the regulatory requirements of that time.

Four parcels containing a total of nearly 290 acres of property have been divested since the license was transferred to the CERT. The Site now consists of approximately 330 acres of rolling hills and 170 acres of floodplain (Figure 1-1). Grassland and temperate forest cover much of the property, and two ponds collect surface water from upland areas.

Decommissioning of materials and equipment, existing buildings and structures, and surface and subsurface soils is complete. The Site was divided into 16 “Subareas” as shown in Figure 1-2, designated Subareas A through O (there were two uranium waste ponds, both designated Subarea O), to facilitate the decommissioning and final survey process for buildings and surface and subsurface soil. Final Status Survey Reports have been submitted for all these media for all 16 Subareas. All but three of the Subareas have been released from the NRC license.

Licensed material exceeds decommissioning criteria for unrestricted release in groundwater in several portions of the Site, described in detail in Section 3, “Radiological Status of Facility”, of this Plan. The intent of this Plan is to reduce the concentration of uranium in groundwater to achieve unrestricted release of the Site and license termination. Section 7, “ALARA Analysis”, demonstrates that the cost to achieve unrestricted release more than satisfies any “As Low As Reasonably Achievable” (ALARA) considerations; the cost per man-rem avoided is far greater than would be justified by an ALARA analysis. The unrestricted release criterion for uranium in groundwater (the NRC Criterion) stipulated in License Condition 27(c) is 180 picoCuries per liter (pCi/L) total uranium. Because the feedstock received at the facility was purified uranium, only three daughters of uranium (i.e., Th-234, Pa-234, and Th-231) are also present at the Site.

Groundwater in several portions of the Site also contains one other radiological contaminant of concern (COC), technetium-99 (Tc-99), and two non-radiological COCs: nitrate and fluoride. The NRC has established an unrestricted release criterion of 3,790 pCi/L for Tc-99 in groundwater. The United States Environmental Protection Agency (EPA) has established Maximum Contaminant Levels (MCLs) for drinking water. The MCLs are 30 micrograms per liter (µg/L) for uranium, 4 millirem per year (mrem/yr) for beta emitters, 10 milligrams per liter (mg/L) for nitrate, and 4 mg/L for fluoride. Tc-99 is a beta emitter; the EPA has established an activity concentration for Tc-99 of 900 pCi/L as equivalent to 4 mrem/yr. The Oklahoma Department of Environmental Quality (DEQ) has established 900 pCi/L for Tc-99, 30 µg/L for uranium, and 4 mg/L for fluoride as remediation goals site-wide.

Because nitrate is present in shallow groundwater at concentrations above its MCL, due at least in part to the use of agricultural fertilizer upgradient from the Site, the DEQ has approved a “mean plus two standard deviations” value of 22.9 mg/L for background nitrate in groundwater, based on analysis of samples from monitor wells located upgradient of any licensed activities. The State-approved remediation criterion for nitrate is 22.9 mg/L. A small amount of property surrounding the former process buildings has been divested and is planned for use as a commercial facility. The State Criterion for nitrate in groundwater in this area is 52 mg/L. State-approved remediation goals for uranium, nitrate, and fluoride will be referred to in this Plan as “State Criterion (or Criteria)”.

Although uranium is the only contaminant exceeding NRC Criteria for the unrestricted release of the Site, this Plan describes the extent and concentration of other COCs because the groundwater remediation processes described in this Plan will result in either the accumulation of COCs in treatment media or the discharge of COCs in groundwater treatment effluent to the Cimarron River.

This is the third revision of the decommissioning plan initially submitted by the CERT in 2015. Previous versions of the decommissioning plan are:

- *Facility Decommissioning Plan* (Environmental Properties Management, 2015, ML16032A285).
- *Facility Decommissioning Plan - Rev 1* (Environmental Properties Management, 2018, ML19352E486).
- *Facility Decommissioning Plan - Rev 2* (Environmental Properties Management, 2021, ML21076A479).

The first revision was submitted in response to NRC requests for additional information (RAIs) generated by the detailed technical review of the 2015 decommissioning plan. Revision 1 included changes to the location of the groundwater treatment facility and measures to increase the likelihood that available funding was sufficient to achieve license termination, such as a reduction in the number of ion exchange skids. Groundwater remediation was removed from several areas where uranium concentrations already comply with the NRC Criterion.

After the submission of Revision 1, meetings were conducted to discuss the impact of Tc-99 in waste streams. Because any waste stream containing detectable Tc-99 would have to be disposed of as low-level radioactive waste (LLRW), it was determined that available funding was not sufficient to remove nitrate from groundwater. Consequently, Revision 2 proposed a phased approach to groundwater remediation; Phase I would provide for the removal of uranium from groundwater only in those areas where uranium exceeds the NRC Criterion. Phase II could continue treatment only for uranium, or (based on remaining funds available) could add remediation in other areas or for other contaminants.

The phased approach proposed in Revision 2 did not provide a single clear path to license termination. After receiving requests for clarification and supplemental information from the NRC, it was decided that the most expedient approach would be to submit *Facility Decommissioning Plan – Rev 3* as a final version of the decommissioning plan. This plan consists of removing uranium from groundwater in only those areas where uranium concentrations exceed the NRC Criterion, followed by post-remediation monitoring, final status surveys, and requesting termination of license SNM-928.

This decommissioning plan includes plans for the installation and operation of groundwater treatment systems that will remove uranium from groundwater by ion exchange. It is estimated that pre-construction activities and construction and operation of groundwater remediation systems will require at least 15 years, followed by over three years of post-remediation monitoring, demobilization, and final status survey. Schedules provided in Section 9, “Schedule”, indicate that construction of groundwater remediation facilities and infrastructure may begin in 2025, and license termination will likely occur in the mid-2040s.

The schedules presented herein demonstrate that the two-year time frame for decommissioning specified in 10 CFR 70.38(g)(4)(vii) cannot be achieved. Consequently, an alternative schedule in accordance with 10 CFR 70.38(g)(2) is requested herein.

This Decommissioning Plan is submitted as a License Amendment Request. For the convenience of reviewers, the accession numbers for documents that are available to the public in NRC’s Agencywide

Document Access and Management System (ADAMS) are provided in parentheses after the document reference. Accession numbers begin with the prefix “ML”.

# 1.0 FACILITY OPERATING HISTORY

In the 1960s and early 1970s, Kerr-McGee Nuclear Corporation (KMNC) purchased nearly 800 acres of property located at the intersection of Highways 74 and 33, approximately seven miles south of Crescent, OK, as shown in Figure 1-1. KMNC manufactured nuclear fuel under two Nuclear Regulatory Commission (NRC) licenses. Uranium fuel was produced under NRC Special Nuclear Material License SNM-928, and mixed oxide fuel was produced under NRC License SNM-1174. Waste was buried in three locations, and wastewater containing licensed material was stored in impoundments and discharged to the Cimarron River, all in accordance with the regulatory requirements of that time.

The Site now consists of approximately 330 acres of rolling hills and 170 acres of floodplain north of the intersection of Highways 74 and 33, located approximately seven miles south of Crescent, Oklahoma (Figure 1-1) in Logan County. The current street address of the facility is 100 North Highway 74, Guthrie, Oklahoma 73044. Grassland and temperate forest cover nearly all the property, and two ponds collect surface water from upland areas.

Decommissioning of materials and equipment, buildings and structures, and surface and subsurface soils is complete. The Site was divided into 16 “Subareas” as shown in Figure 1-2, designated Subareas A through O (two Subareas, both of which contained uranium waste ponds, were designated Subarea O) to facilitate the decommissioning and final survey process for buildings and surface and subsurface soil. Subareas A through E were considered unaffected areas and were designated “Phase I” areas. Subareas F through I contained both unaffected and affected areas and were designated “Phase II” areas. Subareas K through O contained affected areas and were designated “Phase III” areas. Subareas I and K included the former processing buildings; final status surveys for these areas included surveys of the buildings in addition to surface and/or subsurface soil. Only Subareas F, G, and N remain under the NRC license. The rest of the property owned by the CERT is no longer licensed by the NRC.

The word “area” is used in this document to describe the areas given alphabetic designations, remediation areas, and areas associated with a feature, facility, etc. To minimize confusion, when referring to those areas in which final status surveys were performed and for which final status survey plans and reports were prepared, the term “Subarea” will be used. When referring to specific remediation areas, the term “Area” will be used. All other generic references to areas will simply be referred to as “areas”.

## 1.1 LICENSE NUMBER / STATUS / AUTHORIZED ACTIVITIES

The Trustee proposes to complete the decommissioning of the Site in accordance with License SNM-928. The license authorizes the possession of:

- ≤ 1,200 grams of U-235 in any compound containing uranium enriched to ≤ 5 weight percent (wt. %) in U-235
- ≤ 10 grams of U-235 in any compound containing uranium enriched to > 5 wt. % in U-235
- ≤ 2,000 kilograms (kg) of natural and depleted uranium source material
- ≤ 6,000 kg of thorium source material

Licensed material can be in any chemical or physical form. Licensed material at the Site now consists of environmental media (i.e., soil and groundwater) impacted by licensed material from past burials or releases of licensed material to the environment. There is no current inventory of licensed material at the Site; licensed material will enter the inventory as it is extracted from environmental media and concentrated in treatment system media (i.e., ion exchange resin). Excluding uranium in groundwater, licensed material does not exceed criteria for unrestricted release stipulated in License Conditions 27(b) and 27(c) anywhere on the Site.

KMNC submitted an application for renewal of License SNM-928 on March 29, 1982. Sections of the application for license renewal addressing the processing of nuclear materials were deleted “for the standby period”. License SNM-928 was renewed on March 31, 1983. Since the license was last renewed in 1983, 21 license amendments have been issued. A brief description of each follows.

- Amendment 1 was issued October 24, 1985. It transferred SNM-928 from KMNC to Sequoyah Fuels Corporation (SFC), and added letters dated March 28, 1984, September 28, 1984, and October 8, 1984, to License Condition 10, which address planned decommissioning activities.
- Amendment 2 was issued December 20, 1985. It added an August 6, 1985, letter to License Condition 10.
- Amendment 3 was issued April 16, 1986. It authorized the possession of up to 6,000 kg of thorium, which authorized SFC to package and dispose of thorium-impacted material being removed from a site near Cushing, Oklahoma, which was owned by Kerr-McGee Corporation (SFC’s parent corporation), under License SNM-928.
- Amendment 4 was issued April 16, 1986. It increased the authorized quantity of U-235 enriched to ≤ 5 wt. % to 6,000 g, and added letters dated August 6, 1985, November 19, 1985, and March 3, 1986, to License Condition 10.
- Amendment 5 was issued May 4, 1987. It added a letter dated February 19, 1987, to License Condition 10 and extended the deadline to complete decommissioning to December 31, 1988.
- Amendment 6 was issued October 26, 1988. It changed the licensee from SFC to Cimarron Corporation and added a letter dated October 14, 1988, to License Condition 10.

- Amendment 7 was issued December 23, 1989. It added a letter dated November 17, 1988, to License Condition 10 and extended the deadline to complete decommissioning to June 30, 1990.
- Amendment 8 was issued January 5, 1990. It added a letter dated November 2, 1989, to License Condition 10 and added License Condition 21, dealing primarily with control of access to the Site.
- Amendment 9 was issued December 28, 1992. It added letters dated September 11, 1991, and June 24, 1992, to License Condition 10, extended the deadline for decommissioning to June 30, 1995, and added License Condition 22, which authorized the backfill of the excavated sanitary lagoons and several former burial trenches in the eastern portion of the Site.
- Amendment 10 was issued November 4, 1994. It decreased the authorized quantity of U-235 enriched to ≤ 5 wt. % to 1,200 g, deleted License Condition 17 (prohibiting backfill of the excavated sanitary lagoons) and added License Condition 23 (authorizing burial of specified licensed material in an on-site disposal cell). It also included numerous significant changes related to decommissioning.
- Amendment 11 was issued July 26, 1995. It added License Condition 24, designating Karen Morgan as the Radiation Safety Officer (RSO).
- Amendment 12 was issued March 7, 1996. It corrected the name of the licensee since Amendment 11 did not identify Cimarron Corporation as the licensee.
- Amendment 13 was issued April 13, 1996. It added License Condition 25, which released Phase I Subareas (which included Subareas A through E) from the license.
- Amendment 14 was issued July 7, 1997. It made numerous revisions to License Condition 10. It also deleted License Conditions 11, 12, 13, 14, 15, 16, 20, & 21. All of these license conditions contained radiation safety requirements addressed in Annex A, the Radiation Protection Program (RPP). It also added License Condition 26, requiring compliance with Annex A.
- Amendment 15 was issued July 29, 1999. It revised License Condition 10 to include the 1995 *Decommissioning Plan for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility* (Chase Environmental Group, 1995A, ML20202A437). It also added License Condition 27, which specified criteria for unrestricted release, and incorporated a provision for changing the decommissioning plan and/or RPP with ALARA Committee approval. It also revised License Condition 26 to include updates to Annex A.
- Amendment 16 was issued April 17, 2000. It added License Condition 28, which released Subareas J and O from the license.
- Amendment 17 was issued April 9, 2001. It added License Condition 29, which released Subareas H, I, L, and M from the license.
- Amendment 18 was issued May 28, 2002. It added License Condition 30, which released Subarea K from the license.
- Amendment 19 was issued October 3, 2005. It deleted License Condition 22, which authorized the (by then completed) backfill of the sanitary lagoons. It also revised License

Conditions 23 (retaining only remaining requirements related to the on-site disposal cell) and 27(e) (addressing the process for approving changes to the decommissioning plan and/or RPP).

- Amendment 20 was issued June 12, 2009. It deleted License Condition 24, which designated the Site RSO by name, and revised License Condition 27(e) (addressing the process for approving changes to the decommissioning plan and/or RPP).
- Amendment 21 was issued February 14, 2011. This amendment transferred the license from Cimarron Corporation to the CERT.

## 1.2 LICENSE HISTORY

The Cimarron facility was formerly operated by KMNC, a wholly owned subsidiary of Kerr-McGee Corporation. The Cimarron facility operated under two special nuclear material (SNM) licenses. License SNM-928 was issued for the production of uranium fuel, and License SNM-1174 was issued for the production of mixed oxide fuel. The principal operation under License SNM-928 involved the fabrication of enriched uranium reactor fuel pellets, and eventually fuel rods. A third license, License 35-12636-02, was issued for the possession of sealed sources (all cesium-137) for instrument calibration.

### 1.2.1 Mixed Oxide Fuel Production

Mixed oxide fuel was produced in the Mixed Oxide Fuel Fabrication (MOFF) facility from 1970 through 1975. Liquid uranyl nitrate and plutonium nitrate solutions were blended, co-precipitated, calcined, milled, pressed into pellets, and assembled in fuel pins. Because the MOFF facility was decommissioned and released for unrestricted use in 1993, a more detailed description of the manufacturing process is not provided herein. Additional information concerning the mixed oxide processing is presented in *Report No. 6, Decontamination and Decommissioning of the Kerr-McGee Cimarron Plutonium Fuel Plant* (Cimarron Corporation, 1988, ML21158A017).

### 1.2.2 Uranium Fuel Production

Enriched uranium fuel was produced at the Uranium Plant from 1966 through 1975. Process facilities included a main production building; several one-story ancillary buildings, five process-related collection ponds, two original sanitary lagoons, one new sanitary lagoon, a waste incinerator, several uncovered storage areas, and three burial grounds. The main production building was divided into six major areas: ceramic uranium dioxide ($UO_2$), pellet, scrap recycle and recovery, waste treatment, fabrication and the high enriched area. In addition, space was provided for auxiliary services such as administrative and laboratory services, maintenance, and warehousing. Figure 1-3 shows the location of the relevant features of the facility, including the former buildings, roads, burial sites, and impoundments.

The low enriched fuel fabrication process is described as follows:

- Uranium hexafluoride ($UF_6$) gas was received and stored on the Site for processing.
- The $UF_6$ was heated; the gaseous $UF_6$ was then passed through an ammonia solution, producing solid ammonium diuranate.
- Ammonium diuranate was calcined to produce $UO_2$ powder.
- UO powder was ground to break up agglomerates, and then blended and pressed into pellets.
- The pellets were converted into ceramic-grade $UO_2$ in reduction furnaces.
- After sintering, the pellets were ground to a straight-sided right circular cylinder.
- The $UO_2$ removed by grinding was sent to the scrap purification system.

Highly enriched uranium processing was also performed at the Site within the main process building. This fuel fabrication process is described as follows:

- $UF_6$ was vaporized by heating cylinders with steam, then reacted with a chemical to form solid uranium tetrafluoride ($UF_4$).
- The $UF_4$ was dried and placed in small muffle furnaces for conversion to $UO_2$ or uranium octaoxide ($U_3O_8$) metal oxides.
- Subsequent grinding and blending completed the oxide process.
- Uranium metal was made by blending $UF_4$ powder with calcium metal granules and heating.
- The uranium separated and was placed in an acid solution to remove the calcium and oxide slag.
- The metal and oxides were then packaged for shipment to fuel fabricators.

Additional operations at the facility included a solvent extraction process to recover uranium from the processing of scrap and from material that did not meet contract specifications.

### 1.2.3 Technetium-99 Impacted Feedstock

Groundwater samples obtained in the late 1970s yielded elevated results for gross beta activity at concentrations several times the results for gross alpha activity. Chemically purified uranium-238 has two short-lived beta-emitting daughters and one long-lived alpha emitting daughter; U-234 (the other uranium isotope that displays elevated activity in groundwater) has no short-lived daughters. The beta activity should therefore be less than twice the alpha activity. Because this trend was persistent at several locations, additional investigation was conducted, and it was determined that the excess beta activity was due to the presence of technetium-99 (Tc-99) in the groundwater.

Discussions were conducted with the Department of Energy, and it was determined that the Tc-99 came from the cleaning of cylinders at the Paducah facility. The Tc-99 was received at the time wastewater was being stored in Uranium Ponds #1 and #2, and seepage from those impoundments contained Tc-99.

### 1.2.4 Effluents

In general, the plant was designed to be slightly negatively pressurized with plant air primarily discharging through roof vents. Exhaust systems for process equipment and operating areas provided effective control of airborne contaminants generated during processing. Special blowers, absolute filters, and exhaust ducts were utilized in areas of high airborne contamination potential. The main plant for uranium processing had 22 individual exhaust stacks which were routinely monitored for releases of radioactivity. The solvent extraction operation had a single exhaust stack which likewise was continuously sampled and periodically analyzed for radioactivity in the gaseous effluent. The contaminated waste incinerator had efficient stack gas cleaning equipment for controlling air emissions. In addition to the process buildings, there were other areas which were affected either directly or indirectly by operations. These areas included the sanitary lagoons, the waste settling ponds, the on-site disposal areas, some drain lines, and the incinerator.

In converting $UF_6$ gas to a solid fuel, contaminated liquids were generated which required processing prior to discharge to impoundments. The liquid wastes generated during uranium processing were passed through an ion exchange system to recover the uranium. The treated effluent was monitored prior to being discharged to the Cimarron River from 1966 to 1971. From 1971 to 1975, the treated effluent was pumped to wastewater evaporation ponds. Contaminated sludge settled to the bottom of the ponds as the water evaporated.

Sanitary water and laundry water from the Uranium Plant operations were discharged to the East and West Sanitary Lagoons.

Radioactively contaminated solid wastes generated by Uranium Plant activities were buried at a designated on-site radioactive waste disposal area (Burial Area #1) from 1966 to 1970.

### 1.2.5 Termination of Operations

In a letter dated September 2, 1976, KMNC notified NRC that the plant was being placed on standby. In January 1977, KMNC submitted a description of proposed standby activities, which consisted of decontamination and cleanup activities, and requested a license renewal. NRC renewed License SNM-928 on May 3, 1977. Between 1977 and 1981, five license amendments were issued, all related to possession limits for natural and depleted uranium and authorized quantities of U-235 at different enrichments.

KMNC submitted application for another renewal of License SNM-928 on March 29, 1982. Sections of the application for license renewal which addressed the processing of nuclear materials were deleted "for the standby period". License SNM-928 was renewed on March 31, 1983. A description of the license amendments issued since this last renewal are described in further detail in Section 1.1 above.

## 1.3 PREVIOUS DECOMMISSIONING ACTIVITIES

This section addresses the decommissioning of buildings, impoundments, and pipelines. Buildings decommissioned under License SNM-928 include Uranium Building #1, Uranium Tank Storage Building #2, Solvent Extraction Building #3, Uranium Warehouse Building #4, the $UF_6$ Receiving Room, and the Emergency Response Building. Figure 1-4 shows the locations of these buildings, as well as the layout of Uranium Building #1. Impoundments included the Plutonium Waste Pond, Plutonium Emergency Pond, Uranium Emergency Pond, Uranium Waste Pond #1, Uranium Waste Pond #2, the East and West Sanitary Lagoons, and the "New" Sanitary Lagoon, shown in Figure 1-3.

### 1.3.1 Decommissioning Criteria

Decommissioning criteria (herein, the NRC Criteria) are stipulated in License Conditions 23 and 27. For soil and soil-like (volumetrically contaminated) material, License Condition 27 lists unrestricted release criteria of 10 picoCuries per gram (pCi/g) for natural thorium and natural uranium, 30 pCi/g for enriched uranium, and 35 pCi/g for depleted uranium.

Throughout the decommissioning and final status survey process, soil samples were analyzed by gamma spectroscopy in an on-site laboratory. The soil counter provided analytical results for U-238 and U-235, but could not quantify U-234 activity, as there are no gamma-emitting daughters of U-234 in the purified uranium. The background uranium activity for U-234 in soil analyzed on site was based on an average U-235 enrichment of 2.7% by weight. The mean-plus-two-standard-deviations value obtained from analysis of 28 background soil samples was 4 pCi/g total uranium. That value was used as the uranium concentration for background soil in final status survey reports, analysis of soil placed in the onsite disposal cell, and other volumetrically contaminated material until the early 2000s.

In a letter dated June 21, 1995 (ML21355A4334), the licensee compared the analytical results for background soil samples obtained by Oak Ridge Associated Universities (ORAU) and Oak Ridge Institute for Science and Education (ORISE) with results from the onsite soil counter. Correcting the value for U-234 based on natural enrichment, the licensee calculated a background concentration of 2.8 pCi/g total uranium (at a 95% confidence interval). The NRC agreed that if alpha spectroscopy is used to analyze samples, a value of 2.8 pCi/g total uranium is acceptable for use as the background activity concentration for soil.

License Condition 27 also states, “Soil and soil-like material with concentration exceeding the 1981 Branch Technical Position (BTP) Option 1 limits, but less than the Option 2 limits may be disposed in the onsite disposal cell in accordance with License Condition 23.” License Condition 23 states, “The licensee is authorized to bury up to 14,000 cubic meters ($m^3$) (500,000 cubic feet [$ft^3$]) of soil contaminated with low-enriched uranium, in the 1981 BTP Option 2 concentration range, in the location described in the licensee's October 9, 1989, submittal to the NRC. The BTP Option 1 limit for enriched uranium is 30 pCi/g (above background). The BTP Option 2 concentration range is up to 100 pCi/g for soluble uranium and up to 250 pCi/g for insoluble uranium.”

For surfaces of buildings and equipment, License Condition 27 references the NRC’s August 1987 *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for Byproduct, Source or Special Nuclear Material* (USNRC, 1987) which includes the following specific values:

- 5,000 disintegrations per minute (dpm) alpha/100 square centimeters ($cm^2$) (15.5 square inches [$in^{2]}$), averaged over 1 square meter ($m^2$) (10.8 square feet [$ft^2$])
- 5,000 dpm beta-gamma/100 $cm^2$ (15.5 $in^2$), averaged over 1 $m^2$ (10.8 $ft^2$)
- 15,000 dpm alpha/100 $cm^2$ (15.5 $in^2$), maximum over 1 $m^2$ (10.8 $ft^2$)
- 15,000 dpm beta-gamma/100 $cm^2$ (15.5 $in^2$), maximum over 1 $m^2$ (10.8 $ft^2$)
- 1,000 dpm alpha/100 $cm^2$ (15.5 $in^2$), removable
- 1,000 dpm beta-gamma/100 $cm^2$ (15.5 $in^2$), removable

### 1.3.2 Decommissioning of Former Buildings

#### *Uranium Building #1*

Uranium Building #1 was a one-story sheet metal building which contained the offices, laboratory, and change rooms, plus most of the equipment utilized for uranium fuel processing. Decontamination and release of equipment and building surfaces were based on the release criteria now stipulated in License Condition 27(c), measuring both direct and removable alpha contamination. Process equipment was removed from the processing areas, surveyed, and either decontaminated or shipped to a licensed low-level radioactive waste (LLRW) disposal facility.

In 1977, the licensee initiated a procedure for characterizing and decontaminating Uranium Building #1 walls, floors, and ceiling surfaces. During initial characterization, all surfaces were surveyed with a portable gas proportional alpha detector. All areas yielding direct contamination measurements greater than 4,000 dpm/100 $cm^2$ alpha were marked. All floor surfaces and the bottom two meters (m) of each wall were completely surveyed. All hot spots greater than or equal to 15,000 dpm/100 $cm^2$ direct and 1,000 dpm/100 $cm^2$ smearable contamination were decontaminated. This general procedure was utilized to characterize and remediate all the rooms in Uranium Building #1.

Ceiling tiles were removed, vacuumed, and surveyed. Ceiling tiles exceeding 2,000 dpm/100 $cm^2$ direct alpha or 500 dpm/100 $cm^2$ smearable alpha were disposed of at a licensed LLRW disposal facility. The ceiling, ceiling beams, rafters, conduit, piping and duct work were all surveyed. The entire attic area was vacuumed and cleaned. A second survey of the attic was conducted. Any areas identified as greater than 5,000 dpm/100 $cm^2$ alpha were acid washed and re-surveyed. Areas which could not be cleaned to less than 5,000 dpm/100 $cm^2$ alpha were resurveyed to ensure that they were less than 15,000 dpm/100 $cm^2$ alpha maximum and less than 5,000 dpm/100 $cm^2$ alpha average.

A roof grid was set up for the different sections of the 55,000 $ft^2$ roof; direct and removable contamination surveys were taken at grid intersects. Exterior wall panels were removed, surveyed for direct and removable contamination, and decontaminated if necessary. If wall panels were damaged or could not be decontaminated, replacement panels or panel sections from the Solvent Extraction Building were used to replace the exterior wall panels.

Concrete footings were decontaminated and surveyed, and new foot plates were installed prior to replacement of individual wall panels. The concrete slab was surveyed, decontaminated as required, and most of the slab was removed. Releasable and decontaminated slabs of concrete removed from Uranium Building #1 were placed in the spillway of the ponds in Subarea J, and in Subareas F and G.

Contaminated soil under the concrete was removed. Soil containing licensed material in the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell. Soil containing licensed material exceeding the BTP Option 2 concentration range was shipped to a licensed LLRW disposal facility. Floor drains and other drain lines were removed.

Additional details related to the decommissioning of Uranium Building #1 can be found in *Final Status Survey Report for Subarea "K"* (Cimarron Corporation, 2000, ML20213C529). Decommissioning of Uranium Building #1, including the removal of contaminated soil underlying the building and drain lines extending beneath stockpiled soils, was completed in 1997. Uranium Building #1 was located in Subarea K, which was released for unrestricted use in Amendment 18, Condition 30, issued May 28, 2002.

### *Uranium Tank Storage Building #2*

This steel building was located just south of Uranium Building #1. Building #2 was used to house 44 tanks that were 10 inches in diameter and 20 feet (ft) tall. The tanks were used to store uranium nitrate scrap solutions of less than 5% enrichment. This solution was held for subsequent reclamation by processing in the Solvent Extraction Building. The tanks were separated by concrete isolation barriers.

The concrete barriers and floor, as well as soil under and surrounding the building, were contaminated due to tank overflows, pipe leaks and pump leakage. The piping, tanks, and pumps were removed and were either decontaminated, surveyed, and released, or shipped off the Site to a licensed LLRW disposal facility. The building was surveyed, dismantled, and/or disposed of as required based upon alpha survey results. The concrete divider in Building #2 was decontaminated by wet blasting and vacu-blasting. The concrete floor, footings and divider then was surveyed for both alpha and beta/gamma. The concrete floor, footings, and divider were released for unrestricted use and hauled to on-site drainage areas as rip-rap for erosion control.

Contaminated soils from beneath Building #2 were removed. Approximately 19,500 $ft^3$ of soil exceeding the BTP Option 2 concentration range were removed and shipped for disposal at a licensed LLRW facility. The Building #2 area was initially backfilled with soil containing uranium in the BTP Option 2 concentration range up to four ft below grade. This soil was removed in 1994 and stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell.

Additional details related to the decommissioning of Uranium Tank Storage Building #2 can be found in *Final Status Survey Report for Subarea "K"* (Cimarron Corporation, 2000, ML20213C529). Decommissioning of Uranium Tank Storage Building #2 was completed in 1994. Uranium Tank Storage Building #2 was located in Subarea K, which was released for unrestricted use in Amendment 18, Condition 30, issued May 28, 2002.

### *Solvent Extraction Building #3*

This metal building was dismantled in 1986. Some of the building siding was shipped as radioactive waste; some was decontaminated and used as replacement siding for Uranium Building #1. Equipment from this building was either decontaminated for unrestricted release or shipped to a licensed LLRW disposal facility. The concrete flooring from this building was surveyed for alpha only, decontaminated as necessary, released, and used for on-site erosion control. Contaminated soil in this area was excavated and segregated. Soil exceeding the BTP Option 2 concentration range were removed and shipped for disposal at a licensed LLRW facility. Soil containing uranium within the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell.

Additional details related to the decommissioning of the Solvent Extraction Building can be found in *Final Status Survey Report for Subarea "K"* (Cimarron Corporation, 2000, ML20213C529). Decommissioning of the Solvent Extraction Building was completed in 1986. The Solvent Extraction Building was located in Subarea K, which was released for unrestricted use in Amendment 18, Condition 30, issued May 28, 2002.

### *Uranium Warehouse Building #4*

The warehouse is a sheet metal building which was never used to process radioactive materials. However, fuel assemblies were inspected and assembled for a short period of time within this building. Cimarron personnel requested permission from the NRC on December

28, 1979 to decontaminate the warehouse and use the building for coal liquefaction research and development.

Final release surveys were completed on the inside and outside surface of this building in 1980. The NRC gave approval on March 28, 1980, to use the “Coal Building” for non-nuclear purposes based upon these surveys. The survey conducted in 1980 was for alpha only. Additional surveys were conducted in the Coal Building in 1993 for both alpha and beta/gamma activity. These surveys revealed several small areas with elevated levels of beta activity in the concrete floor, which were decontaminated to unrestricted release criteria.

A portion of Uranium Warehouse Building #4 was used for coal liquefaction research and development. Although the process equipment was drained at the conclusion of testing, residual coal tar is still present in some of the process equipment. Another portion of Uranium Warehouse Building #4 was also used for titanium dioxide research and development. Although the process equipment was drained at the conclusion of testing, residual titanium tetrachloride was present in some of the process equipment. That equipment was removed by the current owner of the property on which Uranium Warehouse Building #4 is located.

Additional details related to the decommissioning of Uranium Warehouse Building #4 can be found in *Final Status Survey Report for Subarea “I”* (Cimarron Corporation, 1999B, ML20212L572). Decommissioning of this building was completed in 1994. Uranium Warehouse Building #4 is located in Subarea I, which was released for unrestricted use in Amendment17, License Condition 29, issued April 23, 2001.

### $UF_6$ Receiving Room

This metal building was located adjacent to the south wall of Uranium Building #1. It was within this building that the cylinders of $UF_6$, received from Atomic Energy Commission diffusion plants, were heated with steam to vaporize the $UF_6$ for processing into fuel. Decontamination and decommissioning activities were initiated for the Vaporizer Building in 1991. The inner wall was removed, surveyed, decontaminated as required, and replaced. The roof and all interior and exterior walls were surveyed for direct and smearable alpha contamination. Areas exceeding unrestricted release criteria were decontaminated to comply with these criteria. The concrete floor was surveyed, decontaminated, and released for on-site erosion control.

Soil from under this building containing uranium within the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell.

Additional details related to the decommissioning of the $UF_6$ Receiving Room can be found in *Final Status Survey Report for Subarea "K"* (Cimarron Corporation, 2000, ML20213C529). Decommissioning of the $UF_6$ Receiving Room was completed in 1991. The $UF_6$ Receiving Room was located in Subarea K, which was released for unrestricted use in Amendment 18, Condition 30, issued May 28, 2002.

#### *Emergency Response Building*

During operating years, this building housed medical personnel, records, and emergency decontamination showers. During decommissioning activities, this building was used to house the on-site soil counter and to store records and soil samples. No decommissioning was required for the Emergency Response Building. The Emergency Response Building is located in Subarea I, which was released for unrestricted use in Amendment17, License Condition 29, issued April 23, 2001. This building was surveyed for unrestricted release. The building is currently being used as an office building for Trustee personnel and contractors.

### 1.3.3 Decommissioning of Former Impoundments

#### *Plutonium Waste Pond*

This hypalon-lined evaporation pond was irregular in shape. In 1976, a system was installed to decant and filter water from the Plutonium Waste Pond to Uranium Pond #2. The water was pumped from the surface through the filtration system until approximately 70,000 gallons of water remained, which were not processed because the radionuclide concentration was greater than 0.1 times the maximum permissible contamination limit.

The remaining water contained radioactive particles in colloidal suspension. Treatment of the 70,000 gallons of water in the Plutonium Waste Pond involved decanting water, treating it with ferric sulfate and sodium hydroxide to precipitate an iron hydroxide flocculent, and discharging it to the Plutonium Emergency Pond. The water from the Plutonium Emergency Pond then was decanted to Uranium Pond #2. After all water from the Plutonium Emergency Pond was transferred to Uranium Pond #2, the ferric hydroxide ($Fe(OH)_3$) sludge was transferred to the Plutonium Waste Pond and solidified with concrete. A total of 491 drums of solidified waste containing less than 1 gram of plutonium (total) were shipped off the Site for disposal at a licensed LLRW disposal facility.

The Plutonium Waste Pond liner was surveyed for alpha contamination, rolled up, and left in place prior to backfilling. The liner was later removed in 1986 when the New Sanitary Lagoon was constructed.

The Plutonium Waste Pond is located in Subarea L, which was released for unrestricted use in Amendment 17, License Condition 29, issued April 9, 2001.

### *Plutonium Emergency Pond*

This hypalon-lined evaporation pond was irregular in shape, with a capacity of approximately 250,000 gallons. In 1976, water from the Plutonium Emergency Pond was pumped to Uranium Pond #1 with no visible sludge remaining. The Plutonium Emergency Pond was left undisturbed until it was used for treatment of water from the Plutonium Waste Pond. Waste precipitate residue was removed from the Plutonium Emergency Pond and placed in the Plutonium Waste Pond.

The Plutonium Emergency Pond liner was surveyed for alpha contamination prior to being rolled up and left in place prior to backfilling. The Plutonium Emergency Pond is located in Subarea L, which was released for unrestricted use in Amendment 17, License Condition 29, issued April 9, 2001.

### *Uranium Emergency Pond*

This unlined evaporation pond was irregular in shape, with a capacity of approximately 180,000 gallons. In 1976, water from the Uranium Emergency Pond was pumped to Uranium Pond #1, with no visible sludge remaining. After being pumped dry and characterized, the Uranium Emergency Pond was left undisturbed (no additional remediation was performed) until written approval was received from the NRC to backfill five ponds. The Uranium Emergency Pond is located in Subarea L, which was released for unrestricted use in Amendment 17, License Condition 29, issued April 9, 2001.

### *Uranium Pond #1*

This asphalt, pitch, felt and pea-gravel-lined evaporation pond was rectangular, with a capacity of approximately 1,150,000 gallons. Uranium Pond #1 was closed by crushing the asphalt liner into the pond. The underlying clay dike material and clean soil were used to fill in the depression (a depth of approximately 4 ft). This pond was backfilled in 1978 after confirmatory sampling by NRC.

The closure of Uranium Pond #1 began with the construction and installation of a dike across the south half of the pond. This enabled Waste Pond #1 to be consolidated into a much smaller area. Excess water was decanted to Uranium Pond #2. Sludge solidification consisted of mixing the sludge with approximately 15% cement. 865 drums of solidified waste containing 3,002 grams of U-235 were shipped from Uranium Pond #1 to a licensed LLRW disposal facility.

Uranium Pond #1 is located in Subarea O, which was released for unrestricted use in Amendment 16, License Condition 28, issued April 17, 2000.

### *Uranium Pond #2*

Uranium Pond #2 had a compacted clay bottom liner with poly rubber sidewalls anchored at the bottom and top of the dike. The pond was rectangular, with a capacity of approximately 3,000,000 gallons. Sludge removal was not required because sludge had not been generated in this pond.

Uranium Pond #2 is located in Subarea O, which was released for unrestricted use in Amendment 16, License Condition 28, issued April 17, 2000.

### *East and West Sanitary Lagoons*

These unlined ponds were rectangular in shape, and the capacity of each pond was approximately 500,000 gallons. The East and West Sanitary Lagoons received all liquid waste from the Uranium Plant from 1966 to 1970. In 1970, liquid waste from the Uranium Plant was diverted to other ponds located on the Site. From 1970 until 1985, the MOFF Plant septic tank, the Uranium Plant septic tank, the Uranium Plant laundry, the MOFF Plant lab, the Uranium Plant lab, the Uranium Plant dock drain, and numerous floor drains in the Uranium Plant discharged into the East and West Sanitary Lagoons.

In 1986, residual water in the East and West Sanitary Lagoons was pumped to the New Sanitary Lagoon. Initial soil removal and packaging of contaminated soil from the East Sanitary Lagoon was completed in 1986. Initial soil removal and packaging of contaminated soil from the West Sanitary Lagoon was completed in 1987. Approximately 55,000 $ft^3$ of waste were shipped to a licensed LLRW disposal facility. Final clean-up and survey work was performed on both lagoons in 1990.

The East and West Sanitary Lagoons were located in Subarea H, which was released for unrestricted use in Amendment17, License Condition 29, issued April 23, 2001.

### *"New" Sanitary Lagoon*

The hypalon-lined New Sanitary Lagoon was installed by January 1986. The New Sanitary Lagoon was located directly above the closed Plutonium Waste Pond and a portion of the closed Plutonium Emergency Pond. This lagoon replaced the East and West Sanitary Lagoons, which were being decommissioned. A French drain was installed under the New Sanitary Lagoon prior to construction to divert groundwater that may collect under this area. All liquids from the East and West Sanitary Lagoons were pumped to the New Sanitary Lagoon prior to the start of remediation on the East and West Sanitary Lagoons. Wastewater from the ion exchange system and Uranium Building #1 drains was also released to the New Sanitary Lagoon. The New Sanitary Lagoon was utilized from early 1986 to October 1992.

The rainwater which collected in the lagoon was land applied in accordance with Oklahoma State Department of Health requirements. The sediments were then dewatered, sampled, and analyzed for total uranium. All sediment was removed. Material containing uranium within the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell.

The liner surface was then surveyed in accordance with NUREG-5849. Any liner found to exceed free release criteria was either decontaminated or disposed in a licensed LLRW disposal facility. The liner was cut into sections for removal.

After removal of the liner, surface soil was surveyed at the surface and at 1 m with a micro-R meter. A 5 m x 5 m grid area was established, and any location yielding two times background was marked. At marked locations and grid intersects, soil samples 0 to 6 inches below grade were collected for analysis. Samples were analyzed for total uranium. Areas that yielded uranium at concentrations exceeding the BTP Option 1 limit (30 pCi/g above background) were further characterized by sampling at a greater density. Soil containing uranium at concentrations exceeding the BTP Option 1 limit were packaged and shipped to a licensed LLRW disposal facility.

The “New” Sanitary Lagoon was located in Subarea L, which was released for unrestricted use in Amendment17, License Condition 29, issued April 23, 2001.

### 1.3.4 Decommissioning of Former Pipelines

Figure 1-5 shows the locations of pipelines beneath and near the buildings. Figure 1-6 shows the locations of pipelines and spills site wide. Nearly all the pipelines indicated as “removed” on Figures 1-5 and 1-6 were excavated in 1985. Soil stockpiles containing uranium within the BTP Option 2 concentration range were located east of Uranium Building #1. Only those drain lines which were beneath Uranium Building #1 and extending east of Uranium Building #1 (beneath soil stockpiles) remained until 1997, when the last drain lines beneath the soil stockpile were removed as the soil was placed in the on-site BTP Option 2 Disposal Cell.

The process for removal and survey of drain lines was similar for all pipelines. Pipelines were removed by excavation of a trench following the pipeline. The trench was surveyed and sampled at 10-meter intervals. When scan readings indicated (or soil samples yielded) uranium concentrations exceeding the BTP Option 1 limit, additional measurements and samples were obtained between 10-m locations. Soil exceeding the BTP Option 1 limit was excavated and shipped to a licensed LLRW disposal facility. More detailed information on the decommissioning of each pipeline can be found in “*Radiological Characterization Report for Cimarron Corporation’s Former Nuclear Fuel Fabrication Facility*” (Chase Environmental Group, 1994A, ML20199M359). The following describes the removal of pipelines and surveys of soil related to pipelines for which there was no evidence of leakage or release of licensed material. The removal, survey, and decommissioning of pipelines and releases from those pipelines is further discussed in Section 1.4, “Spills or Releases”.

#### *Drain Line from Uranium Pond #1 to the Cimarron River*

This six-inch polyvinyl chloride (PVC) pipe was installed for liquid effluent discharges from Uranium Pond #1 to the Cimarron River. Records indicate that liquid was only discharged two times from Uranium Pond #1 to the Cimarron River. The drain line was excavated and removed in 1985. Surveys of the trench yielded no areas with elevated uranium concentrations. A soil sampling program was conducted at 10-meter intervals, collecting soil samples at 6-inch intervals for the first ft, and at 1-foot intervals to 4 ft in depth. No samples exceeded BTP Option 1 limits.

### *Drain Line from Uranium Pond #1 to Uranium Pond #2*

This 4-in PVC drain line was used for transfer of liquid from Uranium Pond #1 to Uranium Pond #2. Transferred liquid involved only slightly contaminated water. Uranium Pond #2 was used for evaporation purposes only and did not discharge. This drain line was excavated and removed in 1985. A gamma survey was conducted after the pipe was removed, with measurements taken at the bottom, at the surface, and at 1 m above the surface of the excavated area. No contaminated soil was identified in the trench.

## 1.3.5 Decommissioning of Soil

Decommissioning of both soil and waste was based on criteria specified in the 1981 BTP, SECY 81-576, "Disposal or On Site Storage of Residual Thorium or Uranium (Either as Natural Ores or Without Daughters Present) From Past Operations". The BTP criteria were first formally introduced into the license when the on-site burial of up to 14,000 $m^3$ (500,000 $ft^3$) of material within the BTP Option 2 concentration range was authorized in License Condition 23 of License Amendment 10. The use of the BTP Option 1 criteria as unrestricted release criteria was formally incorporated into the license in License Condition 27 when License Amendment 15 was issued July 29, 1999.

The Site was divided into 16 "Subareas", designated Subareas A through O (Subarea O is comprised of two areas which formerly contained two uranium waste ponds). Subareas A through E were considered unaffected areas and were designated "Phase I" areas. Subareas F through I contained both unaffected and affected areas and were designated "Phase II" areas. Subareas K through O contained affected areas and were designated "Phase III" areas. A total of three final status survey plans were submitted to NRC, one addressing each "Phase" of Subareas. Subareas I and K included former processing buildings, and final status surveys for these areas included surveys of the buildings in addition to surface and/or subsurface soil.

### *Phase I Areas*

The October 24, 1994, *Final Status Survey Plan for Unaffected Areas* (Chase Environmental Group, 1994B, ML092720449) was a single final status survey plan for Subareas A through E. The August 9, 1995, *Final Status Survey Report, Phase I Areas* (Cimarron Corporation, 1995, ML21158A013) presented the results of the final status survey for all five areas. A March 1996 *Confirmatory Survey of the Phase I Unaffected Areas* (Payne, 1996, ML21155A202) concurred with the results of the final status survey. NRC released Subareas A through E from License SNM-928 in License Amendment 13, dated April 23, 1996.

### *Phase II Areas*

The July 25, 1995, *Final Status Survey Plan for Phase II Areas* (Chase Environmental Group, 1995B, ML20202A434) was a single final status survey plan for Subareas F through J.

*Final Status Survey Report for Phase II Subarea J* (Cimarron Corporation, 1997, ML20202A639) was submitted September 5, 1997. NRC released Subarea J from License SNM-928 in License Amendment 16, dated April 17, 2000.

*Final Status Survey Report for Subarea H* (Cimarron Corporation, 1998C, ML20203M180) was submitted November 16, 1998. *Final Status Survey Report, Subarea I* (Cimarron Corporation, 1999B, ML20212L572) was submitted June 29, 1999. NRC released Subareas H and I from License SNM-928 in License Amendment 17, dated April 9, 2001.

*Final Status Survey Report, Subarea G* (Cimarron Corporation, 1999C, ML20043F258) was submitted October 21, 1999. The NRC conducted a confirmatory survey for Subarea G during inspections conducted in 2001, reporting the results in NRC Inspection Report 70-925/01-01 (ML20171A853). The report stated, “The confirmatory exposure-rate measurements, soil sample analysis results, and alpha and beta building measurements were all below the applicable NRC release criteria. These confirmatory measurements were consistent with the licensee's determination that Sub-Areas K and G of the Cimarron Site meets the criteria established in NRC License SNM-928, License Condition 27 for unrestricted use.” When license SNM-928 was transferred to the CERT, the February 16, 2011, license transfer order (ML110270371) stated, “Final status surveys and confirmatory surveys have confirmed that Subareas G and N are releasable for unrestricted use, but NRC has determined that these areas should not be released until groundwater remediation is complete.”

*Decontamination and Final Survey Report for Cimarron Facility Contaminated Waste Burial Ground* (Cimarron Corporation, 1991, ML19363A014), submitted November 25, 1991, presented final status survey results for the excavated burial trenches in Subarea F prior to their backfilling, which NRC approved in License Amendment 9, dated December 28, 1992. *Final Status Survey Report for Concrete Rubble in Sub-Area F* (Chase Environmental, 1998A, ML20043F213) presented final status survey results for concrete slabs which had been removed from buildings and structures in other areas and placed in Subarea F. The NRC conducted a confirmatory survey for the Subarea F concrete rubble during an inspection conducted in July 2012, reporting the results in NRC Inspection Report 070-00925/12-01 (ML12185A121). The report stated, "The inspector also conducted measurements in Sub Area F, with emphasis on an area containing concrete rubble. General area measurements above the concrete rubble at a height of approximately one meter ranged from 6-12 microRoentgens per hour, equal to background levels." *Final Status Survey Report, Subarea F* (Nextep Environmental, Inc., 2005, ML20043F208) was submitted September 5, 2005, with additional information provided in the November 20, 2007, *Burial Area #1 Subsurface Soil Assessment* (Cimarron Corporation, 2007B, ML20043D187). The NRC selected seven subsurface soil samples to be analyzed by ORAU as confirmatory subsurface soil samples. ORAU reported the results for these confirmatory samples in a letter dated March 6, 2013 (Oak Ridge Associated Universities, 2013, ML19106A232); all results were less than one-third of the criteria for unrestricted release. When license SNM-928 was transferred to the CERT, the February 16, 2011, license transfer order (ML110270371) stated, "Because groundwater exceeds license criteria in Subarea F, this area cannot be released for unrestricted use until groundwater remediation is complete."

### Phase III Areas

The June 24, 1997, *Final Status Survey Plan for Phase III Areas* (Chase Environmental Group, 1997, ML092610871) was a single final status survey plan for Subareas K through N. Two final status survey reports were submitted for Subarea O. *Final Status Survey Report for Phase III Subarea O Uranium Waste Ponds #1 and #2 (Subsurface)* (Cimarron Corporation, 1998A, ML20206K825) was submitted March 12, 1998. *Final Status Survey Report, Subarea O (Surface)* (Cimarron Corporation, 1999A, ML20213A859) was submitted February 9, 1999. NRC released the two Subarea O areas from License SNM-928 in License Amendment 16, dated April 17, 2000.

Two final status survey reports were submitted for Subarea L. *Final Status Survey Report for Subarea L (Subsurface)* (Cimarron Corporation, 1996, ML20202A535, ML20202A557, and ML20202A558) was submitted May 29, 1996. *Final Status Survey Report for Subarea L* (Cimarron Corporation, 1998B, ML20205L576) was submitted July 27, 1998.

*Final Status Survey Report for Subarea M* (Cimarron Corporation, 1998D, ML19154A192) was submitted December 31, 1998. NRC released Subareas L and M from License SNM-928 in License Amendment 17, dated April 9, 2001.

*Final Status Survey Report for Subarea K* (Cimarron Corporation, 2000, ML20213C529) was submitted February 15, 2000. NRC released Subarea K from License SNM-928 in License Amendment 18, dated May 28, 2002.

*Final Status Survey Report for Subarea N* (Cimarron Corporation, 2002A, ML20043F229) was submitted January 31, 2002. NRC performed an inspection/confirmatory survey for Subarea N in June 2002. NRC inspection report 70-925/02-01, dated September 18, 2002 (ML022610647), stated, "These confirmatory measurements were consistent with the licensee's determination that Subarea N of the Site meets the criteria established in NRC License SNM-928, License Condition 27 for unrestricted use." When license SNM-928 was transferred to the CERT, the February 16, 2011, license transfer order (ML110270371) stated, "Final status surveys and confirmatory surveys have confirmed that Subareas G and N are releasable for unrestricted use, but NRC has determined that these areas should not be released until groundwater remediation is complete."

### *Summary*

As a result of all the above-described final status surveys, confirmatory surveys, and license amendments, the buildings, pipeline runs, former impoundments and burial trenches, and surface and subsurface soil in all Subareas have been demonstrated to comply with unrestricted release criteria in all Subareas. The only medium for which decommissioning is required is groundwater, and most of the property within which groundwater exceeds license criteria is no longer licensed by NRC.

## 1.4 SPILLS OR RELEASES

Several types of spills or releases of licensed material occurred at the Site. Some subsurface drain lines, including pipelines carrying wastewater to ponds, leaked wastewater in quantities that were too small to be detected during operations, but which yielded elevated scan or soil sample results upon excavation and removal of the pipeline. Beneath Uranium Building #1, soil was found to be contaminated by leaking drain lines or by migration of licensed material through penetrations in the concrete floor, such as locations where cracks developed or where electrical conduit penetrated the floor. Soil removal and disposal (based on the uranium activity of the soil) was required in these cases.

Uranium Ponds #1 and #2 were primarily evaporative ponds, but wastewater seeped through the pond liners and impacted the groundwater underlying the ponds. Movement of groundwater has resulted in migration of uranium, nitrate, and fluoride beyond the footprint of the impoundments, extending into the Western Alluvial Area. The extent of contaminant migration is addressed in Section 3.

Burial of wastes containing licensed material in trenches in the three burial areas that were used during operations resulted in the leaching of uranium and/or nitrate and fluoride into groundwater. Movement of groundwater has resulted in migration of licensed material beyond the burial trenches. The extent of contaminant migration is addressed in Section 3.

Finally, contaminated equipment was stored outside in a storage yard located east of Uranium Building #1. A water supply well (Well 1319) had been drilled in the storage yard but had never been used to produce water for production operations. The well casing was cut off at grade but had not been securely covered. Rainwater rinsed some licensed material off contaminated equipment, which then flowed down the well. This resulted in the contamination of groundwater in the Well 1319 Area. The extent of contaminant migration is addressed in Section 3.

When the Cimarron Site and the NRC license were transferred to the CERT, the CERT did not receive any records of spills or releases from pipelines or other sources than those addressed above. In 2002, a site wide investigation was performed during which soil data in final status survey reports were reviewed; in addition to the impoundments, burial areas, and Well 1319, this data review identified several locations which indicated the potential presence of historic pipeline leaks. Monitor wells were installed downgradient from every potential source of impact to groundwater. Figure 1-6 shows the locations of potential pipeline leaks (constituting a spill, or release) which were identified during their excavation and removal.

### 1.4.1 Leaking Drain Lines Causing Soil Contamination

#### *Main Drain Line from Uranium Building #1 to Uranium Pond #1*

Except for portions of this line underlying Uranium Building #1 and the soil stockpiles, this four-inch PVC line was excavated and removed in 1985. The excavated trench was surveyed, and 150 drums of soil that exceeded the BTP Option 1 limit due to a leak located south and east of Uranium Pond #1 were packaged and shipped to a licensed LLRW disposal facility.

### *Liquid Waste Line from Uranium Building to Emergency Ponds*

This four-inch PVC line was excavated and removed in 1985. Surveys of the trench yielded several areas with elevated uranium concentrations, which were removed and shipped to a licensed LLRW disposal facility.

### *Drain Line from Closed Sanitary Lagoons to Cimarron River*

This four-inch steel drain line was used for liquid effluent discharges from the Sanitary Lagoons to the Cimarron River. The drain line was excavated and removed in 1985. Surveys of the trench yielded several areas with elevated uranium concentrations, which were removed and shipped to a licensed LLRW disposal facility.

### *Uranium Building #1 Drain Lines*

For those drain lines that were under Uranium Building #1, it was not possible to distinguish between soil that had been impacted by releases from drain lines and soil that had been impacted by releases through penetrations in the floor (e.g., electrical conduit, floor joints, etc.). Drain lines under the laboratory were removed in 1990. Drain lines under the Wet Ceramic area were removed in 1990 and 1991. This area was included in a 1991 confirmatory survey performed by ORISE prior to backfilling (Oak Ridge Associated Universities, 1993, ML20043D999). Drain lines under the Scrap Area Floor were removed in 1990 and 1991. This area was included in an ORISE confirmatory review. Drain lines along the North wall of the Uranium Building were removed in 1991. Drain lines east of Uranium Building #1 were excavated and removed in 1992. In all areas beneath the processing areas of Uranium Building #1, soil underlying the concrete slab was surveyed. Soil containing uranium within the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell. Soil exceeding the BTP Option 2 limit was packaged and shipped to a licensed LLRW disposal facility.

Once the stockpiled soil had been placed in the on-site BTP Option 2 Disposal Cell, the pipeline under the stockpile was excavated and removed in 1997. Material containing uranium within the BTP Option 2 concentration range was transferred to the on-site BTP Option 2 Disposal Cell.

## 1.4.2 Leaking Drain Lines Causing Groundwater Contamination

In the Western Alluvial Area, uranium activity exceeds the NRC Criterion, and uranium, nitrate, and fluoride all exceed their State Criteria. Leaking wastewater from a drain line extending from the former lagoons to the Cimarron River resulted in the contamination of groundwater in several areas. A pipeline leak near Well 1350 resulted in a nitrate concentration below its State Criterion but above its MCL. A pipeline leak near Well 1355 resulted in a nitrate concentration below its State Criterion but above its MCL. West of the southern end of the 1206 drainage way, fluoride exceeds its State Criterion in Well 1348.

### 1.4.3 Groundwater Contamination from Leaking Ponds

Leaking wastewater from Uranium Pond #1 has resulted in Tc-99, fluoride, and nitrate exceeding their State Criteria, but uranium concentrations are below the MCL. Leaking wastewater from Uranium Pond #2 has resulted in uranium, Tc-99, fluoride, and nitrate exceeding their State Criteria.

### 1.4.4 Groundwater Contamination from Buried Waste

Burial Area #1 – Leachate from the waste buried in Burial Area #1 (BA1) has resulted in uranium concentrations exceeding the NRC Criterion, but nitrate and fluoride concentrations are at background concentrations. Tc-99 is not present in BA1.

Burial Area #2 – Leachate from the waste buried in Burial Area #2 has resulted in uranium concentrations that formerly exceeded the NRC Criterion, but uranium concentrations dropped below the NRC Criterion in 1999 and dropped below the State Criterion in 2016. Uranium, Tc-99, nitrate, and fluoride concentrations are all below their MCL.

Burial Area #3 – Leachate from the waste buried in Burial Area #3 has resulted in uranium concentrations exceeding the NRC Criterion, and nitrate concentrations exceed the State Criterion. Fluoride concentrations have been below the MCL.

### 1.4.5 Rainwater Causing Contamination through Well 1319

Contaminated runoff from precipitation apparently flowed down the former uncapped water supply Well 1319. The potentiometric surface in this water well appears to have been in Sandstone B because the uranium concentration previously exceeded the NRC Criterion only in Sandstone B (described in Section 2.5). Groundwater extraction reduced the uranium concentration to less than the NRC Criterion, but uranium and nitrate concentrations continue to exceed the State Criteria. Fluoride concentrations are below the MCL.

Figure 1-6 shows the locations of the sources of spills and releases. The extent of contaminant migration in groundwater is addressed in Section 3.

## 1.5 PRIOR ON-SITE BURIALS

During operating years, licensed material was disposed of in burial trenches in three locations, in accordance with subsequently superseded 10 CFR 20.302. Some of the material in these trenches, while complying with 10 CFR 20.302, exceeded unrestricted release criteria later incorporated into License SNM-928 and was removed. Soil containing low concentrations of licensed material has been buried on the Site in a fourth area, as discussed in Section 1.5.4. The locations of all four burial areas are shown on Figure 1-3.

### 1.5.1 Burial Area #1

This burial area, constructed in 1965, was opened in 1966 for disposal of radioactive material, including thorium-contaminated waste from the Kerr-McGee Corporation's Cushing, Oklahoma facility. BA1 was closed and capped in 1970. Records show that 1,303 kg of depleted uranium, 148 kg of enriched uranium, and 5,555 kg of natural thorium were buried in this area. An investigation was initiated in 1984.

Remediation involved the location and excavation of all material exceeding BTP Option 1 and Option 2 soils from BA1. Material containing licensed material in the BTP Option 2 concentration range was stockpiled near the Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell (identified as Burial Area #4 [BA4]; refer to Section 1.5.4). From 1986 through 1988, BA1 disposal trenches were excavated. Waste exceeding the BTP Option 2 limits was shipped for disposal at a licensed LLRW disposal facility. Waste shipment records indicate that approximately 65,000 $ft^3$ of waste were shipped for disposal. Approximately 16,000 $ft^3$ of contaminated soil within the BTP Option 2 concentration range were stockpiled east of Uranium Building #1 pending on-site disposal.

In 1988, ORAU performed a confirmatory survey for BA1 and found eight locations requiring further remediation. An additional 14,000 $ft^3$ of material were removed and stockpiled east of Uranium Building #1. Confirmatory soil sampling and surveys by ORAU were completed in December 1991, with a final report issued in July 1992 (Smith, B.M., 1992, ML20043D984). Five out of the hundreds of samples yielded uranium exceeding 30 pCi/g total uranium; area averaging resulted in no area exceeding 30 pCi/g total uranium. BA1 was released for backfilling with soil containing less than 30 pCi/g uranium and 10 pCi/g thorium in Amendment #9, License Condition 22, issued December 28, 1992.

Data for soil samples collected from BA1 following disposal trench backfilling was obtained from *Final Status Survey Report, Subarea F* (Nextep Environmental, 2005, ML20043F208). A total of 533 surface and subsurface soil samples were collected from BA1 during the final status survey of Subarea F. The net mean uranium concentration for soil in BA1 was 3.4 pCi/g. Table 1-1 presents the data for all soil samples obtained from BA1 during the final status survey.

In 2002, Monitor Wells 02W50, 02W51, and 02W52 were installed in or within 15 feet of the southern (upgradient) portions of three of the four backfilled burial trenches. All three of these monitor wells were sampled in 2002, 2004, 2013, and 2015 and analyzed for isotopic uranium. The highest uranium concentration recorded in groundwater from any of these wells was approximately 7.5 pCi/L total uranium.

The concentration of uranium in soil in the vadose zone is far below the NRC Criterion, and uranium in the soil is not impacting groundwater to concentrations of concern. The NRC has adopted the concept that uranium in the groundwater is now the source of contamination to soil in the northern portion of the former burial trenches, as well as to soil in the saturated zone both there and downgradient from the trenches.

There is no evidence that soil in the vadose zone in BA1 continues to impact groundwater.

### 1.5.2 Burial Area #2

Burial Area #2 (BA2) was utilized in the 1970s for the disposal of industrial solid waste generated during processing operations. Analysis of soil samples collected in May 1990 determined that licensed material was present in this buried waste. Remediation of BA2 began in 1991.

Remediation involved the location and excavation of all material exceeding BTP Option 1 and Option 2 soils from BA2. Material containing licensed material in the BTP Option 2 concentration range was stockpiled east of Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell (BA4; refer to Section 1.5.4). Approximately 20,000 $ft^3$ of material exceeding the BTP Option 2 concentration range were packaged and shipped for disposal in a licensed LLRW disposal facility. Industrial waste was also packaged and shipped for disposal in a licensed LLRW waste disposal facility.

NRC staff supervised a confirmatory sub-surface sampling effort for BA2 on October 30, 1996. Based upon the results of this confirmatory sampling effort, the NRC staff approved the backfilling of BA2 excavations. Excavations were backfilled with soils from unaffected areas, which were sampled and analyzed after placement, and final grading was completed in January 1997.

Data for subsurface soil samples collected from BA2 following backfilling of the excavations was presented in *Final Status Survey Report for Subarea L (Subsurface)* (Cimarron Corporation, 1996, ML20202A535, ML20202A557, and ML20202A558). Data for surface soil samples collected after BA2 had been backfilled and regraded was obtained from *Final Status Survey Report for Subarea L* (Cimarron Corporation, 1998B, ML20205L576). Table 1-2 presents the data obtained from both the 1996 subsurface and the 1998 surface soil samples. The mean net uranium concentration for the 118 soil samples collected from BA2 was 3.3 pCi/g. Two individual samples exceeded the decommissioning criterion of 30 pCi/g total uranium, but the average concentration for the 100 $m^2$ area within which those samples were located did not exceed 21 pCi/g total uranium. BA2 was released for unrestricted use in Amendment17, License Condition 29, issued April 9, 2001.

The July 6, 2017, letter *Removal of Burial Area #2 Remediation from Decommissioning Plan* (Environmental Properties Management, 2017, ML17187A610 and ML17194A805) presented the results of groundwater sampling downgradient from BA2, showing that uranium concentrations in groundwater downgradient of the burial area had declined to less than both State and NRC Criteria. That submittal proposed the removal of planned groundwater extraction infrastructure, as groundwater remediation was no longer needed in this area. Soil in BA2 is not considered a potential source of contamination to groundwater.

### 1.5.3 Burial Area #3

This area was intended to be utilized for the disposal of non-radioactive solid waste materials. In 1990, soil sampling and gamma surveys indicated that radioactive materials were present in the buried waste. In-depth characterization completed in 1992 led to the removal of approximately 100 $ft^3$ of waste exceeding the BTP Option 2 concentration range. This waste was packaged and shipped to a licensed LLRW disposal facility.

Cimarron later excavated all non-native material from the Burial Area #3 (BA3) trenches. All industrial solid waste, soil, and non-native material were spread in lifts approximately 6 inches thick and were surveyed with both gamma scans and collection of soil samples. Material containing licensed material in the BTP Option 2 concentration range was stockpiled east of

Uranium Building #1 for future placement in the on-site BTP Option 2 Disposal Cell (BA4; refer to Section 1.5.4). Material and/or soil exceeding the BTP Option 2 concentration range was packaged and shipped for disposal in a licensed LLRW disposal facility. BA3 was released for unrestricted use in Amendment 17, License Condition 29, issued April 9, 2001.

Data for soil samples collected from BA3 following backfilling of the excavations was presented in *Final Status Survey Report for Subarea M* (Cimarron Corporation, 1998D, ML19154A192). A total of 505 surface and subsurface soil samples were collected from BA3 during the final status survey. The net mean uranium concentration for soil in BA3 is 5.4 pCi/g. Six individual samples exceeded the decommissioning criterion of 30 pCi/g total uranium, but the average concentration for the 100 $m^2$ area within which those samples were located did not exceed 23 pCi/g total uranium. Table 1-3 tabulates the soil data for BA3. The soil in BA3 is not considered a potential source of impact to groundwater.

### 1.5.4 Burial Area #4

BA4 is an on-site disposal cell approved by NRC and DEQ for the on-site disposal of soil containing uranium in the BTP Option 2 concentration range. The lower bound of the BTP Option 2 concentration is 30 pCi/g total uranium. The upper bound varies from 100 pCi/g total uranium for soluble uranium to 250 pCi/g total uranium for insoluble uranium. Cimarron performed tests to evaluate lung solubility as well as tests to determine environmental leachability, including the EPA-approved Extraction Procedure for Toxicity and Toxicity Characteristic Leaching Procedure (TCLP), but was unable to obtain NRC approval for any calculated solubility. Consequently, Cimarron utilized the 100 pCi/g total uranium concentration as the upper bound for the BTP Option 2 concentration range and shipped all soil exceeding 100 pCi/g total uranium to a licensed disposal facility.

Soil containing uranium at concentrations between 30 pCi/g and 100 pCi/g total uranium was placed in four flat-topped stockpiles for final characterization. The North Stockpile (DAP-1) was located north of Uranium Building #1 and measured approximately 40 m by 25 m by 2 m thick. The East Stockpile (DAP-2) was located east of Uranium Building #1 and measured approximately 80 m by 30 m by 2 m thick. Stockpiles DAP-1 and DAP-2 were generated from soil generated during decommissioning activities prior to 1994. Stockpiles DAP-3 and DAP-4 were smaller stockpiles generated from 1994 through 1996.

For these four stockpiles, soil samples were collected for on-site analysis from borings drilled on a 5-m grid and sampled at 0.5-m depth intervals. Soil that exceeded the BTP Option 2 criterion was removed and shipped for disposal at a licensed disposal facility. For Stockpiles DAP-3 and DAP-4, hot-spot averaging criteria contained in NUREG/CR-5849 were applied to the stockpile characterization data.

The disposal cell consisted of three trenches, referred to as Pits #1, #2, and #3. Pit #1 was excavated in 1994 and measured approximately 50 ft (E-W) by 425 ft (N-S) at its base. Placement of BTP Option 2 material was completed in February 1995. Pit #2 was excavated in 1995 and measured approximately 60 ft (E-W) by 470 ft (N-S) at its base. Placement of BTP Option 2 material was completed in September 1996. Pit #3 was excavated in 1997 and measured approximately 60 ft (E-W) by 470 ft (N-S) at its base. Placement of Option #2 material was completed in July 2000. Soil from stockpiles was placed in Pits #1 and #2. Pit #3 was filled with soil excavated in the field as decommissioning operations in various areas were completed.

One-foot lift markers were placed at 50-ft intervals along the east and west walls of each excavated trench. One-foot lifts were placed in the trench, compacted, and field tested with a nuclear density gauge to demonstrate compliance with compaction and moisture criteria. Characterization data from Stockpiles DAP-1 through DAP-4 were used to characterize the soil placed in Pits #1 and #2. As Pit #3 was filled with soil from various areas during the completion of soil and waste decommissioning, each 1-foot lift was sampled on a 5-m grid.

A total of approximately 452,000 $ft^3$ (16,740 cubic yards) of BTP Option 2 soil was placed in the disposal trenches. The average concentration of uranium in soil placed in the three pits varies from 35.7 to 45.0 pCi/g total uranium. The total activity of uranium in the soil placed in BA4 is approximately 0.98 Curies.

After placement of waste, Pits #1 and #2 were covered with at least 4 ft of cover soil. Due to excess capacity, Pit #3 was covered with approximately 6 ft of cover soil. Prior to placement of the cover in Pit #3, two feet of the same cover soil was placed in 1-foot lifts because there was not sufficient BTP Option 2 soil to fill all seven lifts which Pit #3 was designed to accommodate. The top two lifts were compacted and field tested with a nuclear density gauge to demonstrate compliance with compaction and moisture criteria. Cover soil came from areas of the Site not affected by previous operations. Several inches of topsoil were placed over the entire area, which was then seeded with a winter seed mix. Samples of the cover soil were analyzed as part of the final status survey performed for Subarea N. Four concrete cairns were placed at the corners of the BA4 disposal cell. Each cairn contains a brass marker with the words “Radioactive Disposal Area”, lines indicating the boundaries of the pits, and the northing and easting coordinates of the cairn.

A notice was placed in the deed in accordance with License Condition 23(b). The deed notice states that “… notice is hereby provided that uranium-contaminated soil has been buried at the following location: [legal description of the location of Burial Area #4] … [coordinate location of Burial Area #4] … The total volume of uranium-contaminated soil in the containment cell is 452,186 $ft^3$, and the total activity of uranium is 0.98 Curies. Markers are placed at the containment site.” License Condition 23(b) states, “This notification is not to be considered a restriction on the sale or future use of the site.”

License Condition 23(b) also required periodic inspection of the disposal area for subsidence, erosion, and status of the vegetative cover for at least 5 years. Inspections were performed for over five years. To date, there is no evidence of erosion, and despite two years of intense drought (2011 and 2012), the vegetative cover over the disposal cell remains dense and healthy.

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# 2.0 FACILITY DESCRIPTION

## 2.1 SITE LOCATION AND DESCRIPTION

The Site consists of approximately 500 acres of property located in Logan County, Oklahoma (Figure 1-1). The currently owned property is located in Sections 11 and 2, Township 16N, Range 4 W of the Indian Meridian. Its actual acreage varies based on the location of the Cimarron River, which forms the northern property line. Prior to 2015, the Site included property located west of Highway 74, and south of the current property line, occupying approximately 800 acres.

Approximately 117 acres west of the highway and approximately 24 acres containing the former processing buildings were sold in 2015. Those two areas included portions of Subareas E, H, I, J, K, and L. The southwest quarter of Section 12, at the intersection of Highways 74 and 33, representing most of unimpacted Subarea A, was sold in 2017. The property on which the CERT office is located, containing slightly less than 1 acre in Subarea I, was sold in 2018. All of these Subareas had been released from License SNM-928 prior to their sale as described in Section 1. These properties are no longer owned by the licensee, and for the purposes of this Plan are no longer considered part of the Site.

In the sale of the 24-acre property, the CERT retained the environmental liability associated with groundwater which does not require remediation under License SNM-928, but which contains concentrations of nitrate exceeding State Criteria. The concentration of nitrate in groundwater exceeds State Criteria in areas that do not require groundwater remediation for decommissioning purposes. However, plans for reducing the concentration of nitrate in these areas are included herein to eliminate the duplication of effort that would be required to develop a separate groundwater remediation plan for only those areas.

The city of Cedar Valley extends to approximately ½ mile east of the Site. Cimarron City extends to the northern bank of the Cimarron River. Crescent, Oklahoma is located approximately 6 miles north of the Site. Guthrie, Oklahoma is located approximately 9 miles east of the Site. Edmond, Oklahoma extends to approximately 11 miles southeast of the Site, and Oklahoma City extends to approximately 14 miles south of the Site. Figure 1-1 shows the location of the Site relative to these cities. Figure 2-1 presents an aerial image of the Site with the topographic contours of the property.

Figure 2-2 presents a topographic map of an area extending 2 miles around the Site, showing the locations of residences and other facilities, ponds, streams, lakes, the Cimarron River, water wells, and oil and gas wells. The locations of residences and other facilities were obtained from

GoogleEarth®. Table 2-1 lists water wells located within 2 miles of the Site (per the Oklahoma Water Resources Board water well registry as of February 8, 2021). Table 2-2 lists the locations of all oil and gas production or injection wells (per the Oklahoma Corporation Commission Oil and Gas Well Data System as of February 8, 2021).

The Site consists of gently rolling hills, leading northward to the floodplain of the Cimarron River. Ground elevation varies from approximately 925 ft above mean sea level (amsl) at the northeastern property line to approximately 1,015 ft amsl near the southern property line. Two surface water reservoirs are present on the Site. Unnamed ephemeral streams feed these reservoirs, which discharge to the floodplain of the Cimarron River.

## 2.2 POPULATION DISTRIBUTION

The estimated population for Logan County, Oklahoma as of July 1, 2019, was 48,011. This represents a 15% increase since 2010. Guthrie, Oklahoma, located approximately 9 miles east of the Site, had an estimated July 1, 2019, population of 11,661; this represents a 14% growth since 2010. Edmond, Oklahoma, located approximately 11 miles southeast of the Site, had an estimated July 1, 2019, population of 94,054; this represents a 16% growth since 2010. Oklahoma City, Oklahoma, located approximately 14 miles south of the Site, had an estimated July 1, 2019, population of 655,057; this represents a 13% increase since 2010. Within Logan County, Cimarron City, which extends northward from the northern bank of the Cimarron River, had a 2010 population of 150; Crescent, Oklahoma, located approximately 6 miles north of the Site, had a 2010 population of 1,411. Population data for towns with a population below 5,000 is not routinely updated by the United States Census Bureau. Population data were taken from the website www.census.gov.

## 2.3 CURRENT / FUTURE LAND USE

The property owned by the CERT currently lies fallow. Portions of the Site containing grasses that are beneficial for cattle feed are periodically mowed and baled. The bales are removed from the Site for use as cattle feed. Mowing of large portions of the Site is intended to minimize the fire hazard associated with tall prairie grass as well as to maintain access to groundwater monitor wells. An office building (not continuously occupied) is maintained for periodic use by personnel when at the Site.

The area surrounding the Site is primarily used for farming and ranching. The 24-acre property near the office building was developed and utilized for aerospace industry manufacturing; these operations ceased in 2020. The southwest quarter of Section 12 has been returned to agricultural use.

A small commercial development with a service station/convenience store, a building housing several shops, a storage facility, and an oil and gas production facility are located near the intersection of Highways 33 and 74. A golf course is located within one mile of the southeastern corner of the Site. Less than 100 people live within one mile of the Site. Figure 2-2 presents a topographic map of an area extending 2 miles around the Site, showing the locations of residences, other facilities, ponds, streams, lakes, the Cimarron River, and off-site water wells. Table 2-1 lists water wells located within 2 miles of the Site.

## 2.4 METEOROLOGY AND CLIMATOLOGY

Adams and Bergman (Adams, G.P. and D.L. Bergman, 1995) summarized the precipitation for the Cimarron River from Freedom to Guthrie, Oklahoma. Their study showed that precipitation ranges from an average of 24 inches per year (in/yr) near Freedom, Oklahoma, in the northwest part of the Cimarron River floodplain in Oklahoma, to 32–42 in/yr at Guthrie, Oklahoma. Wet years between 1950 and 1991 were in 1973–1975, 1985–1987, and 1990–1991. The wettest months are May through September, while the winter months are generally the dry months. The period from 1973 to 1975 was 23 inches above the normal total for the three-year period (Carr, J.E. and M.V. Marcher, 1977).

Precipitation data collected by the National Oceanic and Atmospheric Administration (NOAA) for Guthrie in Logan County, Oklahoma, and used to calculate the 1981 to 2010 “Climate Normals” indicates that the annual average precipitation is 38.38 inches. The minimum monthly average precipitation is 1.43 inches (January) and the maximum monthly average is 5.38 inches (June). The 1981–2010 Climate Normals are NOAA National Centers for Environmental Information's latest three-decade averages of climatological variables. NOAA's computation of Climate Normals is in accordance with the recommendation of the World Meteorological Organization, of which the United States is a member. While the WMO mandates each member nation to compute 30-year averages of meteorological quantities at least every 30 years, the WMO recommends a decadal update, in part to incorporate newer weather stations. NOAA’s next update to the Climate Normals will be for the data set of 1991 through 2020. (NOAA, 2018)

## 2.5 GEOLOGY AND SEISMOLOGY

The following two sections describe the regional and site-specific geology. These two sections contain information summarized from Conceptual Site Model (Revision – 01), Cimarron Site, Crescent, Oklahoma (ENSR Corporation, 2006A, ML20213C536). More detailed descriptions of the geology and hydrogeology of localized areas of interest are provided in Section 2.7, "Groundwater Hydrology".

### 2.5.1 Regional Geology

The bedrock geology of Logan County is dominated by Permian-age clastic sedimentary rocks of the Garber-Wellington Formation as shown in Figure 2-3. These units dip to the west at 30 to 40 ft per mile. The Permian-age Garber Sandstone and underlying Wellington Formation, which comprise the Garber-Wellington Formation, include lenticular channel and sheet-flood sandstones interbedded with shales and mudstones. The combined thickness of the Garber Sandstone and the Wellington Formation is about 1,000 ft. Because the two formations are difficult to distinguish in drill core and in outcrop and have similar water bearing properties, they are often treated as a single mappable formation and grouped into a single hydrostratigrahic unit, the Garber-Wellington Aquifer (Wood, P.R., and Burton, L.C., 1968).

Structurally, the Cimarron area is part of the Nemaha Uplift (also referred to as the Nemaha Ridge) of Central Oklahoma. The Nemaha Uplift trends northward across Oklahoma and was formed during a period of uplift, faulting, and erosion that occurred between the Mississippian and Pennsylvanian Periods in the Oklahoma area. The Nemaha Uplift consists of north-northwest trending normal faults and anticlinal structures that influenced early Pennsylvanian-age sedimentation in the Oklahoma region. By middle Pennsylvanian time, the Nemaha Uplift was not active. During the Permian, when the Garber-Wellington Formation was deposited, Central Oklahoma was part of the eastern shelf of a shallow marine sea. The sandstones and shales of the Garber-Wellington Formation were deposited as part of a westward-advancing marine delta fed by numerous streams flowing to the west and northwest. Thus, the sands of the Garber-Wellington Formation are often sinuous and discontinuous, and exhibit the rapid facies changes typical of a deltaic channel and overbank depositional system. Sand accounts for 35% to 75% of the Garber-Wellington Formation (Carr, J.E. and M.V. Marcher, 1977).

There is no evidence of subsidence, karst terrain, or landsliding within several miles of the Site. Bank erosion is present along streams and the Cimarron River. Floodplain and upland erosion rates are typically insignificant due the heavy vegetation throughout the area, although agricultural fields are subject to sediment erosion during heavy precipitation events.

There are no man-made geologic features such as mines and quarries within several miles of the Site.

### 2.5.2 Site Geology

The stratigraphy of the Site is dominated by the Garber-Wellington Formation. The Garber Formation is exposed along the escarpment that borders the Cimarron River. The Wellington Formation is not exposed within the project area. The deeper stratigraphic units in the area were penetrated by a proposed deep disposal well that was completed in 1969. This well is the deepest borehole known to have been drilled in the immediate vicinity of the Site. The deep well is on Cimarron facility property near the uranium plant. The depth of the well is 2078 ft. The top of the unit immediately underlying the Garber, the Wellington formation, was identified at 200 ft below the ground surface. The Wellington consists of 960 ft of red shale with several thin siltstone beds. The top of the Wolfcampian age Stratford formation was found at 1160 ft. It is 870 ft thick and consists of red and gray shale with thin anhydrite beds in the upper part (*Site Investigation Report for the Cimarron Corporation Facility,* James L. Grant and Associates, Inc., 1989).

Within the Site, the Garber Formation consists primarily of sandstone layers separated by relatively continuous siltstone and mudstone layers. The sandstone units frequently have interbedded, but discontinuous, red-brown shale and mudstone lenses. Lateral facies changes are common in the sandstones and represent shifting channel locations in the Garber delta. The Garber sandstones can be divided into three basic sandstone units separated by two relatively continuous and identifiable mudstone layers, as follows:

- Sandstone A (SSA) is the uppermost sandstone unit, generally red-brown to tan in color and up to 35 ft in thickness. The bottom of this sandstone unit occurs at an elevation of approximately 950–970 ft amsl. To the south, there is a zone of perched groundwater. Monitor wells installed in the perched zone exhibit a higher groundwater elevation than wells installed in the lower portion of Sandstone A. This is evident in the paired "CDW" wells. Monitor Well 1353 is screened in a perched zone.
- Mudstone A is a red-brown to orange-brown, sometimes tan mudstone and claystone that separates Sandstones A and B. It ranges from 6 to 20 ft thick.
- Sandstone B (SSB) is the second sandstone unit, underlying Mudstone A, and similar in color and sedimentary features to Sandstone A. It is found at elevations between 925 and 955 ft amsl and is up to 30 ft thick.

- Mudstone B consists of mudstone and claystone separating Sandstone B and Sandstone C. It is similar in color to Mudstone A and ranges from 6 to 14 ft thick.
- Sandstone C is the lowermost sandstone in the Garber-Wellington Formation, similar in color and sedimentary features to the overlying sandstones. This unit varies in thickness from 10 to 25 ft at the Site to at least 100 ft thick regionally.

Figure 2-4 presents a lithologic column describing these three zones, based on the boring logs for Monitor wells 1311 and 1321. The three sandstone members of the Garber Formation at the Site are similar in lithology. They are fine to very fine-grained red-brown to tan sandstones with well-sorted sub-angular to rounded grains and contain variable amounts of silt. The silt content ranges from 10% to 50% and the sandstones with high silt content are difficult to distinguish from siltstone. The sand grains are mostly quartz with minor amounts of feldspar and occasional magnetite and mica. The inter-granular porosity varies with the silt content. The sandstones are weakly cemented and often friable. Cementing agents are calcite and hematite. Locally, thin intervals can be found that are well cemented with gypsum and barite. These intervals are often conglomeratic. The sandstones exhibit planar cross-stratification with thin, silty laminae. Conglomeratic intervals are common in most of the borings and they are observed to contain clasts of mudstone and occasionally sandstone in either a sandstone or mudstone matrix. These conglomeratic zones are up to 2.5 ft thick. Vugs found in these conglomerate zones are lined with calcite, gypsum, and barite. The sandstones of the Garber Formation were deposited in a fluvial deltaic environment, probably as channel sands.

The mudstone layers that separate the sandstones in the Garber Formation at the Site are mostly fine-grained, silty to shaley beds with a red-brown to orange-brown and tan color. The mudstones occasionally exhibit desiccation cracks. The mudstones are poorly consolidated. The mudstone layers are often encapsulated by thin, bluish-gray laminae that range in thickness from 0.1 to 4.0 inches. These “reduction zones” are common in red beds; at the Site the thickness of these reduction zones is approximately proportional to the thickness of the mudstone layer. These continuous mudstone layers probably represent deltaic overbank deposits formed during flooding of the Garber delta.

A mineralogical analysis of the sandstones and mudstones of the Garber Formation was conducted by Auburn University using X-ray diffraction, grain-size determinations, and cation exchange capacity measurements. Quartz and feldspar were found to be the main clastic grains with kaolinite and montmorillonite as the clays in the fine-grained fractions. Illite, smectite, chlorite, hematite, and goethite were also among the minerals detected in the clay fractions according to United States Geological Survey (USGS). Calcite, iron oxides, and iron hydroxides were identified as the main cementing agents. The clay fraction ranged from 6% to about 20% in the sandstones and from about 14% to 50% in the mudstones. The mudstones had a cation exchange capacity in the range of 6 to 22 milliequivalent (mEq)/100 grams. The sandstones had a cation exchange capacity generally below 6 mEq/100 grams. Exchangeable cations were generally calcium and magnesium for both the sandstones and the mudstones. Within the “reduction zones,” minerals formed with metals in low oxidation states, including uranium, were identified.

The Cimarron River floodplain alluvium consists of sand and silt, developed by the erosion of the Garber Formation from the escarpment bordering the river on the south, as well as material transported to the floodplain from upstream within the river system. This alluvium formed gradually over time and contains many buried channels reflective of both transport of the alluvial materials northward toward the river from the escarpment and meandering of the main river channel. Near the present river channel, buried oxbow meanders can be expected. Near the escarpment, buried channels would be expected to be the continuation of present drainages incised into the escarpment sandstones. The alluvium is about 30 to 40 ft thick. Along the present escarpment face, there are local transition zones from the sandstones of the Garber Formation to the coarser alluvial materials. These transition zones can be clay-rich, as is the case with the transitional zone identified with borings in BA1.

At the Site, upland areas are underlain by the sandstones and mudstones of the Garber Formation, which rolling hills on either side of ephemeral streams. Two ponds created by earthen dams constructed in the1960s contain water year-round, but the ephemeral streams which supply water to the ponds are dry in the hot, dry summers, and the water level in the ponds typically lowers during the summer.

The upland areas terminate where the floodplain of the Cimarron River exists. The river has carved a floodplain nearly one-half mile wide at the Site. The erosional escarpment is evident in the Western half of the Site and rises over 30 ft above the floodplain in areas. To the east, the escarpment is present only as a shallow slope.

### 2.5.3 Seismology

#### *Seismic History*

In 1976, the NRC initiated several cooperative programs with state geological surveys to study areas of anomalously high seismicity east of the Rocky Mountains. The Oklahoma Geological Survey (OGS) participated in one of these surveys. A summary report on this study is documented in an OGS Special Publication entitled *Seismicity and Tectonic Relationships of the Nemaha Uplift and Midcontinent Geophysical Anomaly* (R. R. Burchett, K. et. al., 1982).

The Nemaha Ridge lies within one of the areas addressed in that report, having a "moderately high" seismic risk classification. The Nemaha Uplift, approximately 415 miles long, extends from Oklahoma to Nebraska. Figures 2-5 and 2-6 show the location of the Nemaha Ridge, which represents the crest of the Nemaha Uplift. OGS compiled data from over 20,000 wells to construct structure-contour maps, from which the following conclusions were drawn.

The OGS structure-contour maps reveal a complex fault pattern associated with the Nemaha Uplift. This fault pattern is dominated by several discontinuous uplifts. These features form a fault zone originating in Precambrian-age igneous/metamorphic basement rock that has displaced overlying pre-Permian sedimentary bedrock and extends from Oklahoma City in a northwesterly direction. Near the Kingfisher-Garfield County line, the orientation of the fault zone becomes north-northeast and extends northward through Kansas and terminates in southeastern Nebraska. The southern end of the Nemaha Ridge is believed to be the Oklahoma City Uplift and its associated faults. Another fault zone, the McClain County Fault zone, intersects the Oklahoma City Uplift in southern Oklahoma County. This fault zone, which is composed of a number of sub-parallel faults and is thought to be temporally related to the Nemaha faults, trends south-southwest and terminates against the Paul's Valley Uplift in Garvin and southern McClain Counties (R. R. Burchett, K. et. al., 1982, p. 14-15).

In 2016, the OGS released the Open-File Report OF2-2016 *Comprehensive Fault Database and Interpretive Fault Map of Oklahoma* (Marsh, S. and A. Holland, 2016), presenting an interpreted fault map compiled from oil and gas industry data and published literature. The interpreted fault map was compiled from the Oklahoma Fault Database, an ongoing database for fault information within the State of Oklahoma. Figure 2-5 includes that portion of the map that is within a 20-mile radius of the Facility. Figure 2-6 includes the portion of the map within a 200-mile radius of the Facility. This map depicts only those interpretive faults that are within the State of Oklahoma, and does not extend them into adjacent states. The Nemaha Uplift and interpretive faults at, and in the vicinity of, the Site are representative of pre-Permian-age (Pennsylvanian-age and older) faults (Ford, 1955).

Based on review of the USGS interactive Quaternary fault map/database (USGS, 2021a), there have been no recognized Quaternary surface faults in the vicinity of the Site that have moved in the past 1.6 million years. The nearest Quaternary fault is the Meers fault located approximately 90 miles southwest of the Site. The Meers fault is part of a group of east-southeast to north-northwest trending faults that form the Frontal Wichita fault system that serves as the boundary between the Paleozoic sedimentary rocks in the Anadarko Basin to the northeast and the Cambrian igneous rocks of the Wichita Mountains to the southwest.

The uppermost groundwater aquifers beneath the Site include the Quaternary-age flood plain alluvium (unconsolidated) along the Cimarron River and the Permian-age Garber Formation (Sandstones A, B, & C). Groundwater flow in the Quaternary-age floodplain alluvium and the Permian-age Garber-Wellington Formation is not affected by the deeper/older Nemaha Uplift and interpreted faults at and in the vicinity of the Site.

Table 2-3 presents a list of all recorded historical earthquakes having a magnitude of at least 3.0 within 200 miles of the Facility as of February 9, 2021, as listed in the USGS Earthquake Hazards Program database (https://earthquake.usgs.gov/earthquakes - USGS, 2018). From 1974 through 2008, 120 earthquakes with a magnitude of at least 3.0 were recorded. Of those, 10 had a magnitude between 4.0 and 4.5 (maximum magnitude). 3,098 earthquakes with a magnitude of at least 3.0 were recorded from 2009 through 2021. Of those, 97 had a magnitude between 4.0 and 5.0, and 4 earthquakes had magnitudes between 5.0 and 5.8 (maximum). Researchers largely agree that the increase in seismic activity within this area is due to injection of wastewater from oil and gas production activities into the Arbuckle formation. The Oklahoma Corporation Commission’s Oil and Gas Conservation Division initiated action to limit the injection of wastewater into the Arbuckle in September 2013. The Oklahoma Corporation Commission established a 15,000-square mile Area of Interest (inclusive of the Facility) where regular reporting of disposal volumes was required. Total injection volumes were reduced within the Area of Interest through directives to reduce injection volumes or to shut down disposal wells.

The OGS stated in a March 2017 Statement, "The seismicity rate has declined as injection activity has declined throughout the state, due to both Oklahoma Corporation Commission directives to curtail wastewater injection rates during 2015 and 2016 and market forces. As illustrated on Figure 2-7, seismic activities within a 200-mile radius of the Facility have been decreasing since the high of 2015. Based on this trend, the reductions implemented by the Oklahoma Corporation Commission on February 24, 2017, appear to have had a positive effect on the seismicity rate and likely will limit future widespread seismic activity like the state experienced in 2015 and 2016." (OGS, 2017).

### *Reported Damage to Pipelines*

Beginning in 2011, increased seismic activity in Oklahoma was observed. An investigation of the potential impact of earthquakes on pipelines in Oklahoma was conducted for the time period January 1, 2011, through August 31, 2018. The Pipeline and Hazardous Materials Safety Administration (PHMSA), a division of the United States Department of Transportation (DOT) maintains records of releases of hazardous liquids including crude oil, carbon dioxide, flammable or toxic fluids, and refined petroleum products; natural gas; and liquefied natural gas. The PHMSA databases of pipeline release information is located at www.phmsa.dot/gov.

179 crude oil releases and 13 natural gas releases were reported to have occurred in Oklahoma during that time period. No liquefied natural gas releases were reported in Oklahoma. Of the 179 crude oil releases reported, all but four were due to corrosion, damage from excavation, operational failure, equipment failure or outside influences such as rifle fire or automobile accidents. Of the four releases reported due to "Natural Force Damage", one was attributed to high winds and three to temperature extremes. Of the thirteen natural gas releases only one was attributed to "Natural Force Damage" and was caused by a lightning strike.

Damage was reported to buildings approximately 30 miles from the Site due to a magnitude 5.8 earthquake near Cushing, Oklahoma in September 2016.

### *Seismic Design Considerations*

Due to the inherent ability of buried piping systems to resist lateral movements and absorb deflection, and the flexible nature of the proposed piping materials (high-density polyethylene [HDPE] and PVC), seismic activity is not expected to generate unacceptable stresses or moments within the buried piping network or at connection points above the ground surface. The buried piping network was evaluated for locations potentially susceptible to damage resulting from the following seismic conditions:

- Surface fault ruptures
- Strong ground motion/shaking
- Soil liquefaction
- Landslides
- Earthquake inducted settlement

The results of the analysis indicated satisfactory buried pipe performance for each of the seismic conditions listed above. However, conservative mitigation measures such buoyancy control, flexible connection fittings, stress loops, etc. will be incorporated into the design. Details regarding seismic analysis methods, assumptions, and results were presented in *Preliminary Seismic Analysis of Buried HDPE Piping Report* Revision A (Burns & McDonnell, 2019A, ML21119A069).

Above-ground piping systems not properly designed for site seismic conditions have the potential for fluid loss through differential movement of the pipe. Above-ground piping systems were designed with supports and expansion features to allow movement that results from seismic events. Design aspects include use of supports that restrict movement, such that piping assemblies move as a unit, not as discrete components. Expansion features include the use of hoses at locations such as connections to tanks and at the entrance to the facility. The use of hose provides for differential movement of the pipe relative to what it is connected to.

A geotechnical investigation was conducted in the area within which the Western Area Treatment facility will be constructed. Like the buried piping assessment provided above, the geotechnical report included specifications to address seismicity. Specifically, the following seismic conditions:

- Surface fault ruptures
- Strong ground motion/shaking
- Soil liquefaction
- Landslides
- Earthquake inducted settlement
- USGS one-year hazard forecast

The results of the analysis indicated relatively low likelihood of the seismic conditions listed above occurring in the vicinity of the Site. However, the potential ground motion data obtained during this evaluation were considered in the design of the treatment facility building and influent and effluent tank foundations. Details regarding seismic analysis methods, assumptions, and results are presented in the Terracon Consultants, Inc.'s *Geotechnical Engineering Report* included as Appendix A.

## 2.6 SURFACE WATER HYDROLOGY

### 2.6.1 Cimarron River

The Cimarron River extends across four states (Colorado, Kansas, New Mexico, and Oklahoma) and flows approximately 698 miles from the headwaters in northeastern New Mexico through central Oklahoma where it flows into Keystone Lake (west of Tulsa, OK) and joins the Arkansas River. The Cimarron River has a watershed area of approximately 19,050 square miles (OK NSF EPSoR, 2021) and consists of the two regional hydrologic units composed of the Upper Cimarron (Hydrologic Unit Code [HUC] 1104; approximately 12,000 square miles) and Lower Cimarron (HUC 1105; approximately 7,050 square miles). The Site is situated within the 25 square mile Gar Creek-Cimarron River (HUC 110500021108) hydrologic unit subregion (EPA, 2021), a smaller localized watershed within the Lower Cimarron River regional watershed (HUC 1005).

The Cimarron River is a perennial, gaining river over its entire course from Freedom (west of the Site) to Guthrie, Oklahoma (east of the Site). Base flow from the alluvial and terrace aquifers and from the Permian sandstone units that border the river is highest in the winter months due to the higher water tables in these aquifers, which result from decreased evapotranspiration. Base flow is lowest from late summer through early winter because water tables are at their low point during that time. Because the Cimarron River is fed mainly by base flow from groundwater aquifers, flow in the Cimarron River parallels this seasonal fluctuation in groundwater levels.

River flow has not been directly measured at the Site because there are no stream gages within the Site boundary. From 1990 to 2017, the Guthrie gage, located approximately 10 miles east of the Site, recorded from 287.1 to 3,695 cubic feet per second (cfs) average annual flow rates (USGS water data website). Adams and Bergman (Adams, G.P. and D.L. Bergman, 1995) reported a low-water median flow rate of approximately 100 cfs and a high-water median flow rate of 600 cfs.

NUREG-1757 cites the minimum annual 7-day average low flow as an example of another low flow measurement. The SWToolbox, a GIS interface and hydrological statistics tool developed by USGS, was utilized to determine a 7Q10, the lowest 7-day average flow that occurs (on average) once every 10 years, at the Guthrie gage. Due to the lack of available data for the Crescent gage, a watershed area ratio was used to obtain a 7Q10 value for this site using the following equation:

$$Q_{outfall} = Q_{gage} \text{ X } (A_{outfall}/A_{gage})$$

Where:

$Q_{outfall}$ = The 7Q10 of the Crescent gage

$Q_c$ = The 7Q10 of the Guthrie gage

$A_{outfall}$ = the Area draining to the Crescent gage

$A_{gage}$ = the Area draining to the Guthrie gage

The USGS website was used to determine the area draining to both the Guthrie (https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=07160000) and Crescent (https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=07159400) gages. Drainage area for the Guthrie gage was 17,006 square miles and drainage area was 16,453 square miles for the Crescent gage. SWToolbox determined that that 7Q10 at the Guthrie gage from October 1983 to July 2022 was 45.1cfs. Using the watershed ratio, the 7Q10 determined for the Crescent gage just upstream of the Project area was determined to be equal to 43.6 cfs.

Flood statistics for the Cimarron River have been compiled by the USGS (Robert L. Tortorelli and Lan P. McCabe, 2001). Peak flow ranges from a 2-year flood with a discharge of 26,700 cfs to a 500-yr flood with a discharge of 237,000 cfs. Floods most typically occur in this area in May-June or October, largely as a function of heavy rainfall in upstream portions of the watershed. The extent of flooding for the 100-year flood includes the entire alluvial valley, but not the upland areas of the Site. This was the case during the most recent significant flood that occurred in May 2019 when flood waters inundated the alluvial areas of the Site but stopped short of reaching the upland area.

Based on review of a Flood Insurance Rate Map (FIRM) for the Site obtained from the Federal Emergency Management Agency's (FEMA) Flood Map Service Center (FEMA, 2021A), the alluvial valley adjacent to the Cimarron River at the Site is classified as Zone A. Zone A areas are subject to inundation by the 1% annual chance (100-year) flood event where no Base Flood Elevation (BFE) or flood depths are shown on the FIRM. Using the Estimated Base Elevation

Viewer maintained by the FEMA (2021B), both flood data and Base Level Engineering analysis are performed by the viewer using high resolution ground elevation data, flood flow calculations, and fundamental engineering modeling techniques to define flood extents and estimate the BFE for the alluvial valley adjacent to the Cimarron River. The estimated BFE of the alluvial valley at the Site for a 1% (100-year) flood event is approximately 951.0 ft amsl.

Highway 74 crosses the Cimarron River at the upstream (western) end of the Site. The bridge and its associated abutments exert a degree of control over the hydrologic system; this permanent structure represents a barrier to flow across the southern approximately 80% of the floodplain, preventing the erosion of the alluvial material across most of the site. Deposition still occurs across the northern portion of the floodplain, but scouring of the south bank and meandering of the river at the Site has been minimized by this man-made structure.

### 2.6.2 Other Surface Water Features

Surface water features at the Site and in the surrounding area are shown in Figure 2-8. Cottonwood Creek is located about seven miles south of the Site and flows northeast through Guthrie. Cottonwood Creek, like the Cimarron River, is a gaining stream and drains southern Logan and northern Oklahoma counties. On the north side of the Cimarron River, across from the Site, springs can be found at Indian Springs and small ponds are present at Crescent Springs. On the south side of the Cimarron River near the Site, Gar Creek to the east and Cox Creek to the west are named drainages that receive most of their flow from groundwater base flow. Most of the other drainages within and near the Site are ephemeral in nature and flow only in response to heavy rainfall or from groundwater base flow when groundwater levels are relatively high (*Site Investigation Report for the Cimarron Corporation Facility,* James L. Grant and Associates, Inc., 1989).

Within the Site, two unnamed drainages have been dammed to form small ponds, referred to as the East and West Pond, as shown in Figure 2-8. Both ponds maintain a pool elevation of approximately 960 ft amsl. The maximum pool elevation in the East Pond is controlled by a spillway. When the East Pond pool elevation exceeds the elevation of the spillways (typically following heavy rainfall), water flows over the top of the spillway into the drainage below. The maximum pool elevation in the West Pond is controlled by two 30-inch corrugated steel culverts. The flow of the ephemeral streams that feed the ponds is negligible relative to the flow of the Cimarron River, and the storage capacity of the ponds is small. The ponds represent negligible impact on the flooding of the site.

The pool elevation of both ponds is above the groundwater elevation in Sandstone B, and Sandstone A does not extend beneath the ponds. Both ponds represent recharge sources for groundwater in Sandstone B. The pond evaporation rate in this part of central Oklahoma is approximately 60 in/yr, as reported in *Site Investigation Report for the Cimarron Corporation Facility* (James L. Grant and Associates, Inc., 1989, ML20202A435).

## 2.7 GROUNDWATER HYDROLOGY

Groundwater in the Permian-age Garber Formation is found in the Garber Sandstones and the underlying Wellington Formation in the area. Shallow groundwater, defined by (Carr, J.E. and M.V. Marcher, 1977) as groundwater at depths of 200 ft or less, is generally fresh and mostly unconfined. Groundwater deeper than 200 ft can be artesian to semi-artesian. The base of fresh groundwater at the Site is at approximately 950 ft amsl and the thickness of the freshwater zones has been estimated at 150 ft (Carr and Marcher, 1977). Data from the Site shows that groundwater in Sandstone C, which is generally more saline than groundwater in Sandstones A and B, is usually at an elevation around 900 to 920 ft amsl. Thus, at the Site, the bottom of fresh water is somewhat lower than estimated by (Carr, J.E. and M.V. Marcher, 1977) for this part of the Garber Formation and, conversely, the thickness of the freshwater zone is somewhat greater. Following (Carr, J.E. and M.V. Marcher, 1977), the groundwater in Sandstone C at the Site, therefore, represents the top of the saline groundwater zone in the Garber Formation.

Recharge to shallow groundwater in the Permian-age Garber Formation near the Site has been estimated at 190 acre-feet per square mile, or about 10% of annual precipitation (Carr, J.E. and M.V. Marcher, 1977). (Adams, G.P. and D.L. Bergman, 1995) estimate a similar recharge of 8% of annual precipitation. A regional groundwater high is located south of the Site between the Cimarron River and Cottonwood Creek (Carr, J.E. and M.V. Marcher, 1977). The maximum groundwater elevation on this high is around 1,050 ft amsl. Groundwater flows north toward the Cimarron River from this location.

Groundwater flow in the Quaternary-age floodplain alluvium (unconsolidated) and the Permian-age Garber Formation (bedrock) is not affected by the deeper/older Nemaha Uplift and interpreted faults in the vicinity of the Site (Figure 2-5). These interpreted faults are pre-Permian in age, and no Quaternary-age surface faults have been identified in the vicinity of the Site (USGS, 2021) as discussed in Section 2.5.3.

The regional northward gradient from the groundwater high to the Cimarron River in the shallow sandstone unit is approximately 0.0021 ft/ft. The gradient to the south to Cottonwood Creek is 0.0067 ft/ft. This groundwater high and the uplands at the Site are within a major recharge area for the Garber Formation.

This suggests that vertical groundwater flow in the area of recharge between Cottonwood Creek and the Cimarron River is downward. At the Cimarron River, regional groundwater flow in the freshwater zone of the Garber Formation is vertically upward to allow for discharge to the river, which acts as a groundwater drain in this part of central Oklahoma (Carr, J.E. and M.V. Marcher, 1977). The nature of vertical groundwater flow in the saline water zone of the Garber Formation at the Cimarron River is uncertain.

In summary, the Site is underlain by the Garber-Wellington Aquifer of Central Oklahoma. At the Site, the Garber Formation can be divided into three separate water-bearing zones that parallel the geological division of the formation into Sandstones A, B, and C. The uppermost water-bearing zone in the Garber Formation is generally unconfined, although it can be locally semi-confined by overlying mudstone and shale units. The two lower units in Sandstones B and C are confined to semi-confined, depending on the thickness and continuity of the overlying mudstone unit.

Groundwater flow in the uppermost water-bearing unit is local in nature and flows from topographic highs, which also act as recharge areas, to topographic low areas such as the drainages. In the western portions of upland areas, groundwater in Sandstone A discharges through groundwater seeps into the escarpment that borders the Cimarron River floodplain. In the northeastern portion of the upland area (BA1), groundwater in Sandstone B flows eastward to the drainage, and northward to the alluvial and transition zone sediments. In the deeper bedrock units, groundwater flow is regionally controlled, with flow predominantly to the north towards the Cimarron River, with a component of upward flow as it ultimately discharges to the River.

The Site is within a recharge area for the upper freshwater zone of the Garber-Wellington Formation. Thus, vertical hydraulic gradients are generally downward, except at major discharge areas such as the Cimarron River. However, the low permeability of the mudstone units results in flow predominantly horizontal in the water-bearing units, with a minor component of flow vertically across units. The Cimarron River is a gaining river and thus receives groundwater from its floodplain alluvium.

### 2.7.1 Saturated Zones

Groundwater occurs in both consolidated (Permian-age Garber-Wellington Formation) and unconsolidated Quaternary (colluvium, terrace, and alluvium) deposits at the Site. Geologically, the Garber Formation Sandstones at the Site have been divided into Sandstones A, B, and C. The Garber and Wellington Formations have been grouped into the Garber-Wellington Formation by (Carr, J.E. and M.V. Marcher, 1977). At the Site, the Garber-Wellington Formation can be further divided into water-bearing units because the mudstone layers that separate the three main sandstone units of the Garber Formation at the Site act as semi-confining units. In the upper 200 ft at the Site, there are thus four main water-bearing units as follows:

- Sandstone A
- Sandstone B
- Sandstone C
- Cimarron River Alluvium and Terrace Deposits

### 2.7.2 Monitor Wells

There are 212 monitor wells at the Site, including those located on the 24-acre property for which the CERT retains responsibility for groundwater remediation. Tables 2-4 through 2-9 provide a listing of all monitor wells present at the Site, with selected installation and location information for each well.

For monitor wells in which the elevation of the top of the well casing exceeds 951.0 ft amsl (the approximate BFE of the Cimarron River at the Site during a 100-year (1%) flood event; [FEMA, 2021B]), a J-plug is installed in the top of the casing to provide a seal that prevents downflow of surface water should the Cimarron River rises above the top of casing during a flooding event.

### 2.7.3 Physical Parameters

Each of the water-bearing units at the Site has its own specific flow patterns and hydraulic properties.

For Sandstone A, slug tests (*Site Investigation Report for the Cimarron Corporation Facility,* James L. Grant and Associates, Inc., 1989, ML20202A435) yielded a geometric mean hydraulic conductivity of $1.03 \times 10^{-3}$ centimeters per second (cm/s) with a range from $2.41 \times 10^{-4}$ cm/s to $5.7 \times 10^{-3}$ cm/s. The geometric mean for transmissivity was 33.4 square feet per day ($ft^2/d$) with a range from 10.3 $ft^2/d$ to 108 $ft^2/d$. For Sandstone C, the geometric mean hydraulic conductivity was $7.85 \times 10^{-5}$ cm/s.

Aquifer tests in BA1 included slug tests on many of the monitor wells and two pumping tests. For Sandstone B, hydraulic conductivity estimates ranged from 9.97 x $10^{-4}$ cm/s to 2.39 x $10^{-5}$ cm/s. For the alluvial sediments of the Cimarron River floodplain, hydraulic conductivity estimates varied from values in the $10^{-2}$ cm/s to $10^{-3}$ cm/s range for the coarser sediments (sandy alluvium) to values in the range of $10^{-3}$ to $10^{-5}$ cm/s for sediments high in clays and silts (transitional zone). Because the alluvial sediments have higher clay and silt content near the escarpment where Sandstone B is exposed, the slug tests in the alluvial sediments gave lower hydraulic conductivities nearer the escarpment.

In 2014, pneumatic slug tests were performed in select monitor wells in the western portion of the floodplain alluvium. A pumping test was conducted at GE-WA-01. Hydraulic conductivity values were calculated to range from $10^{-1}$ cm/s to $10^{-4}$ cm/s.

### 2.7.4 Groundwater Flow Directions and Velocities

The general groundwater flow direction at the Site is northward from the groundwater high south of the Site toward the Cimarron River. Within the Site, groundwater flow directions vary locally depending on depth within the Garber Formation.

To generate more representative potentiometric surface maps than groundwater elevation data from a single measuring event may provide, average groundwater elevations calculated using data from the December 2012 through May 2018 sampling events were used. Table 2-10 provides the groundwater elevation data used to develop the potentiometric surface contours for BA1 presented in Figure 2-9. Table 2-11 provides the groundwater elevation data used to develop the potentiometric surface contours for Sandstone A in the Western Area presented in Figure 2-10. Table 2-12 provides the groundwater elevation data used to develop the potentiometric surface contours values for Sandstone B and alluvial material in the Western Area presented in Figure 2-11.

In those areas where Sandstone A is the uppermost water-bearing unit, the hydraulic gradient in Sandstone A mimics the local overlying topography. Groundwater in Sandstone A flows from the topographically higher areas to adjacent drainages and reflects local recharge from precipitation events. That is, the hydraulic gradients in Sandstone A are northwards towards the escarpment, with components of flow to the east and/or west towards the drainages in the vicinity. This same pattern is observed in water levels in Sandstone B where it is the uppermost water-bearing unit (in BA1).

Flow in deeper Sandstones B and C is more regionally influenced. Generally, flow in Sandstones B and C is north to northwest toward the Cimarron River. Flow in the alluvium is generally northward toward the Cimarron River because the river is a gaining stream from Freedom to Guthrie.

Locally, groundwater flow directions are impacted by local geologic features. Based on the interpretation of subsurface data, a partially hydraulically connected series of sandy lenses in transition zone silts and clays in BA1 may provide a preferential pathway for groundwater flow. The presence of mudstones between sandstone units minimizes flow between the units. Similarly, intermittent layers of silts and clays in the sandy alluvial materials may influence groundwater flow.

In addition to the horizontal groundwater flow, vertical components of hydraulic gradient depend on localized groundwater recharge-discharge relationships. In the uplands and generally to the south, the vertical component of the gradient may be downward, as this is an area of groundwater recharge. In the alluvium and near the Cimarron River, vertical gradients are upward, reflecting groundwater discharge to the River.

Because groundwater flow varies locally across the Site, a discussion of groundwater flow for specific areas of interest is presented in this section.

### *Burial Area #1*

Groundwater in the vicinity of BA1 (Figure 2-9) originates as precipitation that infiltrates into the shallow groundwater unit recharge zone near the former disposal trenches and Sandstone B. Groundwater also enters Sandstone B from upgradient, driven by a relatively steep hydraulic gradient (0.10 ft/ft).

Groundwater in Sandstone B flows across a buried escarpment (the interface between Sandstone B and the floodplain alluvium) into a former drainage channel filled primarily with silts and clays (a transition zone). Groundwater appears to preferentially flow through the transition zone material via a series of sandy lenses, discharging into the more permeable sands of the floodplain alluvium. Once groundwater enters the Transition Zone of the floodplain alluvium, the hydraulic gradient decreases to around 0.023 ft/ft and flow is refracted to a more northwesterly direction. The decrease in hydraulic gradient is due in part to the much higher overall hydraulic conductivity in the floodplain alluvium compared to

Sandstone B and lower permeability material in the Transition Zone ($10^{-1}$ cm/s to $10^{-4}$ cm/s versus $10^{-4}$ cm/s to $10^{-5}$ cm/s in Sandstone B).

Once groundwater passes through the Transition Zone, it enters the sandy alluvial material where the hydraulic gradient is very flat (0.0007 ft/ft). The decrease in gradient is caused by the higher permeability of the sandy alluvium. Groundwater flow in the alluvium is northward, with discharge ultimately to the Cimarron River. In the alluvium, there is expected to be upward flow from the underlying bedrock as groundwater in the bedrock is discharging to the River.

The elevation of Reservoir #2 is above the groundwater in BA1. Any potential hydrologic effect that the reservoir has on groundwater is reflected in the measured groundwater levels. It is unlikely that fluctuations in the level of the reservoir would affect groundwater flow.

Groundwater velocities in BA1 can be estimated based on measured hydraulic gradients and estimated hydraulic conductivities. Average linear groundwater velocities were calculated using the hydraulic properties presented above and assuming porosity for the sandstone of 5%, 20% for the Transition Zone, and 33% for the alluvium. The calculated velocities are 0.6 ft/day for Sandstone B, 0.03 ft/day for the Transition Zone, and 0.3 ft/day for the alluvium.

### *Western Upland*

Groundwater in the Western Upland and the Western Alluvium (Figures 2-10 and 2-11) also originates as precipitation that infiltrates into the shallow groundwater unit recharge zones and flows into Sandstone A. Figure 2-10, which presents the potentiometric surface for Sandstone A, does not utilize groundwater elevation data from Monitor Well 1353, which is screened in a perched groundwater zone that is not present at lower elevations.

In the Western Upland, the 1206 Drainage (west of Monitor wells 1400, 1354, 1352, etc.) and a smaller drainage to the northeast (east of Monitor Wells 1397, 1340, and 1396) act as local drains for groundwater in Sandstone A. Groundwater flows toward the 1206 Drainage from both the east and west. The thick vegetation and groundwater seeps within the drainage attest to groundwater base flow discharging from Sandstone A into this drainage, becoming surface water in the drainage channel.

Groundwater gradients steepen along the cliff faces of the 1206 Drainage. Along the bedrock escarpment, groundwater flows north to northwest toward the floodplain in Sandstone A and discharges in numerous small seeps. Groundwater gradients in Sandstone A vary significantly due to the presence of the drainages, but average approximately 0.01 ft/ft toward the drainage to the northwest and about 0.02 ft/ft toward the north.

To the west of the 1206 Drainage, groundwater flows northeastward towards the drainage, and more northerly toward the alluvial floodplain at greater distances from the drainage. At the western edge of the Western Upland (well south of the escarpment), groundwater flow immediately east of Highway 74 appears to be to the west. However, that westward flow is significantly influenced by the groundwater elevation in Monitor Wells 1327B and 1329, older monitor wells which are screened in a deeper zone than the newer monitor wells installed in Sandstone A (e.g., 1374 and 1376).

Groundwater elevations in Sandstone A (excluding the perched zone in the southern part of the Site) range from approximately 973 ft amsl in Monitor Well 1325, to approximately 960 ft amsl near the escarpment (Monitor Well 1336A).

The presence of mudstone units between sandstone units (i.e., Sandstones A, B, and C) restricts vertical movement of groundwater in preference to horizontal flow. Vertical hydraulic conductivities across units are expected to be significantly smaller than horizontal conductivities within water-bearing units.

This is demonstrated by the presence of the Sandstone A seeps within the 1206 Drainage and along the bedrock escarpment, representing horizontal flow within Sandstone A unit. Seepage from Sandstone A into the drainage way does not infiltrate into Sandstone B, but discharges into the 1206 Drainage, in which it flows as surface water to transition zone material between the upland sandstone and mudstone and the floodplain alluvium.

Groundwater velocity in the Western Upland water-bearing units can be estimated based on measured hydraulic gradients and estimated hydraulic conductivities. Average linear groundwater velocity was calculated using the hydraulic properties presented above and assuming porosity for the sandstone of 5%. The calculated groundwater velocity is 1.2 ft/day for Sandstone A.

Groundwater in Sandstones B and C is present approximately 30 ft below the groundwater in Sandstone A. The deeper groundwater flows northwest toward the Cimarron River. In Sandstone B, the groundwater gradient is toward the north-northwest at about 0.023 ft/ft. In

Sandstone C, the gradient is also toward the north at about 0.013 ft/ft (*Site Investigation Report for the Cimarron Corporation Facility,* James L. Grant and Associates, Inc., 1989). Groundwater flow in Sandstones B and C is below the base of the escarpment in the Western Upland, thus Sandstones B and C do not discharge to seeps located along the escarpment. These two water-bearing units are not intercepted by the 1206 Drainage.

#### *Western Alluvial Area*

The water table in the Western Alluvial Area (Figure 2-11) is found in the alluvial floodplain of the Cimarron River. Groundwater flow in the Western Alluvial Area is generally northward toward the Cimarron River, as shown in the groundwater contour map in Figure 2-11. The hydraulic gradient is approximately 0.002 ft/ft. This gradient is significantly lower than those associated with the adjacent uplands, due to the increased permeability of the alluvial materials.

As in the BA1 area, there is expected to be upward flow from the underlying bedrock into the alluvial material as groundwater in the bedrock is discharging to the Cimarron River.

Average linear groundwater velocity was calculated using the hydraulic properties presented above and assuming a porosity for the alluvium of 33%. The calculated groundwater velocity is 0.9 ft/day for the alluvium in the Western Alluvial Area. The groundwater flow velocity generated by the groundwater flow model is approximately 1.5 ft/day.

### 2.7.5 Unsaturated Zone

Unsaturated zones (vadose zones) exist within the uppermost soils in the upland, transitional, and alluvial material at the Site. No vadose zone monitoring has been performed at the Site.

### 2.7.6 Groundwater Models

Groundwater flow models for the Western Alluvial Area and BA1 were initially developed by ENSR Corporation, and submitted to NRC in *Groundwater Flow Modeling Report*, (ENSR Corporation, 2006B, ML20213C652). Groundwater flow models were revised multiple times based on information obtained from additional groundwater assessment and pilot testing. Revisions made to the flow models were reported in *2016 Groundwater Flow Model Update* (Burns & McDonnell, 2017A, ML17054C271) and *2020 Groundwater Flow Model Review* (Burns & McDonnell, 2020B, ML20059K920. The final revision was based on comments from the NRC; the flow model report is provided in Appendix L. The following paragraphs describe the basic setup for the groundwater flow in Burial Area #1, the Western Alluvial Area, and the Western Upland area.

### Burial Area #1

The model domain for BA1 is shown on Figure 2-12. There are twelve layers in the model which represent a complex lithologic layering which was initially described in the *2006 Groundwater Flow Modeling Report* (ENSR, 2006B, ML20213C652). The model has been periodically updated to reflect newly available information, and is most recently documented within the 2022 BA-1 Groundwater Flow Model Report. Flow into the model domain is from percolation of precipitation as recharge and from upgradient general head boundaries. Flow out of the model is accounted for by simulating groundwater discharge to the Cimarron River. Figure 2-12 shows simulated groundwater elevations potentiometric contours based on static steady state groundwater flow conditions (i.e., conditions where groundwater levels are not influenced by remedial extraction or injection activity).

### Western Alluvial Area

The model domain for the Western Alluvial Area (WAA) is shown on Figure 2-13. The original model domain was expanded eastward to address remedial alternatives in the entire area of the nitrate plume as defined by the 10 mg/L isoconcentration contour; it therefore covers a larger area than the 2006 groundwater model. The WAA model domain includes two layers: Layer 1 represents the alluvium and Layer 2 represents the underlying bedrock. Flow into the model domain is from recharge and general head boundaries and groundwater flow out of the model is to the river. Figure 2-13 also shows the simulated potentiometric surface based on static groundwater elevations (i.e., not influenced by extraction or injection).

### Western Upland

The Western Upland (WU), which includes BA2, BA3, the Process Building Area, the former lagoons, Uranium Pond #1 (UP1), and Uranium Pond #2 (UP2), is underlain primarily by Sandstone A. Sandstone B is exposed near the base of the 1206 Drainage. Near BA3 and the former Sanitary Lagoons, the upper part of Sandstone A is composed mostly of siltstone and shale, rather than sandstone, per *Conceptual Site Model* (Revision – 01) (ENSR, 2006A, ML20213C536).

As in BA1, groundwater in the WU also originates as precipitation that infiltrates into the shallow groundwater unit recharge zones and flows into Sandstone A. In the Western Upland, the 1206 Drainage acts as a local drain for groundwater in Sandstone A. Groundwater flows toward this drainage from both the east and west, including BA3 and the former Sanitary Lagoons. Groundwater gradients steepen along the cliff faces of the drainage. Along the escarpment bordering the Cimarron River floodplain alluvium just north of the former Uranium Pond #1, groundwater flows north to northwest toward the floodplain in Sandstone A and discharges in a myriad of small seeps that are difficult to locate, as described in *Conceptual Site Model* (Revision – 01) (ENSR, 2006A, ML20213C536).

### 2.7.7 Distribution Coefficients

The primary mechanisms controlling transport in groundwater at the Site are advection (within groundwater flow) and dispersion (spreading during transport). Numerical groundwater flow models demonstrate that the groundwater flow directions generally mirror the contaminant plumes moving away from the source areas.

An important aspect of site hydrogeology is the mobility of the contaminants in various strata under influence of groundwater flow. The distribution coefficient, also known as the partition coefficient, $K_d$, is used to describe the decrease in concentration of contaminant in solution through interaction with the geologic material in a soil/rock-groundwater system. The $K_d$ is defined as the ratio of concentration of a species sorbed, divided by its concentration in solution under steady-state conditions. It is an empirical parameter and its use in a given situation implies that soil/rock-groundwater system under study is in equilibrium.

The primary chemicals of concern at the Site are uranium, nitrate, and fluoride. The $K_d$ values can vary across the Site depending upon the geochemistry and soil type, which potentially results in a range of values.

#### *Uranium $K_d$ Literature Values*

$K_d$ values for uranium have been shown to vary with pH, total dissolved carbonate, and dissolved calcium due to geochemical processes (Zachara et al. 2007 and EPA, 1999). Groundwater data (2011-05-06 Comprehensive Water Data tables) from the Site indicate average pH for all measurements is 7.2. $K_d$ values reported by EPA (EPA 1999) range between 63 to 630,000 milliliters per gram (mL/g) for a pH of 7. *Understanding Variation in Partition Coefficient, $K_d$* (EPA, 1999) also noted that the $K_d$ for clays is much larger than the $K_d$ for sands.

### *Site-Specific $K_d$ Values for Uranium*

Using samples of soil and groundwater from the Site, column tests were conducted by Hazen Research, Inc. (Hazen Research, Inc., 2006, ML20199M357). $K_d$ values were calculated and reported in *Conceptual Site Model* (Revision – 01) (ENSR, 2006A, ML20213C536).

Alluvial sand yielded a $K_d$ of 0.5 mL/g, silt yielded a $K_d$ of 2.0 ml/g, and clay yielded a $K_d$ of 3.4 ml/g. All tests were conducted with groundwater from BA1, and it is acknowledged that the minor variations in groundwater geochemistry may impact $K_d$ values. Consequently, more conservative values than those reported were agreed upon for use in retardation calculations.

Because none of the borings completed in the Transition Zones yielded all clay, but consisted of a mixture of clay, silt, and fine sand, the use of a uranium $K_d$ value of 3.4 ml/g for all Transition Zone material was deemed overly conservative. Similarly, borings drilled in Sandstones A and B contained a high degree of silt. Based on these observations, it was decided that a $K_d$ lower than that which had been reported for clay should be used for Sandstones A and B. A conservative value of 3.0 was selected for Sandstones A and B and Transition Zone materials.

Clean sand yielded a uranium $K_d$ of 0.5 during the Hazen tests. However, although borings in the floodplain do contain intervals of very “clean” sand, there is sufficient silt and/or clay to justify the use of a higher $K_d$ value than had been reported for clean sand. A $K_d$ of 2.0 was applied to alluvial areas.

More detailed information on the derivation of site-specific values for $K_d$ was provided in a letter dated July 12, 2016 (EPM, 2016, ML162038251).

### *Nitrate $K_d$ Literature Values*

Nitrate is highly mobile and has little potential for sorption to soil therefore $K_d$ values for nitrate are expected to be very low. (Krupka et al, 2004) recommend for groundwater scenarios a $K_d$ of 0 liters per kilogram (L/kg) for nitrate with a possible range from 0 mL/g to 0.0006 mL/g. Therefore, nitrate is expected to be very mobile in groundwater. For retardation calculations, a very conservative value of 0.6 mL/g was used in retardation calculations.

### *Fluoride $K_d$ Literature Values*

A literature search for fluoride $K_d$ values produced limited published information. Fluoride is usually transported through the water cycle complexed with aluminum. The $K_d$ values were estimated between 16 mL/g to 1166 mL/g (Daniels, John L. and Das, Gautham P., 2007) suggesting fluoride transport in groundwater is very retarded under certain geochemical conditions. However, since fluoride concentrations only slightly exceed the MCL, it was decided that retardation calculations to estimate the time required for remediation would not need to be performed.

#### *Tc-99 $K_d$ Literature Values*

A report on experiments performed at the Hanford, WA site indicate that technetium does not readily complex with other chemical species, and that technetium is relatively non-adsorbing in most environments (*Distribution Coefficient Values Describing Iodine, Neptunium Selenium, Technetium, and Uranium Sorption to Hanford Sediments* [Kaplan DI and RJ Serne 1995]). $K_d$ values for technetium obtained during experiments at the Hanford site varied from 0.1 ± 0.5 to -3 to 0.04 milliliters per gram (ml/g). The same work yielded $K_d$ values for uranium in Hanford soils varying from 1.9 ± 0.1.4 to 2.4 ± 0.6 ml/g. Because the $K_d$ values for uranium are in the same range as those calculated for uranium at the Cimarron Site, it is reasonable to conclude that the values for $K_d$ for technetium at the Cimarron Site should also be less than 1 ml/g.

## 2.8 NATURAL RESOURCES

### 2.8.1 Natural Resources at or Near the Site

The mineral and water resources of Logan County are important to the overall development and progress of the county. Petroleum production is by far the most important mineral-related commercial activity. In 1993, petroleum production in Logan County amounted to about 1.1 million barrels of crude oil (valued at nearly $18.7 million) and about 12 billion $ft^3$ of natural gas (valued at $22.6 million). Due to these production levels, Logan County ranked near the middle of the petroleum producing counties in Oklahoma (NRCS, 2006). Significant exploration and production activities have been performed in Logan County since early 2014.

Sand and gravel have been produced from a number of sites in the alluvial and terrace deposits of the county. Some of the sandstone and siltstone beds may locally be suitable for use as building and fill material.

Agriculture has a key role in the utilization of natural resources in the vicinity of the Site. The native vegetation consists of mid and tall rangeland grasses. The main agricultural enterprises are cattle and wheat production. Cattle are grazed mainly on native grasses and some improved pasture and on the side slopes. Wheat and grain sorghum are grown on the summits and gently sloping side slopes. Wheat, grain sorghum, and alfalfa are grown on the wide flood plains.

### 2.8.2 Water Usability

Abundant quantities of good-quality ground water occur in Quaternary alluvial and terrace deposits as well as in the extremely important Garber-Wellington aquifer that underlies much of the southern part of the county. The Garber-Wellington aquifer covers permeable sandstone layers of both the entire Garber Sandstone section and the upper part of the underlying Wellington Formation. The saturated thickness of this aquifer ranges from about 500 to 700 ft.

Water wells in the Garber-Wellington aquifer commonly yield 25 to 100 gallons per minute (gpm) of fresh water that contains only 200 to 500 mg/L of dissolved solids, although at the Site TDS groundwater typically yields 400 – 2,000 mg/L dissolved solids. The aquifer is recharged by precipitation and runoff that percolates down through the soil into the porous and permeable sandstones of the Garber Sandstone and the Wellington Formation. Groundwater then percolates slowly downward and/or laterally dips down (westward) within the sandstone layers. Groundwater is salty in the lower part of the Wellington Formation and farther west where the Garber Sandstone extends beneath Kingfisher County. Where the Garber Sandstone and the Wellington Formation crop out, ground water generally is found in any permeable sandstone bed at or below the ground-water surface. Farther west, where the relatively impermeable Hennessey Group overlies the Garber Sandstone, wells still must be drilled down into the water-bearing sands of the Garber-Wellington aquifer. Upon encountering a fresh-water sand, the water will be forced up the borehole several hundred ft under artesian pressure to the potentiometric surface, approximately 100 to 200 ft below the land surface. Since the Garber Sandstone and the Wellington Formation contain more shale to the north, the yield of the aquifer decreases northward across the county. Fresh water still occurs in the sands (the same as it does farther south), but the sands are less abundant, and the yields typically are 5 to 40 gpm. Water wells in alluvial and terrace deposits locally yield 25 to 50 gpm, while wells in the prolific Cimarron River terrace aquifer in the west-central part of the county yield 150 to 700 gpm. The water quality in most of these aquifers includes 300 to 1,000 mg/L of dissolved solids, although at the Cimarron Site, groundwater in the alluvial material often exceeds 1,500 mg/L.

### 2.8.3 Economical Evaluation of Natural Resources

As defined in U.S. Geological Survey Circular 831, resources in the vicinity of the Site are inferred to be viable based on known historical oil and gas production. Inferred reserves are currently economic for oil and gas.

### 2.8.4 Mineral, Fuel, and Hydrocarbon Resources

Mineral, fuel, and hydrocarbon resource extraction near and surrounding the Site affect the licensee's dose estimates. The only potential exposure pathway would occur if exploration and production activities occurred in proximity to the remediation areas. Contago Resources, Inc. operates production wells (located southeast of the intersection of Highways 33 and 74) to extract oil from Sections 11 and 12 in T16N-R4W, and Section 7 in T16N-R3W. If another operator would want to drill in Sections 1 or 2 in T16N-R4W, it is likely that the interested party would drill on high ground north of the Cimarron River rather than in the floodplain. A pipeline constructed across Section 12 carries production water for disposal and presents negligible risk from naturally occurring radioactive material. The risk impact to dose estimates is therefore very small.

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# 3.0 RADIOLOGICAL STATUS OF FACILITY

## 3.1 CONTAMINATED STRUCTURES

All formerly contaminated structures at the Site have been decommissioned and released for unrestricted use. Buildings that were formerly associated with licensed activities included:

- Uranium Building #1
- Uranium Tank Storage Building #2
- Solvent Extraction Building #3
- Uranium Warehouse Building #4
- $UF_6$ Receiving Room
- Emergency Response Building (now the Site Office)

A description of the decommissioning of these buildings is provided in Section 1.3.2, "Decommissioning of Former Buildings". All these buildings are or were located in Subareas I and K. Subarea I was released for unrestricted use in License Amendment 17, issued April 9, 2001. Subarea K was released for unrestricted use in License Amendment 18, issued May 28, 2002.

The Site Office (with adjacent storage containers) has been used to support continuing license activities, including:

- Storage of radiological instruments and check sources (exempt quantities only)
- Storage of sampling equipment and supplies
- Storage, packaging, and shipping of samples
- Conducting groundwater treatability tests
- Storage of potentially contaminated material prior to shipment to a licensed disposal facility

Sampling activities and groundwater treatability testing conducted in the Site Office had the potential to contaminate the building and equipment. Both routine and post-activity radiological surveys were conducted in the Site Office; no detectable contamination was present after completion of sampling activities and groundwater treatability testing. This demonstrates that contamination does not exceed criteria for unrestricted release. Routine surveys are routinely performed in the Site Office and storage areas to verify absence of contamination.

The Western Area Treatment Facility is the only structure that will have the potential to become contaminated. Engineering controls incorporated into the design of the operating systems provide sufficient control of licensed material that contamination of the building can only result from leaks or spills during transfer of licensed material in waste streams. Section 11.6, "Contamination Control Program", and Section 12 of the RPP, "Contamination Control", address those measures that will be implemented to identify and remediate contamination during operations.

## 3.2 CONTAMINATED SYSTEMS AND EQUIPMENT

A trash incinerator, located south of BA3, was used to incinerate non-radioactive waste materials released from restricted areas during site operations. Uranium was present in ash at concentrations above background because incineration increased the concentration of licensed material in waste that had been acceptably released for unrestricted use. Ash exceeding restricted release criteria was drummed and shipped to a licensed disposal facility. Soil samples collected from the area beneath the incinerator yielded uranium concentrations below the unrestricted release criteria. This area was included in the Final Status Survey Report for Subarea M. Subarea M was released for unrestricted use in License Condition 29 of Amendment 17 (issued April 2001).

All other radiologically contaminated systems and equipment associated with the former processing buildings were decontaminated and removed during the decommissioning of the buildings. Equipment that could not be practically surveyed for release was shipped for disposal at a licensed disposal facility.

Influent tanks, filter systems, ion exchange treatment systems, resin processing systems, and associated piping represent the systems and equipment that may become contaminated with licensed material. Section 8.9, "Demobilization", and Section 13.1, "Solid Radioactive Waste", address the survey and disposition of potentially contaminated systems and equipment.

## 3.3 SURFACE AND SUBSURFACE SOIL CONTAMINATION

NRC's 1981 *Branch Technical Position on Disposal or On-Site Storage of Residual Thorium and Uranium from Past Operations* (USNRC, 1981) established criteria for uranium in soil. This BTP established four options for disposal or on-site storage. The first option (Option 1) is unrestricted use, and the Option 1 criteria were incorporated into License Condition 27(c) as unrestricted release criteria. The second option (Option 2) is on-site storage, with a minimum of four ft of "clean" cover (the cover could be Option 1 soil). The activity limit for Option 2 varies based on the solubility of the uranium in the soil. Although the licensee demonstrated that the uranium in the soil had a very low solubility, the limit for totally soluble uranium (100 pCi/g total uranium) was utilized as the limit for on-site disposal of uranium. The third and fourth options in the BTP require off-site disposal of higher activity licensed material; Option 3 pertains only to natural uranium, so all material exceeding the Option 2 limit was considered Option 4 material.

The licensee has completed decommissioning and final status surveys for all soil and buildings currently present on the Site. Surface soil (including soil to three ft in depth where soil contamination was detected in the top six inches) in all sixteen Subareas of the Site has been demonstrated to comply with criteria for unrestricted release stipulated in License Condition 27(c) (30 pCi/g total uranium).

Where pipelines were removed, the excavated trenches were surveyed, and wherever contamination was identified below the pipeline, soil was removed until subsurface soil complied with the 30 pCi/g total uranium criterion. Individual samples of surface and subsurface soil may have yielded greater than 30 pCi/g, but if the average concentration in the 100 $m^2$ area surrounding that sample was less than 30 pCi/g, this did not constitute an exceedance of Option 1 limit.

Excavated soil (and other buried material) which exceeded the Option 2 criterion (100 pCi/g total uranium) was packaged and shipped to licensed disposal facilities. All excavated material which contained 30 to 100 pCi/g total uranium was placed in the on-site disposal trenches, now designated as BA4.

All soil exceeding 30 pCi/g uranium was removed from BA1 and BA2. Six surface or subsurface samples in BA3 exceeded 30 pCi/g uranium, but samples collected from within the 100$m^2$ area surrounding those locations averaged less than 30 pCi/g uranium, so that soil was left in place.

Both surface and subsurface soil now comply with license criteria for unrestricted release Site-wide. Subareas A through E were released from the license in license amendment 13, issued April 13, 1996. Subareas A and O were released from the license in license amendment 16, issued April 17, 2000. Subareas H, I, L, and M were released from the license in license amendment 17, issued April 9, 2001. Subareas K and O were released from the license in license amendment 18, issued May 28, 2002.

*Final Status Survey Report for Phase III Subarea O Uranium Waste Ponds #1 and #2 (Subsurface)* (Cimarron Corporation, 1998A, ML20206K825) provides analytical data for subsurface soil beneath UP1 and UP2. License Condition 27(c) states, “For Waste Ponds 1 and 2 in Phase Ill Subarea 0, the licensee may use the "Method for Surveying and Averaging Concentrations of Thorium in Contaminated Subsurface Soils" (reference NRC letter dated February 25, 1997) for volumetric concentration averaging of enriched uranium in soils." The use of volumetric averaging methodology allowed soil exceeding 30 pCi/g total uranium to remain at depth without exceeding unrestricted release criteria. Soil in the one-foot depth intervals between 5 and 9 feet below ground surface (bgs) averages over 30 pCi/g total uranium but complies with the volumetric averaging criteria.

Section 1.3.5, "Decommissioning of Soil", details the final status survey and confirmatory survey processes followed for Subareas F, G, and N, and provides the determination by the NRC that surface and subsurface soil in all three Subareas are releasable for unrestricted use. As uranium-impacted groundwater is removed from water-bearing zones in these (and other) Subareas, desorption of uranium from the solid phase to the aqueous phase will further reduce the concentrations of uranium in soil.

The conclusion of this section is that both surface and subsurface soil has been demonstrated to comply with NRC Criteria site-wide.

## 3.4 SURFACE WATER

All former impoundments which received or may have received licensed material at the Site have been decommissioned and released for unrestricted use. Impoundments that were or may have received licensed material included:

- Plutonium Waste Pond
- Plutonium Emergency Pond
- Uranium Emergency Pond
- Uranium Pond #1
- Uranium Pond #2
- East Sanitary Lagoon
- West Sanitary Lagoon
- "New" Sanitary Lagoon

A description of the decommissioning of these impoundments is provided in Section 1.3.3, "Decommissioning of Former Impoundments". These impoundments were in Subareas H, L, and O. License condition 27(c) stated that for the impoundments in Subarea O, volumetric concentration averaging of enriched uranium in soils are to be used to demonstrate compliance with the NRC Criterion. The use of volumetric averaging methodology allowed some soil exceeding 30 pCi/g total uranium to remain at depth without exceeding unrestricted release criteria. Both impoundment areas identified as Subarea O were released for unrestricted use in License

Amendment 16, issued April 17, 2000. Subareas H and L were released for unrestricted use in License Amendment 17, issued April 9, 2001.

The two freshwater ponds (reservoirs) on the Site are located in Subarea B. Subarea B was released for unrestricted use in License Amendment 13, issued April 13, 1996.

The Cimarron River is located along the northern boundary of the Site. Annual environmental monitoring continues to demonstrate that the Cimarron River is not impacted by any of the COCs associated with the Site.

The eastern and western freshwater ponds on the Site were sampled as part of the environmental monitoring program from 1990 through 1996. The eastern pond yielded 0.6 to 1.4 pCi/L uranium, and the western pond yielded 0.7 to 2.3 pCi/L total uranium. The background (upstream) sampling location for the Cimarron River, location 1201, yielded from 1.2 to 7.9 pCi/L total uranium, and the downstream location, location 1202, yielded from 3.0 to 7.5 pCi/L during that same time period. In the ten years since the license was transferred to the CERT, upstream location 1201 has yielded from 1.6 to 8.8 pCi/L total uranium, and downstream location 1202 has yielded from 1.8 to 8.0 pCi/L total uranium. The Cimarron River and both freshwater ponds are unimpacted by licensed material.

## 3.5 GROUNDWATER

Groundwater is the only environmental medium for which ongoing decommissioning is required to obtain unrestricted release of the Site. This section lists the groundwater assessments that have been performed for the Site and presents the current extent of impact for all COCs in groundwater at the Site.

The NRC Criterion for the Site is 180 picoCuries per liter (pCi/L) total uranium, derived from a risk-based concentration, and stipulated in License Condition 27(c).

Groundwater in several areas of the Site contains two non-radiological COCs: nitrate and fluoride. For uranium and fluoride, the criteria to achieve an unrestricted release from the DEQ are the EPA MCLs for drinking water. The MCLs are 30 µg/L for uranium and 4 mg/L for fluoride. Because nitrate is present at concentrations above the MCL due at least in part to the use of fertilizer, DEQ has designated a value of 22.9 mg/L as the State Criterion, based on analysis of samples from monitor wells located upgradient of processing or disposal activities. The State Criterion for nitrate in the process building area is 52 mg/L. Tc-99 is also present in groundwater, exceeding the State

Criterion in four locations. Monitor Well 1346 contains the highest concentration of Tc-99, and since the Tc-99 concentration has decreased from 2,030 pCi/L in 2011 to 1,650 pCi/L in 2019, it is believed that Tc-99 will comply with the State Criterion in all monitor wells by the time groundwater remediation is complete.

As detailed in Section 2.7.4, groundwater in the vicinity of BA1 originates from infiltration in the transition zone material around the former disposal trenches and in Sandstone B to the south and southwest of the transition zone material. Groundwater in Sandstone B enters the Transition Zone and migrates into sandy alluvial material as it moves northward. In general, groundwater uranium impacts at concentrations greater than the MCL are observed in BA1 in Sandstone B, the Transition Zone, and the floodplain alluvium (see Section 3.5.3 below).

Groundwater in the Western Upland and the Western Alluvium also originates as precipitation that infiltrates into the shallow groundwater unit recharge zones and flows into Sandstone A (see Section 2.7.4). In the Western Upland, the 1206 Drainage (west of Monitor wells 1400, 1354, 1352, etc.) and a smaller drainage to the northeast (east of Monitor Wells 1397, 1340, and 1396) act as local drains for groundwater in Sandstone A, resulting in groundwater base flow discharging from Sandstone A into Transition Zone sediments deposited within these drainages. Some of the groundwater discharged into these drainages temporarily becomes surface water as it seeps from the face of exposed sandstone in these drainages.

In general, uranium, nitrate and fluoride are present at concentrations greater than the State Criteria in the Western Area (Western Alluvium and Western Uplands) in Sandstone A, Sandstone B, the Transition Zone, and the floodplain alluvium (see Section 3.5.3 below).

### 3.5.1 Submittals Addressing Groundwater Assessment

Numerous groundwater assessment efforts have been performed at the Site. The following is a list of reports on groundwater assessment activities.

- April 17, 2002, *Former Burial Area #1 Groundwater Assessment Work Plan*, (Cimarron Corporation, 2002B, ML021120034)
- September 24, 2002, *Tc-99 Site Impact Evaluation and Proposed Groundwater Assessment Work Plan*, (Chase Environmental Group, 2002, ML022730366)
- December 13, 2002, *Well 1319 Area Groundwater Assessment Work Plan*, (Cimarron Corporation, 2002C, ML023510328)
- January 29, 2003, *Burial Area #1 Groundwater Assessment Report*, (Cimarron Corporation, 2003A, ML030360302)

- December 30, 2003, *Draft Tc-99 Groundwater Assessment Report*, (Chase Environmental Group, 2003, ML040080243)
- December 30, 2003, *Assessment Report for Well 1319 Area,* (Cimarron Corporation, 2003B, ML040070526)
- August 10, 2005, *Site-Wide Groundwater Assessment Review,* (Cimarron Corporation, 2005, ML052240432)
- August 11, 2005, *Conceptual Site Model,* (ENSR, 2005, ML090140211 and ML090140212)
- October 18, 2006, *Conceptual Site Model (Revision- 01),* (ENSR 2006A, ML20213C536)
- October 23, 2006, *Groundwater Flow Modeling Report,* (ENSR, 2006B, ML20213C652)
- March 3, 2013, *Pneumatic Slug Testing Memorandum,* (Burns & McDonnell, 2013A, ML21153A394)
- March 15, 2013, *Hydrogeological Pilot Test Report,* (Burns & McDonnell, 2013B, ML20213C674)
- January 6, 2014, *Groundwater Flow Modeling Report* (Burns & McDonnell, 2014A, ML20213C675)
- July 22, 2014, *Hydrogeological Testing Memorandum,* (Burns & McDonnell, 2014B, ML19095B796)
- May 8, 2015, *Report on 2014 Design Investigation,* (Burns & McDonnell, 2015A, ML21120A281)
- July 5, 2016, *Distribution Coefficient Determination for the Cimarron Site,* (EPM, 2016A, ML20204A867)
- January 25, 2017, *Groundwater Flow Model Update,* (Burns & McDonnell, 2017A, ML17054C271)
- May 19, 2017, *Vertical Distribution of Uranium in Groundwater*, (Burns & McDonnell, 2017C, ML17146A133)
- August 22, 2017, *Determination of Conservative U-235 Enrichment Levels for Groundwater at Cimarron Site*, (Enercon Services, Inc., 2017B, ML17303A788)
- March 28, 2018, *1206 Drainage Sediment Assessment and Remedial Alternative Evaluation*, (Burns & McDonnell, 2018B, ML18092A397)
- March 28, 2018, *Groundwater Data Evaluation*, (Burns & McDonnell, 2018A, ML18092A381)
- April 12, 2018, *Determination of Maximum Conservative U-235 Enrichment Levels for Groundwater at Cimarron Site*, (Enercon Services, 2018, ML18128A035)
- April 6, 2018, *Environmental Sequence Stratigraphy (ESS) and Porosity Analysis, Burial Area 1*, (Burns & McDonnell, 2018C, ML18100A297)
- June 28, 2019, *2019 Groundwater Data Evaluation*, (Burns & McDonnell, 2019B, ML20112F352)
- January 31, 2020, *Tc-99 Groundwater Assessment*, (Burns & McDonnell, 2020A, ML20178A371)

- March 24, 2020, *BA#1 Redox Evaluation*, (Burns & McDonnell, 2020C, ML20087H855)
- April 3, 2020, *Vertical Profiling and Monitor Well Abandonment Report*, (Burns & McDonnell, 2020D, ML20106F067)

### 3.5.2 Submittals Addressing Groundwater Remediation

Numerous approaches to groundwater remediation efforts have been considered, and several proposed at different time, to address COCs in groundwater at the Site. The following is a list of submittals addressing groundwater remediation.

- October 22, 2003, *Draft Work Plan – In Situ Bioremediation Treatment of Uranium in Groundwater in Burial Area #1*, (ARCADIS, 2003, ML033020408)
- January 24, 2005, letter proposing a Well 1319 Area post-decommissioning groundwater monitoring plan, (ML050260259)
- December 11, 2006, license amendment request which included *Site Decommissioning Plan, Groundwater Decommissioning Amendment*, ARCADIS. Rejected by NRC w/a request for additional information (RAI) March 27, 2007, (ARCADIS, 2006, ML063470609)
- August 31, 2007, letter requesting that NRC provide closure on Well 1319 Area groundwater remediation, (Cimarron Corporation, 2007A, ML21239A073)
- June 2, 2008, *Groundwater Decommissioning Plan*, ARCADIS, 2008, ML11209C602 and ML21239A126)
- March 26, 2009, license amendment request included *Groundwater Decommissioning Plan*, (ARCADIS, 2009, ML091040289)
- June 30, 2011, *Evaluation of Potential Alternative Groundwater Remediation Technologies,* (EPM, 2011, ML21239A136)
- March 19, 2014, *Treatability Study Report*, (Clean Harbors, 2014, ML19095B798)
- October 30, 2015, *Groundwater Treatability Tests*, (Kurion, Inc., 2015, ML19095B790)
- May 25, 2018, *Explanation of 1206 Drainage Remediation Plan and Cost Impact at the Cimarron Site*, (EPM, 2018, ML18165A411)
- June 19, 2018, *Pilot Test Report,* (Burns & McDonnell, 2018D, ML18171A300, ML18171A305, ML18171A309, ML18171A310, and ML18171A316)
- November 2, 2018, *Cimarron Facility Decommissioning Plan – Rev 1,* (Environmental Properties Management, 2018, ML19352E486)
- February 26, 2021, *Facility Decommissioning Plan – Rev 2,* (Environmental Properties Management, 2021, ML21076A479)

### 3.5.3 Current Extent of COCs in Groundwater

The unrestricted release criteria for groundwater for uranium is 180 pCi/L total (not net) uranium. Tc-99 is not a naturally occurring radionuclide at the Site. Consequently, groundwater assessment to determine background concentrations for the various water-bearing zones at the Site has not been conducted. Evaluation of data to delineate the nature and extent of contamination has shown that concentrations of natural uranium in groundwater increase with depth. Groundwater contained in Sandstone C exceeds the MCL at some locations, including upgradient locations where the concentration of uranium in water-bearing zones above it is below the MCL.

The 2015 *Cimarron Facility Decommissioning Plan* (Environmental Properties Management, 2015B, ML16032A285) presented data from the 2015 groundwater assessment sampling event. In some areas, COC concentrations appeared to be anomalously low in 2015, whereas in other areas, COC concentrations appeared to be consistent with or slightly higher than previous data. NRC recommended that groundwater data be evaluated for evidence of seasonal variability, as well as to determine if changes in COC concentrations were related to changes in groundwater elevation.

Quarterly collection of groundwater samples from 44 monitor wells was begun in the first quarter of 2016. Samples were collected from wells screened in all three sandstone units, in transition zone material in the WAA and BA1, and in alluvial material in the WAA and BA1. Data from 2011 through the Fourth Quarter of 2016 were evaluated, and the evaluation results were presented in *2016 Groundwater Evaluation* (Burns & McDonnell, 2017B, ML17075A215). The evaluation concluded that there is no relationship between either season or groundwater elevation and COC concentrations. This evaluation was updated in 2018 and 2019, and each evaluation yielded the same conclusion.

It is necessary to minimize the potential for individual data points to exercise undue influence on the estimated concentrations of COCs in treatment train influents. Consequently, the decision was made to determine the concentration of each COC at each location at the 95% upper confidence level (95% UCL), based on data obtained from 2011 through the second quarter of 2017. Several wells were installed during the 2017 pilot study (1395 through 1403). These wells were sampled only in the fourth quarter of 2017, and the representative concentration for those locations are the results from that single sampling event. For locations for which the 95% UCL was greater than the maximum concentration, the maximum concentration was used. For locations for which less than four data points were available, the average concentration was used. These concentration values are referred to herein as “representative concentrations”.

Figures 3-1 through 3-4 present isoconcentration contours (isopleths) for each COC, developed using the representative concentrations described above. Figure 3-1 presents an isopleth map for nitrate in the Western portion of the Site. Table 3-1 provides the concentration data used to develop the representative values and isopleths presented in Figure 3-1.

Figure 3-2 presents an isopleth map for fluoride in the Western portion of the Site. Table 3-2 provides the concentration data used to develop the representative values and isopleths presented in Figure 3-2.

Figure 3-3 presents an isopleth map for uranium in the Western portion of the Site. Table 3-3 provides the concentration data used to develop the representative values and isopleths presented in Figure 3-3.

As shown on Figure 3-3, representative uranium concentrations in the Western Area range from 0.63 to 875 µg/L. Representative uranium concentrations for each Western Area monitor well are tabulated on Figure 3-3, and wells with concentrations exceeding NRC or DEQ criteria are indicated on the table via color coding. The average representative uranium concentration in the Western Area is 47.2 µg/L and the maximum and average representative uranium concentrations within each aquifer in the Western Area are as follows:

| Aquifer | Maximum Representative Uranium Concentration (µg/L) | Average Representative Uranium Concentration (µg/L) |
|---|---|---|
| Alluvium | 178 | 53.8 |
| Sandstone A | 875 | 43.4 |
| Transition Zone | 527 | 333 |

The maximum and average representative uranium concentrations within each Western remediation area exceeding the NRC Criterion of 180 pCi/L are as follows:

| Remediation Area | Maximum Representative Uranium Concentration (µg/L) | Average Representative Uranium Concentration (µg/L) |
|---|---|---|
| WAA U>DCGL | 178 | 85.0 |
| 1206-NORTH | 527 | 333 |
| WU-BA3 | 875 | 203 |

Western Area remediation areas are depicted on figures presented in Section 8.0.

Isoconcentration contours depicting the magnitude and extent of uranium contamination in BA1 groundwater are shown on Figure 3-4. Table 3-4 provides the concentration data used to develop the representative values and isopleths presented in Figure 3-4. Representative uranium concentrations for each BA1 monitor well are tabulated on Figure 3-4, and wells with concentrations exceeding NRC or DEQ criteria are indicated on the table via color coding. Representative uranium concentrations in BA1 range from 1.24 to 3516 µg/L. The average representative uranium concentration in BA1 is 412 µg/L and the maximum and average representative uranium concentrations within each aquifer in BA1 are as follows:

| Aquifer | Maximum Representative Uranium Concentration (µg/L) | Average Representative Uranium Concentration (µg/L) |
|---|---|---|
| Alluvium | 3516 | 277 |
| Sandstone B | 2589 | 307 |
| Transition Zone | 2975 | 857 |

The maximum and average representative uranium concentrations within each BA1 remediation area exceeding the NRC Criterion of 180 pCi/L are as follows:

| Remediation Area | Maximum Representative Uranium Concentration (µg/L) | Average Representative Uranium Concentration (µg/L) |
|---|---|---|
| BA1-A | 2975 | 599 |
| BA1-B | 3516 | 388 |

BA1 remediation areas are discussed and depicted on figures presented in Section 8.0.

Attachment 2.1 of the Basis of Design, included in Appendix K, presents the maximum, average, and 95% UCL (if available) nitrate, fluoride, and uranium groundwater concentrations for site monitor wells, based on results generated by groundwater monitoring events conducted from 2011 through the Second Quarter 2017. This attachment also presents the representative nitrate, fluoride, and uranium groundwater concentrations used as the basis for remediation design. The protocols and methods used to determine representative COC groundwater concentrations are described in Attachment L.

The maximum and average representative nitrate concentrations observed in the Western Area are 1,006 mg/L (Monitor Well 1385) and 71.5 mg/L, respectively. The maximum and average fluoride concentrations observed in Western Area are 48.9 mg/L (Monitor Well 1313) and 3.1 mg/L, respectively. The maximum and average uranium concentrations observed in Western Area are 875 µg/L (Monitor Well 1351) and 47.2 µg/L, respectively. The maximum and average uranium concentrations observed in BA1 are 3,516 µg/L (Monitor Well TMW-13) and 412 µg/L, respectively.

Estimated average influent uranium concentrations and remediation system design flow rates (refer to Section 8.2.4 for details) were used to estimate the mass of uranium that will be recovered from each remediation area exceeding the NRC remediation criterion, from the time remediation begins until the NRC remediation criterion is achieved (refer to Section 9.3 for details regarding remediation durations and schedule). The estimated mass that will be recovered from each remediation area exceeding the NRC Criterion is as follows:

- BA1: 589 kg (includes remediation areas BA1-A and BA1-B)
- WA: 271 kg (includes remediation areas WAA U>DCGL, 1206-North, and WU-BA3)

Note: The uranium mass removed from WU-BA3 will be flushed from WU-BA3 via treated water injection and subsequently recovered by extraction trench GETR-WU-02 located in the 1206-NORTH remediation area.

The values used to calculate uranium enrichment must be as accurate as reasonably achievable to estimate the mass of U-235 that may accumulate in ion exchange resin vessels during groundwater treatment. Isotopic analysis was performed prior to 2016 by alpha spectroscopy. At the relatively low uranium concentrations that exist throughout much of the area requiring remediation, the uncertainty associated with the calculated enrichment is high. In estimating enrichment values for uranium, the "mean plus 2-sigma" enrichment value for all data obtained at each location was calculated. Due to the high uncertainty associated with isotopic activity (vs. isotopic concentration) analysis, this calculation method resulted in an over-estimation of enrichment values for the groundwater treatment system influent streams.

In December 2016, groundwater samples were collected from multiple locations to obtain a data set spanning the variability of uranium enrichment and concentration that occurs across the Site. Samples were analyzed for isotopic activity by alpha spectroscopy and for isotopic mass concentration by inductively coupled plasma – mass spectroscopy (ICP-MS). The data was evaluated to determine which method would provide the most accurate isotopic results at low uranium concentrations. The result of this evaluation was reported in a technical memorandum entitled, "*Analysis of Analytical Method for Uranium Enrichment Determination*" (Enercon

Services, Inc., 2017A, ML17128A093). The evaluation conclusively demonstrated that ICP-MS analysis produces isotopic results with far less uncertainty at low concentrations.

Groundwater samples were then collected from 197 monitor wells for isotopic analysis by ICP-MS during the Second Quarter of 2017, including all monitor wells located in areas where groundwater will be extracted for treatment. Samples were analyzed for mass concentration of the U-235 and U-238 isotopes only, because the mass of U-234 at the low enrichment levels encountered at the Site is negligible (less than 0.05% of the total uranium mass),

U-235 enrichment values were calculated by dividing the U-235 mass concentration by the sum of the U-235 and U-238 mass concentrations (the mass of U-234 is negligible). Figure 3-5 presents iso-enrichment contours for the western areas. Contours are drawn for U-235 enrichment values of 1, 2, 3, and 4%. Figure 3-5 clearly shows that the enrichment varies in relation to the source from which the uranium came. Higher enrichment values are observed along the trace of the pipeline which formerly discharged water from the original impoundments to the Cimarron River. Lower enrichment values are associated with leachate from the uranium waste ponds. Enrichment values in groundwater associated with BA3 are typically between those associated with the pipeline and the uranium waste ponds.

Enrichment values for groundwater samples collected from monitor wells in BA1 are posted on Figure 3-6. Because the maximum enrichment in BA1 is less than 2%, the only isopleth in BA1 is the 1% enrichment contour.

The ability of groundwater extraction to recover uranium-impacted groundwater, and for uranium treatment (ion exchange) systems to remove uranium from the recovered groundwater, is unaffected by U-235 enrichment levels. Variability in uranium enrichment levels does however impact the accumulation of U-235 on ion exchange resin, relative to the license possession limit for U-235. In the western areas, this variability is substantially moderated when groundwater extracted from locations containing higher-enriched uranium is combined with groundwater extracted from locations containing lower-enriched uranium prior to treatment.

In BA1, there is little variability in enrichment, with U-235 enrichment varying from natural (0.7%) enrichment to approximately 1.9% enrichment. Even this slight variability is moderated due to the same mixing of groundwater from multiple locations prior to treatment.

## 3.6 BACKGROUND VALUES FOR RADIATION AND RADIOACTIVITY

### 3.6.1 Background Soil Concentration

Background values have been established for exposure rate and for the concentration of uranium in soil. As described in Section 1.3.1, "Decommissioning Criteria", the NRC agreed that if alpha spectroscopy is used to analyze samples, a value of 2.8 pCi/g total uranium is acceptable for use as the background activity concentration for soil. This value will apply site-wide. When soil is analyzed for mass concentration, analysis will be for U-235 and U-238 (the mass of U-234 is negligible). A U-235 enrichment of [U-235 / (U-235 + U-238)] will be used to convert the mass concentration for U-234, U-235, and U-238 to activity concentration for comparison with the NRC Criteria.

### 3.6.2 Background Exposure Rate

The 1995 *Decommissioning Plan for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility* (Chase Environmental Group, 1995A, ML20202A437) provided background information for building surfaces, soil, and exposure rate. Section 1.4.4, "Exposure Rate Survey (Open Land Areas)", documented exposure rates at background locations ranging from 7 – 10 microroentgens/hour (μR/hr). A value of 10 μR/hr will be used as a generic value for maximum background exposure rate. However, background exposure rates vary based on weather and soil type and soil conditions (e.g., saturation). Consequently, when conducting exposure rate surveys for comparison with NRC Criteria, the background exposure rate will be measured in an unaffected area with a similar soil/surface on the day the survey is conducted.

### 3.6.3 Surface Water

The CERT has analytical results for surface water samples collected from the Cimarron River upstream of any licensed operations dating as far back as 1990. Upstream surface water samples collected near the Highway 74 bridge were identified as Location 1201. Table 3-1, "Surface Water Concentrations – Location 1201", tabulates the isotopic activity concentration data from 26 sampling events

The mean total uranium concentration for Location 1201 is 4.7 pCi/L; the maximum total uranium concentration obtained from that location is 8.8 pCi/L.

### 3.6.4 Groundwater

The background concentration for groundwater is dependent upon both the location and the depth of the groundwater. Sandstones A and B are exposed at the surface in different portions of the site; the groundwater is more affected by infiltration from precipitation than is the deeper Sandstone C. Sandstone C contains "older" groundwater, and this deeper groundwater contains higher concentrations of natural uranium. Groundwater in the Cimarron River floodplain consists of contributions from Sandstones B and C as well as infiltration from precipitation, as well as from infiltration from inundation during floods.

#### *Sandstone A*

Figure 2-10 presents a potentiometric surface map for Sandstone A in the Western Area. Monitor Wells 1325 and 1335A are located upgradient from both UP2 and BA4. Monitor Well 1335A replaced Monitor Well 1335 (which had been damaged) in 1996. Groundwater samples from each of these two locations have been analyzed for isotopic uranium activity 18 times from March 1989 through 2010. Table 3-6 presents the analytical data obtained for groundwater samples from these two wells.

The mean total uranium concentration for these 38 analytical results is 2.13 pCi/L, with a "mean plus 2σ" concentration of 6.50 pCi/L. The activity concentration of the sample collected from Monitor Well 1325 seems anomalously high and is believed to be erroneous, with a total uranium concentration of 14.3 pCi/L. If that result is excluded from the dataset, the mean background total uranium concentration is 1.80, with a "mean plus 2σ" concentration of 3.45 pCi/L.

#### *Sandstone B*

Figures 2-9 and 2-11 present potentiometric surface maps for Sandstone B and the alluvium in BA1 and the Western Area, respectively. In BA1, Monitor Wells 1314 and 02W52 are both upgradient of the former burial trenches. In the Western Area, Monitor Wells 1391 and 1319B-2 are both located upgradient of any potential source of contamination. Table 3-7 presents the analytical data obtained for groundwater samples from these four wells.

The mean total uranium concentration for these 40 analytical results is 2.19 pCi/L, with a "mean plus 2σ" concentration of 3.59 pCi/L. The maximum total uranium concentration of 4.09 pCi/L was obtained from Monitor Well 02W52 in June 2002.

### *Sandstone C*

Too few monitor wells have been installed in Sandstone C to generate a potentiometric surface map. However, the average groundwater elevation in Monitor Well 1328 is more than 5 feet higher than in Monitor Well 1319C-1; the average groundwater elevation in Monitor Well 1339 is over 15 feet higher than in Monitor Well 1321. Consequently, these two wells were used to determine the background concentration of uranium in groundwater in Sandstone C. Table 3-8 presents the analytical data obtained for groundwater samples from these two wells.

As stated above, the groundwater in Sandstone C contains elevated concentrations of naturally occurring uranium. The mean total uranium concentration for these 41 analytical results is 28.88 pCi/L, with a "mean plus 2σ" concentration of 43.67 pCi/L. The maximum total uranium concentration of 43.67 pCi/L was obtained from Monitor Well 1328 in October 1989.

### *Alluvium*

Figure 2-11 presents a potentiometric surface map for Sandstone B and the alluvium at the Site. There is no upgradient monitor well for alluvial material on the site because the upgradient edge of the alluvium is north of the former facility. However, the potentiometric surface shown on Figure 2-11 provides evidence that groundwater coming from impacted areas flows not to the north-northwest (perpendicular to the Sandstone A escarpment), but to the north, with a slight trend toward the east.

Consequently, groundwater in the vicinity of Monitor Well 1342 would not be impacted by the facility. Monitor Well T-103 is also outside of the area that would be influenced by impacted groundwater migrating from the UP1 and UP2 areas. These two monitor wells were selected to provide background uranium concentrations for the Cimarron River alluvium.

Table 3-9 presents the analytical data obtained for groundwater samples from these two wells. The data makes it apparent that as groundwater in Sandstone C discharges into the alluvium, it is impacting the groundwater to some extent.

The mean total uranium concentration for the 9 analytical results obtained from these two monitor wells is 7.37 pCi/L, with a "mean plus 2σ" concentration of 12.00 pCi/L. The maximum total uranium concentration of 12.00 pCi/L was obtained from Monitor Well 1342 in June 1999.

*Note: The above information on the background concentration of uranium is provided for information only. Unlike the NRC Criteria for soil or surface contamination, the NRC Criterion for uranium in groundwater is not a "concentration above background". Consequently, there is no reason to establish a background value to which the NRC Criterion of 180 pCi/L total uranium would be added.*

* * * * *

# 4.0 UNRESTRICTED RELEASE CRITERIA

Decommissioning Plan guidance contained in Appendix D of NUREG-1757 is based on the need to utilize a dose model to develop derived concentration goal levels (DCGLs) that will yield a site that is releasable for unrestricted use. However, unrestricted release criteria for building surfaces and equipment, surface and subsurface soil, and groundwater were established in accordance with the Site Decommissioning Management Program. NRC stated in a November 10, 2005, letter that the criteria established under the Site Decommissioning Management Program would be carried forward under the License Termination Plan and are specified in License Condition 27. Consequently, dose modeling was not performed to develop unrestricted release criteria. This section describes the criteria that are stipulated in License Condition 27.

## 4.1 UNRESTRICTED RELEASE CRITERIA FOR FACILITIES & EQUIPMENT

License Condition 27(c) lists the unrestricted release criteria for facilities and equipment. This condition cites the August 1987 *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for Byproduct, Source or Special Nuclear Material* (USNRC, 1987). License Condition 27(c) states, "Buildings, equipment, and outdoor areas shall be surveyed in accordance with NUREG/CR-5849, 'Manual for Conducting Radiological Surveys in Support of License Termination.'" The criteria are:

- 5,000 dpm alpha/100 $cm^2$ (15.5 $in^2$), averaged over 1 $m^2$ (10.8 $ft^2$)
- 5,000 dpm beta-gamma/100 $cm^2$ (15.5 $in^2$), averaged over 1 $m^2$ (10.8 $ft^2$)
- 15,000 dpm alpha/100 $cm^2$ (15.5 $in^2$), maximum over 1 $m^2$ (10.8 $ft^2$)
- 15,000 dpm beta-gamma/100 $cm^2$ (15.5 $in^2$), maximum over 1 $m^2$ (10.8 $ft^2$)
- 1,000 dpm alpha/100 $cm^2$ (15.5 $in^2$), removable
- 1,000 dpm beta-gamma/100 $cm^2$ (15.5 $in^2$), removable

The exposure rate for surfaces of buildings and equipment is 5 μR/hr above background at 1 m (3.3 ft.)

## 4.2 UNRESTRICTED RELEASE CRITERIA FOR SOIL

License Condition 27(c) also lists the unrestricted release criteria for soils and soil-like material. This license condition states, "The licensee shall use … the October 23, 1981, BTP 'Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations' for soils or soil-like material." It also states, "… outdoor areas shall be surveyed in accordance with NUREG/CR-5849, 'Manual for Conducting Radiological Surveys in Support of License Termination'. Soils and soil-like materials with elevated activities exceeding the unrestricted use criteria shall be investigated to determine compliance with the averaging criteria in NUREG/CR-5849. These criteria address averaging concentrations over any 100 $m^2$ (1,070 $ft^2$) area and use the (100/A)1/2 elevated area method." Unrestricted release criteria for soils and soil-like material are:

- Natural uranium 0.37 becquerel per gram (Bq/g) (10 pCi/g) total uranium
- Enriched uranium 1.1 Bq/g (30 pCi/g) total uranium
- Depleted uranium 1.3 Bq/g (35 pCi/g) total uranium
- Natural thorium 0.37 Bq/g (10 pCi/g) total thorium
- 2.6 pCi/kg (10 µR/hr) average above background at 1 m (3.3 ft.)
- 5.2 pCi/kg (20 µR/hr) maximum above background at 1 m (3.3 ft.)

The onsite disposal cell designated BA4 is the only area in which soil exceeding these unrestricted release criteria remains on site. License Condition 23 lists post-closure monitoring and notification requirements for the onsite disposal cell. The onsite disposal cell has been closed and all post-closure monitoring and notification is complete. No additional material exceeding the unrestricted release criteria will be placed in the onsite disposal cell. Any soil or soil-like material that is brought to the surface during decommissioning operations that exceeds unrestricted release criteria will be removed and shipped to a licensed low-level radioactive waste disposal site.

License Condition 23(b) states, "Notification shall be placed on the land title to declare that uranium-contaminated soil has been buried on the site and to record the volume, average uranium concentration, and exact location of the buried soil. This notification is not to be considered a restriction on the sale or future use of the site." The disposal of soil containing 30 to 100 pCi/g uranium will not therefore impact the release of the site for unrestricted use.

## 4.3 UNRESTRICTED RELEASE CRITERIA FOR GROUNDWATER

The only radioactive COCs that are detectable in groundwater are uranium and Tc-99. Uranium is present both as natural uranium and as licensed uranium in groundwater. Nitrate and fluoride are the two non-radioactive contaminants for which groundwater remediation would be required to obtain unrestricted release from DEQ.

### 4.3.1 Uranium

License Condition 27(b) cites the unrestricted release criterion for uranium in groundwater. A dose evaluation reported in the 1998 *Decommissioning Plan Groundwater Evaluation Report* (Chase Environmental Group, Inc., 1998B, ML20203M069) generated a DCGL of approximately

188 pCi/L. However, the 1998 Risk Assessment for Groundwater (ML20059P033) established a risk-based limit of 0.11 mg/L for uranium in groundwater (Roberts Schornick & Associates, Inc., 1998, ML20059P033). The mass concentration of uranium at 0.11 mg/L is approximately equivalent to an activity concentration of 180 pCi/L, assuming an average enrichment of approximately 2.7%. 180 pCi/L total uranium was established as the unrestricted release criterion for groundwater at the Site.

The U-235 enrichment is not constant for all licensed uranium in groundwater at the Site. The U-235 enrichment of uranium in groundwater varies based on the source of the uranium. Data indicates that the U-235 enrichment associated with licensed material originating from BA3 and the pipeline that ran from the sanitary lagoons and emergency ponds is approximately 2.9%. The U-235 enrichment associated with licensed material originating from BA1 and Uranium Waste Ponds #1 and #2 averages 1.3%. The mass concentration that is equivalent to 180 pCi/L at 2.75% enrichment is 123 µg/L total uranium, and the mass concentration that is equivalent to 180 pCi/L at 1.3% enrichment is 201 µg/L total uranium.

To obtain unrestricted release from DEQ, uranium concentrations must comply with the MCL issued in the primary drinking water standards promulgated by the EPA. The MCL for uranium is 30 µg/L.

### 4.3.2 Technetium-99

Unrestricted release criteria for Tc-99 are not stipulated in License SNM-928. The EPA has promulgated a primary drinking water standard of 4 millirem per year (mrem/yr) for beta photon emitters. The NRC developed a concentration limit for Tc-99 based on the 4 mrem/yr dose limit using the 1982 International Commission on Radiological Protection (ICRP) Publication 30, *Limits for Intakes of Radionuclides by Workers* (ICRP, 1982). The NRC concentration limit for Tc-99 is 3,790 pCi/L. The EPA developed a concentration limit for Tc-99 based on the EPA MCL of 4 mrem/yr using the 1959 ICRP Publication 2, *Permissible Dose for Internal Radiation* (ICRP, 1959). The EPA concentration limit for Tc-99 is 900 pCi/L.

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# 5.0 ENVIRONMENTAL INFORMATION

## 5.1 INTRODUCTION

This section presents environmental information related to the decommissioning of the Site by reducing the concentration of uranium in groundwater to concentrations that provide for the release of the Site for unrestricted use and termination of license SNM-928. There are no regulatory deadlines or fixed dates for the initiation or completion of decommissioning activities.

The proposed action involves the extraction of groundwater from impacted areas, followed by removal of uranium by ion exchange. A portion of the treated water will be re-injected into upland areas to flush contaminants to groundwater extraction trenches located in the transition zones. Most of the treated water will be discharged to the Cimarron River in accordance with an Oklahoma Pollution Discharge Elimination System (OPDES) permit.

## 5.2 PURPOSE AND NEED FOR PROPOSED ACTIONS

The proposed actions are necessary to comply with the decommissioning criteria so the NRC can release the Site for unrestricted use and terminate Special Nuclear Materials License SNM-928.

This section follows the organization presented in NUREG-1748, *Environmental Review Guidance for Licensing Actions Associated with NMSS Programs* (USNRC, 2003). Several of the topics referenced in this document are fully presented elsewhere in this Plan and are not completely duplicated herein to reduce duplication and avoid conflicts between different sections of this Plan.

The actions proposed herein will only achieve compliance with the criteria stipulated in SNM-928 and will not result in compliance with State Criteria for uranium, nitrate, or fluoride. The DEQ may require restrictions on the future use of the property, including preventing the use of groundwater for drinking water.

## 5.3 NEED FOR THE PROPOSED ACTION

Release of the Site for unrestricted use and termination of the radioactive materials license will result in the restoration of the Site such that it can be converted to beneficial use without future radiological risks associated with residual licensed material.

Decommissioning activities have been ongoing since 1976 when production activities were terminated. Many of the decommissioning activities were completed in accordance with the licensee's operating license conditions, and the license was amended numerous times as described in Section 1.1. The facilities and remaining processing equipment were decontaminated, and waste and soil were excavated and packaged for shipment and disposal in accordance with License Condition 18 of SNM-928 through its 1983 renewal. After excavation of the sanitary lagoons and the former disposal trenches in BA1, NRC authorized their backfill in License Condition 22 of Amendment 9, issued in December 1992.

The on-site burial of Option 2 material in what is now referred to as Burial Area #4 was authorized in License Condition 23 of Amendment 10, issued in November 1994.

Cimarron Corporation submitted its first decommissioning plan on April 19, 1995. Eight documents responding to NRC comments, clarifying statements made in the decommissioning plan or committing to specific requirements, were submitted between 1996 and the issuance of Amendment 15 in July 1999. One of those submittals was the 1998 *Site Decommissioning Plan Groundwater Evaluation Report* (Chase Environmental Group, Inc., 1998B, ML20203M069), which stated that based upon knowledge of groundwater impact at the time it was believed that active groundwater remediation may not be required to achieve license termination for unrestricted use. The NRC approved the use of the decommissioning plan and stipulated unrestricted release criteria for groundwater, soil, surface contamination, and exposure rate in License Condition 27 of this amendment.

Since that time, it was determined that active groundwater remediation is required to reduce uranium concentrations in groundwater to unrestricted release criteria within an acceptable timeframe. Achieving release of the Site for unrestricted use and license termination significantly reduces the potential for the Site to become a legacy site with no financially solvent owner or licensee.

## 5.4 THE PROPOSED ACTION

The proposed action is to decommission the Site to achieve release for unrestricted use from the NRC and termination of Radioactive Materials License SNM-928. This Plan is submitted in accordance with 10 CFR 70.38(g). This Plan involves the extraction of impacted groundwater followed by treatment by ion exchange.

Influent and effluent concentrations will be monitored to maintain an inventory of the mass of uranium and U-235 adsorbed by the ion exchange resin. Resin bed(s) will be removed and replaced by fresh resin before the mass of U-235 in unprocessed resin reaches the license possession limit for U-235 of 1,200 grams and before the U-235 concentration exceeds the fissile exemption limit of

1 gram of U-235 per 2 kilograms of non-fissile material. Spent resin will be processed, packaged, and shipped to a licensed disposal facility as LLRW.

Treated water will be disposed of in one of two ways:

- A portion of the treated water will be reinjected into fractured sandstone upgradient from the impacted groundwater to drive it to groundwater extractions systems.
- Treated water not used for reinjection will be discharged to the Cimarron River in accordance with a discharge permit to be issued by DEQ.

Periodic groundwater sampling and analysis will provide the data needed to monitor the progress of groundwater remediation and to guide the adjustment of pumping rates to optimize groundwater remediation. Groundwater extraction, treatment, injection, and discharge will continue until uranium concentrations in all wells are below the NRC Criterion. When post-remediation monitoring demonstrates that uranium concentrations remain below the NRC Criterion for a minimum of 8 consecutive quarters, treatment for uranium will be discontinued in all areas and the licensee will apply for termination of the license.

## 5.5 ALTERNATIVES TO THE PROPOSED ACTION

Two alternatives to the active remediation presented in this Plan were considered: no action, and long-term monitoring and control of access.

### 5.5.1 No Action Alternative

No action would involve redefining the licensed area such that all areas within which groundwater does or will in the future exceed NRC Criteria would remain under license. The licensee would need to implement controls to prohibit access to the licensed area indefinitely.

There would be no threat to public health and safety because licensed material exceeding unrestricted release criteria is present only in groundwater at depths from 5 to 30 ft below grade in the Cimarron River floodplain, and at slightly greater depths in the upland areas. The dilution of groundwater discharging to the Cimarron River is great enough that the impact of licensed material could be non-detectable or barely detectable in the river.

Funding for decommissioning is limited to the amount available to the CERT; funding may not be sufficient to maintain license controls indefinitely.

### 5.5.2 Long-Term Monitoring and Control of Access

Like the no action alternative, long-term monitoring and control of access would involve redefining the licensed area such that all areas within which groundwater does or will in the future exceed NRC Criteria would remain under license. The licensee would need to implement controls to prohibit access to the licensed area indefinitely.

Unlike the no action alternative, periodic monitoring of uranium concentrations in groundwater would enable portions of the site to be released from the license as impacted groundwater migrates toward the Cimarron River.

There would be no threat to public health and safety because licensed material exceeding unrestricted release criteria is present only in groundwater at depths from 5 to 30 ft below grade in the Cimarron River floodplain, and at slightly greater depths in the upland areas. The dilution of groundwater discharging to the Cimarron River is great enough that licensed material could be non-detectable or barely detectable in the river.

Funding for decommissioning is limited to the amount available to the CERT; funding may not be sufficient to maintain license controls indefinitely.

## 5.6 AFFECTED ENVIRONMENT

### 5.6.1 Land Use

Prior to the transfer of the license and the property from Cimarron Corporation to the CERT, the license owned nearly 800 acres of property. The exact acreage varies over time because the north property line is the south bank of the Cimarron River, which meanders within the floodplain. The CERT currently owns approximately 500 acres of property. Of that, approximately 52 acres currently remain under license.

The nearly 800-acre site was divided into 16 areas, labeled Subarea A through Subarea O, as shown in Figure 1-2. The Site was divided into these Subareas for the purpose of performing final status surveys for buildings, potentially surface contaminated material such as concrete slabs and pavement, and surface and subsurface soil. The radiological status of groundwater was not considered in the design or implementation of final status surveys or in the release of Subareas from the license.

Subareas A, B, C, D, and E were all considered “unimpacted” areas, designated as “Phase I” areas; they were released for unrestricted use in License Amendment 13, issued April 23, 1996.

The two areas labeled Subarea O and Subarea J were released for unrestricted use in License Amendment 16, issued April 17, 2000.

Subareas H, I, L, and M were released for unrestricted use in License Amendment 17, issued April 23, 2001.

Final Status Survey Reports have been submitted for Subareas F, G and N, demonstrating that surface and subsurface soil in those areas comply with NRC Criteria. Confirmatory surveys for these areas were performed by ORAU; for Subarea F in 1989, 1991, 1992, and 2013, for Subarea G in 2001, and for Subarea N in 2002.

Approximately 24 acres of property containing two of the former processing buildings were purchased by Cimarron Holdings LLC in January 2015 (see Figure 5-1). Industrial/commercial operations were conducted in those facilities until early 2020, at which time operations were discontinued. This parcel contains portions of Subareas H, I, K, and L, which had been released for unrestricted use in License Amendments 16 and 17.

Approximately 117 acres of property located west of Highway 74 was sold to Snake Creek Ranch, Inc. in April 2015 (see Figure 5-1). This property was formerly used to grow grass for cattle feed by a third party; the current owner planned to use the property for grazing and ranching, but it has remained fallow up to the time of submittal of this Plan. This parcel contains the western half of Subarea E and all of Subarea J, which were released for unrestricted use in License Amendments 13 and 16.

Approximately 140 acres of property containing most of Subarea A was sold to Cimarron Holdings LLC in November 2017 (see Figure 5-1). This property was used to grow grass for cattle feed by a third party; the current owner plans to continue growing grass to feed cattle. Subarea A was released for unrestricted use in License Amendment 13.

Slightly less than one acre, which includes the current office building, was sold in July 2018 (see Figure 5-1). The office building is being leased by the Trustee until its offices can be relocated to the Western Area Treatment Facility presented in Section 8 of this Plan. This property represents a very small portion of Subareas E and I, which were released for unrestricted use in License Amendments 13 and 17.

Groundwater remediation infrastructure associated with achieving the NRC Criterion will be contained within approximately 12 acres of property, concentrated in the following four areas:

- Western Area groundwater extraction infrastructure will consist of groundwater extraction wells and a groundwater extraction trench contained within approximately 4 acres located in Subarea H.
- Impacted groundwater will be transferred from Subarea H to a water treatment facility occupying less than 2 acres in portions of Subareas I and N.
- Treated water will be injected into an injection trench located in Subarea M.
- BA1 groundwater extraction and treated water injection infrastructure will consist of five groundwater extraction wells, two groundwater extraction trenches, four treated water injection trenches, and a small groundwater management facility, altogether occupying approximately 4 acres in portions of Subareas C and F.
- Contaminated groundwater will be piped from BA1 to the water treatment facility and treated water will be piped from the water treatment facility to BA1 through Subareas F, C, G, O, and N; the piping will occupy less than one-half of an acre.

Once decommissioning activities have been completed, the property still owned by the CERT may be divested in accordance with the Trust Agreement. Portions of the Site which will include the building constructed for the water treatment facility may be used commercially. The rest of the property is most likely to be used for grazing and/or farming.

Prior to the construction of nuclear material processing facilities, the property was used for grazing and farming. Throughout the years of construction and licensed operations, much of the property was leased to a third party for farming, grazing, and harvesting grass for cattle feed. These areas are shown in Figure 5-2. Grazing and harvesting grass for cattle feed has continued in those same areas since the decommissioning process began in 1975. The return of the remainder of the property to productive agricultural or commercial/industrial activities will represent a return to beneficial use of the property. The Trust Agreement requires that the Trustee provide for the disposition of the property and termination of the Trust. Because the property will be releasable for unrestricted use, farming, grazing, commercial/industrial, or recreational use all represent beneficial uses.

### 5.6.2 Transportation Impact

Figure 1-1 shows that the Site can be accessed directly from State Highway 74 and a section line road that runs along the eastern edge of Section 12. Gates through which materials will be transported during construction and operation will open directly onto Highway 74. Highway 74 experiences frequent traffic by freight trucks, farm equipment, and trucks carrying oilfield equipment, pipeline equipment, etc.

Trucks bringing equipment to the Site for construction and installation of the groundwater remediation facilities will represent a marginal increase in traffic for a period of several months. Throughout the duration of remediation, trucks bringing resin to the Site or taking waste material from the Site will represent a negligible increase in truck traffic. The CERT has been granted unrestricted access to roads running through the property between Highway 74 and the Site. Specific details regarding anticipated personnel, equipment, and vehicle requirements to facilitate construction activities are presented in the following paragraphs. Specific details regarding potential impacts to air quality are presented in Section 5.6.6.

The average number of workers using personally owned vehicles (POVs) will vary during the various phases of construction but could range from as little as 2 workers for a single small crew to as many as 20 or more workers if several activities are occurring concurrently. The direction of their daily travel is unknown but are likely to arrive to the Site via Highway 74 from the Oklahoma City metropolitan area to the south, or via Highway 33 through Guthrie from the east.

During operation, the number of workers will vary daily, generally 2 to 3 workers using POVs. The direction of their daily travel is unknown but are likely to arrive to the Site via Highway 74 from the Oklahoma City metropolitan area to the south, or via Highway 33 through Guthrie from the east.

The hours for construction are anticipated to be between the hours of 6 AM and 7 PM. Hours of operation are anticipated to be between the hours of 7 AM and 6 PM.

The anticipated types of construction vehicles are described in Section 5.6.6. The number of vehicles will be dependent on the execution plan and construction means and methods.

The types of vehicles employed during operations are described in Section 5.6.6. The number of vehicles will be dependent on the operations being performed. Routine operation and maintenance will involve only a few POVs. Single over-the road trucks will enter the Site to deliver materials or to pick up containers of waste for off-site disposal. The frequency of material deliveries is addressed in Sections 8.3.2.

Construction and operating supplies are likely to come from the south via Highway 74, out of the Oklahoma City metropolitan area, or from the east via Highway 33 through Guthrie.

Given that the marginal traffic impact from transporting material during construction is temporary and the long-term traffic impact during operation of the groundwater remediation systems is minimal, no traffic infrastructure improvements outside of the licensed area are needed.

### 5.6.3 Geology and Soils

Section 2.5 describes the geology of the Site and the area surrounding the Site. The installation, operation, and demobilization of groundwater remediation systems will have no impact on the geology or the soil except for the reduction in concentration of COCs that desorb from soil particles during groundwater extraction. Therefore, the impact of remaining decommissioning activities to Site geology and soil will be a positive impact.

A geotechnical investigation was performed to determine the requirements for earthwork (e.g., excavation, subgrade preparation, fill, etc.), foundations for tanks and buildings, building floor slabs, gravel bases, and pavements. The investigation included an evaluation of seismic hazards and the stipulation of seismic design requirements, as well as the requirements for installation of a septic leach field. A summary of the seismic conditions evaluated, and evaluation results, is provided in Section 2.5.3. The field activities and results of the geotechnical investigation are presented in the Geotechnical Report included as Appendix A to this Plan.

Additionally, a seismic analysis was conducted on the proposed buried piping network to evaluate unacceptable risks associated with seismic activities in the vicinity of the Site. The results of the analysis indicated satisfactory buried pipe performance for each of the seismic conditions listed in Section 2.5.3.

### 5.6.4 Water Resources

Decommissioning activities are designed to improve the quality of the shallow groundwater at the Site, which currently discharges to the Cimarron River. Groundwater remediation is needed to comply with license criteria for groundwater based on the use of groundwater as a drinking water source and for the raising of produce (including both plants and livestock) by a resident farmer.

During construction of groundwater remediation and water treatment facilities, surface water will be protected from impact due to sediment migration during precipitation events. Best Management Practices (BMPs) for the protection of surface water will be implemented in accordance with a Stormwater Pollution Prevention Plan (SWPPP) prepared in accordance with an OPDES stormwater permit. The SWPPP provided in Appendix B was prepared for the 2017/2018 Pilot Test, which involved some of the same construction activities that will be performed during full-scale construction. This SWPPP will be revised for full-scale construction after this Plan is approved.

Figure 5-3 shows the locations of injection and extraction trenches that will be constructed in the western areas of the Site. It also shows the location of the Western Area Treatment Facility (WATF), and the trenches through which utilities, control wiring, and piping will run from extraction wells to the WATF and from the WATF to injection trenches. It shows the location of the discharge piping leading to Outfall 001. The area within which excess spoils (displaced by imported silica gravel) will be mixed with sediment removed to install the 1206 drainage pipe is shown on Figure 5-3. Finally, the approximate locations of BMPs installed to prevent migration of sediment to surface water (i.e., silt fence) are shown on Figure 5-3.

Figure 5-4 shows the locations of injection and extraction trenches that have been or will be constructed in the eastern portion of the Site. It shows the location of the BA1 remediation facility (BARF) and the trenches through which utilities, control wiring, and piping will run. The approximate locations of BMPs installed to prevent migration of sediment to surface water (i.e., silt fence) are also shown on Figure 5-4.

Areas within which BMPs provide for protection of surface water are referred to as “disturbed areas”. Excavated spoils and imported backfill material (e.g., silica gravel to be used as backfill for injection trenches) will be stockpiled within the disturbed areas until they are either returned to the trenches as backfill or transported to the excess spoils placement area. It should be noted that the approximate BMP layouts depicted on Figures 5-3 and 5-4 are estimated and conceptual in nature. Additional BMPs will be installed, as required, for all additional disturbed areas such as equipment laydown areas, soil stockpile and staging areas, etc. These additional areas will be established based on the detailed design and feedback from prospective bidders following approval of this Plan and incorporated into a SWPPP.

Further information on the stockpiling and management of excavated soil during construction of groundwater extraction trenches and treated water injection trenches is provided in Sections 8.2.2 and 8.4.1, respectively. Further information on the stockpiling and management of excavated soil during construction of water treatment facilities is provided in Section 8.3.1.

During groundwater remediation operations, groundwater will be extracted, treated, and discharged to the Cimarron River in accordance with an OPDES permit which provides for the protection of surface water. No treated water will be discharged to onsite reservoirs; the OPDES permit will not authorize discharge to the onsite reservoirs. Treated water discharged to the river will comply with discharge limits stipulated in an OPDES Permit. Discharged water will have chemical characteristics that are similar to the groundwater that is currently discharging to the Cimarron River except the concentrations of COCs will be less than permitted concentration limits.

Potable water is provided by Logan County Rural Water District #2. Decommissioning operations will require the use of potable water primarily for janitorial functions and sanitation; potable water will also be used to sluice resin from resin vessels. This use will be minimal and is not expected to impact users of potable water provided by the Water District.

### 5.6.5 Ecological Resources

As stated above and depicted on Figures 5-3 and 5-4, groundwater remediation infrastructure associated with achieving the decommissioning criteria will be contained within less than 12 acres of property owned by the CERT. This includes construction of Outfall 001 to facilitate discharge of treated water to the Cimarron River in accordance with an OPDES permit. BMcD conducted an evaluation of the flora and fauna at the Site, including threatened or endangered species.

In general, the property consists of three areas of existing vegetation: Riparian, Floodplain, and Upland. The riparian area is located along the south bank of the Cimarron River at the north property boundary. The area includes a well-developed stand of phreatophyte species including cottonwood and salt cedar with an understory of wildrye, Western wheat, and seaoat grasses. The existing Cimarron River floodplain is bound by the south side of the river and the bluffs. This area has a general stand of mixture of native grasses, tree and shrub species including Johnson grass, wildrye, bermudagrass, soap berry, cottonwood, Eastern red cedar, black willow, and cottonwood. The upland area has an excellent stand of generally native tallgrass prairie species including big bluestem, Indiangrass, switchgrass, little bluestem, and sideoats grass with a diverse group of forbs and wildflowers. This area has been historically mowed for hay.

The United States Fish and Wildlife Service (USFWS) lists 19 species of threatened or endangered animals, and one threatened plant, which are listed in and occur in the State of Oklahoma. Of those, four species of threatened or endangered animals occur in Logan County. These include:

- Whooping Crane (*Grus Americana*) - Endangered

- Piping Plover (*Charadrius melodus*) – Threatened
- Arkansas River Shiner (*Notropis girardi*) – Threatened
- Least Tern – (*Sterna antillarum*) – Endangered

An Oklahoma Ecological Services Field Office online project review was performed in June 2018. As part of this process, a letter was submitted stating concurrence with the online assessment concluding that the proposed Project will have no effect or is not likely to adversely affect species protected under the Endangered Species Act. No issues were raised by the USFWS regarding the Bald & Golden Eagle Protection Act and the Migratory Bird Treaty Act. The concurrence from USFWS was received by email and is provided in Appendix C. The 45-day review period expired on July 22, 2018, without further response from the USFWS; therefore, the Section 7 Consultation under the Endangered Species Act is complete for this Project.

BMcD submitted a wetland delineation report to the United States Army Corps of Engineers (USACE) regarding impacts to jurisdictional waters of the United States per Section 404 of the Clean Water Act. Based on review of this submittal and follow up discussions, it was determined by USACE that Nationwide Permit 12 (NWP-12) would be required to construct the Project. NWP-12 is specific to construction of utility line activities which result in less than ½ acre of loss of jurisdictional waters. Details regarding NWP-12 submittal are presented in Section 5.6.13.

### 5.6.6 Air Quality

The types of equipment that will likely be utilized during construction and operations activities which have the potential to produce air emissions are summarized below. Estimates of common pollutant constituents generated by general equipment types are presented on Table 5-1.

- Construction of remediation infrastructure: Standard earthmoving machinery and hauling equipment will be used for excavation and trenching, material handling, and clearing, grading, and utility construction. A drilling rig will be used for well installation. A crane, boom lift, or other lifting equipment may be used for equipment and structure placement. Pipe welding equipment will be used to weld piping.

- Construction of treatment systems: Standard earthmoving equipment will be used for site grading and preparation. Concrete trucks and/or mixers and finishing equipment will be used to construct concrete foundations and installation of security fencing. A crane or other lifting equipment will be used to erect the WAA treatment facility, to place tanks, and to place the BARF components.

- Operation: Over-the-road trucks will transport chemicals, drums of LLRW, and other supplies. Over-the-road trucks delivering bulk liquid chemicals will use equipment to fill tanks. A forklift will be used to move spent resin vessels, drums of spent resin, fresh resin drums, and bulk bags of inert material used for mixing with spent resin). A pickup truck (or similar vehicle) will be used for daily operation and maintenance.

The extraction and treatment of groundwater, and the subsequent injection and/or discharge of treated water will have no impact on air quality. Backup diesel generators will operate periodically for routine testing and may run for several days if the electrical supply to the Ste is interrupted.

### 5.6.7 Noise Impact

The extraction and treatment of groundwater, and the subsequent injection and/or discharge of treated water will not produce noise that can be heard by neighbors. Individuals working onsite will not be exposed to sound levels that would require hearing protection. Consequently, decommissioning activities will have no noise impact.

To confirm this, ambient noise levels were monitored, and anticipated noise levels were modeled based on conservative assumptions about the noise levels generated by operating equipment. A technical memorandum describing the monitoring, evaluation of data, and modeling of noise levels is included as Appendix D. The following summarizes the information presented in Appendix D.

Ambient, sound level measurements were made at six locations that were accessible and representative of noise-sensitive receivers. Ambient A-weighted Leq sound levels (defined in Appendix D) varied from a low of 34.8 A-weighted decibels (dBA) during the midnight measurements to a high of 67.8 dBA during the morning measurements.

Sound-emitting equipment that is anticipated to be used includes various equipment and pump skids, air compressors, air handling units, and building exhaust fans. All sound emitting equipment was assigned a sound pressure level of 85 dBA at 3 ft horizontally from the equipment. This is a conservative assumption, as some of the equipment may emit much lower sound levels. Based on noise level modeling, there are no significant increases to ambient sound levels at off-site receiver locations. Generally, a 5-decibel change is considered significant, and a 3-decibel change in overall sound is considered noticeable. The largest increase over the quietest measured background ambient sound level is expected to be approximately one decibel. More detailed information on anticipated noise levels is provided in Appendix D.

### 5.6.8 Historical and Cultural Resources

United States Department of the Interior's National Park Service maintains a list of over 90,000 historic places. The following 16 historic places are located in Logan County:

- Guthrie, Oklahoma
  - Benedictine Heights Hospital
  - Carnegie Library
  - Co-Operative Publishing Company Building
  - Excelsior Library
  - Guthrie Armory
  - Guthrie Historic District
  - Logan County Courthouse
  - Scottish Rite Temple
  - St. Joseph Convent and Academy
- Langston, Oklahoma
  - Langston University Cottage Row
  - Morris House
  - Ozark Trails-Indian Meridian Obelisk
- Marshall, Oklahoma
  - Debo, Angie, House
  - Methodist Church of Marshall
- Mulhall, Oklahoma
  - Mulhall United Methodist Church
  - Oklahoma State Bank Building

None of these sites are located within approximately 7 miles from the Site.

During correspondence associated with the NWP-12 permit extension request (see Section 5.6.13), the USACE requested consultation with the Oklahoma State Historic Preservation Office to evaluate potential cultural resources in the vicinity of the Site. A cultural resources survey was performed in May 2020. Because construction activities will be performed on the 24-acre property currently owned by Cimarron Holdings LLC, as well as on the approximately 500 acres owned by the CERT, both properties were designated as the Area of Potential Effect (APE). The survey identified the following structures as having the potential for listing on the National Register of Historic Places:

- The former Mixed Oxide Fuel Fabrication (MOFF) Building and associated structure (Resources 01 and 01a, respectively)
- The former Warehouse #4 (Resource 02)
- The former Emergency Response Facility (now the CERT office building; Resource 03)
- Three diesel pump stations (Resources 04 through 06)

The cultural resources survey also identified a location where the remnants of what appeared to have been a corral and a cart remain on CERT property (Resource 07). This was not considered to have the potential for listing on the National Register of Historic Places. The approximate locations of these resources are illustrated on Figure 5-5.

As detailed in Section 8, remediation activities will generally be accomplished via installation of groundwater extraction wells and trenches, treated water injection wells and trenches, construction of groundwater treatment facilities, and installation of associated piping, electrical, and controls utility infrastructure. The locations of groundwater remediation and treatment facilities are presented on Figure 5-5, which shows the extent of construction activities in relation to the locations of the potential historic resources. Appendix E includes the 2020 report on the Cultural Resources Survey.

### 5.6.9 Visual/Scenic Resources

The Site has been essentially dormant for decades. All the former uranium process buildings were removed prior to the transfer of license SNM-928 to the CERT. The remaining buildings were deteriorating, with the utilities shut off and no maintenance being performed. The nearly two acres of pavement had deteriorated, with vegetation reclaiming portions of it. Fencing had not been maintained west of Highway 74. Much of the property has become overgrown, and cedar trees invaded large areas.

The sale of portions of the Site has resulted in the repair of fences and gates west of Highway 74. The sale of approximately 25 acres containing the former processing buildings has resulted in the renovation of the buildings, the repair of pavement, and improved fencing and gating of the Site. Landscaping on the property on which the industrial/commercial operations were conducted was improved; however, ongoing landscaping and maintenance have decreased since the owner’s bankruptcy filing in mid-2020.

Viewshed analysis has been conducted to establish the areas in which the proposed groundwater remediation structures can be viewed and provide an inventory of features that could be visually impacted. This analysis is provided as Appendix F and indicates that no visual impacts to sensitive receptors are anticipated to be associated with this project. Installation and operation of groundwater extraction, transfer, treatment, and injection or discharge will not impact the visual/scenic resource of the Site.

Previously completed decommissioning activities have already had a positive impact on the visual/scenic resources of the Site, and completing decommissioning activities, with subsequent disposition of the property, will add to that positive impact.

### 5.6.10 Socioeconomic Impacts

During operation, the licensee employed approximately 175 to 200 workers at the Site. From 1975 to 1997, the licensee employed approximately 20 to 25 workers to perform decommissioning activities. As decommissioning progressed, the number of employees decreased. By the time the license was transferred to the CERT, there were no full-time workers at the Site.

After construction, proposed decommissioning activities will require the support of approximately three operations and maintenance and health physics personnel. Decommissioning operations will not significantly impact employment.

Upon completion of decommissioning, the approximately 500 acres of property still owned by the CERT will be divested in accordance with the Trust Agreement. It is presumed that a significant portion of this property will be used for agriculture and/or ranching.

Specification sheets for construction equipment will not be generated; standard construction equipment will be utilized as described below. Specifications for some of the equipment utilized during operations are included in some of the 60% design phase drawings. The types of equipment that will be utilized during operations which have the potential to produce air emissions are identified in Section 5.6.6.

### 5.6.11 Public and Occupational Health

Residual levels of radiation above the land surface site-wide are indistinguishable from background. Because impacted groundwater is not used for drinking water, irrigation, or any other activity, there is no current exposure to radioactive material or radioactivity.

Decommissioning activities will involve the concentration of uranium in anion resins which will be packaged and transported to a licensed facility for disposal. Personnel will rarely be working in proximity to the anion resin beds (an average of less than eight hours per week), and the exposure rate at 30 cm from the resin beds has been estimated to be less than 30 μR/hr.

The treatment facility components have been designed, and operating procedures established, so that the exchange of anion resin, the process of mixing it with non-fissile material to yield a fissile-exempt material for shipping, and the packaging and loading of the fissile-exempt material for transportation and disposal are all conducted in accordance with the ALARA principle. It is not anticipated that any worker will receive a total effective dose equivalent (TEDE) exceeding 100 mrem/yr.

## 5.6.12 Waste and Hazardous Chemical Management

### *Waste – Low Level Radioactive Waste*

It is anticipated that each anion resin exchange will generate between 40 and 50 $ft^3$ of waste after blending with sufficient absorbent material to comply with the licensed disposal facility's waste acceptance criteria (WAC), based on a resin bulk density of 670 g/L. During the first year of operation, as many as ten exchanges may occur, yielding between 400 and 500 $ft^3$ of LLRW. As uranium concentrations decline, anion resin exchanges may become less frequent, reducing the volume of LLRW generated each successive year. The packaging, transportation, and disposal of spent resin is described further in Section 13.1.1.

Potentially contaminated material which cannot be practically surveyed will be drummed and disposed of as LLRW. Examples of this kind of material are gloves, disposable sampling devices, etc., which contacted licensed material and could exceed release criteria, but which it is not practical to survey. The packaging, transportation, and disposal of this waste will be the same as for spent resin, as described in Section 13.1.1.

Section 13.1, "Solid Radioactive Waste" addresses the storage of LLRW after processing and prior to loading into trucks for transportation to a licensed disposal facility.

### *Waste – Solid Waste*

Upon demobilization of the treatment facility equipment, components that can be practically surveyed for unrestricted release will be surveyed. All equipment which can be practically surveyed and demonstrated to be releasable will be disposed of at a municipal solid waste or construction and demolition waste landfill.

The quantities of all wastes discussed above represent an insignificant fraction of the material that the respective disposal sites receive. Section 8 contains more information on the waste-producing processes discussed above.

#### *Hazardous Chemicals*

Hydrochloric acid, the only hazardous chemical associated with groundwater remediation, will be used to adjust the pH of the influent to the treatment systems. Usage is anticipated to be approximately 35 gallons/day, injected into influent lines upstream of the ion exchange systems. Hydrochloric acid will stored in and delivered to the influent lines from a 5,000-gallon, double-walled tank located next to the WATF building. The tank will be refilled approximately every 3 months by a chemical delivery truck.

The only other consumable materials are the ion exchange resin and the non-hazardous inorganic absorbent to process spent resin.

The ion exchange systems are designed to produce water that can be discharged to the Cimarron River without the addition of chemicals. Additional post-ion-exchange treatment of water used for re-injection may be required to prevent mineral scaling and fouling of the injection system infrastructure and subsurface formation but the need for such additional treatment cannot be determined prior to beginning water treatment operations. Treated water injection systems are detailed further in Section 8.4.3.

### 5.6.13 Permits

#### *Stormwater Permit*

A Notice of Intent to comply with OPDES General Permit OKR10 will be submitted to the DEQ for authorization to discharge stormwater. As part of the OPDES General Permit requirements, a stormwater pollution prevention plan (SWPPP) will be developed prior to construction activities and maintained on-site. Appendix B contains a copy of General Permit OKR10 and the SWPPP that was prepared for the 2017/2018 Pilot Test. The SWPPP for the full-scale construction project will be prepared after the 90% design is complete and RAIs have been received and reviewed.

BMPs (likely to consist primarily of silt fence and erosion control blankets) will be installed, and corrective measures will be conducted and documented in accordance with SWPPP requirements. Inspections will be performed and documented throughout construction and will continue in accordance with the permit until vegetation is established and BMPs are removed. Bi-weekly inspection of BMPs will trigger improvement of BMP installation if evidence of sediment migration or damage to BMPs is noted in inspections. Additional inspections will be performed following precipitation events exceeding 0.5 inches.

A Notice of Termination for the OPDES General Permit will be submitted following establishment of a minimum of 70% coverage with perennial vegetation.

### *Floodplain Permits*

Portions of the groundwater remediation infrastructure will be constructed in the floodplain of the Cimarron River. An application for floodplain development will be submitted to Logan County. A copy of Floodplain Development Permit LG-17-01 (issued February 28, 2017, for the 2017/2018 Pilot Test) is provided in Appendix G. Due to the time gap between the issuance of this permit and the beginning of construction, an application for a new floodplain development permit will be submitted after approval of this Plan and prior to construction.

The United States Corps of Engineers must approve the construction of the treated water discharge outfall under the Nationwide Permit for Utility Line Activities (NWP-12). A historical and cultural resources survey was submitted to the Oklahoma Historic Preservation Office in June 2020. A Section 106 review of that submittal was performed by the Oklahoma Historical Preservation Office and the Oklahoma Archeological Society. The revised *Phase I Cultural Resources Survey of the Cimarron Environmental Response Trust Property* (Burns & McDonnell, 2020E, ML20254A140). An application for an NWP-12 permit will be submitted after approval of this Plan and prior to construction.

### *Discharge Permit*

Effluents will be discharged to the Cimarron River in accordance with an OPDES Permit. The OPDES permit will be effective for five years and can be renewed should treatment and discharge of treated water continue. A description of the anticipated requirements of the OPDES permit is provided in Section 12.2.

### *Underground Injection Permit*

Injection of treated water must comply with DEQ's Underground Injection Control (UIC) program. Due to the configuration of the injection trenches and the fact that treated water will be injected into more contaminated shallow groundwater, the DEQ has determined that an underground injection permit will not be required. An inventory of injection components and estimates of the maximum quantity of injectate to be injected into each component will be submitted to the DEQ. Once operations begin, the quantity of treated water injected into each injection trench will be reported to the DEQ on a monthly basis.

### *Air Permit*

A determination of the need for an air permit will be conducted to determine if a permit is required for the diesel-powered backup generators. It is assumed that no air permit will be needed based on de minimus emissions levels.

## 5.7 ENVIRONMENTAL IMPACTS

### 5.7.1 Radiological Impacts

Radiological impacts may occur during operation of the groundwater remediation system as well as during dismantlement and removal. These potential radiological impacts may require mitigation.

### *Contamination Control*

Day-to-day contamination control will be managed and monitored in accordance with the RPP. Rigorous implementation of the RPP will eliminate onsite and off-site radiological contamination impacts.

### *Airborne Contamination*

Airborne radioactive contamination is unlikely because radioactively impacted materials will consist primarily of ion exchange resin, PPE, and tubing, for which the potential for airborne suspension of particulates is insignificant. Spent resin exchange, processing, and packaging will be within containment, and the resin particles are too large to become airborne and respirable (600 ± 50 microns). Monitoring of the engineering controls implemented in accordance with the RPP will verify that there are no measurable onsite or off-site impact to the environment due to airborne radioactive contamination.

### *Discharge of Treated Water*

During operation of the groundwater remediation system, discharge of treated water will be controlled and monitored in accordance with an OPDES permit. Treated water will contain concentrations of COCs that comply with OPDES permit limits. Compliance with permit limits will be confirmed by periodic sampling stipulated in the OPDES permit.

### *Civil Engineering Controls*

Excavation activities will be monitored during construction of the groundwater remediation infrastructure. Standard measures will be implemented to prevent impacts due to potential radioactivity in excavated materials. These measures are not being implemented because surface or subsurface soil are radiologically impacted above unrestricted release criteria, but to identify and responsibly manage non-native material or groundwater that may contain elevated concentrations of radioactive material. Civil engineering controls will include identification and management of groundwater if encountered while excavating in impacted areas and of non-native material encountered during excavation.

### *Accidents*

There is a slight potential for a radiological accident occurring during decommissioning activities to result in the uncontrolled release of radioactive materials to the work area or environment. Such a release would most likely be associated with leaking contaminated water from the treatment system tanks and/or piping. Monitoring will be conducted in accordance with the RPP during the removal, maintenance, or relocation of all system components. Draining of tanks and pipes before removal (or moving, in the case of resin vessels during decommissioning operations) will be sufficient to prevent uncontrolled release.

An uncontrolled release of radioactive material could also occur during a transportation accident. Strict adherence to NRC, DOT, and State waste packaging and shipping regulations will minimize the potential for an uncontrolled release due to a traffic accident.

Fire is another possible source of an uncontrolled release of radioactive materials. However, the majority of flammable or combustible materials (e.g., gasoline or diesel fuel) that will be present onsite will be radiologically unimpacted. Potentially contaminated combustibles may include waste such as personnel protective clothing, rags and towels used for site cleanup and decontamination of tools, or other small items. The radioactivity contained in these materials would not be sufficient to result in a measurable release during such an incident.

### 5.7.2 Non-Radiological Impacts

Non-radiological impacts may occur during operation of the groundwater remediation system as well as during dismantlement and removal. These potential non-radiological impacts may require mitigation.

#### *Fugitive Dust*

Fugitive dust is particulate matter discharged into the atmosphere due to a construction activity such as excavation and grading, stockpiling of soil, or packaging of waste. A written Dust Control Plan will be prepared and submitted in accordance with applicable County or State requirements.

Dust control requirements, summarized below, will be maintained throughout the duration of decommissioning activities:

- Dust suppression measures, such as water sprays, will be implemented for unpaved areas subject to vehicular traffic during construction activities.
- The speed of vehicles and equipment traveling across unpaved areas will be no more than 15 miles per hour.
- Soil stockpiles and disturbed areas not subject to vehicular traffic will be stabilized by being kept wet, treated with a chemical dust suppressant, or covered when material is not being added to or removed from the pile.
- As necessary, construction vehicles leaving the Site will be cleaned to prevent dust, silt, mud, and dirt from being released or tracked off-site.
- Prior to performing ground disturbing activities near property lines, including grading, excavating, and land clearing, sufficient water will be applied to prevent dust emissions from crossing the property line.
- When wind speeds are high enough to result in dust emissions crossing the property line, despite the application of dust mitigation measures, grading and earthmoving operations shall be suspended.
- If required by the Dust Control Plan, hand-held dust monitoring equipment, such as DataRAM, will be utilized.

#### *Discharge of Treated Water*

During operation of the groundwater remediation system, discharge of treated water will be controlled and monitored in accordance with an OPDES permit. Treated water will contain concentrations of COCs that comply with OPDES permit limits. Compliance with permit limits will be confirmed by periodic sampling stipulated in the OPDES permit.

### *Civil Engineering Controls*

If construction or demobilization activity results in disturbance of ground over an area greater than one acre, a SWPPP will be prepared and implemented in accordance with DEQ requirements. The SWPPP may include requirements for:

- Erosion and sedimentation control
- Stabilization
- Pollution prevention

### *Accidents*

A fire is a possible source of an uncontrolled release of toxic materials. Combustible materials such as gasoline or diesel fuel will be properly stored in accordance with applicable ordinances. A Fire Protection Plan will be developed and implemented in accordance with OSHA standards.

## 5.8 SUMMARY OF ENVIRONMENTAL IMPACTS

Decommissioning operations are expected to achieve the decommissioning criteria stipulated in License Condition 27. Implementation of this Plan will have essentially no impact on transportation in the vicinity of the Site, air quality, noise levels, historical and cultural resources, visual/scenic resources, members of the public or workers at the Site.

Implementation of this Plan will have a positive impact on the geology and soils, water resources, and the socioeconomic environment, and will make possible the beneficial use of property that has rarely been beneficially used since the early 1970s.

* * * * *

# 6.0 REVISIONS TO THE LICENSE

## 6.1 INTRODUCTION AND BACKGROUND

License SNM-928 was transferred, along with the Cimarron Site, from Cimarron Corporation to the Cimarron Environmental Response Trust (the Trust) on February 14, 2011. As received, several license conditions reference documents (tie-downs) which are no longer relevant to the decommissioning of the Site. Buildings, equipment, and soils have been decommissioned to comply with unrestricted release criteria stipulated in the license, and tie-downs which govern those aspects of decommissioning are no longer needed. License conditions should continue to list those documents that pertain to the completion of decommissioning activities. This Section proposes revisions to license conditions to more closely address current conditions and plans for the Site.

## 6.2 LICENSE CONDITION 8 – POSSESSION LIMIT

License Condition 8(A) authorizes the licensee to possess up to 1,200 grams of "Uranium enriched to ≤ 5.0 wt. % in U-235." License Condition 8(B) authorizes the licensee to possess up to 100 grams of "Uranium enriched to > 5.0 wt. % in U-235". An asterisk in License Condition 8(B) refers to a note stating, "If during the decontamination of the facilities and equipment at the Cimarron Plant, uranium solutions or compounds are generated that have a U-235 isotopic content greater than 5.0 wt. %, prompt action shall be taken to degrade these materials to below 5.0 wt. % U-235." EPM does not believe it is necessary to retain the provision to down-blend > 5% enriched material because uranium in groundwater does not exceed 5% enrichment.

Another issue related to the note in License Condition 8 relates to the decontamination of equipment of facilities and equipment. This provision was made to address the decontamination of material and equipment used in the uranium fuel processing operations, which was completed decades ago. Decontamination of equipment that will be performed during the remaining decommissioning activities consists of washing or pressure washing equipment with water to remove soil so that release surveys can be performed. This applies to excavating equipment, drilling equipment tools such as augers and drill pipe, shovels, downhole sampling equipment, etc. Because environmental media do not contain uranium exceeding 5% enrichment, decontamination cannot produce material exceeding 5% enrichment. Both the license possession limit stipulated in License Condition 8(B) and the note should be removed from License Condition 8.

Special Nuclear Material packaged for transportation meets the fissile exempt definition in 10 CFR 71.15 if it meets any one of the criteria listed in 10 CFR 71.15(a)-(f). Appendix H provides justification for the issuance of a new possession limit in License SNM-928 that applies to packaged waste that meets the requirements for transportation as “fissile exempt” material in 10 CFR 71.15. The license should retain the 1,200 g possession limit for uranium present in groundwater remediation systems but should authorize the possession of additional uranium in packaged waste that has been demonstrated to comply with fissile exemption criteria.

Tc-99 is present in groundwater in some western remediation areas (see Section 3.5.3). The ion exchange resin used to treat groundwater for uranium is expected to capture some if not all the Tc-99. The maximum concentration of Tc-99 in groundwater to be treated (see Figure 8-3) is estimated to be 1.26 nanograms per liter (ng/L). The western area treatment system will receive a maximum of 125 gpm of groundwater from the western remediation areas, and resin vessels will be changed out approximately every 120 days.

If the ion exchange resin were to capture 1.26 ng/L of Tc-99 throughout a 120-day period in which 125 gpm of water was treated, a total mass of approximately 0.3 grams of Tc-99 would accumulate in the resin. Drums containing the spent resin/absorbent mixture will be stored in the on-site storage area until a full shipment (approximately 40 drums) has accumulated. Each resin vessel will generate at least 8 drums of resin/absorbent mixture, so three resin exchanges from the Western Area (WA) treatment system, plus three resin exchanges from the BA1 treatment system will constitute more than a full shipment. If all the resin from three exchanges from the WA treatment system were awaiting shipment in storage, and the lead vessel in the WA treatment system also contained 0.3 grams of Tc-99, there would be a total of less than 2 grams of Tc-99 on-site. If a small quantity of Tc-99 were still present in lag and polishing vessels, a Tc-99 mass possession limit of 5 grams would be more than sufficient.

The specific activity of Tc-99 is 1.71E+10 pCi/g, or 17,100 µCi/g. The quantity of Tc-99 that would require licensing stipulated in 10 CFR 20 Appendix C quantity is 100 µCi. To dispose of this resin, licensed disposal facilities will evidence that the licensee is authorized to possess such a quantity of Tc-99. Authorization to possess Tc-99 in the license is requested herein to provide for disposal of the resin/absorbent mixture. The NRC has agreed that because Tc-99 is not technically a byproduct material but is present as a contaminant in the special nuclear material, a separate license for byproduct material is not needed. Specifically listing Tc-99 as a contaminant in the waste stream in SNM-928 will authorize the licensee to possess, transport, and dispose of the waste generated during groundwater treatment. Consequently, a possession limit of 5 grams of Tc-99 as a contaminant in the waste stream is requested herein.

EPM requests that License Condition 8 be amended to read:

| | | |
|---|---|---|
| A. *Uranium enriched to ≤ 5.0 wt. % in U-235* | A. *Any compound* | A. *1,200 grams of contained U-235 (Note 1)* |
| B. *Natural and depleted uranium source material* | *B. Any compound* | *B. 2,000 kilograms of uranium* |
| *C. Thorium source material* | *C. Any compound* | *C. 6000 kilograms of Thorium* |
| *D. Uranium enriched to ≤ 5.0 wt. % in U-235* | *D. Any compound as packaged waste in containers that meet the transportation requirements in 10 CFR 71.15* | *D. (Notes 1 and 2)* |
| *E. Technetium-99* | *E. Any compound as a contaminant in special nuclear material* | *E. 5 grams* |

*Note 1: The total mass of U-235 possessed under Conditions 8A and 8E shall be limited to less than 0.5 effective kilogram of special nuclear material of low strategic significance. The requirements of 10 CFR Part 74.31 for the Nuclear Material Control and Accounting are therefore not applicable.*

*Note 2: Special Nuclear Material packaged for transportation that meets the fissile exempt definition in 10 CFR 71.15(c) or (d) may be handled, stored, and transported for disposal without nuclear criticality safety controls, nuclear criticality monitoring systems, or mass-based limits, and is exempt from SNM security (physical protection) requirements of 10 CFR Part 73.*

## 6.3 LICENSE CONDITION 9 - AUTHORIZED PLACE OF USE

### 6.3.1 The Current Licensed Area

Condition 9 in license SNM-928, “Authorized Place of Use”, reads “The licensee’s Cimarron Uranium Plant, located 1/2 mile North of the Highway 33 and Highway 74 junction near Crescent, Oklahoma”.

Of the original 800-plus-acre site, only 52 acres of the former site remain under license. Figure 6-1, “Currently Licensed Area”, shows how the entire former Cimarron Site was divided into 16 Subareas (as shown in Figure 1-2). It also shows the CERT property boundary as surveyed in

2018; the property line to the north varies as the Cimarron River moves northward across its floodplain.

Subareas A through E, H through M, and O have been released for unrestricted use. License Conditions 25, 28, 29, and 30 all state that these portions of the Cimarron Site have been released for unrestricted use and that they are "… no longer licensed by NRC." The shaded area on Figure 6-1 is that portion of the former Cimarron Site that remains licensed.

The purple areas in Figure 6-1 show that uranium concentrations in groundwater exceed the NRC Criteria in small portions of Subareas C, D, E, F, H, and M. Of these, only Subarea F remains under license. Uranium concentrations do not exceed NRC Criteria in Subareas G and N, both of which the NRC has stated are releasable for unrestricted use, but they have not been formally removed from the license.

NRC regulations and regulatory guides do not provide a definition of "unrestricted use", but NUREG-1757, *Consolidated Decommissioning Guidance*, does refer to "unrestricted use areas". 10 CFR 20.1003 defines an unrestricted area as "… an area, access to which is neither limited nor controlled by the licensee."

While there is no reason to implement controls in accordance with the provisions of the license (herein referred to as "licensee controls") in areas that the NRC has confirmed are releasable for unrestricted use, areas where uranium exceeds the NRC Criteria for groundwater should be subject to licensee controls; access to these areas should be limited.

The use of 30+ year old designations of Subareas to define what property now only document the justification for the past release of property and are no longer useful for defining those portions of the CERT property that should be subject to licensee controls. Maintaining the location of the site (i.e., The licensee's property located approximately 1/2 mile north of the junction of Oklahoma State Highway 33 and Highway 74) is appropriate to define the "Authorized Place of Use". However, the definition of those areas which remain under licensee controls should be incorporated into the license. Consequently, EPM proposes that the NRC stipulate the area which remains under license in License Condition 9. This will provide the framework for future compliance inspections, as most of the property satisfy the criteria for "unrestricted use areas", while a portion should continue to be subject to licensee controls.

### 6.3.2 Areas to Which License Controls Should Apply

The areas of the CERT property which should be subject to licensee controls include:

- Areas where the concentration of uranium in groundwater exceed the NRC Criterion
- Areas where extracted groundwater is stored and/or transferred to the WATF for treatment
- Areas where uranium is accumulated in ion exchange resin in groundwater treatment systems
- Areas where spent resin and other LLRW is stored

Red dashed lines in Figures 6-2 and 6-3 outline these areas for BA1 and the Western remediation areas, respectively. For the sake of simplicity, these figures are entitled, “BA1 Licensed Area” and “Western Licensed Area”, respectively. The orange outlines indicate areas subject to licensee controls; they will contain radiologically restricted areas. Influent tanks, groundwater treatment systems, and storage areas for spent resin and other LLRW are all located in the WATF and the BARF. Only the entrance to the building, the offices, the lunchroom, and the conference room in WATF building will be accessible to untrained personnel.

Black lines indicate where groundwater does not comply with the NRC Criterion. Bright green lines indicate where piping will transfer groundwater exceeding the NRC Criterion from extraction wells to treatment facilities and from the BARF to the WATF. These are all are surrounded by a red outline indicating the area subject to limited control of access. They will not be considered restricted areas because being in these areas does not present any radiological risk. License controls (including control of access) will be implemented in these areas when personnel work with or are exposed to licensed material exceeding NRC Criteria.

Ingress and egress controls and surveys for both personnel and material/equipment in restricted areas will be implemented in accordance with the Radiation Protection Plan. Access to radiologically controlled areas (outlined in orange) will be controlled by doors and gates that will remain locked except when personnel are working on site.

The area outlined in red will be demarcated by:

- Placing radioactive materials area labels on the fence surrounding the BARF and the WATF,
- Placing radioactive materials area labels on all monitor wells within the licensed area,

- Placing radioactive materials area labels on cairns installed where monitor wells cannot be used, and
- Installing posts at 200-foot intervals along the centerline of the pipeline that transfers groundwater from the BARF to the WATF (the licensed area will extend 8 feet on either side of the centerline, providing a 5-meter-wide licensed corridor).

Tables 6-1 and 6-2 provide the station ID and State Plane coordinates for the corners of the licensed area.

The CERT will continue to implement appropriate access controls throughout the CERT property. Fencing and gates will be maintained on the western, southern, and eastern property lines, and gates will remain locked when personnel are not working on site. Fencing will not be installed on the north property line, or at the northern ends of the western and eastern property lines where fencing is not practical due to Cimarron River flooding.

### 6.3.3 Release of Portions of Subareas F, G, and N

#### *Burial Area #1*

In BA1, small portions of Subareas C and F contain groundwater that exceeds the NRC Criterion and will contain pipelines that carry contaminated groundwater. The BARF will also be located within a small portion of Subarea F. Subarea C is not licensed by the NRC. The NRC has not formally documented that final status surveys and confirmatory surveys have demonstrated that surface and subsurface soil, and concrete slabs located in Subarea F comply with the NRC Criteria.

Subarea F included trenches in which licensed material had been buried (then referred to as Burial Ground #1) and slabs of concrete removed from the former uranium processing building that had been placed in Subarea F for erosion control. Final status survey reports were submitted for:

- The excavated burial trenches, in *Decontamination and Final Survey Report for Cimarron Facility Contaminated Waste Burial Ground* (Cimarron Corporation, 1991, ML19363A014).
- The concrete rubble, in *Final Status Survey Report for Concrete Rubble in Sub-Area F* (Chase Environmental Group, 1998A, ML20043F213).
- Soil, in *Final Status Survey Report, Sub-Area F* (Nextep Environmental, 2005, ML20043F208).

The NRC has performed confirmatory surveys for the formal burial trenches and the concrete rubble in Subarea F and collected confirmatory soil samples from soil borings in 2013. The confirmatory survey process has been completed for both surface and subsurface soil.

In addition, *Subsurface Data Supporting Release of Subarea F Outside of the 2016 Proposed Licensed Area* (Environmental Properties Management LLC, 2016B, ML17072A260) presented the data for soil samples and groundwater that were collected in that portion of Subarea F which was not proposed to remain under license controls. The area within Subarea F that is proposed to remain under license controls is essentially the same as that proposed in 2016. None of the 453 soil samples collected since 1991 and none of the groundwater samples collected since 2004 exceeded License Criteria.

There is no reason to retain that portion of Subarea F within which groundwater does not exceed the NRC Criterion. Defining the licensed area as depicted in Figure 6-2 would result in the re-establishment of license controls for approximately 2 acres of the approximately 120-Subarea C and releasing approximately 18 acres of the 20-acre Subarea F from license controls.

### *Western Areas*

In the western portion of the site, small portions of Subareas, D, E, H, and M are underlain by groundwater that exceeds the NRC Criterion. Pipelines carrying groundwater exceeding the NRC Criterion will pass through Subareas D, G, H, M, N, and O. The WATF will occupy portions of Subareas I, M, N, and O. Subareas D, E, H, I, M, and O are not licensed by the NRC. Those areas were released from the license in 2000 and 2001.

Regarding NRC's decision to retain Subarea G under license, *Final Status Survey Report for Subarea G* (Cimarron Corporation, 2001, ML20043F258) was submitted to the NRC in late October 2001. Before the NRC completed its review of the final status survey report, it had been determined that uranium concentrations in groundwater exceeded the NRC Criterion stipulated in License Condition 27 in portions of several of the Subareas which were no longer licensed by the NRC. In addition, the presence of Tc-99 in groundwater (exceeding the NRC Criterion) was identified in Subarea G.

Consequently, in a letter dated March 12, 2002 (ML020710721), the NRC stated, "staff has identified regulatory issues concerning the release of Subareas G and K, related to the occurrence of technetium-99 (Tc-99) in Subarea G, … NRC staff has decided to … withhold release of Subarea G until Cimarron addresses the onsite Tc-99 contamination."

Cimarron has since addressed the onsite Tc-99 contamination and has demonstrated multiple times that Tc-99 does not exceed the NRC Criterion in groundwater anywhere on site.

The NRC's February 15, 2011, license transfer order stated, "Final status surveys and confirmatory surveys have confirmed that Subareas G and N are releasable for unrestricted use, but NRC has determined that these areas should not be released until groundwater remediation is complete. The license transfer order did not include the basis or reason for that decision. If the area that will be subject to license controls is defined to incorporate the areas described in Section 6.3.2, there is no longer any need to unnecessarily retain the entirety of these old Subareas in the license.

Defining the area subject to license controls as depicted in Figure 6-3 would require bringing the following areas back into the license (cited acreage is approximate):

- 3 acres of the 45-Subarea D
- Less than 1 acre of the 150-acre Subarea E
- 1 acre of the 20-acre Subarea G
- 11 acres of the 40-Subarea H
- 1/4 acre of the 20-acre Subarea I
- 1/10$^{th}$ acre of the 3-acre Subarea M
- 1-1/2 acres of the 12-acre Subarea N
- Less than 1 acre of the 2-acre Subarea O

It would also involve releasing 19 acres of the 20-acre Subarea G and 10-1/2 acres of the 12-acre Subarea N from license controls. An additional justification for releasing the bulk of Subarea N from the license is the fact that a portion of Subarea N is on a 24-acre property that was sold with NRC approval with no restrictions on the future use of that property.

*EPM requests that License Condition 9 to define the Authorized Place of Use as the licensee's property located approximately 1/2 mile north of the junction of Oklahoma State Highway 33 and Highway 74. EPM also requests that the license clarifies that Figures 6-2 and 6-3 of Facility Decommissioning Plan – Rev 3 define those portions of the licensee's property within which license controls are required.*

## 6.4 LICENSE CONDITION 10 – FINAL SURVEY AND ON-SITE DISPOSAL

License Condition 10 lists 39 documents (there are 40 citations, but one date is listed twice). These documents primarily address final status surveys and the burial of soil in the on-site disposal cell. Other documents referenced in License Condition 10 include license amendment requests related to the authorization to possess specific quantities of radioactive material (this has since been incorporated into License Condition 8), the Radiation Safety Officer, and responses to NRC comments related to groundwater assessment and remediation. This section briefly describes each document listed in License Condition 10 and provides justification to delete License Condition 10 from the license.

November 19, 1985 – This letter from Kerr-McGee Corporation (ML21103A313) requested an amendment to the license to authorize possession of up to 6,000 kgs of thorium, which would allow the excavation, packaging, and shipment of thorium from the Cushing site (which has been buried at the Cimarron Site) for disposal at a licensed facility. License amendment No. 3, issued in April 1986, revised Item 8(D) to authorize possession of 6,000 kg of thorium. This authorization is still present in Item 8(D) of the current license. The reference to this document is no longer needed.

March 3, 1986 – This letter (ML20203P607) from Sequoyah Fuels Corporation (predecessor to Cimarron Corporation) requested an amendment to the license to increase the authorized quantity of < 5 wt. % U-235 from 1,200 grams to 6,000 grams, to provide latitude for the licensee to accumulate sufficient material on the Site to load several trucks with contaminated material for transportation to a licensed disposal facility. License amendment No. 4, issued in April 1986, revised Item 8(A) to authorize possession of 6,000 grams of < 5 wt. % U-235. However, this authorization is again limited to 1,200 grams of < 5 wt. % in Item 6(A) of the current license. License amendments No. 5 through 9 only addressed changes to later license conditions, and the authorized amount is not listed in those amendments. It appears that when license amendment No. 10 was issued on November 4, 1994, NRC reverted the authorized quantity of < 5 wt. % U-235 back to the previous 1,200 grams. The reference to this document is no longer needed.

September 4, 1987 – This letter from Sequoyah Fuels Corporation (ML21103A315) requested an amendment to the license to authorize the stockpiling of material designated as “Option 2 material” in the 1981 SECY 81-576, *Disposal or Onsite Storage of Residual Thorium or Uranium (Either as Natural Ores or Without Daughters Present) From Past Operations* (USNRC, 1981) (hereafter referred to as “Option 2 material”) so that other areas could be decommissioned for release while on-site burial of this material was under consideration. License amendment No. 10, issued in

November 1994, added this letter as a tie-down to Condition 10 to authorize the stockpiling of Option 2 material. Disposal of Option 2 material is complete, and authorization to create soil stockpiles is no longer needed. The reference to this document is no longer needed.

November 2, 1989 – This submittal from Cimarron Corporation (ML21103A316) included results of the final release surveys of the MOFF facility. There is no reason for this document to be included in SNM-928; the operation and decommissioning of this facility was subject to NRC License SNM-1174, and SNM-1174 was terminated in 1993. Regardless, Subarea I, in which the MOFF plant is located, was released for unrestricted use in License Amendment No. 17, issued April 9, 2001. The reference to this document is no longer needed.

August 22, 1990, and September 14, 1990 – The August 1990 letter (ML092610951) from Cimarron Corporation stated that the MOFF facility had been decommissioned, that decommissioning of the uranium plant was nearly complete, and that all major exhaust systems had been removed. Consequently, there were no longer effluents to monitor, and Cimarron planned to discontinue filing effluent monitoring reports as had been required per 10 CFR 70.59. In the September 14, 1990, letter (ML21103A318), the NRC stated, "Since the reports are required for licensees authorized possession or use of SNM for processing and fuel fabrication and your license authorizes possession or use of SNM subsequent to decontamination and decommissioning only, we have no objection to your discontinuation of the effluent release reports." Effluent release reports have not been submitted for over twenty years, and these tie-downs are no longer needed. The references to these documents are no longer needed.

June 24, 1992 – This letter from Cimarron Corporation (ML21103A320) requested information from the NRC, maintaining that NRC was causing "unnecessary delay and additional expense in decommissioning the Cimarron facilities because of indecision and non-responsiveness of the Commission." It is not clear why this letter is referenced in Condition 10. The reference to this document is no longer needed.

February 25, 1993 – This letter from Kerr-McGee Corporation (ML21103A322) responded to the NRC's request for additional information dated January 8, 1993. This letter addressed subsidence, wind and water erosion, deed notice and location markers, all associated with the proposed on-site burial cell. It also contained a commitment to submit a radiological characterization report and complete the decommissioning of the Site. On-site disposal of Option 2 material was approved by NRC in license amendment No. 10, issued November 4, 1994. Decommissioning of soil and burial in the on-site disposal cell is complete. The deed notice was filed, and the corner markers (cairns) were installed. The post-closure monitoring of the cell for subsidence and/or erosion associated with the on-site disposal cell is complete. The radiological characterization report was submitted in 1994. The NRC has documented that Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. The required 5-year post-closure monitoring period expired in 2006 (16 years ago). There is no reason to maintain this tie-down in the license. The reference to this document is no longer needed.

April 19, 1994 – This letter from Kerr-McGee Corporation (ML21103A323) requested NRC approval of a procedure entitled, “Onsite Disposal Plan”. This procedure defined the responsibilities of various personnel, the characterization, transportation, and disposal of Option 2 material in the cell, the determination of total activity in the filled cell, the construction of run-on and run-off controls and the final cover, and the record of disposal. On-site disposal of Option 2 material was approved by NRC in license amendment No. 10, issued November 4, 1994. Decommissioning of soil and closure of the on-site disposal cell is complete. The NRC has documented that Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. There is no reason to maintain this tie-down in the license. The reference to this document is no longer needed.

May 31, 1994 – This letter from Kerr-McGee Corporation (ML21103A327) responded to the NRC’s request for additional information dated April 19, 1994. The response addressed the final survey of Option 2 material in the on-site disposal cell, determination of the average concentration of material in the cell, Regulatory Guide 1.86 criteria, acceptance of a 100 pCi/g Option 2 limit for soil to be placed in the on-site disposal cell, hot spot averaging, the final survey of excavations, and the final survey of the disposal cell cap using the 1992 NUREG/CR-5849, *Manual for Conducting Radiological Surveys in Support of License Determination* (Berger, D., 1992). Decommissioning of soil and closure of the on-site disposal cell is complete. The NRC has documented that Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. There is no reason to maintain this tie-down in the license. The reference to this document is no longer needed.

July 20, 1994 – This letter from Kerr-McGee Corporation (ML092660429) responded to the NRC’s request for additional information dated July 18, 1994. It addressed how soil samples would be collected for the determination of the distribution coefficient ($K_d$) value for soil in the on-site disposal cell. Decommissioning of soil and closure of the on-site disposal cell is complete. The NRC has documented that Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. There is no reason to maintain this tie-down in the license. The reference to this document is no longer needed.

September 21, 1994 – This letter from Cimarron Corporation (ML092660380) responded to the NRC's request for additional information dated August 12, 1994. It addressed hot spot averaging of soil in the on-site disposal cell, the analysis of quality control samples, NUREG/CR-5849 calculations, and calibration of the on-site soil counter, all associated with the placement of Option 2 material in the on-site disposal cell. Decommissioning of soil and closure of the on-site disposal cell is complete. The NRC has documented that Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. There is no reason to maintain this tie-down in the license. The reference to this document is no longer needed.

November 3, 1994 – This letter from Cimarron Corporation (ML21103A334) responded to an NRC question raised during a teleconference conducted November 1, 1994. It addressed exposure to workers placing soil in the on-site disposal cell. Decommissioning of soil and closure of the on-site disposal cell is complete. The NRC has documented that Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. There is no reason to maintain this tie-down in the license. The reference to this document is no longer needed.

November 15, 1994 – This letter from Cimarron Corporation (ML092660378) requested a license amendment to eliminate tie-downs related to Appendix A of a 1976 license renewal request, and Annex A of a 1982 license renewal request. Both Appendix A and Annex A were previous versions of the Radiation Protection Plan. None of the referenced documents are relevant to the current license, Decommissioning Plan, or Radiation Protection Plan. This submittal is no longer relevant to the license. The reference to this document is no longer needed.

December 16, 1994 – This letter from Cimarron Corporation (ML21103A336) requested a license amendment to designate Karen Morgan RSO. Ms. Morgan has not been RSO for the Cimarron Site since 2007. This submittal is no longer relevant to the license. The reference to this document is no longer needed.

April 12, 1995 – This letter from Cimarron Corporation (ML21103A343) responded to the NRC's request for additional information dated March 29, 1995. It addressed the analysis of samples from and hot-spot averaging used in the South Uranium Yard. Decommissioning and disposal of soils in the South Uranium Yard, which is part of Subarea K, is complete. Subarea K was released for unrestricted use in license amendment No. 18, issued May 28, 2002. This submittal is no longer relevant to the license. The reference to this document is no longer needed.

June 5, 1995 – This letter from Cimarron Corporation provided a resume for Karen Morgan to justify her designation as RSO. Ms. Morgan has not been RSO for the Cimarron Site since 2007. License Condition 27(e)(3) of the current license (Amendment No. 21) states, "The Radiation Safety Officer shall be named in the licensee's Radiation Protection Plan", hence, neither the June 5, 1995, tie-down, nor a more up-to-date equivalent, need to be referenced in the license. The reference to this document is no longer needed.

July 5, 1995 – This letter from Cimarron Corporation (ML21103A369) provided a response to an NRC telephone inquiry on hot spot averaging in the South Uranium Yard. Decommissioning and disposal of soils in the South Uranium Yard, which is part of Subarea K, is complete. Subarea K was released for unrestricted use in license amendment No. 18, issued May 28, 2002. This submittal is no longer relevant to the license. The reference to this document is no longer needed.

July 25, 1995 – This document is the *Final Status Survey Plan for Phase II Areas* (Chase Environmental Group, 1995B, ML20202A434). Subarea F is a Phase II area and is the only area in which the NRC has not yet formally agreed that soils are releasable for unrestricted use. In August 2005, Cimarron Corporation submitted a final status survey plan in accordance with this final status survey plan and supplemented it with subsurface soil data in November 2007. In March 2013, ORAU published the analytical results for confirmatory subsurface samples selected by NRC. All results were less than one-third the license criteria for unrestricted release. That final status survey plan is no longer relevant to the unrestricted release of Subarea F. The reference to this document is no longer needed.

August 9, 1995, and November 13, 1995 – The August 9 document is the *Final Status Survey Report, Phase I Areas* (Cimarron Corporation, 1995, ML21158A013). The November 13 letter (ML21258A249) responds to September 5, 1995, NRC comments on the final status survey report. All five of the Phase I areas (Subareas A through E) were released for unrestricted use in license amendment No. 13, issued April 23, 1996. Groundwater containing uranium exceeding NRC Criteria for unrestricted release, as well as uranium and nitrate exceeding State Criteria, is present in portions of Subareas C, D, and E. The remediation of groundwater in these areas is addressed in this Plan, submitted as part of this license amendment request. Portions of Subareas C, D, and E will be drawn back under the license; the relicensing of those areas that should be licensed are being addressed in a separate license amendment request. The final status survey of soils described in Phase I areas is not relevant to the groundwater remediation plan proposed herein. Consequently, these submittals are no longer relevant to the license. <u>The references to these documents are no longer needed.</u>

<u>January 23, 1996</u> – This letter from Cimarron Corporation (ML092670504) requested a license amendment to recognize an organization change. The organizational change reported in this submittal is no longer relevant, and the license was transferred to a new licensee in February 2011. License amendment No. 21 sets forth the organizational requirements for the Trust, which are addressed in the Radiation Protection Program. This tie-down does not reflect the current licensee's organization and is no longer relevant to the license. <u>The reference to this document is no longer needed.</u>

<u>April 25, 1996 (Listed twice) and June 10, 1996</u> – The April 25 letter from Cimarron Corporation (ML092670410) proposed an Option 2 material disposal procedure change from stockpiling to direct transportation to the on-site disposal cell. The June 10 letter from the NRC (ML092670281) approved this procedural change. Decommissioning of soil and closure of the on-site disposal cell is complete The NRC has documented that Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. These tie-downs established requirements for work that has already been completed and are not relevant to current site conditions. <u>The references to these documents are no longer needed.</u>

<u>August 28, 1996</u> – This letter from Cimarron Corporation (ML092670405) described hot-spot averaging procedures which were being used in the evaluation of material in stockpiles and the on-site disposal cell and clarified that hot-spot averaging was not performed in the five wastewater pond areas. Decommissioning of soil and closure of the on-site disposal cell is complete. The NRC has documented that Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. This tie-down was established to control work that has already been completed and is no longer relevant to current site conditions. <u>The reference to this document is no longer needed.</u>

<u>September 20, 1996</u> – This letter from Cimarron Corporation (ML092670400) responded to an August 1996 NRC request for additional information and revised the November 15, 1994, license amendment request. Cimarron Corporation was seeking to eliminate tie-downs related to Appendix A of a 1976 license renewal request, and Annex A of a 1982 license renewal request. During the ensuing two years, additional sections of the license were determined to need revision. A new RPP

was submitted in this license amendment request, which was to represent a new "Annex A" to the *Decommissioning Plan for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility* (Chase Environmental Group, 1995A, ML20202A437). That RPP has been superseded several times, and other documents referenced in this submittal are no longer relevant to the license. This submittal is no longer relevant to the license. The reference to this document is no longer needed.

November 20, 1996 – This letter from Cimarron Corporation (ML092660285) proposed to perform a lung fluid solubility test to determine the biological solubility of uranium in site soils. The intent of this proposal was to determine if the Option 2 limit for soil for on-site disposal should be between the 100 pCi/g and the 250 pCi/g limits for totally soluble uranium and totally insoluble uranium, respectively. The issue is now moot since decommissioning of soil and closure of the on-site disposal cell is complete. The NRC has documented that Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. This submittal is no longer relevant to the license. The reference to this document is no longer needed.

January 2, 1997 – This letter from Cimarron Corporation (ML21113A241) responded to the NRC's December 2, 1996, comments on Annex A, the RPP submitted in the September 20, 1996, license amendment request. The RPP has been superseded numerous times since this submittal, and the 1996 RPP is no longer relevant to the license. The reference to this document is no longer needed.

January 28, 1997 – This letter from Cimarron Corporation (ML092680270) responded to the NRC's October 31, 1996, comments on *Final Status Survey Plan for Phase II Areas* (Chase Environmental Group, Inc., 1995B). Subarea F, which is the only area in which NRC has not yet formally agreed that soils are releasable for unrestricted use, is a Phase II area. Cimarron Corporation submitted a final status survey plan in accordance with this final status survey plan, in August 2005, and supplemented it with subsurface soil data in November 2007. In March 2013, ORAU published the analytical results for confirmatory subsurface samples selected by the NRC. All results were less than one-third the license criteria for unrestricted release. That final status survey plan is no longer relevant to the unrestricted release of Subarea F. The reference to this document is no longer needed.

May 6, 1997 – This letter from Cimarron Corporation (ML092610946) responded to the NRC's February 25, 1997, comments on the 1995 decommissioning plan. This response addressed volumetric characterization of concrete in drainage and spillways, the State's classification of groundwater, and volumetric averaging at Uranium Ponds 1 and 2. The first two issues were addressed in subsequent decommissioning efforts. The two areas containing Uranium Ponds 1 and 2, the two Subarea O parcels, were released for unrestricted use in Amendment No. 16, issued April 17, 2000. Both NRC and DEQ approved criteria for groundwater under an unrestricted use scenario in 1999. This submittal is no longer relevant to the license. The reference to this document is no longer needed.

May 16, 1997 – This letter from Cimarron Corporation (ML092660227) responded to the NRC's March 5, 1997, comments on the RPP. The RPP has been superseded numerous times since this submittal, and the 1996 RPP is no longer relevant to the license. The reference to this document is no longer needed.

December 5, 1997 – This letter from Cimarron Corporation (ML092680324) responded to the NRC's October 3, 1997, Comments on the *Final Status Survey Plan for Phase III Areas* (Chase Environmental Group, Inc., 1997). Final Status Survey Reports (FSSRs) for all Phase III areas have been submitted and approved by NRC. This submittal is no longer relevant to the license. The reference to this document is no longer needed.

February 10, 1998 – This letter from Cimarron Corporation (ML092610654) was the letter of submittal for the June 24, 1997, *Final Status Survey Plan for Phase III Areas* (Chase Environmental Group, Inc., 1997). FSSRs for all Phase III areas have been submitted and approved by the NRC. This submittal is no longer relevant to the license. The reference to this document is no longer needed.

June 26, 1998 – This letter from Cimarron Corporation (ML092610650) responded to the NRC's February 9, 1998, comments on the June 24, 1997, *Final Status Survey Plan for Phase III Areas* (Chase Environmental Group, Inc., 1997, ML20202A560). FSSRs for all Phase III areas have been submitted and approved by NRC. This submittal is no longer relevant to the license. The reference to this document is no longer needed.

July 2, 1998 – This letter from Cimarron Corporation (ML092610647) responded to the NRC's July 1, 1998, conference call comments regarding the soil counter used to prepare the *Final Status Survey Report, Phase II Subarea J* (Cimarron Corporation, 1997). With the exception of Subarea F, the NRC has formally agreed that soils in all Phase II areas are releasable for unrestricted use. A July 1, 1998, letter also addressed a similar soil counter comment on the Phase III Final Status Survey Plan. FSSRs for all Phase III areas have since been submitted and approved by NRC. The soil counter used for final status survey samples was demobilized from the Site prior to 2010. This tie-down regarding the traceability of the soil counter is no longer relevant to the license. The reference to this document is no longer needed.

February 15, 2000 – This document was the *Final Status Survey Report, Subarea K* (Cimarron Corporation, 2000, ML20213C529). Subarea K was released for unrestricted use in license amendment No. 18, issued May 28, 2002 – This submittal is no longer relevant to the license. The reference to this document is no longer needed.

February 20, 2001 – This letter from Cimarron Corporation (ML010590080) responded to the NRC's January 9, 2001, comments on the *Final Status Survey Report, Subarea K* (Cimarron Corporation, 1997). Subarea K was released for unrestricted use in license amendment No. 18, issued May 28, 2002. This submittal is no longer relevant to the license. The reference to this document is no longer needed.

April 17, 2002 – This letter from Cimarron Corporation (ML021090498) proposed a decommissioning schedule based on information available at that time. That schedule is no longer relevant to the license. The reference to this document is no longer needed.

May 10, 2002 – This letter from Cimarron Corporation (ML021360011) revised the decommissioning schedule, revising the assumptions behind the April 17, 2002, schedule. That document is no longer relevant to the license. The reference to this document is no longer needed.

*In summary, none of the 39 documents listed in License Condition 10 are still relevant to the licensing and decommissioning of the Cimarron Site. EPM requests that License Condition 10 be removed from the license.*

## 6.5 LICENSE CONDITION 23 – ON-SITE DISPOSAL

License Condition 23 authorized the licensee to bury up to 500,000 $ft^3$ of soil contaminated with low-enriched uranium in the location described in an October 9, 1989, submittal to the NRC. Approximately 452,000 $ft^3$ of such soil was buried in what has been designated Burial Area #4. That portion of the former Subarea N (on which Burial Area #4 is located) has been released for unrestricted use, so this authorization is no longer needed.

*EPM requests that this license condition be deleted.*

## 6.6 LICENSE CONDITION 26 – RADIATION PROTECTION PROGRAM

License Condition 26 requires the licensee to implement a version of the RPP that was submitted as Annex A to the 1996 site decommissioning plan. This license condition also lists a specific set of clarifications and revisions to the 1996 Annex A dated September 20, 1996, January 2, 1997, May 16, 1997, June 30, 1997, January 23, 1998, June 29, 1998, October 26, 1998, and December 11, 1998. The RPP has been revised on an annual basis, resulting in 15 subsequent revisions since the last submittal referenced in this license condition. By the time license amendment No. 15 was issued, the RPP consisted of the 1996 submittal as amended by NRC approval of changes submitted in the eight subsequent documents listed in License Condition 26.

License amendment No. 15, issued August 20, 1999, provided for subsequent revision of the Decommissioning Plan and RPP without NRC approval, provided conditions specified in License Condition 27(e) are met. The RPP has been revised nearly every year, and annual reports of all changes made under License Condition 27(e) have been submitted to NRC, usually with complete copies of the then-current RPP.

License SNM-928 was transferred to the Trust on February 14, 2011. The RPP was revised significantly to reflect changes in the licensee and the licensee's organization. The RPP has since been revised to reflect changing conditions and programs at the Site; all revisions have been approved as provided for by License Condition 27(e).

*EPM requests that License Condition 26 be amended to reference Radiation Protection Plan – Rev 5, with revisions made to address RAIs and/or revisions made in accordance with License Condition 27(e).*

## 6.7 LICENSE CONDITION 27 – SITE DECOMMISSIONING

### 6.7.1 License Condition 27(a)

This license condition authorizes the licensee to remediate the Site in accordance with the April 1995 site decommissioning plan, as supplemented by eight subsequent documents. Numerous additional submittals address subsequent commitments and work to decommission the Site, specifically the characterization and remediation of Site groundwater. EPM believes this license condition needs to be amended incorporate the characterization work that justifies the re-definition of the licensed area. The amended license condition should also incorporate the groundwater remediation plan submitted in this license amendment request to provide for the completion of decommissioning activities needed to achieve unrestricted release of the Site and termination of the license. This section addresses each of the documents referenced in License Condition 27(a) and explains why each should be deleted from or retained in the license.

April 19, 1995 – This submittal was the *Decommissioning Plan for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility* (Chase Environmental Group, Inc., 1995A, ML20202A437). This document provided for the decommissioning of buildings, materials, and soil site-wide. It did not address groundwater remediation. This decommissioning plan was approved by the NRC under the Site Decommissioning Management Plan (SDMP). In a letter dated June 8, 2004 (ML041560310), the NRC advised the Cimarron Corporation that the SDMP was being eliminated, stating, "Although your facility will no longer be referred to as an "SDMP site," the NRC staff will continue to manage the decommissioning of your site in the same manner, using the same criteria that have been applied in the past." In a letter dated November 10, 2005 (ML053140316), the NRC stated that "Cimarron may continue decommissioning under the SDMP". That letter went on to say, "Cimarron must apply for and obtain a license amendment to change its approved method of groundwater remediation from MNA to excavation or pump and treat." *Facility Decommissioning Plan - Rev 3*, submitted in this license amendment request satisfies this requirement. Although this document is no longer relevant to the ongoing decommissioning of the Cimarron Site, it should be retained in License Condition 27(a) because it provides the basis for the decommissioning activities that have been completed.

September 10, 1996 – This letter from Cimarron Corporation (ML092670402) responded to NRC's July 11, 1996, comments on the April 1995 *Final Status Survey Plan for Phase II Areas* (Chase Environmental Group, Inc., 1995B). NRC's comments primarily addressed the decommissioning and final status survey of areas which were subsequently released for unrestricted use. Except for groundwater, which has received substantial characterization since that time, and for which a remediation plan is submitted herein, all the work addressed in this submittal has been completed. This submittal is no longer relevant to the license. If the license is amended as requested in Section 6.3 of this D-Plan, the reference to this document could be deleted.

May 6, 1997 – This letter from Cimarron Corporation (ML092610946) responded to NRC's February 25, 1997, comments on Cimarron's September 10, 1996 (ML092670402) response letter. NRC's comments addressed volumetric averaging, final survey of paved areas, groundwater classification, and the characterization of concrete. Except for groundwater, which has received substantial characterization since that time, and for which a remediation plan is submitted herein, all the work addressed in this submittal has been completed. This submittal is no longer relevant to the license. If the license is amended as requested in Section 6.3 of this D-Plan, the reference to this document could be deleted.

August 26, 1997 – This letter from Cimarron Corporation (ML092610943) responded to NRC's July 1, 1997, comments on issues related to Cimarron's September 10, 1996 (ML092670402) response letter. NRC's comments addressed volumetric averaging in Uranium Ponds #1 and #2 and the characterization of concrete. All the work addressed in this submittal has been completed. This submittal is no longer relevant to the license. If the license is amended as requested in Section 6.3 of this D-Plan, the reference to this document could be deleted.

March 10, 1998 – This submittal was *Final Status Survey Report for Concrete Rubble in Sub-Area F* (Chase Environmental Group, 1998A, ML20043F213). This report presented the results of surveys of concrete rubble (primarily floor slabs and footers) which came from demolished buildings in Subarea K. NRC performed a confirmatory survey of the concrete rubble in Subarea F in June 2012, and in a letter dated September 7, 2012, NRC released the rubble for unrestricted use. If the license is amended as requested in Section 6.3 of this D-Plan, the reference to this document could be deleted.

March 12, 1998 – This submittal was *Final Status Survey Report for Phase III Subarea O, Uranium Waste Ponds #1 and #2 (Subsurface)* (Cimarron Corporation, 1998A, ML20206K825). The two Subareas identified as Subarea O were released for unrestricted use in license amendment No. 16, issued April 17, 2000. This submittal is no longer relevant to the license. If the license is amended as requested in Section 6.3 of this D-Plan, the reference to this document could be deleted.

June 15, 1998 – This letter from Cimarron Corporation responded to NRC's May 20, 1998, comments on *Final Status Survey Report for Concrete Rubble in Sub-Area F* (Chase Environmental Group, 1998A, ML092610651). If the license is amended as requested in Section 6.3 of this D-Plan, the reference to this document could be deleted.

October 6, 1998 – This letter from Cimarron Corporation (ML092710481) responded to NRC's September 10, 1998, comments on residential inhalation dose from concrete rubble in Subarea F. If the license is amended as requested in Section 6.3 of this D-Plan, the reference to this document could be deleted.

March 4, 1999 – This letter from Cimarron Corporation (ML21111A336) responded to NRC's January 19, 1999, comments on *Decommissioning Plan Ground Water Evaluation Report* (Chase Environmental Group, 1998B), in which Cimarron stated that groundwater in Well 1315 (in Subarea F) exceeded the criteria for uranium. At that time, Cimarron personnel did not believe that groundwater exceeding release criteria extended beyond Well 1315, much less beyond the boundary of Subarea F. NRC required additional characterization of groundwater in Subareas F and C. Since that time, substantial characterization of groundwater, not only in Subareas F and C, but site-wide, has been performed, culminating in the submittal of *Conceptual Site Model (Revision – 01)* (ENSR, 2006A). Consequently, Cimarron's response to NRC comments on the 1998 groundwater evaluation report are no longer relevant to the continued decommissioning of the Site. If the license is amended as requested in Section 6.3 of this D-Plan, the reference to this document could be deleted.

*In summary, EPM requests that License Condition 27(a) be amended to reference the 1995 Decommissioning Plan for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility and this Plan, with revisions made in accordance with responses to RAIs and/or revisions made in accordance with License Condition 27(e).*

### 6.7.2 License Condition 27(b)

In October 1999, License amendment No. 15 established (in License Condition 27(b)) the radiological release criterion for uranium in groundwater and established a monitoring requirement to demonstrate that groundwater complies with the criterion. License Condition 27(b) states, "NRC will not terminate Radioactive Material License SNM-928 until Cimarron demonstrates that the total uranium concentrations in all wells have been below the groundwater release criteria for eight consecutive quarterly samples (the past 2 years)."

It was then believed that uranium exceeded the license release criterion in only a very limited area, and that natural attenuation would reduce the concentration of uranium in groundwater to less than the release criterion within a few years. There were 50 monitor wells on site; 25 of them have since been plugged and abandoned.

Since that time, groundwater assessment has shown that groundwater exceeds license release criteria in several areas of the Site, and that natural attenuation processes alone will not reduce groundwater concentrations to less than release criteria for decades. A total of 298 monitor wells have been installed on site; 212 monitor wells are still present at the Site. Many of these have never yielded groundwater exceeding the release criterion for uranium.

The requirement to collect and analyze groundwater samples from ***all wells*** for eight quarters is not appropriate. Section 8.8 of this plan specifies a post-remediation monitoring program which will demonstrate that uranium and Tc-99 concentrations in groundwater comply with unrestricted release criteria. Approval of this decommissioning plan therefore constitutes specification of post-remediation groundwater monitoring requirements.

*EPM requests that License Condition 27(b) be amended to read, "The release criteria for groundwater at the Cimarron Site is 6.7 Bq/L (180 pCi/L) for total uranium and 3,790 pCi/L for Tc-99." NRC will not terminate Radioactive Material License SNM-928 until the licensee demonstrates that the total uranium concentration in all wells have been below the groundwater release criteria for eight consecutive calendar quarters.*

### 6.7.3 License Condition 27(c)

License Condition 27(c) includes the following paragraphs:

"For Waste Ponds 1 and 2 in Phase III Subarea O, the licensee may use the "Method for Surveying and Averaging Concentrations of Thorium in Contaminated Subsurface Soils" (reference NRC letter dated February 25, 299) for volumetric concentration averaging of enriched uranium in soils. For concrete rubble located in Phase II and Phase III subareas, the licensee may use the concentration averaging for concrete rubble as described in submittals dated March 10, 19998, June 15, 1998, and October 6, 1998.

Material that exceeds the above averaging criteria shall be removed and shipped off-site to a licensed low-level radioactive waste disposal site."

The two areas containing Waste Ponds 1 and 2 (the two Subarea O parcels) were released for unrestricted use in Amendment No. 16, issued April 17, 2000. Concrete slabs were placed in Phase II Subareas F, G, and J; the concrete floor of the former Uranium processing facility remained in Phase III Subarea K. A confirmatory survey of the concrete rubble (slabs) in Subarea G was documented in NRC Inspection Report 70-925/98-02. Confirmatory surveys of the concrete rubble (slabs) in Subarea F were documented in NRC Inspection Reports 70-925/98-02 and 70-925/12-001. Subareas J and K were released from the license in Amendments 16 and 19, respectively.

*These references are no longer relevant to remaining decommissioning activities. EPM requests that the license be amended to delete these paragraphs from License Condition 27(c).*

### 6.7.4 License Condition 27(d)

License Condition 27(d) states, “Access gates to the Cimarron facility shall be locked and secured when no personnel are onsite, and fences and locks will be maintained.”

This license condition is no longer necessary. NRC regulations require that access to restricted areas be limited to individuals who have received the appropriate training. EPM will control access to all areas within which operations, offices, and radioactive material storage areas are located. Additional controls will be implemented for any areas that will be designated as restricted areas.

*EPM requests that License Condition 27(d) be deleted from the license.*

* * * * *

# 7.0 ALARA ANALYSIS

## 7.1 DECOMMISSIONING GOAL

Section 1, "Facility Operating History", describes how the Cimarron Site was divided into subareas for decommissioning and final status survey. Based solely on final status surveys and confirmatory surveys performed for equipment and building surfaces and surface and subsurface soil, all but three of the sixteen subareas (Subareas F, G, and N) have been released for unrestricted use. Even for Subareas F, G, and N, final status surveys and confirmatory surveys have shown that both surface and subsurface soil complies with the criteria for unrestricted release. The only environmental medium that remains to be decommissioned is groundwater.

License Condition 23(b) provides the unrestricted release criterion of 6.7 becquerels per liter (Bq/L) (180 pCi/L) for uranium in groundwater. No unrestricted release criterion for Tc-99 has yet been stipulated in License SNM-928. As discussed in Section 4.3.2, NRC developed a derived concentration level of 3,790 pCi/L for Tc-99, based on the EPA's 4 mrem/yr dose limit for beta emitters in drinking water.

The Cimarron Site is being decommissioned in accordance with the requirements of the Site Decommissioning Management Program (SDMP), and the 25 mrem/yr dose limit specified in 10 CFR 20.1402 is not strictly applicable. In addition, the *Environmental Assessment* prepared for License Amendment 15 stated, "... Cimarron maintains, and ODEQ agrees, that the naturally poor quality of groundwater and surface water at the Cimarron site, as well as the availability of other sources of water in the area, make it unlikely that the groundwater will ever be used for domestic or agricultural purposes. As a result, NRC staff finds it more appropriate to use the 0.1 mSv/yr (100 mrem/yr) dose limit of 10 CFR 20.1301 for individual members of the public for groundwater and all other exposure pathways at the Cimarron site." (underlining added)

Regardless, the concentration limit for uranium was based on achieving a 25 mrem/yr dose limit for an exposure limit that includes a drinking water pathway, and the following ALARA analysis was prepared based on 10 CFR 20.1402, which states,

*"A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into*

*account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal."*

## 7.2 COST BENEFIT ANALYSIS

To terminate the Site's license, EPM must demonstrate that the criteria stipulated in License Conditions 27(b) and 27(c) have been met. Demonstration of whether it is feasible to further reduce the levels of residual radioactivity to levels below those necessary to meet the dose criteria (i.e., to levels that are ALARA) is discussed in NUREG-1757. Per NUREG 1757 Volume 2, Appendix K, the following definition applies:

*"'Reasonably achievable is judged by considering the state of technology and the economics of improvements in relation to all the benefits from these improvements. (However, a comprehensive consideration of risks and benefits will include risks from nonradiological hazards. An action taken to reduce radiation risks should not result in a significantly larger risk from other hazards.) NRC Regulatory Guide 8.8, Revision 3 (1978)."*

10 CFR 20.1402, 20.1403(a), 20.1403(e), and 20.1404(a)(3) contains specific requirements to demonstrate that residual radioactivity has been reduced to a level that is ALARA. NUREG 1757 Volume 2 Appendix N provides specific examples of an ALARA demonstration. ALARA for site closure can be demonstrated using the equation shown below.

$$\frac{Conc}{DCGL_w} = \frac{Cost_T}{\$2000 \ x \ P_D \ x \ Dose_A \ x \ F \ x \ A} \ x \ \frac{r + \lambda}{1 - e^{-(r+\lambda)N}}$$

The residual radioactivity level that requires initiation of an ALARA assessment is the point when the concentration, Conc reaches the $DCGL_W$ value (180 pCi/L). Thus, this ALARA assessment is applied after the concentration is reduced to the $DCGL_W$ value, i.e., site remediation standards have been met. Factors in this equation are defined below along the specific values used for this ALARA evaluation.

$P_D$ = Population density for the critical group scenario in people/m$^2$. For the Cimarron facility, the total plant area is approximately 500 acres. The sale of 24-acres of the Site containing the $TiO_2$ and MOFF buildings may lead to an estimated 24 workers assigned to the Site, providing a population density of 2.78 x$10^{-4}$ people/m$^2$. Logan County estimates the population in 2017 to be 46,800. Logan County is approximately 749 square miles (1,940 square kilometers). This scenario provides a population density value of 2.41 $x10^{-5}$ people/$m^2$. As a conservative selection, the higher value of 2.78 $x10^{-4}$ people/$m^2$ was selected.

$A$ = Area being evaluated in square meters ($m^2$). The total site area is approximately 500 acres, or 2.861 $x10^6$ $m^2$. The combined area of the western alluvial and BA1 is approximately 108 acres, or 4.37 $x10^5$ $m^2$. For the purposes of the ALARA calculation, the area being evaluated is 4.37 $x10^5$ $m^2$.

$Dose_A$ = Annual dose to an average member of the critical group from residual radioactivity at the Derived Concentration Guideline Level ($DCGL_W$) results in 25 mrem/yr.

$F$ = Effectiveness, or fraction of the residual radioactivity removed by the remediation action. The effectiveness was assumed to be 1 (complete removal).

$Conc$ = Average concentration of residual radioactivity in the area being evaluated in units of activity per unit area for buildings or activity per unit volume for soils. For the purposes of the ALARA calculation, the concentration of that will remain after decommissioning was assumed to be 180 pCi/L of total uranium in the groundwater.

$DCGL_W$ = Derived concentration guideline equivalent to the average concentration of residual radioactivity that would give a dose of 0.25 mSv/y (25 mrem/yr) to the average member of the critical group, in the same units as "Conc". For the purposes of the ALARA calculation $DCGLw$ is 180 pCi/L.

$r$ = Monetary discount rate in units per year. For durations exceeding 100 years, the NRC approved value is 0.03.

$\lambda$ = Radiological decay constant for the radionuclide in units per year. The radiological decay constant for uranium-234 is 2.77 x $10^{-6}$. For the purpose of the ALARA calculation, the radiological decay constant for U-234 was selected as the most conservative value.

$N$ = Number of years over which the collective dose will be calculated, or 1,000 years.

For the ALARA analysis, $Cost_T$ can include all of the costs shown in the equation below.

$Cost_T = Cost_R + Cost_{WD} + Cost_{Acc} + Cost_{TF} + Cost_{WDose} + Cost_{PDose} + Cost_{other}$

Where:

| | | |
|---|---|---|
| $Cost_R$ | = | Monetary cost of the remediation action (may include "mobilization" costs) |
| $Cost_{WD}$ | = | Monetary cost for transport and disposal of the waste generated by the action |
| $Cost_{Acc}$ | = | Monetary cost of worker accidents during the remediation action |
| $Cost_{TF}$ | = | Monetary cost of traffic fatalities during transporting of the waste |
| $Cost_{WDose}$ | = | Monetary cost of dose received by workers performing the remediation action and transporting waste to the disposal facility |
| $Cost_{PDose}$ | = | Monetary cost of the dose to the public from excavation, transport, and disposal of the waste |
| $Cost_{other}$ | = | Other costs as appropriate for the particular situation |

The process steps for the ALARA calculation are as follows:

1. Assume that the concentration (*Conc*) is equal to the $DCGL_W$.

Solve the ALARA equation to calculate the total monetary value of remediation at which *Conc* equals $DCGL_W$ (i.e., ratio of 1).

Compare the cost in the ALARA calculation to the NRC-adopted value of $2,000 per person-rem of averted dose.

Using the values and process steps described above, the ALARA equation gives:

$$\frac{180\ pCi/L}{180\ pCi/L} = \frac{Cost_T}{\$2000\ x\ 0.000278\ x\ 0.025\ x\ 1\ x\ (4.37\ x\ 10^5)}\ x\ \frac{(0.03\ +\ 2.77\ x\ 10^{-06})}{1-\ e^{-(0.03+2.77x\ 10^{-06})*1000}}$$

The computed value of $Cost_r$ from the above equation is $202,250. This cost represents the net present worth of future remediation to be considered when the dose exposure has been reduced to 25 millirem per year by achieving 180 pCi/L. The decommissioning cost estimate far exceeds the NRC approved limit of $2,000 per person-rem averted, thus no further remediation to achieve additional averted dose is justified once the concentration is reduced to 180 pCi/L.

The calculation of cost per man-rem avoided will be significantly greater than is presented in this analysis because of the following:

- A relatively high population density was assumed
- Assumed area used only the footprint of the impacted area rather than the entire site
- Removal efficiency was assumed to be 1
- The collective dose is assumed at the highest future potential dose rate over 1,000 years

Overall, the ALARA analysis shows that the Site will meet ***any*** regulatory ALARA criteria upon achieving 180 pCi/L.

## 7.3 RESIDUAL DOSE IS ALARA

This ALARA analysis addresses only the cost to reduce the activity concentration of uranium in groundwater to less than the NRC Criterion stipulated in License Conditions 27(b) and 27(c). It is not realistic to project that EPM can staff and operate the groundwater remediation system to achieve a lower activity of uranium in the groundwater for a cost of $202,250 or less. It would be further unjustifiable to perform additional decommissioning of soil to achieve further reduction of the activity concentration of uranium in soil. The cost associated with reducing surface contamination levels to less that the limits stipulated in License Condition 27(c) would further impact the ALARA analysis. It is concluded that achieving 180 pCi/L is ALARA and continued spending to achieve lower groundwater uranium levels is not justified by ALARA.

The cost estimate provided in Section 16 complies with the applicable regulatory requirements of 10 CFR 70.38(g)(4)(v).

* * * * *

# 8.0 PLANNED DECOMMISSIONING ACTIVITIES

Sections 1 through 3 of this Plan describe remediation activities performed to date at the Cimarron Site. Decontamination of former operating facilities and equipment is complete. Decommissioning of former impoundments, waste burials, pipelines, and soils is complete. The only decommissioning activities that remain are associated with the removal of contaminants from groundwater in areas where groundwater exceeds unrestricted release criteria.

Reducing the concentration of uranium to less than 180 pCi/L is required to complete site decommissioning and obtain unrestricted release from the NRC. The groundwater remediation plan presented in this section is based on the results of groundwater assessment, aquifer testing, groundwater flow modeling, treatability tests conducted in 2013 and 2015, and a pilot test conducted in 2017 and 2018. Construction, installation, and operation of remediation and treatment systems will be performed in accordance with this Plan. Data obtained from in-process monitoring of groundwater and water treatment may indicate that modifications to the remediation infrastructure or process are needed. Any modifications will be evaluated in accordance with License Condition 27(e) prior to implementing those modifications.

Design drawings related to groundwater extraction, treated water injection, and treated water discharge are provided in Appendix I. Appendix I has been subdivided into Appendices I-1 through I-6; the following is a description of the contents of each sub-appendix:

- Appendix I-1 – Index of drawings and symbols, notes, and legends that may appear throughout various Appendix I drawings.
- Appendix I-2 – Overall Site plans
- Appendix I-3 – Extraction system details
- Appendix I-4 – Injection system details
- Appendix I-5 – Electrical system details
- Appendix I-6 – Well field details

Design drawings related to groundwater treatment are provided in Appendix J. Appendix J has been subdivided into Appendices J-1 through J-5; the following is a description of the contents of each sub-appendix:

- Appendix J-1 – Index of drawings and symbols that may appear throughout various Appendix J drawings.
- Appendix J-2 – Western Area Treatment Facility

- Appendix J-3 – Western Area Process Overview and Uranium Ion Exchange System
- Appendix J-4 – Spent Resin Handling
- Appendix J-5 – Burial Area #1 Facility

## 8.1 GROUNDWATER REMEDIATION OVERVIEW

This Section provides an overview of the groundwater remediation process. Sections 8.2 through 8.9 provide more detailed descriptions of the aspects of the remediation program introduced in this Section.

### 8.1.1 Groundwater Remediation Basis of Design

To facilitate planning and communication, the Site has been broadly divided into two areas: BA1 and the WA.

BA1 has been subdivided into the following remediation areas (see Figure 8-2):

- BA1-A (the area in which uranium exceeds the NRC Criterion in Sandstone B and the Transition Zone)
- BA1-B (the area in which uranium exceeds the NRC Criterion in alluvial material)

The Western Area has been subdivided into the following remediation areas (see Figure 8-1):

- WAA U>DCGL (the area in which uranium exceeds the NRC Criterion in alluvial material)
- WU-BA3 (the area surrounding former Burial Area #3 in which uranium exceeds the NRC Criterion)
- 1206-NORTH (the drainage area in which uranium exceeds the NRC Criterion)

The boundaries of the remediation areas are neither precise nor are they “fixed”; they were developed based on the estimated boundaries of COC concentration levels and zones of hydraulic influence (groundwater extraction and water injection), geological features, and the estimated locations of contaminant sources. The distinguishing characteristic of each remediation area is not the shape as defined in this Plan, but the remediation strategy and infrastructure that will remediate areas containing groundwater which exceeds the NRC Criterion.

The starting point for developing a basis of design is to define existing site conditions (e.g., hydrogeologic environment, nature and extent of contamination, etc.) and identify the remediation goals. The Basis of Design (Appendix K) documents the development of the plan to achieve remediation goals for the Cimarron Site based on the evaluation of available data.

### 8.1.2 Groundwater Remediation Process

Groundwater remediation in select remediation areas will be accomplished by recovering impacted groundwater from extraction wells and/or trenches. Groundwater extraction infrastructure and operations are addressed in detail in Section 8.2, Groundwater Extraction.

Groundwater produced by extraction systems will be treated to reduce the concentration of uranium to less than discharge permit limits. Treatment for uranium will consist of removal by ion exchange. The treatment systems are not designed to reduce the concentrations of nitrate, fluoride, or Tc-99. The concentration of fluoride in the treatment system influent will be less than the anticipated discharge permit limit of 10 mg/L and the DEQ has indicated that the concentrations of nitrate and Tc-99 in the treatment system influent will be less than any permit limit that may be issued. Data from treatability testing performed in 2013 demonstrates that the ion exchange resin will remove Tc-99 from the influent groundwater, but the data is not sufficient to determine if all the Tc-99 will be removed. Groundwater treatment is addressed in detail in Section 8.3, Groundwater Treatment.

Treated water will be injected into the WU-BA3 and BA1-A remediation areas to flush contaminants in upland sandstone units and transition zone units to groundwater extraction trenches and wells located in downgradient areas. Injection of treated water will be performed in accordance with the DEQ UIC program. Treated water injection is addressed in detail in Section 8.4, Treated Water Injection.

Treated water not used for injection will be discharged to the Cimarron River in accordance with an OPDES permit. An application for an OPDES permit will be submitted approximately one year before construction is complete. The concentrations of COCs in treated water will not exceed OPDES permit limits. Treated water discharge infrastructure, monitoring, and operations are addressed in more detail in Section 8.5, Treated Water Discharge.

The concentration of uranium in the combined influent for each treatment system will decrease over time and may decrease below the uranium discharge limit before the NRC Criterion for groundwater is achieved in all wells within the remediation areas that feed that treatment system. If this is the case, the influent groundwater associated with that system will no longer require treatment prior to discharge.

The ion exchange vessels are designed for a range of flow, varying from a minimum to a maximum flow rate. Consequently, all extraction components associated with a given treatment system will continue to operate to provide the necessary treatment system influent flow rate until all in-process monitor wells in the remediation areas which feed that treatment system achieve the NRC Criterion for three consecutive in-process monitoring events. Treatment system shutdown may occur either because the NRC Criterion for groundwater remediation is achieved, or because uranium in the combined treatment system influent decreases below the discharge limit.

### 8.1.3 In-Process Monitoring

The four categories of in-process monitoring that will be implemented throughout groundwater remediation are: groundwater extraction monitoring, water treatment monitoring, treated water injection and discharge monitoring, and groundwater remediation monitoring. All four of these in-process monitoring programs are described in more detail in Section 8.6, In-Process Monitoring.

### 8.1.4 Treatment Waste Management

Groundwater treatment will generate one primary type of waste – spent ion exchange resin removed from the uranium treatment systems. A minor waste stream consisting primarily of in-line water filters, gloves, and other consumables for which release survey is impractical, will be generated in operating the water treatment systems. In-process monitoring will provide the data needed to determine when resin in the ion exchange systems becomes spent, requiring removal and replacement. The management and disposal of this waste stream is addressed in more detail in Section 8.7, Treatment Waste Management and Section 13, Radioactive Waste Management.

### 8.1.5 Post-Remediation Monitoring

Post-remediation monitoring of groundwater will be performed to demonstrate compliance with the NRC Criteria for uranium and Tc-99. Post-remediation monitoring will begin when all in-process groundwater monitor wells yield uranium concentrations below 180 pCi/L for at least three consecutive monitoring events. The U-235 enrichment in groundwater will decline as the concentration of licensed material in groundwater declines. During post-remediation monitoring, isotopic mass concentrations will be converted to activity concentrations based on the U-235 enrichment calculated for each monitoring location. Activity concentrations will be evaluated against the NRC Criterion. Post-remediation groundwater monitoring is addressed in more detail in Section 8.8, Post-Remediation Groundwater Monitoring.

### 8.1.6 Demobilization and Final Status Survey

Demobilization of treatment systems, the resin processing system, and groundwater extraction infrastructure will begin after post-remediation monitoring demonstrates that uranium and Tc-99 concentrations in groundwater comply with the NRC Criterion. All uranium treatment and resin processing systems will be demobilized prior to requesting termination of the NRC license. Demobilization is addressed in more detail in Section 8.9, Demobilization.

A final status survey will be performed for the WATF building and those portions of the BARF that will remain on site. Release surveys and final status surveys are addressed in Section 15, Facility Radiation Surveys.

## 8.2 GROUNDWATER EXTRACTION

This section presents the design for the groundwater extraction infrastructure, equipment, and associated controls, as well as the rationale for the operation of the system. The locations of groundwater extraction wells and trenches are depicted on Drawings C002 through C005 (Appendix I-2).

### 8.2.1 Groundwater Extraction Wells

Four groundwater extraction wells (GE-WAA-02 through GE-WAA-05) will be screened in alluvial material in the WAA U>DCGL remediation area. Three groundwater extraction wells (GE-BA1-02 through GE-BA1-04) will be screened within alluvial material in BA1. Extraction well construction details are provided on Drawing M201 (Appendix I-3).

In December 2016, groundwater samples were collected from discrete depth intervals at 10 locations in the alluvial aquifer. A direct-push rig equipped with a Hydraulic Profiling Tool (HPT) yielded a hydraulic conductivity profile at each location. Evaluation of lab data and the HPT profiles indicated that uranium is not evenly distributed (vertically) throughout the saturated thickness of the aquifer. The results of this evaluation were documented in *Vertical Distribution of Uranium in Groundwater* (Burns & McDonnell, 2017C, ML17146A133).

In June 2017, the DEQ notified EPM that groundwater extraction well screens should span the entire interval in which uranium concentrations exceed the MCL. Consequently, extraction well screens will be installed to generally span this interval, except that in no case will the top of the well screen extend higher than 5 ft bgs.

To further evaluate the non-uniform vertical distribution of uranium in groundwater, additional vertical profiling data consisting of HPT logs and depth-discrete groundwater samples were collected in 2019 and 2020 at each then-proposed alluvial extraction well location. Additionally, soil samples were collected for grain size distribution (GSD) analysis at select alluvial groundwater extraction well locations to provide data needed to finalize extraction well designs. Extraction well screen intervals, slot sizes, filter pack gradation, etc. were adjusted based on an evaluation of the vertical profiling and analytical results. Submersible pump intake depths were selected based on the vertical profiling results. Extraction wells are designed to maximize the mass of contaminant removed during groundwater remediation efforts while minimizing the recovery and treatment of minimally contaminated groundwater. The wells were also designed to minimize suspended solids in extracted groundwater. Reducing the recovery of minimally contaminated groundwater is expected to reduce the time required to achieve remediation goals. The results of this evaluation were documented in *Vertical Profiling and Monitor Well Abandonment Report* (Burns & McDonnell, 2020D, ML20106F067).

Borings for extraction wells installed in the alluvium will be advanced to the base of the alluvium using standard drilling methods. Each extraction well boring shall extend at least 0.5 ft into the sandstone or mudstone at the base of the alluvium, if practical. Subsurface lithology will be recorded by the field geologist on drilling log forms. The boring will then be reamed to a nominal 10” diameter.

The wells will be constructed as detailed on Drawing M201 (Appendix I-3), using 6” poly-vinyl chloride (PVC) well casing with 6” PVC wire-wrapped screen. The annular filter pack will consist of sand as specified for each extraction well, based on evaluation of the GSD data discussed above, on Drawing M201. The surface seal will be comprised of hydrated bentonite and a bentonite/cement grout, as necessary. All extraction wellheads will be constructed flush with the surrounding grade. Well installation details will be recorded by the field geologist on a well installation diagram.

The 4” electric submersible pump installed in each well will include a shroud that will cause water to be drawn from below the pump and past the motor at the base of the pump unit. The flow of water past the motor will cool the motor. The bottom of the shroud will generally be located at or near the zone of maximum COC concentration in each groundwater extraction well, or approximately 3 ft below the average groundwater elevation for that location, whichever is deeper. In no case will the pump be installed within the bottom 24 inches of the well to provide space for sediment to fall out. Specific submersible pump installation locations for each alluvial well are presented in the *Vertical Profiling and Monitor Well Abandonment Report* (Burns & McDonnell, 2020D, ML20106F067) and listed on Drawing M203 (Appendix I-3).

A typical groundwater extraction well installation is depicted on Drawing M102 (Appendix I-3). Extraction well pump size and depth information are provided on Drawing M203 (Appendix I-3). A water level transducer will be installed approximately 2 ft above the top of the pump and a pitless adapter will be installed in the well casing, approximately 3 ft below grade for the connection of subgrade groundwater discharge piping to the pump drop pipe. The pitless adapter also facilitates installation and removal of the pump from the well. A 30-inch diameter by approximately 30-inch-deep steel vault will be installed over each extraction well. A capped 1-inch galvanized steel pipe shall extend from approximately 5 ft below grade to approximately 5 ft above grade. The manhole cover shall serve as a reference point for location and elevation, and a metal tag displaying the sump identification will be fastened to the steel pipe.

A typical groundwater extraction valve/metering vault is depicted on Drawing M101 (Appendix I-3). The valve/metering vault components will be contained in an 8-foot diameter open-bottom HDPE or steel vault with a steel lid. The valves will include two (2) ball valves to facilitate isolation of the instrumentation components, a globe valve to adjust extraction flow rates, a check valve to prevent backflow of groundwater into the well, and a sampling port. Instrumentation in the vault will include an in-line pressure transmitter and electromagnetic flow meter that will communicate with the remediation controls system to monitor well field conditions and trigger alarms as applicable.

Groundwater extraction wells shall be developed by alternating water removal, via air lift, surging, if practical, and stabilization periods that allow the water level to return to static elevation. Development pumps, surge blocks, and/or swabs may be used to enhance well development if the driller and field geologist agree that pumping and surging may be more effective in achieving development criteria and aquifer communication. Development will continue until the field geologist approves termination of development activities; the goal if achievable is production of clear water. Well development information shall be recorded on well installation diagrams.

After all groundwater extraction wells have been installed and developed, groundwater samples will be collected for laboratory analysis. Groundwater samples collected from all extraction wells will be analyzed for uranium. Groundwater samples collected from western area extraction wells will also be analyzed for nitrate and fluoride, and the sample collected from GE-WAA-03 will also be analyzed for Tc-99. The baseline data obtained from these groundwater samples will be compared to initial treatment system influent concentration estimates and used to assess influent concentration trends over the course of remedial operations. These results are expected to demonstrate that that the representative concentrations used to estimate initial treatment system influent concentrations for uranium to each of the treatment systems are higher than the concentrations that will be received in the actual influent.

### 8.2.2 Groundwater Extraction Trenches

The groundwater remediation system will include three groundwater extraction trenches:

- GETR-BA1-01 was constructed during the Pilot Test. GETR-BA1-01 is approximately 184 ft long and will extract groundwater from the BA1 transition zone material.
- GETR-BA1-02 will be installed in BA1 transition zone material, west of GETR-BA1-01.
- GETR-WU-01 will be installed in transition zone material in the 1206-NORTH area.

Groundwater extraction trench subsurface profiles are depicted on Drawing C101 (Appendix I-3) and construction details are provided on Drawing M201 (Appendix I-3).

#### *Extraction Trench Excavation*

Stormwater management controls (BMPs) will be implemented in accordance with the site-specific SWPPP prepared for compliance with OPDES Stormwater Permit OKR10. Silt fence (or equivalent) will be installed around the downslope side(s) of disturbed areas and maintained until permanent vegetation is established. The stormwater permit and an example SWPPP are provided in Appendix B; the SWPPP will be prepared prior to beginning construction.

Extraction Trench GETR-BA1-01 was constructed during the 2017-2018 pilot test. Groundwater Extraction Trenches GETR-WU-01 and GETR-BA1-02 will be located within the 100-year floodplain. The trenches will be excavated to a minimum width of 2 ft using standard excavation and earthmoving construction equipment. The excavations will extend to the base of the transition zone material, generally located at the bedrock interface, and may be over-excavated to allow sumps and gravel backfill to extend deeper than the invert elevation of the lateral trench drainpipes.

An inorganic high-density slurry or other physical trench stabilization equipment (sliding trench box, etc.) will be used to maintain an open trench during excavation within the unconsolidated transition zone materials. If an inorganic slurry is used, the slurry will be mixed and stored in frac tanks staged outside of the 100-year floodplain.

Both excavated and imported material will be staged outside of the 100-year floodplain if remaining above grade overnight. Disturbed areas will be designated for frac tank staging areas and excavated soil staging areas (for soil that will be returned to the trench). BMPs will be installed on the downhill side of all disturbed areas in accordance with the requirements of the SWPPP.

A portion of the soil and/or rock excavated from the trenches will be replaced by specified gravel backfill and will not be returned to the excavation. This material will be transported to the laydown area to be mixed with sediment from the 1206 Drainage as described in the "1206-NORTH" portion of Section 8.2.4. This area will also be treated as a disturbed area, with BMPs installed in accordance with the SWPPP until a vegetative cover is established.

The locations and sizes of spoil stockpiles will vary based on the length of the trench and the volume of material being stockpiled. BMPs installed downslope from disturbed areas will protect downhill/downstream areas from being impacted by stormwater-transported sediment.

The disturbed areas associated with the construction of the groundwater extraction trenches are as follows:

- GETR-WU-01 – Approximately 275 ft by 75 ft (additional disturbed areas outside of the 100-year floodplain will be established for the staging of frac tanks and excavated soil that will be returned to the trench.)
- GETR-BA1-02 – Approximately 200 ft by 75 ft (additional disturbed areas outside of the 100-year floodplain will be established for the staging of frac tanks and excavated soil that will be returned to the trench.)

### *Extraction Trench Construction*

Following excavation of each trench, approximately 6 inches of granular bedding will be placed in the bottom of the trench. A lateral HDPE drainpipe and sump risers will be assembled via butt fusion welding and placed on bedding installed along the bottom of the trench. Weights will be used as required to sink the piping through the trench slurry.

The lateral drainpipe will be constructed as detailed on Drawing C101 (Appendix I-3). Following piping placement, the trench will be backfilled with clean, free draining aggregate to the desired depth. A geotextile fabric will be placed on top of the drainage layer before backfilling the trench to grade with soil previously excavated from the trench. Trench sumps will be constructed flush with the surrounding grade and trench construction details will be recorded by the field geologist or engineer on construction drawings.

Drawings M101 and M102 (Appendix I-3) present a typical groundwater extraction trench sump installation. As shown on the drawing, each sump will be equipped with a 4" electric submersible pump installed near the invert elevation of the lateral trench drainpipe to allow for maximum trench dewatering, if necessary. Extraction sump pump size information is provided on Drawing M203 (Appendix I-3). A water level transducer will be installed approximately 2 ft above the top of the pump and a pitless adapter will be installed in the sump casing for the connection of subgrade groundwater discharge piping to the pump drop pipe. The pitless adapter also facilitates installation and removal of the pump from the sump.

A 30-inch diameter by approximately 30-inch-deep steel vault will be installed over each extraction well. A capped 1-inch galvanized steel pipe shall extend from approximately 5 ft below grade to approximately 5 ft above grade. The manhole cover shall serve as a reference point for location and elevation, and a metal tag displaying the sump identification will be fastened to the steel pipe. Groundwater extraction sump construction information shall be recorded on sump installation diagrams.

After all the groundwater extraction trenches have been installed and developed, groundwater samples will be collected for laboratory analysis. Samples collected from all extraction trench sumps will be analyzed for uranium. The baseline data provided by these groundwater samples will be compared to initial treatment system influent concentration estimates and used to assess influent concentration trends over the course of remedial operations. These results are expected to demonstrate that the 95% UCL COC concentrations used to estimate initial treatment system influent concentrations are higher than the concentrations in the actual influent.

### 8.2.3 Piping and Utilities

General locations of groundwater conveyance piping and other well field utilities associated with the groundwater extraction systems are depicted on Drawing C002 (Appendix I-2). Figure 8-3, the Well Field and Water Treatment Line Diagram, depicts the flow of groundwater from groundwater extraction components to treatment systems, and the flow of treated water from treatment systems to treated water injection components or the OPDES outfall. Mechanical details for extraction well and trench sump wellhead connections, controls, and instrumentation are provided on Drawings M101 and M102 (Appendix I-3).

### *WAA and 1206-NORTH*

Partial site plans depicting detailed layouts for groundwater conveyance, discharge piping, water utility piping, electrical power, instrumentation, and communications runs for the WAA and WU are presented on Drawings C003 and C004 (Appendix I-2). Drawings C006 and C007 (Appendix I-2) include partial plans for the WATF that receives groundwater recovered from WAA and 1206-NORTH extraction wells and trenches. As shown on the drawings referenced above, individual groundwater conveyance piping runs (i.e., branch lines) originating at extraction well and trench sump pumps connect to trunk lines that convey groundwater from the various remediation areas to the groundwater influent tank (TK-101) located at the WATF. A single trunk line will convey groundwater to TK-101.

The general groundwater extraction branch line configuration for the WAA and 1206-NORTH (including branch-trunk line connections) is depicted on Drawing P101 (Appendix I-3). This drawing also shows the general arrangement of equipment and instrumentation for the WAA and 1206-NORTH extraction components. General quantities and subsurface configurations for piping and conduits associated with extraction well utilities are shown on Drawings C104 and C105 (Appendix I-6). As shown on these drawings, electrical power cables are routed to each groundwater extraction well/sump via dedicated conduits. Separate, dedicated conduits are also provided for the routing of instrumentation and communication cables.

General design information for the electrical power and control system serving WAA and 1206-NORTH groundwater extraction pumps is provided on single-line diagrams presented on Drawing E101 (Appendix I-5). Additional cable and conduit design details for WAA and 1206-NORTH electrical service, instrumentation, control, and communication feeds are provided on Drawings E103 and E104 and E201 through E203 (Appendix I-5). Finally, the WAA and 1206-NORTH control system configuration is depicted on the communication system architecture diagram provided on Drawing E204 (Appendix I-5).

### *BA1*

A partial site plan depicting the detailed layout for BA1 groundwater conveyance, discharge piping, electrical power, instrumentation, and communications runs is presented on Drawing C005 (Appendix I-2). Drawings C009 and C010 (Appendix I-2) include partial plans for the BARF that receives groundwater recovered from BA1 extraction wells and trenches. As shown on the drawings referenced above, individual groundwater discharge piping runs (i.e., branch lines) originating at extraction well and trench sump pumps connect to a common trunk line that conveys groundwater from the BA1 well field to the groundwater influent tank (TK-201). Groundwater recovered from BA1 will be routed from TK-201 to the WATF for treatment. Treated water will then be either re-routed back to BA1 for injection or combined with water recovered from WA remediation areas and routed to Outfall 001 for discharge.

The general groundwater extraction branch line configuration for BA1, including branch-trunk line connection, is depicted on Drawing P102 (Appendix I-3). This drawing also shows the general arrangement of equipment and instrumentation for BA1 extraction components. General quantities and subsurface configurations for piping and conduits associated with extraction well utilities are shown on Drawing C105 (Appendix I-6; see Section E on the drawing). As shown on these drawings, electrical power cables are routed to each groundwater extraction well/sump via dedicated conduits. Separate, dedicated conduits are also provided for the routing of instrumentation and communication cables. Finally, dedicated conduits are provided for fiber optic communication cables, used for the transmission of signals between the BA1 and WATF control systems.

General design information for the electrical power and control system serving the BA1 groundwater extraction pumps is provided on the single-line diagram presented on Drawing E102 (Appendix I-5). Additional cable and conduit design details for BA1 electrical service, instrumentation, and communication feeds are provided on Drawings E103, E105, E106, and E201 through E203 (Appendix I-5). Finally, the BA1 control system configuration is depicted on the communication system architecture diagram provided on Drawing E205 (Appendix I-5).

## 8.2.4 Groundwater Extraction Strategy by Area

Groundwater extraction components located in the WA are shown on Figure 8-1 and extraction components located in BA1 are shown on Figure 8-2. Figure 8-3, the Well Field and Water Treatment Line Diagram, presents nominal flow rates for each remediation component.

Additionally, the anticipated COC concentrations for the groundwater influent are also depicted on Figure 8-3. Groundwater extraction flow rates for each extraction well and trench are also summarized on Drawing P205 (Appendix I-3).

### BA1

The technical memorandum *Environmental Sequence Stratigraphy (ESS) and Porosity Analysis, Burial Area 1* (Burns & McDonnell, 2018C, ML18100A297) depicted complex stratigraphic layering within BA1 transition zone deposits. This technical memorandum demonstrated that the highly variable distribution and interconnection of higher-permeability deposits within the transition zone matrix significantly impacts the ability of groundwater flow models to predict the effect of groundwater extraction and treated water injection on groundwater elevations in the BA1-A area.

Acknowledging the uncertainty related to the BA1-A area, particle tracking analysis supported by the groundwater flow model was conducted to optimize positions and flow rates for extraction wells. Nominal extraction rates for each BA1 extraction well are presented in Figure 8-3 and Drawing P205 (Appendix I-3).

Attachment 3 in Appendix K includes figures presenting the output of particle tracking analysis, which demonstrates that at nominal extraction rates, all groundwater exceeding the NRC Criterion will be captured. Under the pumping scenario depicted in the model, groundwater is extracted from the BA1-A and BA1-B areas at a combined rate of approximately 100 gpm.

In the BA1-B area, in-process monitor wells are located approximately midway between extraction wells. Figure 8-4 presents the results of a particle tracking analysis conducted for BA1 alluvial material. The NRC expressed concern that groundwater may be stagnant between extraction wells, and under the “Nominal Pumping Scenario” in Figure 8-4, the particle tracking analysis shows areas between extraction components that appear to be potential stagnation zones (indicated by the blue stars on Figure 8-4).

Should in-process monitoring indicate that the concentration of uranium in groundwater at these locations is not declining as anticipated, the extraction rates for wells located in the BA1-B area may be adjusted to alternately increase and decrease extraction rates in these three extraction wells (while maintaining an approximately 86 gpm total extraction rate for the BA1-B area).

The two "Operating Scenarios" in Figure 8-4 show that changing the extraction rates in BA1-B extraction wells would eliminate the potential stagnation of groundwater between extraction wells. The yellow lines on Figure 8-4 show particles placed at the blue stars report first to one extraction well in Operating Scenario 1 to the opposite extraction well under Operating Scenario 2. The varying of extraction rates similar to those presented in Figure 8-4 may be implemented as a contingency plan should there appear to be zones of stagnation.

Extraction Trench GETR-BA1-01 was constructed for pilot tests conducted in 2017. An organic polymer slurry was used to prevent collapse of the unconsolidated material during construction. After the pilot tests were completed, uranium concentrations significantly decreased in monitor wells located near and downgradient of the trench – apparently caused by the biodegradation of biopolymer slurry, establishing reducing conditions near GETR-BA1-01.

An ongoing evaluation of BA1 aquifer redox conditions indicates that groundwater is re-oxidizing and aqueous uranium concentrations are rebounding in some areas. Groundwater extraction and treated water injection is expected to accelerate the rebound of uranium concentration in these areas.

Calculation of the rate of decline in the concentration of uranium in each remediation area indicates that the concentration of uranium in the influent tank may be less than the OPDES discharge limit, while the concentration of uranium near individual extraction wells still exceeds the NRC Criterion. Should this occur, groundwater remediation may continue without requiring treatment through the BA1 ion exchange system.

### *WAA U>DCGL*

As shown on Figure 8-1, the extraction of groundwater from the WAA U>DCGL area will be accomplished through the operation of extraction wells GE-WAA-02 through GE-WAA-05.

Attachment 36.4 in Appendix K includes figures presenting the output of particle tracking analysis, which demonstrates that at nominal extraction rates, all groundwater exceeding the NRC Criterion will be captured. Under the pumping scenario depicted in the model, groundwater is extracted from the WAA U>DCGL and 1206-NORTH areas at a combined rate of approximately 107 gpm.

In the WAA U>DCGL area, in-process monitor wells are located approximately midway between extraction wells. Figure 8-5 presents the results of a particle tracking analysis conducted for WA alluvial material. The NRC expressed concern that groundwater may be stagnant between extraction wells, and under the "Nominal Pumping Scenario" in Figure 8-5, the particle tracking analysis shows areas between extraction components that appear to be potential stagnation zones (indicated by the blue stars on Figure 8-5).

Should in-process monitoring indicate that the concentration of uranium in groundwater at these locations is not declining as anticipated, the extraction rates for wells located in the WAA U>DCGL area may be adjusted to alternately increase and decrease extraction rates in these three extraction wells (while maintaining an approximate 99 gpm extraction rate for the WAA U>DCGL area).

The two "Operating Scenarios" in Figure 8-5 show that changing the extraction rates in WAA U>DCGL extraction wells would eliminate the potential stagnation of groundwater between extraction wells. The yellow lines on Figure 8-5 show particles placed at the blue stars report first to one extraction well in Operating Scenario 1 to the opposite extraction well under Operating Scenario 2. The varying of extraction rates similar to those presented in Figure 8-5 may be implemented as a contingency plan should there appear to be zones of stagnation.

### *1206-NORTH*

The 1206-NORTH area consists of a western branch, an eastern branch, and a confluence area. The 1206 Drainage contains saturated sediments deposited in channels cut through Sandstone A.

The confluence portion of the 1206 Drainage serves as a transition between the WU sandstone formations and the WAA alluvium; consequently, the deposits within the 1206 Drainage are referred to as Transition Zone deposits. Groundwater extraction for remediation will only be conducted in the northern (confluence) portion of the 1206 Drainage.

Impacted groundwater in this area will be recovered by extraction trench GETR-WU-01 (see Figure 8-1). GETR-WU-01 will also capture seepage from the WU-BA3 area resulting from the injection of treated water in that area (see below). GETR-WU-01 will continue to operate until in-process monitoring indicates that uranium groundwater concentrations throughout the 1206-NORTH area have remained below the NRC Criterion for at least three consecutive monitoring events **and** treated water injection in WU-BA3 has been discontinued.

The 1206 Drainage is unique in that it is the only area in which excavation and disposition of sediment will be performed as a groundwater remediation strategy. As reported in the technical memorandum *1206 Drainage Sediment Assessment and Remedial Alternative Evaluation* (Burns & McDonnell, 2018B, ML18092A397), the west and east branches of the 1206 Drainage contain very small quantities of impacted sediment, and excavation and disposition of this sediment will expedite groundwater remediation in this area. The sediment contains concentrations of uranium that are below the NRC Criterion, but near the EPA screening level for residential soil. Because most of the seepage from the UP1 Area into the 1206 Drainage flows over or through this fine-grained sediment, the sediment impedes its migration to GETR-WU-01. Consequently, the excavated sediment will be mixed with excess spoils generated during injection trench excavation and placed in a soil laydown area. Following mixing and placement, vegetation will be established over the material.

After placement of the sediment/spoils mixture is complete (prior to establishing vegetation), a 10-meter grid will be established over the laydown area. Samples of the mixture will be collected at each grid location. Composite samples representing each one-foot depth interval will be collected from each location. Duplicate samples will be collected at a minimum of 10% of the 10-meter grid locations.

Samples collected from the 10-meter grid locations will be submitted for isotopic analysis of U-235 and U-238 by method EPA 3050B/6020. An additional set of 20 "confirmatory" samples will be collected from randomly selected 10-meter grid locations. These samples will be retained should the NRC desire to analyze those samples for confirmatory survey or inter-laboratory comparison.

For each 10-meter sample that yields less than 30 picoCuries per gram (pCi/g) total uranium above background, the material within that grid will be considered in compliance with the NRC Criterion. Should a sample from a 10-meter grid location exceed 30 pCi/g above background, samples of the sediment/spoils mixture will be collected from the same depth interval on a 5-meter grid surrounding that sample to determine if the average activity over a 100 $m^2$ area complies with the Criterion. If the average activity for the 10-meter grid sample and the four surrounding 5-meter grid locations is less than the Criterion, the material within that grid will be considered in compliance with the NRC Criterion.

After sampling on a 10- and 5-meter grid, should any sediment/spoils mixture exceed the NRC Criterion, that material will be excavated, placed in drums along with sufficient absorbent to ensure that there will be no free liquid and disposed of as low-level radioactive waste.

To convey seepage from WU-BA3 to GETR-WU-01, a slotted pipe will be installed in the east branch of the 1206 Drainage after sediment removal. The same non-reactive gravel used in the construction of injection and extraction trenches will be used as backfill to maintain the integrity of the drainage channel and protect the slotted pipe. The extent of sediment excavation and the installation of the slotted pipe and gravel backfill are shown on Drawings C004 and C011 (Appendix I-2).

## 8.3 GROUNDWATER TREATMENT

Drawing C002 (Appendix I-2), shows the location of the WATF within the dashed area labeled "C006 & C007". The WATF will include a permanent building which houses offices, filter units, uranium treatment systems, the spent resin processing system, and storage for LLRW. Groundwater recovered from BA1 will be conveyed along the "Pipe and Conduit Alignment" shown on Drawing C002 to the WATF for treatment. The BARF will be constructed at the southern end of BA1, in the dashed area labeled "C009".

Drawing C007 (Appendix I-2) provides utility plans for the WATF. Utilities required to support this facility include electric, potable water, communications, and septic sewerage. Connections to utilities will be predominately underground with access provided where appropriate.

Drawing C-110 (Appendix J-2) presents the facility layout for the WATF. Drawing A-110, Sheets 1 and 2 (Appendix J-2) present elevations for the WATF. The WATF water treatment systems are comprised of ion exchange trains as shown on the Drawing G-100, (Appendix J-2) and the Process and Instrumentation Diagram (P&ID), P-115 (Appendix J-3). Major WATF components include the following:

- One (1) acid injection skid with 5,000-gallon, double-walled acid tank (TK-103) and one (1) 700-gallon scrubber (TK-104)
- One (1) 12,000-gallon, double-walled influent tank (TK-101 – WA Influent Tank)
- One (1) 12,000-gallon, double-walled influent tank (TK-105 – BA1 Influent Tank)
- Two (2) back flushable multimedia particulate filters (FLT-121/122/123 and FLT-131/132/133)

- Two (2) uranium ion exchange (UIX) treatment trains (UIX WA Train 1 and UIX BA1 Train 2)
- One (1) 9,000-gallon single-walled backwash collection tank (TK-106)
- One (1) 12,000-gallon, single-walled effluent tank (TK-102)

Each uranium treatment train will contain three 48” diameter resin vessels designed for flow rates varying from 100 to 125 gpm.

Drawing C009 (Appendix I-2) shows the grading and utility plan for the BARF. The system that transfers recovered groundwater from BA1 to the WATF for treatment (i.e., the groundwater transfer system) will require electric utility service and a fiber optic communication line (to facilitate communications between the BA1 and WATF control systems). Treated water returning from the WATF to BA1 will collect in a treated effluent water tank that will supply the BA1 injection system.

The BARF will include tanks and a pumping skid to transfer recovered groundwater to WATF for processing as shown on drawings C-210 and P-215 (Appendix J-5). Major BARF components include the following:

- One (1) 12,000-gallon, double-walled influent tank (TK-201)
- One (1) influent groundwater transfer pump skid
- One 12,000-gallon, single-walled effluent tank (TK-202)
- One (1) treated effluent water transfer pump skid

Some connections between tanks and other facilities will require above ground piping. Examples include connections between:

- The two WATF influent tanks and the WATF building,
- The WATF building and the WA injection system,
- The WATF building and the BA1 effluent transfer pump (transfers treated water to the BARF effluent tank),
- The influent tank in the BARF and the influent transfer pump skid (transfers recovered groundwater to the WATF for treatment), and
- The effluent tank in the BARF and the effluent transfer pump skid (transfers treated water to the BA1 injection system).

Heat trace and insulation will be installed on above grade exterior process piping, as required, for freeze protection. The WATF building will be equipped with heating and ventilation to protect interior process components (piping and equipment) from freezing and overheating.

### 8.3.1 Uranium Treatment Facility

For construction of the WATF, topsoil will be removed from an area measuring approximately 275 ft by 320 ft and stockpiled in an area southeast of the area of construction. Radiological surveys of soil will be performed as described in Section 13.1. Concrete foundations will include:

- An approximately 115 ft by 140 ft foundation for the treatment building
- Two (2) approximately 13 ft diameter ring foundations for the 12,000-gallon WATF influent and effluent tanks (the influent tank is double-walled and equipped with a liquid sensor to detect a leak in the internal tank and inform the control system)
- One (1) approximately 13 ft diameter ring foundation for the 12,000-gallon BA1 influent tank (double-walled with a liquid sensor to detect a leak in the internal tank and inform the control system)
- One (1) approximately 13 ft diameter ring foundation for the 9,000-gallon backwash tank
- An approximately 23 ft by 12 ft foundation for the 5,000-gallon acid storage tank
- One (1) approximately 9 ft by 6 ft pad for the WATF effluent discharge pump
- One (1) approximately 31 ft by 11 ft foundation for the WA injection system
- One (1) approximately 7 ft by 16 ft foundation for the emergency generator
- One (1) approximately 18 ft by 16 ft pad, and one approximately 4 ft by 5 ft pad for the two air handling units
- One (1) approximately 6 ft by 11 ft foundation for the BA1 effluent water transfer pump

A Truegrid® permeable paving system will surround the concrete foundations, creating a total area of approximately 275 ft by 320 ft, as shown on Drawings C006 (Appendix I-2) and C-110 (Appendix J-2). Approximately 10,400 cubic yards of clean borrow soil will be required to achieve the proposed final surface elevations. In addition, a drainage channel will be constructed along the southern and eastern perimeter of the paving system to collect and convey stormwater run-on and runoff to the existing drainage channel north of the road (see Drawing C006 in Appendix I-2). Following construction of the facility, topsoil will be spread over disturbed soil and in the surrounding area, and vegetation will be established.

For construction of BA1, topsoil will be removed from an area measuring approximately 150 ft by 175 ft and stockpiled in an area west of the area of construction. Radiological surveys of soil will be performed as described in Section 13.1. Concrete foundations will include:

- An approximately 10.5 ft by 6 ft foundation for the influent transfer pump skid (transfers recovered groundwater to the WATF for treatment)
- An approximately 9 ft by 6 ft foundation for the effluent transfer pump skid pump skid (transfers treated water to the BA1 injection system)

- Two approximately 13 ft ring foundations for the 12,000-gallon influent and effluent tanks (the influent tank will be a double-walled tank with a liquid sensor to detect a leak in the internal tank and inform the control system)
- An approximately 47 ft by 10.5 ft foundation for the BA1 injection system
- An approximately 10 ft by 5 ft foundation for the emergency generator

A Truegrid® permeable paving system will surround the concrete foundations, creating a total area of approximately 75 ft by 80 ft, as shown on Drawings C009 (Appendix I-2) and C-210 (Appendix J-5). Additionally, a gravel "pavement" will surround the Truegrid® permeable paving, creating a total "paved" area of approximately 150 ft by 175 ft, as shown on Drawing C-210 (Appendix J-5). The civil design provides for similar quantities of cut and fill, such that excess spoils will be limited. Following construction of the facility, topsoil will be spread over disturbed soil in the surrounding area, and vegetation will be established. Topographic stormwater diversion will be constructed to divert stormwater from the gravel-paved area.

In both areas, storm water management controls will be installed downslope from the construction area, in accordance with the site-specific SWPPP, as described in Section 5.6.4, Water Resources. BMPs will remain in place until permanent vegetation is established. Bi-weekly and post-precipitation inspections of BMPs will trigger improvement of BMPs if needed. Additional inspections will be performed following precipitation events exceeding 0.5 inches.

### 8.3.2 Uranium Treatment Systems

Drawings M-110, Sheets 1 and 2 (Appendix J-3) depict the configuration of a UIX treatment train.

The WA and BA1 UIX trains each include a feed pump that transfers groundwater from their respective influent tank through separate multimedia filters. Each filtration system is equipped with a secondary containment with sufficient capacity such that any leak from the filters will be visually identified and captured.

A differential pressure monitor provides data to the control system and initiates automated backwashing of the filters. The filtered water is pumped from the filters through the respective UIX treatment train (in Appendix J-3, see Drawings P-115 Sheet 1 for the WA train and P-115 Sheet 3 for the BA1 train).

Each treatment train contains lead (primary), lag (secondary), and polishing (tertiary) resin vessels. All resin vessels are of the same size and configuration and include ports for the collection of water samples at the influent of each resin vessel and the effluent of the treatment train. The WA and BA1 influents are treated separately. A portion of the WA treated water is directed to the WA injection system, and a portion of the BA1 treated water is directed to the BA1 injection system. The remaining treated water from both uranium treatment skids is combined and directed to the WATF effluent tank for discharge through Outfall 001(in Appendix J-3, see Drawing P-115 Sheet 5.

Each uranium treatment train will include a pH meter at the inlet to monitor the pH of the influent groundwater stream. A metering pump will inject hydrochloric acid into the influent line to maintain a pH of 6.8 – 7.0. In-line monitoring of pH pre- and post-injection into the influent will provide real-time information to the process control system to automatically adjust the acid flow rate as needed to maintain the target pH. Maintaining this pH range will prevent scaling in the resin vessels without converting the uranyl carbonates to a form that the ion exchange resin would not adsorb as efficiently.

The rate of groundwater flow through the resin vessels will be measured by a flowmeter. Each resin vessel will contain approximately 38 $ft^3$ of anion exchange resin that will exchange chlorine ions for uranyl carbonate, removing the uranium from the groundwater. The anion exchange resin is also expected to remove some of the Tc-99 present in the WATF influent.

Hydrochloric acid (36 wt. %) and ion exchange resin are the only “consumable” items used within the uranium treatment systems. The following summarizes the predicted annual average usage of these consumables for the BA1 and WATF systems:

- Hydrochloric Acid: Average usage is anticipated to be approximately 35 gallons per day, supplied from the 5,000-gallon, doubled walled tank located next to the treatment enclosure. The tank will be refilled directly from a chemical delivery truck approximately every 3 to 4 months.
- Resin: From the WA treatment system, the usage is anticipated to annually average approximately 114 $ft^3$ per year (3 vessels per year). Resin is expected to be delivered in 55-gallon fiber drums (each drum contains slightly over 7 $ft^3$) by truck. Fresh resin will be loaded into vessels in the WATF building.
- Resin: From the BA1 treatment system, usage will vary over time; usage is anticipated to be approximately 266 $ft^3$ for year one (7 changeouts) and 190 $ft^3$ for year two (5 changeouts) and then drop to 114 to 152 $ft^3$ per year for the remaining treatment duration (varies from 3 to 4 vessels per year) as influent concentrations

decline. The overall annual average usage is estimated to be approximately132 $ft^3$ per year.

The adsorption capacity of the ion exchange resin declines as the uranium concentration in the influent declines; current estimates indicate that no resin vessel will exceed 356 grams of U-235. The total mass of U-235 in an individual treatment train (lead and lag vessels combined) is not expected to exceed 450 grams. Consequently, the resin vessels in both treatment trains combined will be unable to adsorb sufficient uranium to approach the U-235 possession limit of 1,200 grams. Figure 8-6 presents the calculated U-235 loading for each uranium treatment train. The total mass of U-235 in both treatment trains combined is not expected to exceed 800 grams at any given time. The maximum U-235 loading occurs during the first two years of operations; the combined total mass of U-235 in both trains combined will drop to approximately 500 grams by year three and less than 300 grams by the end of treatment operations.

Exchange and replacement of the lead ion exchange resin vessel will be triggered when the uranium concentration in the effluent from the lead vessel exceeds 80% of the uranium concentration in the influent. This trigger criterion will be evaluated and modified as appropriate during operations to maximize utilization of the resin capacity and minimize the volume of solid waste generated for disposal.

Once a resin vessel exchange is triggered, the lead vessel will be removed from the treatment train. The valve alignment (OPEN/CLOSED) will be changed such that the lag vessel will become the lead vessel, the polishing vessel will become the lag vessel, and a vessel filled with fresh resin will become the polishing vessel. Spent resin will be processed as described in Section 8.7, Treatment Waste Management, and stored and disposed of as LLRW as described in Section 13, Radioactive Waste Management.

The UIX vessel and valve configuration depicted on Drawings P-115 (Appendix J-3) is the same for all UIX treatment trains. Using the valve numbering for UIX WA Train 1 and UIX BA1 Train 2 (P-115, Sheets 2 & 4), Table 8-1 shows the required valve position (OPEN or CLOSED) needed to enable use of a given UIX vessel as the lead, lag, or polishing vessel.

The time required for effluent from the lead ion exchange vessel to reach the triggering concentration (80% of the influent concentration) is a function of both the rate of flow and the concentration of the uranium. During a system shutdown (planned or resulting from an upset condition such as loss of power), the lead vessel may establish a different chemical equilibrium, releasing some adsorbed species back into solution. In previous treatability studies, such a release of uranium was observed during a shutdown. The use of a lead, lag, and polish vessel configuration minimizes the potential to exceed the required effluent concentration upon restart of the system. Prior to restarting the system following a shutdown exceeding 24 hours, the lead vessel will be removed from service and the resin will be processed as though it is spent.

Effluent from UIX WA Train 1 will be split and routed to the WA injection skid and/or the effluent tank (TK-102). The effluent from UIX BA1 Train 2 (located at WATF) will be split and routed to the BA1 effluent tank (TK-202) and/or to effluent tank TK-102.

### 8.3.3 Western Area Groundwater Treatment

Figure 8-3, Well Field and Water Treatment Line Diagram, illustrates how water will be transferred from groundwater extraction wells and trenches to the water treatment facilities. This section describes the treatment planned for influent groundwater streams. TK-101 will serve as the influent tank for UIX WA Train 1.

Based on representative concentrations described in Section 3.5.3, groundwater conveyed to Influent Tank TK-101 from these remediation areas is anticipated to initially contain uranium at a maximum concentration of approximately 160 ug/L (see Figure 8-3). Treatment for nitrate, fluoride, or Tc-99 will not be required either for injection or for compliance with OPDES discharge permit limits.

The enrichment of the uranium in groundwater recovered from WA remediation areas is estimated (at the 95% UCL) to be 2.75%. This enrichment value will initially be used to calculate the estimated content of U-235 accumulating in the ion exchange resin. Results from the isotopic analysis of samples of the ion exchange resin, as described in Section 8.7.3, will provide a more accurate enrichment value than can be calculated from groundwater data. Following collection and analysis of the first resin samples, the initial groundwater data-based enrichment value will be replaced by more accurate values derived from isotopic laboratory analytical results for the resin samples. Enrichment values obtained from each batch of processed resin will be used to estimate the content of U-235 accumulating in the ion exchange resin in the next batch of ion exchange resin for that treatment train.

The treatment of recovered groundwater for the removal of uranium will continue until the concentration of uranium in TK-101 is less than 30 µg/L for a minimum of two consecutive months. At that time, influent groundwater may bypass UIX treatment; a portion of the effluent will be routed directly to the injection skid tank for injection and the remainder will be routed to TK-102 for discharge.

### 8.3.4 Burial Area #1 Remediation System

Groundwater recovered from extraction components in BA1 will be delivered to the BA1 influent tank (TK-201); from there it will be pumped from TK-201 to WATF Tank TK-105 for treatment in the BA1 UIX Train 2, (see Figure 8-3).

Based on representative concentrations described in Section 3.5.3, groundwater pumped to TK-105, will initially contain uranium at a concentration of approximately 1,200 ug/L, (see Figure 8-3). Nitrate and fluoride will be at background concentrations, and Tc-99 is not present in BA1, so treatment for nitrate, fluoride, or Tc-99 is not needed. A portion of the treated groundwater will be routed from the WATF back to BA1 Effluent Tank TK-202 for injection; the remainder will be combined with the WA treated groundwater and discharged from Effluent Tank TK-102 to the Cimarron River via Outfall 001.

Based on analytical data from in-process samples, the first several batches of resin in the BA1 treatment train will be removed from service before accumulating sufficient uranium to exceed fissile exempt criteria. The adsorption capacity of the resin decreases as the concentration of uranium in groundwater declines; after the first several exchanges, the resin in the BA1 treatment train will not be able to accumulate enough uranium to exceed fissile exempt criteria.

The enrichment of the uranium in BA1 groundwater is estimated to be 1.3% at the 95% UCL. This enrichment value will initially be used to calculate the estimated content of U-235 accumulating in the ion exchange resin. Results from the isotopic analysis of ion exchange resin samples, as described in Section 8.7.3, will provide a more accurate enrichment value than can be calculated from groundwater data. Following collection and analysis of the first resin samples, the initial groundwater data-based enrichment value will be replaced by more accurate values derived from isotopic laboratory analytical results for the resin samples. Enrichment values obtained from each batch of processed resin will be used to estimate the content of U-235 accumulating in the ion exchange resin in the next batch of ion exchange resin for that treatment train.

Treatment of groundwater for uranium will continue until the concentration of uranium in TK-201 is less than 30 µg/L for a minimum of two consecutive months. At that time, influent groundwater in TK-201 may bypass UIX treatment; a portion of the effluent will be routed directly to the BARF injection skid for injection; the remainder will be routed to TK-102 for discharge.

### 8.3.5 Start-Up and Commissioning

The skid-based approach for the uranium treatment systems will enable acceptance testing at the fabrication shop including, but not limited to:

- Verification of pump flow rate using the end valve to adjust system back pressure
- Pipe pressure testing
- Verification of monitoring and control components
- Sampling methods
- Fit-up of vessels with piping and ease of access for manually operated components

Once accepted at the fabrication shop, the skids will be transported to the Site for installation and connected via field-installed piping, power, and communication cables.

Commissioning is expected to be limited primarily to integrated checks of hydraulic performance and control and communication systems. Start-up activities should be able to commence as soon as leak testing of field piping connections is complete.

## 8.4 TREATED WATER INJECTION

Treated groundwater will be injected into Sandstone A in the WU-BA3 area and into Sandstone B and the transition zone in BA1 to enhance the hydraulic gradient and drive impacted groundwater to groundwater extraction components. Treated water will be delivered to the subsurface via gravity flow (i.e., the wells will not be pressurized) and will propagate through the targeted formation under hydrostatic heads developed by raising the water level in trenches or wells above the static groundwater elevation. Only water that has been treated to reduce the concentrations of uranium to less than its MCL will be injected.

Pilot tests conducted from September 2017 through February 2018 demonstrated that injection trenches constructed in Sandstone A and Sandstone B are capable of delivering more treated water per square foot of saturated trench surface than had been estimated based on borehole packer test results and the groundwater flow model.

This section presents the detailed design for the treated water injection infrastructure, equipment, and associated controls, as well as the rationale for operation of the system. The locations of treated water injection wells and trenches are depicted on Drawings C002, C004 and C005 (Appendix I-2).

### 8.4.1 Water Injection Trenches

The following five treated water injection trenches will be installed at the Site:

- GWI-BA1-01 – This trench is approximately 175 ft long. It was installed in Sandstone B during the 2017 Pilot Test at the southern end of the BA1-A area.
- GWI-BA1-02 – This trench will be approximately 110 ft long. It will be installed in Sandstone B in the BA1-A area.
- GWI-BA1-03 – This trench will be approximately 100 ft long. It will be installed in Sandstone B in the BA1-A area.
- GWI-BA1-04 – This injection component will be approximately 130 ft long. It will be installed in the BA1 transition zone between Extraction Trenches GETR-BA1-01 and GETR-BA1-02.
- GWI-WU-01 – This trench will be approximately 225 ft long. It will be installed in Sandstone A in the WU-BA3 area.

Subsurface profiles for these injection trenches are depicted on Drawings C102 and C103 (Appendix I-4). Construction details are provided on Drawings M102 and M202 (Appendix I-4).

Prior to trenching, the top four to six inches of soil (topsoil) will be stripped from the trench area and stockpiled nearby. BMPs will be installed around the topsoil stockpile. An access trench may be excavated both to provide a level working surface for the excavator, and to enable the excavator to reach the required maximum trenching depths (up to 25 ft bgs). This soil will be stockpiled separately from topsoil, also near the trench, and BMPs will be installed around the downslope sides of the stockpile.

Trenches will be excavated to a minimum width of 2 ft using a tracked excavator. Standard excavation and earthmoving construction equipment (e.g., track excavators and bulldozers) is suitable for injection trench excavation. This was confirmed during trenching activities performed during the 2017/2018 Pilot Test. Soil excavated from injection trenches will be stockpiled with the soil that was removed as described above.

Excavator-mounted pneumatic hammers or other rock excavation equipment will be employed, if necessary, to achieve the required trench depths. Injection trench excavations are expected to remain open during construction; high-density slurries or excavation shoring techniques are not anticipated to be necessary, with the exception to GWI-BA1-04 (see below).

Excavated rock will be stockpiled separately from topsoil and soil removed during access trench excavation; that portion of the excavated rock that is displaced by specified gravel fill will be transported to the soil mixing area shown on Drawings C002 and C004 (Appendix I-2). BMPs will be installed around the excavated rock that is not displaced by specified gravel fill.

Following excavation of each injection trench, the bedrock walls and bottom of the trench will be visually inspected. If necessary, the walls and bottom of the trench may be cleaned using a high-pressure water jet or other means to remove soil smearing, achieve scarification of the bedrock wall faces, and improve overall communication with the bedrock formation. The trenches will then be backfilled with clean, free draining aggregate to the desired depth. A geotextile fabric will be placed on top of the drainage layer before backfilling the trench to grade with soil previously excavated from the trench.

Delivery of treated groundwater to each injection trench, and monitoring of trench water levels, will be accomplished through the installation and operation of injection wells. One injection well will be installed within each injection trench. Injection well design elements, installation details, and operational procedures are detailed in Section 8.4.2, Water Injection Wells.

The excavation for GWI-BA1-04 will extend to the base of the transition zone material, generally located at the bedrock interface. Similar to the construction of the BA1 extraction trenches (see Section 8.2.2), an inorganic high-density slurry or other physical trench stabilization equipment (sliding trench box, etc.) will be used to maintain an open trench during excavation within the unconsolidated transition zone materials. If an inorganic slurry is used, the slurry will be mixed and stored in frac tanks staged outside of the 100-year floodplain (see below).

Stormwater management controls will be implemented in accordance with the site-specific SWPPP prepared for compliance with OPDES Stormwater Permit OKR10. BMPs include the installation of silt fence (or other equivalent measures) around the downslope side(s) of disturbed areas until permanent vegetation is established.

#### *Burial Area #1*

Injection trench GWI-BA1-01 was constructed during the 2017/2018 Pilot Test. This injection trench is approximately 175 ft long and averages approximately 20 ft in depth, essentially penetrating Sandstone B. One injection well was installed in the approximate center of this trench. The trench is positioned and oriented to achieve maximum penetration and interconnection of the former BA1 waste disposal trenches. A nominal 10 gpm of treated water will be injected into this trench.

Injection trenches GWI-BA1-02 and GWI-BA1-03 will be excavated as shown on Drawing C103 (Appendix I-4). Both injection trenches will essentially penetrate Sandstone B. Both trenches are positioned to drive residual uranium in Sandstone B toward the transition zone for capture via groundwater extraction trenches, and toward the BA1-B area for capture via groundwater extraction wells. A nominal 4 gpm of treated water will be injected into each trench.

Trenches GWI-BA1-02 and GWI-BA1-03 are located in the 100-year floodplain. Both excavated and staged material will be staged outside of the 100-year floodplain if remaining above grade overnight. Only material which will be placed back in the trench the same day will be staged near the trench.

Injection trench GWI-BA1-04 will be excavated as shown on Drawing C103 (Appendix I-4). This trench is positioned to drive residual uranium to both GETR-BA1-01 and GETR-BA1-02. A nominal 10 gpm of treated water will be injected into this trench. Both excavated and imported material will be staged outside of the 100-year floodplain if remaining above grade overnight. Disturbed areas will be designated for frac tank staging areas and excavated soil staging areas (for soil that will be returned to the trench).

The disturbed area associated with the construction of GWI-BA1-02 is anticipated to be approximately 150 ft by 50 ft. GWI-BA1-03, GWI-BA1-04, and GETR-BA1-02 will be managed as a single disturbed area, occupying an area approximately 250 ft by 400 ft.

### *WU-BA3*

Injection trench GWI-WU-01 will be excavated to a length of approximately 225 ft. The trench will be located east of the 1206 Drainage and upgradient of the former BA3. One injection well will be installed in the approximate center of the trench. A cross-sectional depiction of the trench and well are shown on Drawing C102 (Appendix I-4). In this area, a depth of 25 ft should fully penetrate Sandstone A.

The disturbed area associated with the construction of GWI-WU-01 is anticipated to be approximately 270 ft by 50 ft.

The trench will be positioned and oriented to achieve maximum penetration and interconnection of the former BA3 waste disposal trenches. Uranium impact may reside within the fractures in the fractured sandstone, and to a lesser extent in the backfill of the former disposal trenches. Both fractures in the sandstone and the backfill of the disposal trenches may provide preferential flow paths for injected water. A nominal 8 gpm of treated water will be injected into this trench.

### 8.4.2 Treated Water Injection Wells

Five treated water injection wells are listed on Drawing M202 (Appendix I-4). One of these, GWI-BA1-01, was installed during the 2017/2018 Pilot Test. The other four injection wells will be installed within injection trenches and screened within the trench drainage layer. Injection well construction details are provided on Drawing M202 (Appendix I-4).

Injection wells located within injection trenches will be installed during trench construction (see Section 8.4.1). The wells will be installed by placing the well screen and casing in the excavated trench prior to backfill placement. The wells will be constructed, as detailed on Drawing M202 (Appendix I-4), using 6” PVC well casing with 6” PVC wire-wrapped screen. Injection well screens will extend no higher than 5 ft bgs. Injection trench drainage materials will be placed around the injection wells during backfilling and each well will be completed with a surface seal comprised of hydrated bentonite and a bentonite/cement grout, if necessary. All injection wellheads will be constructed flush with the surrounding grade. Well installation details will be recorded by the field hydrogeologist on a well installation diagram.

Drawing M102 (Appendix I-4) presents typical treated water injection well installations. As shown on the drawing, each well will be equipped with a pitless adapter, connected to the well casing approximately 3 ft below grade, for the connection of subgrade water conveyance piping to the injection drop pipe. The pitless adapter also facilitates installation and removal of the drop pipe from the well. A water level transducer will be installed approximately 2 ft above the injection drop pipe outlet. A 30-inch diameter by 30-inch-deep steel well vault will be installed over each well. A capped 1-inch galvanized steel pipe shall extend from approximately 5 ft below grade to approximately 5 ft above grade. The manhole cover shall serve as a reference point for location and elevation, and a metal tag displaying the well identification will be fastened to the steel pipe. Treated water injection well construction information shall be recorded on well installation diagrams.

### 8.4.3 Treated Water Injection Systems

Mechanical systems required for the pretreatment, distribution, and metering of treated groundwater to injection wells will consist of feed tanks, chemical pretreatment systems, transfer pumps, manifold systems, control valves, instrumentation, and associated piping and appurtenances.

### *Western Area Injection*

The injection system serving GWI-WU-01 will consist of a self-contained unit housed in a modular enclosure and installed adjacent to the WATF building. The location of the WU injection system is depicted on several design drawings, including Drawing C-110 (Appendix J-2) and Drawings C006 and C007 (Appendix I-2).

A P&ID for the WU water injection system is provided. As shown on the drawings, an actuated valve (MOV-002 on Drawing P103 (Appendix I-4)) controls the flow of treated groundwater coming from the ion exchange system and prevents overfilling of injection feed tank TK-001. Water will be pretreated in TK-001, as necessary, to prevent mineral scaling and fouling of the injection system piping, wells, trenches, and subsurface formation. Transfer pump P-001 will convey water from TK-001 to the injection manifold system.

An actuated valve on the injection manifold on (MOV-001 on Drawing P104 (Appendix I-4)) controls the flow of water to Injection Well GWI-WU-01 based on water levels continuously monitored via transducers installed in the injection well (LT-1101 on Drawing P104). The pumping pressure and injection flow rate for the injection manifold line is also monitored by the control system and injection manifold valve MOV-001 can be closed if abnormal flow rate, pressure, or water level values are detected. The general arrangement of the WU injection system to be installed adjacent to the WATF building is depicted on Drawing M103 (Appendix I-4).

### *BA1 Injection*

The system serving the BA1 injection components will consist of a self-contained unit housed in a modular enclosure and installed adjacent to BA1 Influent Tank (TK-201) and BA1 Effluent Tank (TK-202). The location of the BA1 injection system is depicted on Drawing C-210 (Appendix J-5) and Drawing C009 (Appendix I-2).

A P&ID for the BA1 water injection system is provided on Drawing P105 (Appendix I-4). As shown on the drawing, treated groundwater is supplied to an injection feed tank (TK-004) by the BA1 Effluent Tank (TK-202). The process rationale and control logic for the BA1 injection system are the same as those described above for the WU injection system. The general arrangement of the BA1 injection system is depicted on Drawing M104 (Appendix I-4).

### 8.4.4 Piping and Utilities

Locations of water conveyance piping runs, and other well field utilities associated with the treated water injection systems are depicted on Drawing C002 (Appendix I-2). Mechanical details for injection well wellhead piping connections and instrumentation are provided on Drawing M102 (Appendix I-4).

#### *WU*

A partial site plan depicting detailed layouts for water conveyance piping and instrumentation conduits for the WU injection components is presented on Drawing C004 (Appendix I-2). Drawing C007 (Appendix I-2) include partial plans for the WATF where the injection system delivering treated groundwater to the WU injection well and trench is located. Injection piping will convey treated groundwater from the WU injection system to WU-BA3.

These drawings also show the general arrangement of the instrumentation service run for the WU injection well, and the general arrangement of electrical power, instrumentation, and communication services for the WU injection system located adjacent to the WATF building. General quantities and subsurface configurations for instrumentation conduits associated with the injection well are shown on Drawing C105 (Appendix I-6).

General design information for the electrical power and control system serving the WU treated water injection system is provided on the single-line diagram presented on Drawing E101 (Appendix I-5). Additional cable and conduit design details for the WU injection system electrical service, instrumentation, control, and communication feeds are provided on Drawings E103 through E105 (Appendix I-5). Finally, the WU control system configuration is depicted on the communication system architecture diagram provided on Drawing E204 (Appendix I-5).

#### *Burial Area #1*

A partial site plan depicting detailed layouts for water conveyance piping and instrumentation conduits for BA1 injection components is presented on Drawing C005 (Appendix I-2). Drawing C009 (Appendix I-2) includes a partial plan for the BARF layout that includes the injection system delivering treated groundwater to all BA1 injection wells and trenches. As shown on the drawings referenced above, individual water injection piping runs convey treated groundwater from the injection system to the four BA1 injection wells/trenches.

The general treated water injection water conveyance piping configuration for the BA1 is depicted on Drawings C005 and C009 (Appendix I-2) and M104 (Appendix I-4). These drawings also show the general arrangement of instrumentation service runs for the BA1 injection wells, and the general arrangement of electrical power, instrumentation, and communication services for the BA1 injection system. General quantities and subsurface configurations for instrumentation conduits associated with the injection wells are shown on Drawing C105 (Appendix I-6). As shown on these drawings, dedicated conduits are provided for the routing of instrumentation cables required for transmission of water level transducer signals.

General design information for the electrical power and control system serving the BA1 treated water injection system is provided on the single-line diagram presented on Drawing E102 (Appendix I-5). Additional cable and conduit design details for the BA1 injection system electrical service, instrumentation, control, and communication feeds are provided on Drawings E103 through E105 (Appendix I-5). Finally, the BA1 control system configuration is depicted on the communication system architecture diagram provided on Drawing E205 (Appendix I-5).

### 8.4.5 Water Injection Strategy by Area

The anticipated treated water injection flow rates for each injection well/trench are summarized on Drawing P205 (Appendix I-4). The strategies for treated water injection in applicable remediation areas and areas are detailed below.

All injection of treated water will be performed in accordance with the requirements of the DEQ's UIC Program. A UIC permit was not required for the injection of treated water because the water being injected into the shallow subsurface contains lower concentrations of COCs than the formation into which it is being injected contains. However, monthly reports of the quantity and quality of water injected in each location will be submitted to DEQ.

#### *WU Injection Systems*

Treated water will be injected into the WU-BA3 area via the injection trench described in Section 8.4.1, Injection Trenches. A trench is considered the best technology for injection of treated water into Sandstone A due both to the low permeability of the sandstone and the presence of secondary porosity features (i.e., fractures and former excavations or re-worked areas).

The WU-BA3 injection trench will continue to operate until in-process monitoring indicates that uranium groundwater concentrations in the WAA U>DCGL, WU-BA3, and 1206-NORTH areas have remained below the NRC Criterion for at least three consecutive monitoring events.

### *BA1 Injection System*

Treated water will be injected into the Sandstone B formation in the BA1-A area via three injection trenches (GWI-BA1-01, GWI-BA1-02, and GWI-BA1-03). As with Sandstone A injection in the WU-BA3 area, trenches are considered the best technology for the injection of treated water into the BA1 Sandstone B formation due both to the low permeability of the sandstone and the presence of secondary porosity features (i.e., fractures and former excavations or re-worked areas).

Treated water will be injected directly into the higher permeability zones between Extraction Trenches GETR-BA1-01 and GETR-BA1-02 via GWI-BA1-04. The goal is to maintain saturation within the sand lenses to minimize or eliminate the creation of unsaturated zones between the two extraction trenches, as well as to optimize the delivery of uranium to the BA1 treatment system and minimize the duration of remediation.

The BA1 injection trenches will continue to operate until in-process monitoring indicates that uranium groundwater concentrations in all in-process monitor wells in BA1 have remained below the NRC Criterion for at least three consecutive monitoring events. Water delivery to each injection trench will only be permitted if the extraction component(s) responsible for capture of the injected water are operating and maintaining sufficient capture.

## 8.5 TREATED WATER DISCHARGE

All treated water not utilized for injection will be discharged to the Cimarron River in accordance with an OPDES permit. The OPDES permit will authorize the discharge of treated water from one constructed outfall (Outfall 001). The location of Outfall 001 is shown on Drawings C002 and C003 (Appendix I-2). Outfall details are presented on C106 (Appendix I-6).

An application for an OPDES permit will be submitted approximately one year prior to the expected start of groundwater treatment and discharge. Additional information on the sampling and analysis of treated water discharged in accordance with the OPDES permit is provided in Section 8.6.3 of this Plan.

If all WA and BA1 groundwater extraction systems operate at nominal capacity 207 gpm of water will be delivered to the WATF (Figure 8-3). A nominal 36 gpm of treated water will be injected during operations, so 171 gpm of treated water will be discharged to the Cimarron River through Outfall 001.

As previously stated, groundwater will be treated to reduce concentrations of uranium to less than its permit limit prior to discharge. Removal of nitrate, fluoride, or Tc-99 will not be required to comply with OPDES permit limits. It is anticipated that samples of discharged water will be collected for analysis twice monthly.

## 8.6 IN-PROCESS MONITORING

This section addresses the in-process monitoring that will be performed to:

- Optimize the groundwater extraction and treatment processes,
- Determine when remediation can be discontinued, and
- Identify when to cease groundwater remediation and begin post-remediation monitoring.

In-process monitoring of radiological conditions is addressed in Section 11, Radiation Safety Program.

### 8.6.1 Groundwater Extraction Monitoring

In-process monitoring of groundwater will begin when the groundwater extraction components are started after startup of the ion exchange systems (see Section 9.3.1). In-process monitoring of groundwater extraction systems includes real-time recording, logging, and evaluating pumping rates and pressures, groundwater elevations in extraction trenches and wells, and pump run times. The control system will store the data and control extraction and injection flow rates.

In-process groundwater monitor wells for each remediation area are listed on Table 8-2. Figure 8-7 shows the locations of in-process monitor wells in the western remediation areas. Figure 8-8 similarly shows the locations of in-process monitor wells in BA1.

In the WA, two additional monitor wells (T-104 and T-105) will be installed to facilitate groundwater monitoring near GE-WAA-02, GE-WAA-03, and GE-WAA-05 (see Figure 8-7). In BA1, two additional monitor wells (1410 and 1411) will be installed to facilitate groundwater monitoring near GE-BA1-03 and GE-BA1-04. Additionally, Monitor Wells 02W02 and TMW-09 will be abandoned during construction of GWI-BA1-04. Following construction of this injection trench, two additional monitor wells (1412 and 1413) will be installed to collect groundwater data between this trench and extraction trenches GETR-BA1-01 and GETR-BA1-02 (see Figure 8-8).

Depth to groundwater (DTW) will be measured manually in all in-process groundwater monitor wells daily for the first week, weekly for the second through the fourth week, and after two and three months of operation. After the first three months of operation, DTW will be measured on a quarterly basis for all in-process monitor wells. This will provide the data needed to assess drawdown and hydraulic influence throughout the plumes targeted for remediation.

The data and assessments described above will be evaluated periodically to adjust groundwater extraction rates for individual wells and/or trenches to optimize COC removal rates, capture of groundwater plumes, and operational efficiency. Individual pumping rates will be adjusted as needed to maintain the influent flow rates required for proper operation of the groundwater treatment systems.

In-process DTW measurements will also provide feedback on the capacity for injection wells and trenches to deliver treated water to Sandstones A and B. Injection rates may be adjusted as appropriate to optimize the recovery of uranium in groundwater.

Table 8-2 lists the frequency for which groundwater samples collected from in-process monitor wells will be analyzed. Uranium concentration data from in-process monitor wells will identify locations where uranium concentrations are declining more or less quickly than anticipated. The rate of extraction and/or injection may be adjusted based on in-process groundwater monitoring data to optimize the effectiveness of the remediation process.

In-process groundwater monitoring will provide the data needed to evaluate the decline in uranium concentration in potential stagnation zones between extraction wells installed in alluvial material.

### 8.6.2 Water Treatment Monitoring

In-process monitoring of the groundwater treatment systems will provide information needed to:

- Monitor the effectiveness of the treatment systems,
- Determine when ion exchange resin vessels require replacement and reconfiguration,
- Maintain compliance with license possession limits,

- Determine when influent concentrations decline to the point that treatment is no longer needed,
- Document compliance with disposal requirements for spent resin, and
- Evaluate compliance with discharge and injection criteria.

Tables 8-3 through 8-6 present the in-process monitoring program that will be implemented to monitor and operate the water treatment systems. Table 8-3 presents the critical continuous in-line monitoring locations and parameters. Table 8-4 presents the samples collected and analyses that will be performed on a weekly basis. Table 8-5 presents the samples collected and analyses that will be performed on a bimonthly basis to monitor (and report compliance with) discharge permit parameters and underground injection control program requirements. Table 8-6 presents the samples collected and the analyses that will be performed to characterize the spent resin/absorbent mixture packaged for disposal (upon each changeout).

### *Uranium Treatment Monitoring*

Pumping rates, pressures, and level switches will be continuously monitored to maintain flow rates described in Section 8.2. The control system will not allow the flow rate to either uranium treatment skid in the WATF to exceed 125 gpm.

The pH of the influent coming from TK-101 and TK-105 will be continuously monitored and electronically transmitted to the treatment control system. Speed controllers on the pumps which control the rate of acid addition will automatically adjust the pH of the influent to each ion exchange skid. The pH of influent water entering the ion exchange skids will be continuously monitored prior to the in-line mixer where acid is added for pH adjustment. See Drawing P-115 (Sheets 2 and 4, Appendix J-3) for the location of the pH sensors. After the mixer, the pH is continuously monitored to verify that the influent to the ion exchange vessels is 6.8 – 7.0. A sample port is in the process line both upstream and downstream of the in-line mixer to provide a secondary check of the pH. Table 8-3 identifies the in-line sensors that provide data to control the treatment system.

Sampling ports will be located between the filter and the lead resin vessel, prior to the lag and polishing vessels, and at the effluent from the polishing vessel. See Drawing P-115 (Sheets 2 and 4, Appendix J-3) for the specific location of sample ports. Samples will initially be collected from each sampling port on a weekly basis and analyzed for uranium concentration. The volume of groundwater (operating time multiplied by the volumetric flowrate) multiplied by the difference between the influent and effluent concentrations (mass of total uranium per volume of groundwater) will yield the mass of uranium contained in each resin vessel. The U-235 enrichment is used to determine the U-235 content with a vessel. Once consistent compliance with discharge criteria has been demonstrated, the WATF effluent sampling frequency will be reduced to semi-monthly. It is anticipated that the data obtained from the first two changeouts of each treatment train may indicate that the frequency of sampling may be reduced to semi-monthly. Table 8-4 shows the locations from which samples will be collected.

Exchange and replacement of the lead vessel will be triggered when the uranium concentration in the effluent from the lead vessel exceeds 80% of the uranium concentration in the influent. This trigger criterion will be evaluated and modified as appropriate during operations to maximize the utilization of the resin capacity and minimize the volume of solid waste that must be disposed of as LLRW.

If laboratory analytical results for a sample collected from the effluent from the polishing vessel exceeds 10 µg/L of uranium, an evaluation will be conducted to determine if an exceedance of the OPDES permit limit may have occurred. If a permit exceedance may have occurred, the lead ion exchange vessel will be replaced prior to the 80% trigger stipulated above.

Calculations indicate that no individual resin vessel will ever accumulate more than 356 grams of U-235 and no uranium treatment train (i.e., lead and lag vessels combined) will accumulate more than 450 grams of U-235. As the concentration of uranium in the influent declines, the adsorption capacity of the resin declines. Figure 8-6 presents the calculated U-235 loading for each uranium treatment train. Figure 8-6 also shows that the total mass of U-235 in all treatment trains combined is not expected to exceed 800 grams.

### *Radiological Monitoring*

Radiological monitoring of the treatment facilities and processes will consist of monitoring dose rates to ensure compliance with regulatory exposure limits, as well as monitoring the mass and enrichment of uranium accumulated in each ion exchange resin to assess compliance with license-stipulated possession limits. Radiological monitoring is addressed in more detail in Section 11, Radiation Protection Program, and Section 15, Facility Radiation Surveys.

### 8.6.3 Treated Water Injection and Discharge Monitoring

#### *Injection System Monitoring*

For the BA1 and WU-BA3 remediation areas, treated water injection rates were estimated from injection tests and the results of packer tests conducted during previous investigation activities. As previously stated, the injection of treated water into bedrock aquifer units will be accomplished by gravity flow (i.e., the wells will not be pressurized). Injection rates will initially be adjusted to maintain water levels within injection wells and trenches at the desired elevations. Water elevations will not be allowed to rise above 2 ft bgs.

Sample ports are located at the discharge point from each injection skid. Samples of treated water being injected into remediation areas will be collected from each injection skid for laboratory analysis on a semi-monthly basis. Analytical parameters will be the same as for discharge monitoring. This data will be provided to the DEQ on a monthly basis.

In-process monitoring of treated water injection systems will consist of recording, logging, and evaluating well field and injection process data including injection rates and pressures, and groundwater elevations in injection wells. Well field and injection process instrumentation will provide real-time measurements for these data and the control system will store data records for future access, trending, and reporting. Groundwater elevations will also be periodically recorded in monitor wells located in each remediation area containing treated water injection wells and/or trenches; however, these measurements will be recorded manually. The data described above will be used to adjust treated water injection rates to maximize the flushing of COCs from the targeted upland sandstone units as well as from higher-permeability material between the BA1 extraction trenches.

Transducers will be installed in all treated water injection wells to monitor the potentiometric head maintained at the initial injection rates. In-process groundwater monitor wells for each remediation area are listed on Table 8-2 and Figures 8-7 and 8-8 show the locations of in-process monitor wells.

Evaluation of groundwater elevation data will be used to maximize the driving head from areas of impact toward groundwater extraction features, while minimizing the potential for contaminant displacement to areas outside the boundaries of capture zones.

### *Discharge Monitoring*

Groundwater treatment discharge monitoring will be conducted to demonstrate compliance with the OPDES discharge permit.

Groundwater samples from monitor wells located in the remediation areas within which groundwater will be extracted were analyzed for gross beta activity during the 2021 environmental monitoring program. Analytical data was submitted to the NRC and the DEQ on October 1, 2021 (ML21274A052). Tc-99 and the three daughters of uranium that could be present after only 50 years are all beta emitters. The mean gross beta activity reported for samples collected from wells located in the WA-BA3, 1206-NORTH, and WAA U>DCGL remediation areas is less than 100 pCi/L. The mean gross beta activity reported for samples collected from wells located in the BA1-A and BA1-B remediation areas is less than 200 pCi/L. Because the influent to the treatment systems will contain less than one quarter of the State Criterion, it is anticipated that the OPDES permit will not stipulate a limit for and will not require analysis for or reporting of Tc-99 or other beta emitters.

Communications with DEQ indicate that with groundwater extraction limited to areas in which uranium exceeds the NRC Criterion and with no treatment of the influent for fluoride, permit limits for uranium and fluoride will be 30 µg/L and 10 mg/L, respectively. The permit will require effluent pH to remain between 6.5 and 9.0 standard units. There will be no limit for nitrate, but the permit may require the concentration of nitrate in the discharge to be reported.

The flow rate to Outfall 001 will be recorded, and samples of treated water being discharged will be collected for laboratory analysis on a semi-monthly basis. Discharge monitoring reports will report this data to DEQ on a monthly basis in accordance with the OPDES discharge permit. Table 8-5 identifies the locations of sample ports from which flow will be recorded or samples will be collected for laboratory analysis.

The influent concentrations of uranium and Tc-99 presented in Figure 8-3 were used as a basis to evaluate compliance with 10 CFR 20.2001. Although the concentration of uranium in WATF effluent is expected to be below laboratory detection limits, it was conservatively assumed that the concentration of uranium in discharged water would be 5 pCi/L. Although the solubility of thorium is typically orders of magnitude lower than that of uranium, it was also conservatively assumed that the three daughters of uranium are present in groundwater at the same activity concentration as the influent, and that no Tc-99 or uranium daughters would be removed by the ion exchange resin.

10 CFR Part 20, Appendix B stipulates the following effluent limits used in this evaluation:

- For all three uranium isotopes – 3.00E-7 µCi/mL (3.00E+02 pCi/L)
- For Tc-99 – 6E-05 µCi/mL (6.00E+04 pCi/L)
- For both thorium isotopes – 5.00E-05 µCi/mL (5.00E+04 pCi/L)
- For Pa-234 – 3.00E-05 µCi/mL (3.00E+04 pCi/L)

Table 8-7 provides the unity rule analysis for estimated activity concentrations of uranium and Tc-99 in effluent discharges as follows:

- Per Figure 8-3, the projected groundwater extraction flow rates for WA and BA1 are 107 gpm and 100 gpm, respectively.
- Per Figure 8-3, the projected concentrations of uranium in WA and BA1 influent are 159 and 1,018 µg/L, respectively.
- Per Figure 8-3, the maximum projected concentration of Tc-99 in WA and BA1 influent groundwater are 1.26 and 0 ng/L, respectively (there is no detectable Tc-99 in BA1).
- Table 8-7(a) shows that, assuming that all groundwater is treated and discharged (no injection), the concentrations of uranium and Tc-99 in the combined influent are 574 µg/L and 0.65 ng/L, respectively.
- From *Determination of Conservative U-235 Enrichment Levels for Treatment Trains at Cimarron Site* (Enercon Services, Inc., 2022, ML22273A083), the U-235 enrichment of WA and BA1 influent are 2.75% and 1.3%, respectively. This results in a U-235 enrichment for the combined water of 2.1%. The percent of mass presented in Table 8-7 for each uranium isotope in the combined influent was also taken from this report.
- Table 8-7(b) presents the activity concentration of each radionuclide in the combined influent, calculated using the specific activity of each radionuclide isotope and the % of mass for each uranium isotope. It was assumed that the activity concentration of each uranium daughter was the same as the activity concentration of the parent.
- In Table 8-7(b), the mass concentration of the uranium in the effluent was assumed to be 5 ug/L. The activity concentration for each uranium isotope was calculated based on this mass concentration. However, the activity concentrations of the daughter isotopes and Tc-99 were assumed to be equal to the activity concentration in the influent (i.e., the ion exchange resin captures no daughter isotopes or Tc-99).
- Table 8-7(c) lists the effluent limit and the effluent activity concentration for each radionuclide and calculates the fraction of the limit for each radionuclide. The sum of

all fractions is 0.07, indicating that radionuclide concentrations will be a negligible fraction of the NRC-stipulated effluent limit.

Evaluation of the calculated effluent concentrations for radionuclides in Table 8-7 indicates that the maximum total beta activity in the effluent would be less than 450 pCi/L even if none of the Tc-99 or uranium daughters in the influent are captured by the ion exchange resin (also assuming that the activity concentration of the uranium daughters is the same as the parent radionuclide in the influent). Over 90% of the beta activity comes from uranium daughters, which are not detected in groundwater, so this evaluation is extremely conservative. Controlling the concentration of uranium in the effluent is the key to achieving compliance with both OPDES and NRC effluent limits.

The flow rate to Outfall 001 will be recorded, and samples of treated water being discharged will be collected for laboratory analysis on a bi-weekly basis. Discharge monitoring reports will report this data to DEQ on a monthly basis in accordance with the OPDES discharge permit. Parameters and locations for in-process discharge monitoring are presented in Table 8-5.

### 8.6.4 Groundwater Remediation Monitoring

Uranium concentrations obtained by in-process monitoring will be monitored to evaluate progress toward achieving the NRC Criterion and to determine when remediation within a given area should be discontinued and post-remediation groundwater monitoring should begin. Locations of in-process monitor wells are depicted on Figures 8-7 and 8-8. Table 8-2 lists the wells by remediation area.

Monitoring uranium concentrations within each remediation area will provide the information needed to adjust extraction and injection flow rates, assess progress toward achieving the NRC Criterion, evaluate when operation of specific wells or trenches can be discontinued, and determine when to cease remediation in a specific area and begin post-remediation monitoring.

In-process groundwater monitoring will provide data to evaluate the rate of decline of uranium concentrations in groundwater. Section 8.1.5 states that post-remediation monitoring will begin when at least three consecutive events of in-process monitoring data shows that all in-process monitoring wells yield uranium concentrations below the NRC Criterion. However, evaluation of in-process monitoring data may indicate that treatment should continue to reduce the risk of exceeding those criteria during post-remediation monitoring.

Table 8-2 lists the frequency for which groundwater samples collected from in-process monitor wells will be analyzed. The quarterly analysis of groundwater samples collected from specific locations may be discontinued once the concentration of uranium is less than the NRC Criterion for four consecutive quarters. The frequency of analysis of groundwater from locations designated as “annual” in Table 8-2 may be increased to quarterly when the concentration of uranium is less than the NRC Criterion.

In addition to evaluating remedial progress, in-process groundwater monitoring results will be used to assess the effectiveness of specific remediation components in each area. Based on the results, groundwater extraction and injection system operations may be adjusted to focus extraction on areas with higher levels of impact, while extraction from areas of lesser impact may be reduced. The data may also be used to maximize operational efficiency (e.g., minimize power consumption) and inform decisions regarding system modifications (e.g., shut down or cycling of individual extraction wells or trenches).

## 8.7 TREATMENT WASTE MANAGEMENT

Section 8.3.2, Uranium Treatment Systems, describes the process whereby uranium and Tc-99 are removed from groundwater by adsorption onto organic resin. This section describes the process whereby “spent” resin is removed from the treatment system and processed and packaged for shipment as LLRW. The disposal of LLRW is addressed in Section 13 of this Plan.

### 8.7.1 Resin Vessel Replacement

Once it is determined that the resin in the lead vessel is “spent”, the system will be shut down and the lead vessel will be disconnected and removed from the treatment train. As explained in Section 8.3.2, the valve alignment will be changed such that the lag vessel will become the lead vessel, the polishing vessel will become the lag vessel, and a new vessel filled with fresh resin will become the polishing vessel. This replacement process ensures that there will always be three vessels in series with the final (polishing) vessel containing fresh anion resin.

### 8.7.2 Spent Resin Processing

Unless noted otherwise, all drawings cited within this section are provided in Appendix J-4. Spent resin processing operations are shown on P&ID Drawing P-125. Spent resin processing involves the following steps:

- The spent resin vessel is removed from a uranium treatment train.

- The ion exchange vessel will be transported by forklift to the Spent Resin Handling Area (see Drawing G-121, Appendix J-4).
- Potable water from the domestic water supply will be used to sluice the spent resin out of the vessel into a scrolling centrifuge. Once the water contacts the resin, it becomes process water and is routed back to the WA UIX Train 1 influent prior to the filter system.
- The scrolling centrifuge dewaters the resin. The dewatered resin will drop by gravity into a ribbon blender.
- The ribbon blender is sized to blend the contents of a resin vessel plus the amount of inert absorbent material needed to meet transportation and waste acceptance criteria. The ribbon blender will produce a uniform mixture. Enough absorbent will be added to the mixture so the packaged material contains no free liquid and will not produce free liquid during transportation.

The resin and the resin/absorbent mixture remain contained throughout spent resin processing until the 55-gallon drums have been filled with the resin/absorbent mixture. The drum liner will be disconnected from the ribbon blender long enough to collect a sample for laboratory analysis, after which it will be folded over the resin so the drum can be lidded.

The absorbent and the 55-gallon drums in which the resin/absorbent mixture is packaged are the only consumable materials used in the Resin Handling System. Current calculations indicate that the uranium concentration in WA groundwater is low enough that the resin's absorbent capacity will not be high enough to accumulate uranium at levels approaching the fissile exemption limit for transportation (based on the bulk density of the resin (670 grams/liter) and volume of the resin within the vessel). Although the resin is expected to remove some Tc-99 from the WA groundwater influent, the extremely small mass concentration of Tc-99 in groundwater is not sufficient to impact the resin's capacity to capture the uranium in the WA groundwater. The initial twelve to thirteen resin vessels in the BA1 treatment system will require replacement before they reach full capacity to prevent the resin (prior to the addition of absorbent) from exceeding the fissile exemption limit.

A specific adsorbent material has not been identified; however, the material selected will be approved by the LLRW disposal facility. Absorbent is currently estimated to be added to the resin at a volumetric ratio of 1:10 (absorbent volume to resin volume).

Absorbent will be loaded into a hopper that directly feeds into the ribbon blender. Usage is anticipated to average approximately thirty-four 55-pound sacks per year. Absorbent may be delivered in containers other than sacks to mitigate the potential for the absorbent to adsorb moisture from the air during the extended period (months) between vessel changeout.

Once a resin vessel has been emptied, the vessel will remain in the Resin Handling Area to be filled with fresh ion exchange media. A pre-determined quantity of new, fresh resin will be added to HPR-301 utilizing a drum lifter to assist in positioning the drum to the elevated hopper (see Drawing G-121, Appendix J-4). Using process water, the resin will be sluiced into the vessel; the resin is retained within the vessel by internal screens located on the outlet line from the vessel (the same screens that maintain the resin in the vessel during normal operation). The operation will continue until visual observations into HPR-301 show that the hopper no longer contains resin (e.g., the resin has been added and retained in the vessel).

Because of the potential for residual contamination in a vessel, excess water will be collected and routed upstream of the filter skid for processing. Once filled, the vessel will be stored in a designated area in the Resin Handling Area until needed.

The processing equipment is based on commercial models selected for their processing function. Elevation views of the resin processing equipment is shown on Drawing G-121, Appendix J-4. Using a single station for both the removal of spent resin and the addition of fresh resin minimizes vessel movement within the facility.

### 8.7.3 Resin Packaging and Storage

The blended resin/absorbent mixture will be transferred from the ribbon blender to 55-gallon drums equipped with a plastic liner. The liner will be fastened to the chute coming down from the ribbon blender to minimize the potential for airborne suspension of particulates and not expose the worker to the material as the drums are being filled.

A sample of the resin/absorbent mixture will be collected from each drum and analyzed for isotopic mass concentration of uranium and activity concentration for Tc-99. The collection of multiple samples from a single batch will provide the data needed to assess the homogeneity of the mixture. Once homogeneity has been established as described in Section 13.1.1, the sampling frequency will be reduced to one sample per batch. The analytical data from these samples will provide the basis for shipping papers and manifests and to document that disposal criteria have been met. Table 8-6 presents the sample identification and analytical method information for samples of processed resin.

Filled drums will be labeled and placed in a designated area, separate from drums of waste for which data has been received and manifests have been generated. The spent resin storage area will be located in the southern portion of the WATF as shown on Drawing G-100, Appendix J-2.

Disposal of processed resin is addressed in Section 13.1, Solid Radioactive Waste. The average annual quantity of spent resin (including absorbent) projected to be generated is less than 620 $ft^3$ (see Section 8.3.2), or less than eighty-five 55-gallon drums per year.

## 8.8 POST-REMEDIATION GROUNDWATER MONITORING

Post-remediation groundwater monitoring will be performed to demonstrate compliance with NRC Criteria required for license termination. This section describes the groundwater sampling and analysis that will be performed in each area requiring groundwater remediation. Post-remediation groundwater monitoring will continue for 8 consecutive quarters in accordance with License Condition 27(b). To demonstrate compliance with NRC Criteria, the concentration of uranium must be less than 180 pCi/L in every post-remediation monitor well for 8 consecutive quarters.

In areas where drawdown due to extraction is significant (i.e., extraction trenches in transition zone material), uranium may remain sorbed to soil that becomes unsaturated during groundwater extraction. Once extraction ends and groundwater elevations return to static conditions, uranium may desorb from soil, increasing the concentration of uranium in the groundwater (i.e., rebound). Eight quarters of post-remediation monitoring will provide more time than needed to identify such rebound.

In-process remediation monitoring (in areas where drawdown had been negligible) will already have demonstrated that groundwater outside of the center of each uranium plume complies with the NRC Criterion. Post-remediation monitor wells are located between extraction wells, where the potential for uranium concentration rebound is greatest.

If the uranium concentration data for a post-remediation monitor well indicates that the concentration may rebound above the NRC Criterion, remediation will resume. If remediation resumes, the 8-quarter post-remediation monitoring period will be restarted, and a new value will be established for in-process monitoring to indicate that the remediation objective has been achieved.

Tc-99 already complies with the NRC Criterion of 3,790 pCi/L site-wide. However, in a letter dated April 22, 2013 (ML20171A868), the NRC stated, "… the NRC staff has concluded that Tc-99 will not have to be addressed in the groundwater remediation plan. However, the NRC staff requests that the post-remediation monitoring plan leading to license termination includes four calendar quarters of monitoring for Tc-99 to be collected, shortly before requesting license termination, to confirm that previous concentrations have remained below NRC's DCL." Monitor wells in the remediation areas being addressed in this decommissioning plan have never yielded groundwater containing Tc-99 exceeding either the NRC Criterion or the State Criterion.

Groundwater from three monitor wells (1336A, 1346, and 1402) recently yielded Tc-99 concentrations exceeding the State Criterion of 900 pCi/L; although all results were less than half of the NRC Criterion. Groundwater samples will be collected from these three monitor wells during the first four quarters of post-remediation monitoring. These three monitoring wells will be the only ones sampled for Tc-99.

Locations of post-remediation monitor wells are depicted on Figures 8-9 (WA) and 8-10 (BA1). Table 8-8 list the wells by remediation area and identifies the COCs to be analyzed for groundwater samples collected from each well. The following subsections detail the post-remediation monitoring approach and criteria for various portions of the Site.

## 8.9 DEMOBILIZATION

The WATF Building and some ancillary equipment (e.g., fencing, emergency power generator, utilities, security system, etc.) will remain onsite following the completion of groundwater remediation activities. The WATF Building will be subject to a final status survey after all equipment and material used for uranium treatment and spent resin processing, and all packaged LLRW have been removed.

After the data from 8 quarters of post-remediation monitoring demonstrates that groundwater complies with the NRC Criterion site wide, all tanks, the filtration systems, ion exchange systems, and the spent resin processing system will be demobilized from the WATF. The tanks, injection skid, transfer pump, and emergency generator will be demobilized from the BARF. The following sections detail demobilization activities associated with this equipment. Groundwater remediation infrastructure, water treatment systems, and waste processing equipment will be demobilized from the Site as described below.

### 8.9.1 Uranium Treatment Systems

Prior to demobilization of each uranium treatment train, samples of fresh (i.e., unused) resin will be analyzed for uranium concentration to develop a background concentration for resin. The maximum uranium concentration result for the unused resin samples will represent the concentration limit for unimpacted resin.

The resin in all three vessels (lead, lag, and polishing) in each treatment system will be sampled and analyzed for uranium concentration. Resin yielding a total uranium concentration that is less than or equal to the concentration limit described above will be disposed of as non-radioactive solid waste. Resin yielding a total uranium concentration greater than this maximum value will be processed and packaged as described in Sections 8.7.2 and 8.7.3 and shipped for disposal as LLRW.

Once all resin has been removed from the vessels, empty resin vessels and/or all process equipment that cannot be practically surveyed for release for unrestricted use will be packaged and shipped for disposal as LLRW. Empty resin vessels and process equipment that can be surveyed for release for unrestricted use will be surveyed and either released or packaged and shipped for disposal as LLRW. The decommissioning cost estimate (DCE) assumes that they will be disposed of as solid waste.

It is currently anticipated that it will be more economical to dispose of material and equipment as LLRW than to decontaminate and conduct an additional survey of this material or equipment for release. However, decontamination technologies continue to evolve over time and new methods may be available in the future. Accordingly, the decision for disposal versus decontamination will not be made until detailed planning for demobilization of material or equipment in the treatment or resin processing systems is undertaken. Should it be determined that decontamination of material or equipment is more economical than disposal, the method of decontamination and the radiation protection measures to be implemented during decontamination will be submitted to the NRC for review prior to initiating decontamination.

### 8.9.2 Resin Processing System

The spent resin processing system will not be demobilized until all uranium treatment systems have been demobilized. Once all processed resin has been removed from the system and disposed of as described in Section 8.7.2, all resin processing equipment that cannot be surveyed for release for unrestricted use will be packaged and shipped for disposal as LLRW. Resin processing equipment that can be surveyed for release for unrestricted use will be surveyed and either released or packaged and shipped for disposal as LLRW. The DCE assumes that the spent resin processing equipment will be releasable.

Should it be determined that decontamination of material or equipment is more economical than disposal, the method of decontamination and the radiation protection measures to be implemented during decontamination will be submitted to the NRC for review prior to initiating decontamination.

### 8.9.3 Groundwater Extraction and Injection Infrastructure

Influent and effluent tanks and groundwater transfer equipment will be surveyed to determine if they meet the criteria for release for unrestricted use. If releasable for unrestricted use, they will be recycled, salvaged, or disposed of as solid waste. If not releasable, they will be packaged and shipped for disposal as LLRW at a licensed facility. The DCE assumes that they will be releasable.

Groundwater extraction wells will be removed and surveyed for release for unrestricted use. The boring will then be plugged in accordance with Oklahoma Water Resources Board (OWRB) regulations. If the well materials are releasable for unrestricted use, they will be disposed of as solid waste. If not releasable, they will be packaged and shipped for disposal as LLRW.

Groundwater extraction sumps will be cut off approximately three feet below grade; the cut off casing will be removed and surveyed for release for unrestricted use. If the sump material is releasable for unrestricted use, it will be disposed of as solid waste and the extraction sump will be plugged in place. If not releasable, the sump will be removed from the trench and packaged and shipped for disposal as LLRW. The DCE assumes that all well and sump material will be releasable.

Sections of piping through which groundwater exceeding the NRC Criterion was pumped will be removed and surveyed for release for unrestricted use. The sections to be removed for testing include piping located between the following:

- Extraction Sump GETR-BA1-02A and the BA1 header
- Extraction Well GE-BA1-02 and the BA1 header
- The BA1 influent tank (TK-201) and the point at which the transfer pipe leaves the Cimarron River floodplain
- Extraction Sump GETR-WA-01A and the WA header
- Extraction Well GE-WAA-02 and the WA header
- The WA influent tank (TK-101) and the junction of the lines coming from GETR-WA-01A and GE-WAA-02

If releasable for unrestricted use, the surveyed piping sections will be disposed of as solid waste and the remaining piping will be left in place. If not releasable, groundwater extraction piping for that portion of the piping represented by the removed section will be packaged and shipped for disposal as LLRW. Additional sections of piping may be removed and surveyed to minimize the amount of piping requiring disposal as LLRW. The DCE assumes that all piping will be releasable. Piping that cannot be practically surveyed will be packaged and shipped for disposal as LLRW.

Treated water injection wells will be plugged and abandoned in accordance with OWRB regulations. Plugging reports for all abandoned wells and sumps will be filed with the OWRB. Copies of plugging reports will be retained in the CERT document repository.

### 8.9.4 Monitor Wells

Monitor wells located within the licensed area will be over-drilled with a hollow stem auger and removed so they can be surveyed and disposed of in the same manner as groundwater extraction wells. After pulling the well materials from the auger, the boring will be plugged in accordance with OWRB regulations. For purposes of cost estimation, the DCE assumes they will be releasable. All monitor wells that are not located within the licensed area will be abandoned in accordance with OWRB regulations.

Plugging reports for all abandoned monitor wells will be filed with the OWRB and copies of plugging reports will be retained in the CERT document repository.

### 8.9.5 Utilities

Electric power lines and instrumentation and control wiring will be removed for recycling, salvage, or disposition as solid waste. Surveys of power and instrumentation cables will not be performed, because they will not have been exposed to licensed material.

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# 9.0 SCHEDULE

This section presents the schedule upon which the decommissioning cost estimate is based. It is understood that the schedule is contingent upon NRC approval of the DP. Furthermore, circumstances that affect project schedule can change during decommissioning; if it is determined that decommissioning cannot be completed as outlined in the schedules presented in this section, an updated schedule will be provided to the NRC and the DEQ. The schedule is broken into four components, with each component presented in a separate figure:

- A pre-construction schedule (Figure 9-1) presents activities that begin with the submittal of this Plan and conclude with the completion of pre-mobilization activities (e.g., contracting, training, etc.) to prepare for construction.
- A construction schedule (Figure 9-2) presents a conceptual schedule for the construction of groundwater remediation (extraction, injection, and discharge) infrastructure, the construction of foundations and facilities, the fabrication and installation of water treatment and waste processing systems, and the installation of utility and control systems. This schedule begins with the mobilization of contractors and subcontractors and ends with the conclusion of startup activities.
- A remediation schedule (Figure 9-3) presents the duration of groundwater extraction, water treatment, and treated water injection and discharge. It begins with the initiation of extraction, injection, and treatment system operations and concludes with the termination of these operations.
- A post-remediation schedule (Figure 9-4) presents the activities that begin with the shutdown of all extraction, treatment, injection, and discharge systems and end with termination of the license.

The schedules presented herein do not comply with the two-year time frame for decommissioning specified in 10 CFR 70.38(g)(4)(vii). Rather, the schedules presented herein demonstrate the need for an alternative schedule in accordance with 10 CFR 70.38(g)(2). The licensee herein requests NRC approval of an alternative schedule for decommissioning.

The NRC suggested that it may be in the public interest to excavate the contaminated transition zone material and dispose of that material offsite, if that could be accomplished within the two-year time frame for decommissioning specified in 10 CFR 70.38(g)(4)(vii). The licensee evaluated this approach for Burial Area #1 prior to the transfer of the license to the CERT; that evaluation resulted in the following conclusions:

1. A dewatering system would need to be installed and the groundwater extracted to dewater the material would require treatment. The design, construction, and operation of a groundwater treatment system would still be required; this would result in a decommissioning schedule far longer than two years.

2. While excavation of the transition zone material would remove some of the groundwater exceeding the NRC Criterion, it would not remove the majority of the groundwater exceeding the NRC Criterion.

EPM believes it is in the public interest to reduce the concentration of uranium in all of the groundwater as much as can be achieved, rather than leave a significant portion of groundwater in which uranium still significantly exceeds the NRC Criterion. Consequently, it is believed that approval of an alternate schedule is in the public interest.

## 9.1 PRE-CONSTRUCTION

The pre-construction schedule presented in Figure 9-1 is based upon numerous assumptions regarding the time required for agency reviews and responses. Because pre-construction activities incur costs and impact the date upon which construction and remediation can begin, this section describes the sequence of events from submission of this Plan to contractor mobilization and provides the following assumptions upon which the schedule provided in Figure 9-1 is based.

- The NRC will accept this Plan for detailed technical review by the end of 2022.
- The NRC will conduct the technical review of this Plan and issue RAIs by the end of April 2023.
- RAIs will not require additional field work, pilot testing, substantial re-design, or resubmission of the D-Plan. EPM will respond to RAIs by the end of June 2023.
- After the NRC approves or comments on EPM's responses to RAIs, Burns & McDonnell and VNS–Federal Services will prepare bid packages for the fabrication, construction, and installation of groundwater remediation infrastructure and water treatment facilities by the end of 2023. As the design and specifications are advanced to issue-for-bid status, Burns & McDonnell, VNS-Federal Services, and Enercon Services will begin preparation of operating procedures and radiation protection procedures.
- Bid packages will be issued to bidders, bidders will issue (and contractors will respond to) requests for information/clarification, and bidders will submit bids by the end of March 2024.
- The NRC will review the responses to RAIs and prepare a draft Environmental Assessment (EA), a draft Safety Evaluation Report (SER), and a draft amended license, for internal review and revision, and send a draft license to the CERT by the end of March 2024.
- EPM will comment on the draft EA, SER, and amended license by the end of May 2024.
- NRC will issue the amended license by the end of October 2024.

The bidding process includes soliciting bids, responding to requests for information, evaluating and awarding bids, and negotiating the terms and conditions that will eventually be incorporated into construction contracts. The NRC and the DEQ will be advised of the basis of selection of each vendor or contractor responsible for the fabrication and/or installation of major components and other significant aspects of construction (e.g., well/trench construction, civil excavation and backfill, building fabrication & erection, foundation construction, etc.). Vendors and contractors will be requested to provide indicative (+/- 10%) bids.

EPM will submit a request for construction funding to the NRC and the DEQ upon receipt of the draft EA, SER, and amended license. Vendors' and contractors' indicative bids will provide the basis for the construction funding request. This funding request will be separate from annual budget proposals because construction may not take place within the time frame for which annual budgets are approved. It is assumed that the NRC and the DEQ will approve funding for construction prior to issuing the final amended license. Contracts will not be executed until the license amendment is issued and funding is approved; individual contracts will be executed as needed based on the construction schedule.

Pre-mobilization activities consisting of site orientation, safety training, review and revision of contractor submittals, etc., will commence following contract execution. Construction subcontractor personnel and equipment will be mobilized to the Site following the completion of pre-mobilization activities.

## 9.2 CONSTRUCTION

A conceptual construction schedule is provided on Figure 9-2, "Construction Schedule". Descriptions of construction task durations, sequencing, and interdependencies are provided below. As indicated by Task 20 on Figure 9-2, the construction schedule includes a 30-day allowance for weather delays.

### 9.2.1 Groundwater Remediation Infrastructure

Mobilization will be followed by clearing, grubbing, road improvements, and installation of BMPs.

Following initiation of these activities, slurry trench and rock construction will continue to completion. Extraction and injection wellhead installations and utility connections, as well as outfall construction, will be coordinated with extraction and injection trench construction and well field utility construction.

Clearing, sediment excavation, and related activities will be completed in the 1206 Drainage following installation of GETR-WU-01 in the 1206-NORTH remediation area.

### 9.2.2 Water Treatment Facilities

As depicted on Figure 9-2, construction at both the WATF and BARF locations will begin with site grading and equipment pad and foundation pours. Once foundations and equipment pads have cured, the WATF treatment building will be erected and internal and external process components (e.g., tanks, treatment system components, injection skid, etc.) will be installed. BA1 internal and external process components will also be installed once foundations have cured at that facility location. Utility routing and connections for electric, water (WATF only), and communication services required for both WATF and BA1 facilities will be completed prior to the conclusion of facility construction activities.

The following activities are not shown on Figure 9-2, but will begin immediately upon execution of contracts:

- Fabrication and factory testing of uranium treatment skids
- Fabrication of the resin processing mezzanine, tanks, and ancillary equipment
- Fabrication of injection skids and control systems
- Procurement of resin processing equipment (e.g., centrifuge, ribbon blender, etc.)

Startup and commissioning activities are scheduled to last approximately 30 days.

## 9.3 GROUNDWATER REMEDIATION

### 9.3.1 Startup

The resin vessels in both ion exchange treatment systems will be filled with fresh resin. Groundwater extraction components in the WA and BA1 will be started to fill their respective influent tanks with groundwater; once the influent tanks are full, groundwater extraction will cease. Operation of the filtration systems and ion exchange systems will then begin; water will be sent to the corresponding effluent tank. A sample of the effluent will be collected for laboratory analysis. The treated water will remain in the effluent tank until analytical results are received. The water will then be discharged (if it complies with discharge limits) or pumped back to the corresponding influent tank for treatment and adjustment of the ion exchange system. Operation of the inline sensors and automated controls will be tested to ensure compliance with treatment system requirements.

Once the treatment system is fully operational, the groundwater extraction system will be re-started. Extraction flow rates will be adjusted until the flows, pressures, and control operations achieve design requirements. Until the system complies with design requirements (or alternative requirements based on in-process groundwater monitoring) all treated water will be diverted to the discharge line.

Once full-scale operation of groundwater extraction treatment systems is underway, injection of treated water will begin. Startup of the injection system will involve adjusting the injection flow rates to achieve the design water elevations in injection trenches. The design injection flow rates and/or water elevations in injection components may be modified based on the rate at which the injection trenches can deliver treated water to the formation.

As described in Section 8.6, in-process groundwater monitoring will be performed at an accelerated frequency during startup activities. Both extraction and injection flow rates will be evaluated based on groundwater elevation data obtained during the first weeks of operation. Flow rates for either treated water injection or groundwater extraction may be modified to optimize the extraction and treatment of groundwater.

### 9.3.2 Western Area Remediation

Groundwater extraction, water treatment, and treated water injection and discharge will begin in WA remediation areas as described in Section 8 upon completion of startup activities. In-process monitoring will be performed as described in Section 8.6. Remediation duration estimates indicate that groundwater in WAA U>DCGL will take the longest of the western remediation areas to achieve the NRC Criterion. Figure 9-3 presents the estimated remediation duration by remediation area.

Remediation duration calculations indicate that:

- It will require slightly more than 11 years to reduce the uranium concentration in groundwater to less than the NRC Criterion in the WAA U>DCGL Area.
- It will take approximately 5 months to reduce the uranium concentration in the 1206-NORTH Area to less than the NRC Criterion.
- It will take approximately four years to reduce to the uranium concentration in the WU-BA3 Area to less than the NRC Criterion.

Although the NRC Criterion is anticipated to be achieved in the 1206-NORTH area within one year, groundwater extraction from GETR-WU-01 will continue as long as injection continues in the WU-BA3 area.

The schedule and decommissioning cost estimate assume that operation of all WA extraction components and water treatment systems will terminate when in-process monitoring indicates that all monitor wells in the WA have remained below the NRC Criterion for at least three consecutive monitoring events.

### 9.3.3 Burial Area #1 Remediation

Remediation duration calculations indicate that it will require approximately 150 months (12.5 years) to reduce uranium concentrations to less than the NRC Criterion. This is the longest estimated remediation timeframe for any remediation area at the Site. As such, the reduction of uranium concentrations in BA1-A is the “critical path” activity that establishes the time required to achieve license termination.

Treatment of BA1 groundwater may be terminated before extraction, injection, and discharge are terminated if the concentration of uranium in the influent declines below the OPDES discharge limit. It is estimated that the concentration of uranium in the influent may decline below the OPDES discharge limit two years before the NRC Criterion are achieved in all BA1 monitor wells.

In the BA1 Transition Zone, uncertainties associated with the distribution of dissolved uranium in more permeable sand channel deposits, versus the surrounding silt and clay-rich matrix, and the interconnected-ness of these channel deposits, make the estimated remediation timeframe for this area less certain. In-process monitoring data will be reviewed for evidence that would support revision of the estimated time required to reduce uranium concentrations below the NRC Criterion in this area.

Remediation duration calculations indicate that it will require approximately five years to reduce the uranium concentration in groundwater in the BA1-B remediation area to below the NRC Criterion.

Figure 9-3 presents the estimated remediation duration for each remediation area.

Note: Sections 8.1, 8.2, 8.4, and 8.6 state that groundwater remediation will be terminated when three consecutive in-process monitoring events indicate that all monitor wells in the WA or in BA1 have remained below the NRC Criterion for at least three consecutive monitoring events. Due to the potential to vary flowrates to maximize the extraction of groundwater from areas containing the highest uranium concentration, in conjunction with the potential to reduce the time interval between in-process monitoring events, the schedule does not include two calendar quarters between achieving the NRC Criterion and initiating post-remediation monitoring in a given area.

## 9.4 LICENSE TERMINATION ACTIVITIES

The term "License Termination Activities", as used in this plan, involves performing post-remediation monitoring, dismantling, and demobilizing groundwater treatment facilities, and performing the surveys and dose modeling that are required to demonstrate the Site can be released for unrestricted use. License termination activities also include the preparation of responses to NRC requests for information related to the termination of the license. Figure 9-4, Post-Remediation Schedule, presents the sequence of activities that begin with the termination of groundwater remediation and conclude with license termination

### 9.4.1 Post-Remediation Groundwater Monitoring

Both the schedule and the decommissioning cost estimate in this plan assume that post-remediation monitoring will be conducted in all WA and BA1 areas concurrently, following achievement of the NRC Criterion for uranium concentration in groundwater in BA1. Post-remediation groundwater monitoring will be performed on a quarterly basis for a minimum of 8 calendar quarters.

### 9.4.2 Decommissioning Systems Demobilization

After the data from 8 quarters of post-remediation monitoring demonstrates that groundwater complies with the NRC Criterion in all remediation areas, the filtration systems, ion exchange systems, and the resin processing system will be demobilized from the WATF.

Prior to demobilization of ion exchange systems, the ion exchange resin will be removed from the resin vessels in each treatment system (see Figure 9-4). Ion exchange resin that exceeds the maximum concentration of uranium in unused resin (discussed in Section 8.9.2) will be processed, packaged, and shipped for disposal as LLRW.

Water treatment equipment will be surveyed as practical and either salvaged, disposed of as solid waste, or packaged and disposed of as LLRW. All chemicals will be returned, recycled, or disposed of in accordance with applicable regulatory requirements.

### 9.4.3 Residual Dose Model

A residual dose model will be prepared to determine the residual radiological dose to the average member of the critical group based on a reasonable resident farmer exposure scenario. The dose model will use groundwater concentration data from the last post-remediation groundwater monitoring event and soil data from final status survey reports.

The NRC's July 1999 Environmental Assessment for the 1995 *Decommissioning Plan for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility* (Chase Environmental Group, 1995A, ML20202A437) stated, "Cimarron maintains, and ODEQ agrees, that the naturally poor quality of groundwater and surface water at the Cimarron site, as well as the availability of other sources of water in the area, make it unlikely that the groundwater will ever be used for domestic or agricultural purposes."

Preliminary dose modeling indicates that the dose to the average member of the critical group for the WAA U>DCGL, WU-BA3, and 1206-NORTH remediation areas may be less than 25 mrem/yr using current soil and groundwater concentrations as inputs if ingestion of produce produced through irrigation is not included as an exposure pathway.

It is anticipated that the dose model will demonstrate that the residual dose will be less than 25 mrem/yr in the WAA U>DCGL, WU-BA3, and 1206-NORTH remediation areas. If the dose model indicates that the residual dose is greater than 25 mrem/yr, but less than 100 mrem/yr, representative surface and subsurface soil samples may be collected from borings located near post-decommissioning monitoring locations in the WAA U>DCGL, WU-BA3, 1206-NORTH, BA1-A, and BA1-B remediation areas to generate then-current soil data for input into the dose model. Although surface and subsurface soil has already been demonstrated to comply with the license criteria for soil, it's contribution to the total dose may justify determining the extent to which the desorption of uranium from saturated soil during groundwater remediation reduces the concentration of uranium in the soil.

### 9.4.4 Final Status Survey

Preparation of a final status survey plan will begin during the final quarter of post-remediation monitoring (see Figure 9-4). Following NRC review and revision of the final status survey plan, the final status survey will be performed after all material and equipment slated for removal has been demobilized. Section 15.4, “Final Status Survey Design” describes the general scope of the final status survey.

### 9.4.5 Request for License Termination

A request for termination of license SNM-928 will be submitted after the final status survey report and residual dose model have been revised based on comments from the NRC. The schedule assumes that the NRC will terminate the license within three months of submitting the request for license termination. Figure 9-4 provides the assumed schedule for license termination activities on which the cost estimate in Section 16 of this Plan is based.

## 9.5 SCHEDULE CHANGES

The schedules provided in this section are presented as reasonable estimates. The inputs for cost and schedule estimates for groundwater remediation (e.g., groundwater flow model projections, distribution coefficient calculation, and pore volume estimates) are at best approximations of highly complex and variable natural systems. The schedule for remediation will require periodic revision once groundwater concentration data is obtained during the groundwater remediation process.

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# 10.0 PROJECT MANAGEMENT AND ORGANIZATION

## 10.1 DECOMMISSIONING MANAGEMENT ORGANIZATION

Decommissioning activities are being and will be performed in the following phases:

- Pre-construction
- Construction and startup
- Remediation
- Post-remediation monitoring and license termination

Throughout the decommissioning of the Site, the positions described in Section 10.1 will be responsible for the management of all decommissioning activities. Figure 10-1 presents an "overview" organization chart which depicts the general organizational structure applicable through all phases of decommissioning.

### 10.1.1 Trust Administrator

The Trust Administrator is responsible for the management of Trust assets and provides the resources needed to complete the decommissioning of the Site. The Trust Administrator monitors and reports the financial status of the Trust accounts. The Trust Administrator is responsible for the preparation of periodic decommissioning funding cost estimates and annual budgets. The Trust Administrator is a permanent member of the ALARA Committee.

The Trust Administrator must have experience managing organizations responsible for radiological decommissioning and environmental remediation, as well as overseeing the preparation of financial reports and cost estimates.

### 10.1.2 Trustee Project Manager

The Trustee Project Manager (PM) is responsible for overseeing the construction and operation of decommissioning systems, the implementation of the radiation safety, safety & health, and quality assurance programs, and compliance with regulatory requirements. The Trustee PM is responsible for ensuring that all personnel performing decommissioning activities, or working in radiation protection, health and safety, quality assurance, or environmental compliance receive training and have the skills and experience required to perform those functions.

In conjunction with the Trust Administrator, the Trustee PM prepares decommissioning cost estimates and annual budgets. The Trustee PM retains contractors/consultants with appropriate qualifications and experience to maintain and implement the site-specific radiation protection, quality assurance, and safety & health programs. The Trustee PM is a permanent member of the ALARA Committee.

The Trustee PM reports directly to the Trust Administrator. The Trustee PM must have experience in the following areas:

- Managing environmental remediation and/or radiological decommissioning projects
- Complying with license and regulatory requirements
- Preparing and tracking work scopes and cost and schedule plans

### 10.1.3 Radiation Safety Officer

The Radiation Safety Officer (RSO) is responsible for the maintenance and implementation of the radiation protection program. The RSO is responsible for the review and revision of the Radiation Protection Plan and procedures, radiation exposure monitoring, dose reporting, the radiological instrument program, and all levels of radiation training. The RSO is responsible to ensure that all activities comply with license requirements, chair the ALARA Committee, and manage the health physics staff. The RSO is given specific authority to implement and manage the licensee's radiation protection program, either directly or through qualified individuals who are designated in writing as having authority to exercise specific functions. All radiation protection personnel have stop work authority.

The RSO is responsible for the implementation and review of the Material Control and Accountability program. The RSO establishes training programs applicable to all individuals that implement activities in accordance with the Material Control and Accountability Plan. The RSO designates specific individuals that will implement activities in accordance with the Material Control and Accountability Plan.

The RSO reports directly to the Trustee PM, but also has a direct communication line to the Trust Administrator. The qualifications of the RSO are specifically detailed in Section 3.2, Radiation Protection Organization, of the Radiation Protection Plan (Appendix M).

### 10.1.4 Quality Assurance Coordinator

The Quality Assurance Coordinator (QAC) is responsible for the maintenance and implementation of the quality assurance program. The QAC performs or schedules periodic and/or ad hoc audits and observations of all decommissioning and program management functions. All quality assurance personnel have stop work authority. The QAC is also responsible to perform periodic evaluations of the effectiveness of the quality assurance program and to ensure that all personnel performing quality-critical tasks have received the appropriate level of training on the site-specific quality assurance program. The QAC is a standing member of the ALARA Committee.

The QAC reports to the Trustee PM, but also has a direct communication line to the Trust Administrator. The QAC is required to have the following qualifications:

- Experience in managing quality control / quality assurance programs
- Familiarity with license and regulatory requirements
- Familiarity with site-specific radiation protection, quality assurance, health and safety, and sampling and analysis programs
- Familiarity with data verification and validation protocols

## 10.2 ALARA COMMITTEE

An ALARA Committee has been established in accordance with regulatory and license requirements. Throughout the decommissioning of the Site, the ALARA Committee will be responsible to ensure that procedures and engineering controls used are based upon sound radiation protection principles to achieve occupational doses and dose to members of the public that are ALARA. The ALARA Committee will meet at least once per quarter. The responsibilities of the ALARA Committee are detailed in Section 4.3.1, ALARA Committee Responsibilities, of the Radiation Protection Plan (Appendix M).

The ALARA Committee will be chaired by the RSO and report directly to the Trust Administrator.

## 10.3 PRE-CONSTRUCTION ACTIVITIES

As depicted in Figure 9-1, between the time this Plan is submitted and the beginning of construction, activities will primarily consist of detailed design, preparation of requests for bids, bid evaluation and award, contracting, and limited monitoring and/or construction on the Site. The individuals identified in Section 10.1 are responsible for the performance of these activities. Site maintenance and monitoring activities will be managed by Activity Leaders.

### 10.3.1 Activity Leader

Quality critical work is work that leads to the achievement of Trust objectives or that must comply with applicable regulatory requirements. Examples of quality critical activities are the collection of groundwater samples for laboratory analysis, the performance of radiological surveys, and installation of monitor wells. Activities such as mowing and cleaning the office are not quality-critical activities.

Activity Leaders (ALs) are supervisors of crews performing non-routine quality critical work at the Site. ALs are responsible for the implementation of activity plans and the procurement of services and materials needed for the activities they oversee. ALs will ensure that all personnel performing work are familiar with the activity plan under which the work is being performed, and that they have received the training needed and are qualified to perform the tasks for which they are responsible. ALs are responsible for monitoring the schedule, cost, and quality of project work.

Activity Leaders typically report to the Trustee PM. Should construction work be performed, ALs may report to a Construction Project Manager as described in Section 10.4. They are indirectly responsible to the RSO and QAC. As do all workers, ALs have authority and the responsibility to stop work if conditions or the performance of work pose a risk to safety and health or the environment, or compliance with license, decommissioning plan, or quality requirements. Activity Leaders must meet the following qualifications:

- Experience managing environmental assessment and remediation operations
- Familiarity with license and regulatory requirements
- Familiarity with site-specific radiation protection, quality assurance, health and safety, and sampling and analysis programs
- Ability to assist in the preparation and/or revision of activity plans and to manage work performed in accordance with activity plans
- Experience managing resources to perform work within schedule and budget, while maintaining quality and regulatory compliance

## 10.4 CONSTRUCTION AND STARTUP

For the purpose of the QA program, “Construction” includes installation of groundwater remediation (extraction, injection, and discharge) infrastructure, the construction of foundations and facilities, the fabrication and installation of water treatment and waste processing systems, and the installation of utility and control systems. This work will be managed as a combination of projects directed by an engineering, procurement, and construction (EPC) Contractor. The Trustee PM will maintain responsibility for the oversight of the EPC Contractor. Figure 10-2 depicts the organization and reporting hierarchy of subcontractors and suppliers that will be engaged in the construction and installation of these facilities and systems.

### 10.4.1 EPC Lead

The EPC Lead will oversee the management of construction and procurement projects and will report directly to the Trustee PM and indirectly to the RSO and the QAC. The EPC Lead will oversee the procurement of subcontractors, equipment, and materials, and the execution of construction, fabrication, and installation activities.

Upon completion of construction activities, the EPC Lead will be responsible for compiling documentation demonstrating conformance with design requirements.

### 10.4.2 Construction Project Managers

Construction PMs will be responsible for each phase of construction (e.g., well installation, utility & foundation installation, trench installation, construction of the WATF building, etc.), and will report to the EPC Lead. Contracts will include the scope of work, design and specifications, and cost and schedule provisions for each of these phases. Some phases may involve multiple contracts and contractors; for instance, the fabrication and procurement of ion exchange systems may be contracted separately from the fabrication and installation of the resin processing equipment. Construction PMs will confirm that all personnel working under contracts for their phase of work have received the appropriate training and are qualified to perform the tasks they have been assigned. Construction PMs will be responsible for monitoring the schedule, cost, and quality of their respective projects.

Construction PMs must meet the following qualifications:

- Experience managing similar construction projects
- Familiarity with project-specific license and regulatory requirements
- Familiarity with site-specific radiation protection, quality assurance, and health and safety requirements
- Experience in the preparation and tracking of work scopes and cost and schedule estimates
- Experience managing resources to perform work within schedule and budget, while maintaining quality and regulatory compliance

Essentially no construction activities will involve working with radioactive material or work in radiologically restricted areas. The WATF and most groundwater extraction and injection wells and trenches and piping and utility runs will be constructed in areas that have already been released for unrestricted use. Both surface and subsurface soil have been demonstrated to comply with license criteria for unrestricted use. Personnel who perform work on construction projects which may result in exposure to contaminated groundwater or potentially contaminated materials will receive radiological training that is commensurate with their work, as described in Section 2, Training, of the Radiation Protection Plan (Appendix M).

## 10.5 GROUNDWATER REMEDIATION OPERATIONS

Upon completion of startup activities, the decommissioning organization will transition from a project organization to an operations organization (see Figure 10-3). The individuals identified in Section 10.1 will maintain responsibility for the oversight of operations personnel.

Operation and maintenance of groundwater extraction, water treatment, waste processing, and treated water injection and discharge systems will be performed by operations personnel overseen by one or more Front-Line Supervisors. Environmental Compliance activities consisting of compiling data, preparing discharge monitoring reports and other permit-required reports, will be performed by personnel designated by the Trustee PM. Operations personnel will likely support more than one of these functions, and precise definition of "who does what" cannot be defined at this time. Radiation protection and quality assurance functions, such as conducting audits and observations and maintaining licensed material inventory records, will be performed by Radiation Protection (RP) and/or QA personnel who are independent of those performing the work.

### 10.5.1 Front-Line Supervisors

Front-Line Supervisors are responsible for the performance of routine quality critical work. Job Supervisors ensure that personnel performing work are familiar with the applicable work instructions (including procedures and desk instructions), have received required training, and are qualified to perform the tasks for which they are responsible. Front-Line Supervisors are responsible for monitoring the schedule, cost, and quality of project work.

Front-Line Supervisors typically report to one of the managers listed in Section 10.2. As do all workers, Front-Line Supervisors have authority and the responsibility to stop work if conditions or the performance of work pose a risk to safety and health or the environment, or compliance with license, decommissioning plan, or quality requirements. Front-Line Supervisors must meet the following qualifications:

- Experience performing the routine work for which they are responsible
- Familiarity with license and regulatory requirements
- Familiarity with site-specific radiation protection, quality assurance, health and safety, and sampling and analysis programs

### 10.5.2 Front-Line Supervisor

Front-Line Supervisors will be responsible for the procurement of materials and the performance of decommissioning operations. Front-Line Supervisors will ensure that all personnel performing work have received the training required for the work they perform, and have been task-qualified to perform the work for which they are responsible. Front-Line Supervisors are responsible for monitoring the schedule, cost, and quality of the operations for which they are responsible.

Routine groundwater extraction and transfer operations, groundwater filtration and treatment, waste processing and packaging, treated water injection and discharge, and in-process monitoring will be performed in accordance with standard operating procedures. Non-routine activities will be performed in accordance with an activity plan that provides work instructions covering that activity. Activity Leaders will typically be assigned to oversee work performed for a non-routine activity; a Front-Line Supervisor may also function as an Activity Leader. Examples of non-routine activities that may be performed during remediation operations include:

- Modifying groundwater extraction or injection infrastructure or operations
- Collecting and analyzing samples not specified for in-process monitoring
- Plugging and abandoning monitor wells prior to termination of groundwater remediation

Front-Line Supervisors and Activity Leaders will report directly to the Trustee PM and indirectly to the RSO and QAC. As with all workers, Front-Line Supervisors have authority to stop work if conditions or the performance of work pose a risk to safety and health or the environment, or compliance with license, decommissioning plan, or quality requirements.

## 10.6 LICENSE TERMINATION

Few post-remediation monitoring and other license termination activities will be routine activities. These activities will be managed in the same manner as pre-construction activities, as discrete projects rather than as ongoing operations. For instance, the dismantling and demobilization of water treatment and waste processing systems will be managed as “deconstruction” projects. Activities such as radiological release surveys and post-remediation groundwater sampling will be managed as routine activities by Front-Line Supervisors. The individuals identified in Section 10.1 will maintain responsibility for the oversight of all activities performed to obtain license termination. Figure 10-4 presents an overview of the organizational positions.

## 10.7 TRAINING

All personnel performing decommissioning activities will receive training on the site-specific radiation protection program, the safety & health program, the quality assurance program, and the sampling and analysis plan and procedures, as appropriate. Personnel performing decommissioning operations or related activities (e.g., radiological surveys) will be task-qualified for the activities they will perform. Personnel performing activities under an activity plan will also be trained on the requirements of the activity plan.

Prior to performing a task for the first time, supervisors will generate, and the work crew will review, an Activity Hazard Analysis identifying potential radiological and non-radiological hazards and measures that will be implemented to mitigate or minimize the hazard. Supervisors then meet with all personnel performing decommissioning activities on a daily basis. Issues identified the previous day will be identified and measures implemented to improve safety, quality, or efficiency will be recorded. At a minimum, daily review of the Pre-Task Safety Analysis form and weekly records of safety meetings will be documented and maintained in the CERT document repository.

Radiation Safety Training requirements are tiered to provide an appropriate level of training based on the type of radiological work and individual will perform at the Cimarron Site. The Trustee PM and RSO shall not assume that radiation safety training has been adequately covered by prior employment or training. Radiation safety training is described in Section 2, “Training”, of the RPP (Appendix M).

## 10.8 CONTRACTOR SUPPORT

Nearly all decommissioning tasks will be performed by contractors. The Trust Administrator and the Trustee PM may be the only employees of the CERT; they will retain companies that will provide the resources for each position (e.g., RSO, QAC), project (e.g., construction, assessment), and operation (e.g., groundwater extraction, water treatment). All contractors must be qualified by evaluation by both the Trustee and the QAC. Contracts will require monthly reports on activities completed, cost and schedule status, activities to be performed during the next month(s), and issues identified and/or resolved during the reporting period.

Contractor managers (e.g., RSO, QAC, EPC Lead, Activity Leaders, and Front-Line Supervisors) will be responsible to ensure that their personnel receive training as described above, commensurate with the work they will perform. All contractor personnel will have stop work authority if conditions, procedures, or work practices threaten the safety or quality of the work.

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# 11.0 RADIATION PROTECTION PROGRAM

The RPP establishes radiation protection program requirements that will be implemented during decommissioning (extraction and treatment of uranium-impacted groundwater), specifically related to radiation safety controls and monitoring of workers. The licensee implemented a RPP that was approved by the NRC in Amendment 15 to license SNM-928. Since NRC approval, the RPP has been revised in accordance with License Condition 27(e) numerous times, each time reflecting changing conditions at the Site. Each year, evaluations performed by the ALARA Committee approving those changes, along with updated versions of the RPP, have been submitted to NRC, and have been reviewed during the numerous NRC inspections conducted since Amendment 15 established the change process. Revision 5 of the RPP is included as Appendix M of this Plan.

## 11.1 AIR MONITORING PROGRAM

The air monitoring program for the Cimarron Site is described in in Section 10.8 of the RPP. The RPP provides the following information:

- A demonstration that an air sampling program that is representative of the workers' breathing zones will be initiated whenever a worker's intake is likely to exceed the criteria in 10 CFR 20.1502(b).
- A description of the criteria used for selection of the placement of air samplers in work areas where potential for airborne hazards exists.
- A description of the criteria demonstrating that air samplers with appropriate sensitivities will be used; and that samples will be collected at appropriate frequencies.
- It is not anticipated that constant air monitors (CAMs) will be utilized. If needed, the RPP will be revised to provide a description of the conditions under which CAMs (or similar equipment), will be used, including a description of their readouts, annunciators, and alarm setpoints.
- A description of the conditions under which general air and breathing zone samplers will be used.
- A description of the criteria used to determine the frequency of calibration of the flow meters on the air samplers.
- A description of the action levels for air sampling results, including the actions to be taken when they are exceeded.
- A description of how minimum detectable activities (MDAs) for each specific radionuclide that may be collected in air samples are determined.

## 11.2 RESPIRATORY PROTECTION

The need for respiratory protection for radiological work is not envisioned at the Cimarron Site. Section 14 of the RPP provides a discussion of evaluations that will be conducted prior to process or operation changes to determine if a Respiratory Protection Program needs to be implemented. If needed, the program that will be generated and implemented will incorporate the following elements:

- A description of the process controls, engineering controls, or procedures to control concentrations of radioactive materials in air.
- A description of the evaluation that will be performed when it is not practical to apply engineering controls or procedures, that demonstrates that the use of respiratory protection equipment is ALARA.
- A description of the considerations used to demonstrate that respiratory protection equipment is appropriate for a specific task, based on the guidance on assigned protection factors (APF).
- A description of the medical screening and fit testing required before workers will use any respirator that is assigned a protection factor.
- A description of the written procedures maintained to address all the elements of the respiratory protection program.
- A description of the use, maintenance, and storage of respiratory protection devices in such a manner that they are not modified and are in like-new condition at the time of issue.
- A description of the respiratory equipment users' training program.
- A description of the considerations made when selecting respiratory protection equipment to mitigate existing chemical or other respiratory hazards instead of (or in addition to) radioactive hazards.

## 11.3 INTERNAL EXPOSURE DETERMINATION

The program to determine internal exposure for the Cimarron Site is described in in Section 6.6 of the RPP. As discussed in Section 6.6 of the RPP, the need for internal monitoring is not envisioned. The RPP provides the technical basis for determining that internal monitoring of workers is not needed and commits to re-evaluating this need based upon facility design changes and operating experience. In addition, the Section 10.8 of the RPP discusses air sampling that will be conducted to confirm that internal monitoring is not needed and how air sampling may be used to determine worker intakes, if necessary. However, if internal monitoring is needed, the RPP commits to preparing and implementing procedures which provide the following information:

- A description of the monitoring to be performed to determine worker exposure during routine operations, special operations, maintenance, and clean-up activities.
- A description of how worker intakes are determined using measurements of quantities of radionuclides excreted from or retained in the human body. The description will include the following:

  - o How frequencies for bioassay measurements for baseline, periodic, special, and termination assays are assigned.
  - o How radioactivity measured in the human body by bioassay techniques are converted into worker intake.
  - o Action levels for bioassay samples, actions to be taken when they are exceeded, and their technical bases.
- A description of how worker intakes are determined by measurements of the concentrations of airborne radioactive materials in the workplace. To determine worker intake by measurements of the concentrations of airborne radioactive materials in the workplace, the description will include the following:
  - o How airborne concentrations of radioactivity are measured.
  - o How airborne concentrations are converted to determine intakes.
  - o Action levels for a worker's intake based on dose, and actions to be taken when they are exceeded.
  - o Action levels for a worker's intake based on chemical toxicity if soluble uranium is present in the work area.
  - o A description of how worker intakes, for an adult, a minor, and a declared-pregnant woman (DPW) are determined using any combination of the measurements above.
  - o A description of how worker intakes are converted into committed effective dose equivalent (and organ-specific committed dose equivalent), including how the intake of radioactivity by a DPW will be converted into a dose to the embryo/fetus.

## 11.4 EXTERNAL EXPOSURE DETERMINATION

The program to determine external exposure for the Cimarron Site is described in in Section 6.5 of the RPP. As discussed in Section 6.5 of the RPP, the need for external monitoring is not envisioned. The RPP provides the technical basis for determining that external monitoring of workers is not needed and commits to re-evaluating this need based upon facility design changes and operating experience. Area radiation monitoring, as described in the RPP, will be used to demonstrate that external monitoring thresholds have not been exceeded. However, if external monitoring is needed, the RPP commits to prepare and implement procedures which provide the following information:

- A description of the individual-monitoring devices that will be provided to workers who meet the criteria in 10 CFR 20.1502(a) and 20.1601 for external exposures.
- A description of the type, range, sensitivity, and accuracy of each individual-monitoring device.
- A description of the use of extremity and whole-body monitors when the external radiation field is non-uniform.
- A description of when audible-alarm dosimeters and pocket dosimeters will be provided, and a description of their performance specifications.
- A description of how external dose from airborne radioactive material is determined.

- A description of the procedure to ensure that surveys necessary to supplement personnel monitoring are performed.
- A description of the action levels for workers' external exposure, including the technical bases and actions to be taken when they are exceeded.

## 11.5 SUMMATION OF INTERNAL AND EXTERNAL EXPOSURE

The program to determine radiation exposure for the Cimarron Site is described in in Section 6.0 of the RPP. As discussed in Sections 6.5 and 6.6 of the RPP, the need for internal or external monitoring is not envisioned. Section 6.8 of the RPP commits to the preparation and implementation of procedures which will provide the following information for the summation of internal and external exposure, if needed:

- A description of how the internal and external monitoring results are used to calculate Total Organ Dose Equivalent (TODE) and TEDE doses to occupational workers.
- A description of how internal doses to the embryo/fetus, which is based on the intake of an occupationally exposed, declared-pregnant woman, will be determined.
- A description of the monitoring of the intake of a declared-pregnant woman if determined to be necessary.
- A description of the program for the preparation, retention and reporting of records for occupational radiation exposures.

## 11.6 CONTAMINATION CONTROL PROGRAM

The contamination control program for the Cimarron Site is described in in Sections 8.0 and 12.0 of the RPP. The RPP provides the following information:

- A description of the written procedures to control both access to and stay time in contaminated areas by workers if they are needed (Section 8.2.1).
- A description of surveys to supplement personnel monitoring for workers during routine operations, maintenance, clean-up activities, and special operations (Section 8.2.1).
- A description in matrix or tabular form that describes contamination action limits (i.e., actions taken either to decontaminate a person, place, or area, or to restrict access, or to modify the type or frequency of radiological monitoring).
- A description (included in the matrix or table mentioned above) of radiological contamination guidelines for specifying and modifying the frequency for each type of survey used to assess the reduction of total contamination.
- A description of the procedures used to test sealed sources and to ensure that sealed sources are leak tested at appropriate intervals if such sources are obtained for use at the Cimarron Site.

Note: NUREG-1757 states that the RPP should provide a description of the surveys that will be performed to determine the baseline of background radiation levels and radioactivity from natural sources for areas where decommissioning activities will take place. However, background levels have already been established, as described in Section 3.6 of this Plan.

## 11.7 INSTRUMENT PROGRAM

The Radiation Protection Instrumentation program for the Cimarron Site is described in in Section 7.0 of the RPP. The RPP provides the following information:

- A description of the instruments to be used to support the health and safety program including the manufacturer's name, the intended use of the instrument, the number of units available for the intended use, the ranges on each scale, the counting mode, and the alarm set-points.
- A description of instrumentation storage, calibration and maintenance facilities for instruments used in field surveys, including onsite facilities used for laboratory analyses of samples collected during surveys.
- A description of the method used to estimate the Minimum Detectable Concentration (MDC) or MDA (at the 95 percent confidence level) for each type of radiation to be detected.
- A description of the instrument calibration and quality assurance procedures
- A description of the methods used to estimate uncertainty bounds for each type of instrumental measurement (Section 13.3).
- A description of air sampling calibration procedures or a statement that the air sampler instrument air flow indicators will be calibrated in accordance with manufacturer's recommendations using a reference air flow calibrator that has been calibrated by an accredited laboratory.

Analytical laboratory measurements are performed by others. For field measurements, other than release surveys and measurement used as part of the final status survey documentation, evaluations of uncertainty are not important. The RPP includes a requirement that survey plans developed for the release of property or equipment associated with non-routine activities will include methods used to estimate uncertainty bounds for each type of instrument measurement consistent with the methodology provided in NUREG/CR-5849 section 8.2. Final status surveys will be conducted as part of license termination and will be subject to future development and submittal to NRC for approval.

## 11.8 NUCLEAR CRITICALITY SAFETY

The National Academies' *Affordable Cleanup?: Opportunities for Cost Reduction in the Decontamination and Decommissioning of the Nation's Uranium Enrichment Facilities* (National Academy of Sciences, 1996) states, "Criticality is not possible in unmoderated uranium with less than 5 percent by weight 235U." Nevertheless, a nuclear criticality safety analysis was conducted to assess the potential for nuclear criticality as the low-enriched licensed material accumulates on the resin during treatment.

The program to assure nuclear criticality safety for the Cimarron Site is described in in Section 11.2 of the RPP. This includes responsibilities, training, and basic parameters necessary to stay within the nuclear criticality safety analysis described below. Operational Nuclear Criticality Safety is implemented by maintaining knowledge and control of the mass and concentration of SNM on the Site. Section 11.2 of the RPP describes the Material Control and Accounting Program which will maintain an inventory of uranium processed at the Site and ensure that license possession limits for U-235 are not exceeded. The following information describes the analysis that was conducted to evaluate nuclear criticality safety during operations.

### 11.8.1 Groundwater Handling and Storage

The highest concentration of uranium in the groundwater is in the BA1 area. The highest measured uranium concentration in groundwater from BA1 was 5,110 µg/L, from a sample collected in 2013. At 1.3% enrichment, this is equivalent to 66.4 micrograms (µg) of fissile material per kg of non-fissile material. This is less than 5,000 times less concentrated than the definition for fissile exempt material (500,000 µg of fissile per kg of non-fissile). This demonstrates that there is a large margin of safety for the handling and storage of untreated groundwater with respect to nuclear criticality safety. No special precautions will be required.

### 11.8.2 Groundwater Treatment by Ion-Exchange

Based on the information obtained during the groundwater treatment program, collection of enriched uranium on the ion-exchange resin will concentrate the U-235 to concentrations that may exceed the transportation definition for fissile exempt material but to less than a criticality safe mass limit. Appendix N provides the results of the evaluation that was conducted to demonstrate nuclear criticality safety for the groundwater treatment system during operations. Process and administrative controls will monitor and control the accumulation of uranium in the groundwater treatment system as described in Section 11.2 of the RPP.

### 11.8.3 Packaged Materials

The resin processing operation involves blending resin with non-resin material. Blending will result in uniform distribution of SNM throughout the packaged waste matrix in compliance with the transportation requirements. Discussions have been held with a proposed waste disposal site to confirm that the packaged waste does conform to the WAC for that site. Appendix H provides the analysis used to demonstrate that packaged waste that has been demonstrated to comply with fissile exemption criteria.

All packaged materials that are stored on-site in preparation for shipment off-site for disposal will meet all transportation regulatory requirements for the shipment of enriched uranium. None of the processes to be conducted on-site are capable of extracting the enriched uranium from waste materials that have been prepared for shipment and disposal.

### 11.8.4 Nuclear Criticality Accident Monitoring System

Condition 19 of License SNM-928 provides an exemption from the provisions of 10 CFR 70.24, "Criticality Accident Requirements". Maintaining a site-wide possession limit of 1,200 grams of U-235 obviates the need for a criticality accident monitoring system.

## 11.9 HEALTH PHYSICS AUDITS, INSPECTIONS, AND RECORDKEEPING

The program describing the assessment of the radiation protection program is provided in Section 5.0 of the RPP, which includes the following information:

- A general description of the annual program review conducted by executive management.
- A description of the records to be maintained of the annual program review and executive audits.
- A description of the types and frequencies of surveys and audits to be performed by the RSO and RP staff.
- A description of the process used in evaluating and dealing with violations of NRC requirements or license commitments identified during audits.
- A description of the records maintained of RSO audits.

## 11.10 SNM INVENTORY CONTROL AND ACCOUNTING

The program for nuclear material inventory control and accounting is provided in Section 11.2 of the RPP. Plans and procedures will be established and implemented at the Cimarron Site to ensure compliance with special nuclear material (SNM) possession limits addressed in NRC regulations and License SNM-928.

All measurements associated with the determination of the mass of enriched uranium recovered from the underground aquifer and concentrated in ion exchange resin will be included in the accounting of the total SNM present aboveground. This includes all treatment system components subsequent to the groundwater extraction wells. Certain components will contain small quantities of

SNM and these may be assigned a conservative fixed value for the mass present. These SNM mass determinations are important to:

- Demonstrate compliance with the license possession limits specified in Condition #8 of License SNM-928.
- Demonstrate compliance with the requirements for the transport of radioactive material under the provisions of the transportation regulations.

License Condition 8 of License Number SNM-928 stipulates the “Maximum Amount the Licensee May Possess at Any One Time Under This License". Section 6.2, “License Condition 8 – Possession Limit” proposes to amend the license to provide a 1,200-gram possession limit for uranium in the treatment systems, and a separate possession limit for all uranium on site, including that in drums which contain the spent resin/absorbent material that complies with the fissile release exemption criteria. The procedures for nuclear material inventory control and accounting will provide for compliance with the license possession limits by establishing methods for adding the SNM content of materials recovered from the groundwater to an inventory log and for removing SNM from the inventory when a waste is shipped or disposed.

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# 12.0 ENVIRONMENTAL MONITORING AND CONTROL

The July 1999 Environmental Assessment (EA) and August 1999 Safety Evaluation Report (SER) discuss an environmental monitoring program as a safeguard for limiting effluent releases to the environment and radiation exposure to workers and the public. The licensee committed to performing environmental monitoring at various locations to maintain compliance with license conditions and applicable regulations. The environmental monitoring program has changed over the years. The former process buildings were decommissioned and released from the license.

The EA and SER discuss the use of environmental air sampling and thermoluminescent dosimeters to monitor for releases and exposure in the environment. Decommissioning activities that could generate airborne suspension of particulates or airborne effluents ended, so environmental air sampling was discontinued. Air sampling and exposure rate surveys will be conducted in groundwater processing and waste treatment and storage areas as deemed appropriate by the RSO. The RPP describes the air sampling program and radiation monitoring program that ensure that will ensure that exposures to workers and the public meet regulatory limits and are ALARA.

Annual collection and analysis of soil, vegetation, and surface-water and groundwater were also discussed in the EA and SER. Sampling and analysis of vegetation and soil (for environmental monitoring purposes) was discontinued in 2000. The decommissioning of soil has been completed and both surface and subsurface soil have been shown to comply with unrestricted release criteria site-wide. Section 8.6 provides both in-process and post-decommissioning monitoring programs; these will replace the existing surface water and groundwater monitoring program.

## 12.1 ENVIRONMENTAL ALARA EVALUATION

### 12.1.1 ALARA Goals

In accordance with License Condition 27(e) of NRC License No. SNM-926, the licensee has established an ALARA Committee. The RPP describes the composition of the ALARA committee that includes a designated ALARA Committee chairman. Per License Condition 27(e), the ALARA committee will at a minimum consist of the following:

- One member with expertise in management who has managerial and financial responsibility for the decommissioning of the Site.
- One member with expertise in decommissioning who is responsible for site decommissioning.

- The Radiation Safety Officer who is responsible for ensuring conformance to radiation safety and environmental requirements.

License Condition 27(e) also specifies the evaluation the ALARA Committee must perform to determine if tests or changes to the Decommissioning Plan, or the Radiation Protection Plan require NRC approval. If not, the ALARA Committee can approve the test or change without NRC approval. The ALARA Committee sets ALARA dose goals for the Cimarron Site.

This Plan restricts the concentration of licensed material in effluents generated during decommissioning to less than the MCL. The MCL is the ALARA goal for both uranium and Tc-99 at the Site; the ALARA goal for uranium applies to the uranium daughters as well.

A proposed change to the decommissioning process that could impact effluent concentrations would require the ALARA Committee to review the proposed change in accordance with License Condition 27(e). The change evaluation will be documented and maintained on-site for review during regulatory inspections.

ALARA Committee meeting agenda and minutes, change evaluations and approvals of changes, and proposed and/or approved modifications of ALARA goals and processes, are distributed to all members of the ALARA Committee. Consequently, management remains fully informed of all ALARA issues associated with the decommissioning and release of the Site.

### 12.1.2 ALARA Controls

In keeping with the ALARA principle, the highest priority in maintaining doses ALARA involves engineering controls designed to minimize the potential for release of untreated water outside of the treatment system or treated water to injection or discharge components. The addition of a third resin vessel to the ion exchange treatment system to reduce the concentration of both uranium and Tc-99 to far less than the MCL represents one application of the ALARA principle to the treatment system design.

Influent tanks will be double-walled tanks equipped with sensors to detect a leak from the inner tank; pumping will be shut down and an alarm will be generated if such a leak is detected. High-level and low-level switches will provide data to the control system to adjust flows from the well field to prevent excessive flow to the treatment skids.

The filtration system is equipped with a containment with a capacity such that any leak from the filters will be identified and captured. Like the double-walled influent tanks, pumping will be shut down and an alarm will be generated if such a leak is detected.

The treatment skids are equipped with containment ceiling and “walls” and a containment capacity such that any leak from the treatment system will be identified and captured. Like the double-walled influent tanks, pumping will be shut down and an alarm will be generated if such a leak is detected.

In-line, automated controls of flow rates, water levels in influent and effluent tanks, pre- and post-filtration pressure, and pre- and post-pH adjustment minimize the potential for the treatment systems to fail to achieve treatment standards. The resin processing system was designed to provide containment throughout all resin processing and packaging to the extent reasonable. These controls are described in Sections 8.3.1, “Uranium Treatment Facilities”, and 8.3.2, “Uranium Treatment Systems”, and shown on various drawings in Appendix J.

Administrative controls will include training on the control system, monitoring and adjustment of flows, pressures, and pH, resin processing and packaging, waste characterization and manifesting, and the radiological monitoring and controls associated with all of this. Procedures will be developed to provide instructions on:

- Adjusting process controls,
- Collecting, packaging, and shipping samples of groundwater, in-process water, and processed resin for laboratory analysis,
- Changing out resin vessels and processing and packaging resin,
- Transferring and storing resin vessels and processed waste,
- Loading waste for transportation to disposal facilities.
- Performing radiological surveys, data evaluation, and other radiation protection functions (e.g., inventory documentation, internal exposure determination, etc.) as described in Section 11, “Radiation Protection Program”.

In addition, personnel operating groundwater treatment and waste processing systems and transporting and storing materials will meet on a regular basis with professional supervisory staff to provide updates on progress and issues identified, to adjust controls as appropriate, and to maintain management involvement in the groundwater remediation process.

## 12.2 EFFLUENT MONITORING

The extent and concentration of both licensed material (i.e., uranium) and non-radiological contaminants of concern (i.e., nitrate and fluoride) have been established as described in Section 3.5.3 of this Plan.

Once groundwater remediation begins, effluent will consist of extracted groundwater containing COC concentrations that are less than their permit limits. Effluent will be discharged to the Cimarron River via DEQ-permitted Outfall 001. The location of Outfall 001 is shown on Drawing C002 in Appendix I-2. Samples of the discharge will be collected from a sampling port installed on the pipeline discharging from Effluent Tank TK-102. Samples will be collected in accordance with a procedure which will be developed and approved in accordance with Section 5.10, “Plan and Procedure Approval”, of the Quality Assurance Program Plan (QAPP). Discharge samples are collected near the effluent tanks because they are located outside of the 100-year floodplain and are not subject to flooding. Samples will be analyzed in accordance with OPDES Permit requirements.

Only treated water containing uranium concentrations less than the OPDES permit limit can be discharged to the Cimarron River ***or*** reinjected into treated water injection trenches. Monitoring the effluent from each vessel provides sufficient information to prevent the release of licensed material exceeding discharge limits.

As described in Section 8.3.2, an extended system shutdown may result in a release of uranium from the lead ion exchange vessel. Although the lag and polishing vessels should capture any uranium released from the lead vessel, if a shutdown exceeds 24 hours, the lead vessel will be removed from the system and processed for disposal. The removed vessel will be replaced with a vessel containing fresh resin, and the valves will be adjusted to redirect the flow of water as for any other resin vessel exchange. In this way, any groundwater in which the concentration of uranium may exceed the MCL will be reprocessed. In addition, Drawing P-115, Sheet 1 in Appendix J-3 shows that effluent from the polishing vessel can be routed back through the ion exchange system for additional processing, if needed.

If laboratory analytical results for a sample collected from the effluent from the polishing vessel exceed 10 µg/L for uranium, an evaluation will be conducted to determine if an exceedance of the OPDES permit limit may have occurred. If so, exchange and replacement of the lead vessel will be performed before resuming groundwater extraction and water treatment.

If no treated water were to be injected (the most conservative assumption), 207 gallons per minute (gpm) of groundwater would be discharged to the Cimarron River. At a low flow condition of 43.6 cfs (see Section 2.6.1, “Cimarron River”), the flow in the Cimarron River would be 26,928 gpm. The dilution factor at these conditions would be approximately 130.

The effluent is expected to contain essentially no uranium; however, if the action limit of 10 µg/L uranium were present in the effluent, the calculated concentration of uranium in the Cimarron River, assuming low flow conditions as described above, would be approximately 0.077 µg/L, barely above the laboratory detection limit for dissolved uranium (0.067 µg/L). For Tc-99 and the uranium daughters; the impact to the Cimarron River would not be detectable. There will be no dose to workers or members of the public.

Sample collection frequency, compositing, and analytical methods will be stipulated in the OPDES permit. A procedure for discharge sampling will be prepared in accordance with the Site quality assurance program and added to the DEQ-approved Sampling and Analysis Plan.

The OPDES permit is expected to specify daily maximum concentration limits of 30 µg/L for uranium and 10 mg/L for fluoride. The permit will require the pH of discharged water to remain between 6.5 and 9.0. The permit is not expected to stipulate a limit for nitrate; however, the permit may require reporting of effluent nitrate concentrations.

In this Plan, it is assumed that samples will be collected twice monthly and analyzed for pH, uranium, nitrate, and fluoride. The minimum quantification limit for nitrate is 50 µg/L; samples will be analyzed for nitrate by method EPA 353.2, which has a detection limit of 17 µg/L. The minimum quantification limit for fluoride is 1,000 µg/L; samples will be analyzed for fluoride by method EPA 300.0, which has a detection limit of 66 µg/L. There is no specified minimum quantification limit for uranium; samples will be analyzed for uranium by method EPA 200.8, which has a detection limit of 0.067 µg/L, significantly less than the permit limit of 30 µg/L.

Laboratory analytical data will undergo data quality review in accordance with *National Functional Guidelines for Inorganic Superfund Methods Data Review* (EPA, 2017). Sampling, analysis, and recordkeeping will be performed in accordance with Sections 5.4, “Sampling and Analysis Procedures (SAPs)”, 8.2, “Quality Control in Environmental and Effluent Sampling”, and 12.1, “Quality Assurance Records” of the QAPP.

As stated in Section 8.6.3, because the expected WATF influent Tc-99 concentration is expected to comply with the EPA drinking water standard, which is lower than the NRC standard, Tc-99 will not be addressed in the OPDES permit application; consequently, the OPDES permit will not stipulate a limit for Tc-99, nor will it require monitoring for Tc-99. Section 8.6.3 includes a demonstration of compliance with NRC effluent criteria stipulated in 10 CFR 20.2001.

Other radionuclides that may be present in the effluent include Th-234 and Th-231. Pa-234 will not be present in the effluent because its half-life is too short to still be present in the effluent. Section 8.6.3 demonstrates that even if Tc-99 and all uranium daughters are present at the same concentration as the influent, the concentration of all radionuclides combined will be a small fraction of the effluent limits stipulated in 10 CFR 20.2001. No controls or in-process monitoring is therefore needed for these daughter radionuclides.

OPDES permits are issued for a five-year period. The OPDES permit is expected to require reporting of flow and analytical results on a monthly discharge monitoring report by the fifteenth day of each month.

## 12.3 EFFLUENT CONTROL

Excluding discharges of treated water to the Cimarron River in accordance with the OPDES permit, releases of radioactive material to the environment can occur during groundwater remediation through:

- A leak or leaks in well heads or vaults
- A leak or leaks in piping or intermediate vaults
- A release of contaminated water from influent tanks
- A release of contaminated water from the filter systems
- Failure of an ion exchange vessel that has processed impacted groundwater

A leak or leaks from the well head, piping, or intermediate vaults would return the uranium to the groundwater, or to the vadose zone above the groundwater. These should be considered releases, not effluents, because they are not accessible to workers or members of the public.

Influent tanks are double-walled tanks with leak detection between the tank walls. Should the interior tank in an influent tank develop a leak, the leak detection sensor will trigger the control system to shut off all groundwater extraction pumps. As the treatment system continues to operate, the low-level sensor will then trigger a shut-down of the pumps transferring water to the treatment system. Even if both tanks fail simultaneously (and catastrophically), the maximum volume of impacted water that could be released would be a single volume of the influent tank.

The filtration system is equipped with a containment with a capacity such that any leak from the filters will be identified and captured. Like the double-walled influent tanks, pumping will be shut down and an alarm will be generated if such a leak is detected.

Each uranium treatment train is installed within a shallow containment. If a resin vessel (or a connection to a resin vessel) develops a leak, a conductivity sensor will trigger a shut-down of the pumps transferring groundwater from the influent tank to the treatment train. The maximum volume of the release will therefore be the volume of water in the treatment train. Because most of this water has already been in contact with the resin, the concentration of licensed material in the resin will be significantly less than that of the influent.

Any release of contaminated water any of these systems will be evaluated to demonstrate compliance with dose limits set forth in 10 CFR 20.1302, and radiological surveys will be conducted to demonstrate that materials and equipment comply with unrestricted release limits.

There is no release of impacted water to a sewer system, so the requirements of 10 CFR 20.2003 do not apply to the decommissioning of the Site.

## 12.4 STORMWATER CONTROL

Stormwater runoff during construction activities has the potential to impact the environment, particularly surface water. As discussed in Section 5.6.13, A Notice of Intent to comply with OPDES General Permit OKR10 will be submitted to the DEQ for authorization to discharge stormwater. The SWPPP for the full-scale construction project will be prepared after the 90% design is complete and RAIs have been received and reviewed.

BMPs will be installed, and corrective measures will be conducted and documented in accordance with SWPPP requirements. A Notice of Termination for the OPDES General Permit will be submitted following establishment of a minimum 70% coverage with perennial vegetation.

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# 13.0 RADIOACTIVE WASTE MANAGEMENT

## 13.1 SOLID RADIOACTIVE WASTE

All solid radioactive waste will be Class A waste. Solid radioactive waste generated by groundwater remediation activities will fall into one of two categories:

- Spent anion resin
- Potentially contaminated material; examples include the following:
  - Protective clothing, materials, and equipment used to maintain the systems and process groundwater (also referred to as dry active waste, or DAW)
  - Contaminated piping and equipment removed from ion exchange treatment systems

### 13.1.1 Spent Anion Resin

Each resin vessel will contain approximately 750 kg resin. Estimates based on the anticipated worst-case concentration of uranium in influent groundwater indicate that no resin vessel will ever theoretically accumulate more than 450 grams of U-235; as the concentration of uranium in the influent declines, the adsorption capacity of the resin declines. The total mass of U-235 in both treatment trains combined is not expected to exceed 800 grams at any given time.

The resin processing operation involves blending spent resin with non-fissile material in a ribbon blender. No chemicals will be used; the non-fissile material will consist of an inorganic absorbent. Mixing in the ribbon blender will result in the uniform distribution of SNM throughout the resin/additive mixture (blended waste) in compliance with transportation requirements. The blended waste will be packaged in 55-gallon drums (or other suitable containers as required).

Uranium activity concentrations and the total activity of the consignment in the drums of resin/waste mixture waste will exceed DOT’s 49 CFR 173.436 threshold for radioactive material (i.e., Class 7); therefore, the processed resin be transported in accordance with the transportation requirements for radioactive material. However, the waste will contain less than one-gram U-235 per 2 kg non-fissile material and will therefore be considered fissile exempt (i.e., the resin waste will be Class A, fissile exempt, low level radioactive waste).

Initially, a sample will be collected from each drum for analysis for the mass concentration of uranium. The collection of multiple samples from a single batch provides the data needed to assess the homogeneity of the processed resin waste mixture. Analytical data will provide the information needed to fill out shipping documentation and to document that fissile exemption and disposal criteria have been met. Table 8-6 presents the identification and analytical methods for samples of processed resin.

The homogeneity of the blended spent resin material will be assessed by conducting a process qualification on at least one batch. The Student's t-test will be used as the statistical measurement of homogeneity. If no individual sample result is significantly different from the average for all the samples at the 90% level of confidence ($\alpha = 0.05$) for all the samples, the process will be qualified as producing a homogenous mixture.

During operations, four 55-gallon drums of processed resin waste will be loaded onto a pallet and the drums will be strapped together. Each pallet of drums will be placed in the spent resin storage area located in the southern portion of the WATF building. Drawing G-100 (Appendix J-2) depicts the placement of jersey barriers in this portion of the building to delineate these storage areas. The palleted drums will remain in the storage area until enough drums have accumulated to constitute a full consignment. The spent resin mixture will then be shipped by common carrier to a licensed disposal facility for disposal as Class A, fissile exempt, low level radioactive waste.

The blended waste will be certified as in compliance with the WAC for the disposal site. The blended waste will comply with the following requirements:

- The SNM will be uniformly distributed throughout the matrix of resin. This material is considered soil-like but is not a $SiO_2$ matrix.
- The waste form will be in containers which will be received and disposed of at the licensed disposal site in accordance with the disposal site's license requirements for containerized waste.

Discussions have been held with two potential waste disposal facilities: Energy*Solutions* in Utah and Waste Control Specialists in Texas, to confirm that the packaged waste will conform with their respective WAC. The analysis demonstrating that a potential criticality condition related to the transportation or disposal of the spent resin mixture is not credible has been incorporated into Appendix N.

### 13.1.2 Potentially Contaminated Material

Tubing, filters, and other materials which only contact groundwater post-treatment (e.g., injection piping, tubing, etc.) will be disposed of as solid waste. Single use in-line filters and tubing used to collect samples from monitor wells will also be disposed of as solid waste.

Two drums containing potentially contaminated material are currently stored in a secured area of the CERT office building. Once construction is complete, these two drums will be relocated to the storage area located in the southern portion of the WATF building. Potentially contaminated material such as described above will initially be placed in these drums until they are full, and they will then be transferred to the storage area located in the southern portion of the WATF building.

Small diameter tubing, in-line filters, and other materials which repeatedly contact untreated water, and which cannot be surveyed practically to demonstrate that they are releasable for unrestricted use, will be assumed to be radioactively contaminated and segregated from other solid waste for disposal. This potentially contaminated material will be packaged and shipped to a licensed disposal facility for disposal as Class A fissile exempt waste. This waste is estimated to be less than 15% of the total volume of radioactively contaminated waste.

If a method for bulk survey of these materials is developed, these materials may be bulk surveyed to demonstrate that they comply with unrestricted release criteria, so they can be disposed of as solid waste, reducing the cost of disposal.

### 13.1.3 Volumetrically Contaminated Material

Subsurface soil will be brought to the surface during installation of injection and extraction trenches, monitoring wells, trenches for piping and utilities, etc. As provided in the D-Plan, there will be no excavation in any area of the Site where there is known to be soil at depths greater than 4 feet that exceeds a net 30 pCi/g uranium. The subsections below discuss requirements for surveying and sampling subsurface material at the Site. Results will determine if the subsurface material contains contamination exceeding a net 30 pCi/g uranium. Walk-over surveys (gamma surveys herein) using a sensitive gamma detection instrument such as ratemeter with a 2-inch by 2-inch sodium iodide (NaI) detector will be used to determine relative levels of radioactivity. Instrument selection will be approved by the RSO and identified in the applicable desk instruction or activity plan.

#### *Foreign or Suspect Materials*

Gamma surveys will be performed should soil-like material (e.g., crushed asphalt, debris, etc.) which may be volumetrically contaminated be encountered during excavation of trenches for piping, instrumentation, foundations, etc. Soil-like material yielding elevated gamma counts per minute will be removed, segregated, and sampled for laboratory analysis;

if not releasable, the material will be packaged and disposed of as low-level radioactive waste.

### Shallow Excavations

Gamma surveys shall be performed when subsurface soil is brought to the surface during trenching for installation of instrumentation, piping, and utilities, and other excavations 4 feet or less in depth. Instructions for performing and documenting the survey shall be documented in a desk instruction or activity plan to include the following:

- A walkover gamma survey shall be performed over the length of the spoils. A zig-zag pattern should be employed to identify "hot spots" (i.e., activity detected greater than twice background).
- A soil sample shall be taken once every 100 feet along the length of the trench and at "hot spot" locations. If a "hot spot" area persists over an area greater than 10 feet in diameter, then the RSO will evaluate the survey results and determine if additional sampling in that area is warranted.

### Deep Excavations

Gamma surveys shall be performed when subsurface soil is brought to the surface during the installation of extraction and injection trenches and other excavations that are 4 feet or greater in depth. Instructions for performing and documenting the survey shall be documented in a desk instruction or activity plan to include the following:

- A walkover survey shall be performed over the length of the spoils. A zig-zag pattern should be employed to identify "hot spots" (i.e., activity detected greater than twice background).
- A soil sample shall be taken once every 50 feet and at "hot spot" locations. If a "hot spot" area persists over an area greater than 10 feet in diameter, then the RSO will evaluate the survey results and determine if additional sampling in that area is warranted.

### Borings and Wells

Borings for monitoring and extraction wells will yield soil cores varying from less than two feet to five feet in length. Each increment shall be surveyed using a sensitive gamma detector (e.g., 2-inch by 2-inch NaI detector or alternate approved by the RSO). A minimum of one soil sample shall be taken from each 5-foot depth interval at the location where the highest activity level is detected.

### WATF Disturbed Area

Grading required for construction of the WATF will involve excavation of soils and back-fill with clean imported material. Surveys and soil sampling are not required in areas where clean back-fill material is placed. Consistent with the methodology discussed in NUREG/CR-5849 for affected areas, soil sampling shall be performed in areas where excavated soil forms the final grade following completion of civil construction activities. A 10-meter grid will be established over the area, and a gamma walk-over gamma survey will be employed to collect soil samples at a depth of 0 to 6 inches at the location that yields the highest gamma counts per minute in each grid.

### BARF Disturbed Area

Grading required for construction of the BARF will involve cut and fill, in which subsurface soil will be exposed at final grade in some areas, and excavated soil will be placed over what had been surface soil in other areas. Surveys and soil sampling shall be performed following completion of construction activities. Consistent with the methodology for affected areas provided in NUREG/CR-5849, a 10-meter grid will be established over the area, and a gamma walk-over gamma survey will be employed to collect soil samples at a depth of 0 to 6 inches at the location that yields the highest gamma counts per minute in each grid.

### 1206 Sediment/Spoils Mixture

As discussed in section 8.2.4 (1206-North) of the D-Plan, the 1206 Drainage is unique in that it is the only area in which excavation and disposition of sediment will be performed as a groundwater remediation strategy. The sediment will be mixed with excess spoils generated during trench excavation and placed in a soil laydown area. Following mixing and placement, vegetation will be established over the material.

After placement of the sediment/spoils mixture is complete, a 10-meter grid will be established over the laydown area. Samples of the mixture will be collected at each grid location. Composite samples representing each one-foot depth interval will be collected from each location. Duplicate samples will be collected at a minimum of 10% of the 10-meter grid locations.

Samples collected from the 10-meter grid locations will be submitted for isotopic analysis. An additional set of 20 “confirmatory” samples will be collected from randomly selected 10-meter grid locations. These samples will be retained should the NRC desire to analyze those samples for confirmatory survey or inter-laboratory comparison.

For each 10-meter sample that yields less than 30 pCi/g total uranium above background, the material within that grid will be considered in compliance with the NRC license criterion. Should a sample from a 10-meter grid location exceed 30 pCi/g above background, samples of the sediment/spoils mixture will be collected from the same depth interval on a 5-meter grid surrounding that sample to demonstrate that the average activity over a 100 m2 area complies with the license criterion. If the average activity for the 10-meter grid sample and the four surrounding 5-meter grid locations is less than the license criterion, the material within that grid will be considered in compliance with the license criterion.

Should any grid/depth interval exceed the license criterion, that material will be excavated, placed in drums along with sufficient absorbent to ensure that there will be no free liquid and disposed of as low-level radioactive waste.

### 13.1.4 Storage of Solid Radioactive Waste

During operations, spent resin/absorbent and potentially contaminated material will be stored in designated areas in the southern portion of the WATF building. Three areas will be designated for the storage of packaged (i.e., drummed) waste:

- One area for palleted drums of spent resin/absorbent which has been sampled, but for which analytical data has not been received.
- One area for palleted drums of spent resin/absorbent for which analytical data shows that the waste complies with fissile exempt criteria and the licensed disposal facility’s waste acceptance criteria, but for which shipping forms/manifests have not yet been generated.
- One area where packaged resin waste is ready to ship. “Ready to ship” means that radiological surveys of packages have been completed and shipping forms/manifests have been filled out.
- One area for palleted drums of spent resin/absorbent for which analytical data shows that the waste does not comply with fissile exempt criteria or the licensed disposal facility’s waste acceptance criteria. It is not anticipated that this area will be needed, but a storage area for waste that requires repackaging or reprocessing will be established as a contingency measure.

These dedicated areas will be clearly delineated with postings and physical barriers (e.g., jersey barriers).

## 13.2 LIQUID RADIOACTIVE WASTE

All effluent will contain licensed material at concentrations below NRC effluent limits listed in 10 CFR Appendix B to Part 20. No liquid radioactive waste will be generated during decommissioning operations. Effluent from groundwater treatment will either be injected into impacted areas in accordance with Oklahoma's UIC program or discharged to the Cimarron River in accordance with an OPDES permit.

## 13.3 MIXED WASTE

There are no hazardous constituents in the groundwater, and pH adjustment (for uranium treatment) will not result in the generation of hazardous waste. As a result, no mixed waste will be generated during decommissioning operations.

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# 14.0 QUALITY ASSURANCE

The CERT Trustee is dedicated to promoting quality at every level of Cimarron Site work, and to fostering an environment that encourages continual quality improvement. The CERT Quality Assurance (QA) Program provides adequate controls to support site decommissioning.

The current revision of the Cimarron Site QAPP is included as Appendix O to the Decommissioning Plan. The QAPP establishes a Quality Assurance Program meeting the applicable requirements of the following:

- NUREG-1757, *Consolidated Decommissioning Guidance, Decommissioning Process for Material Licensees* (USNRC, 2006)
- NRC Regulatory Guide 4.15, *Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination) – Effluent Streams and the Environment* (USNRC, 2007)
- NRC License SNM-928

In addition, quality requirements not required by NUREG 4.15 or NUREG 1757 were included in this QA program; these were obtained from various sources including NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications*.

## 14.1 QUALITY ASSURANCE PROGRAM

QAPP Section 1.0 provides an overview of the purpose and the applicability of the quality assurance program. The quality assurance program applies to all quality-critical design and activities performed for the decommissioning of the Cimarron Site as well as provide compliance with all regulatory and license requirements.

## 14.2 GLOSSARY

QAPP Section 2.0 provides a glossary defining terms related to the quality assurance program.

## 14.3 ORGANIZATIONAL STRUCTURE AND RESPONSIBILITIES

QAPP Section 3.0 provides the structure of the organization as it relates to the Quality Assurance Program. The authorities, duties, and responsibilities of the positions within this organization, down to the first-line supervisory level, are described. This includes the following:

- A description of the QA program organization.
- A description of the QA program management organization.

- Descriptions of the duties and responsibilities within the organization and how delegation of responsibilities is managed within the decommissioning program.
- A description of the authority of each unit[1] within the QA program.
- An organization chart of the QA program organization.
- A description of the Trustee Project Manager responsibilities for ensuring that activities affecting quality are (a) prescribed by documented instructions, procedures, and drawings and (b) accomplished through implementation of these documents – Section 3.2.

## 14.4 QUALIFICATIONS AND TRAINING OF PERSONNEL

QAPP Section 4.0 provides personnel qualification, training, self-assessment, and documentation. Topics addressed in Section 4.0 include:

- A description of the instruction provided to personnel responsible for performing activities affecting quality pertaining to the purpose, scope, and implementation of the quality-related manuals, instructions, and procedures – Section 4.1.
- The content and frequency of QAPP training – Section 4.1.
- A description of the qualification requirements of lead auditors and inspectors – Section 4.2.
- A description of the self-assessment program to confirm that activities affecting quality comply with the QA program – Section 4.3.
- A commitment that people performing self-assessment activities are not to have direct responsibilities in the area they are assessing – Section 4.3.
- Documentation of formal training and qualification, including attendees, date of attendance, and the objectives and content of the program – Section 4.4.
- A description of how work performance is evaluated – Section 4.4.

## 14.5 OPERATING PROCEDURES AND INSTRUCTIONS

Decommissioning activities will be conducted in accordance with written plans and procedures that have been approved by individuals identified in Table 5-1, Plan and Procedure Approval Responsibility", of the QAPP. QAPP Section 5.0 provides that requirements for quality-critical activities be specified in written procedures and/or instructions.

The following sections list existing approved procedures for activities that have been performed to date. Additional procedures will be developed and as needed as designs and specifications are advanced to the point that processes and equipment are sufficiently described or depicted to provide for procedure development.

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[1]As presented in NUREG-1757, the term "unit(s)" may not always be applicable. In this section, and in the QAPP, description of individual personnel responsibilities and authorities may be substituted for responsibility or authority of a "unit".

### 14.5.1 Radiation Protection Procedures

- RP-01 – Organization and Administration
- RP-04 – Radiation Protection Assessments
- RP-05 – Radiation Protection Reports and Notifications
- RP-06 – Procedure Generation, Review, and Approval
- RP-07 – Control of Radiation Protection Procedures, Records, and Documents
- RP-10 – ALARA Program
- RP-11 - ALARA Committee Reviews and Evaluations
- RP-13 – Access Control
- RP-14 – Training
- RP-16 – Administrative and Regulatory Dose Limits
- RP-17 – External Exposure Monitoring
- RP-18 – Internal Exposure Monitoring
- RP-19 – Dosimetry Records
- RP-31 – Personnel Contamination Monitoring and Decontamination
- RP-33 – Decontamination of Tools and Equipment
- RP-35 – Radioactive Material Receipt, Control, Inventory, Leak Testing, and Disposal
- RP-38 - Survey Requirements and Frequencies
- RP-39 - Performance of Radiation, Contamination, and Airborne Radioactivity Surveys
- RP-40 - Survey Documentation and Review
- RP-46 - Calibration and Use of Radiation Detection Instrumentation
- RP-101 - Operation and Use of the Ludlum Model 12 With 44-9 Detector
- RP-102 - Operation and Use of the Ludlum Model 19 Micro-R Survey Meter
- RP-103 - Operation and Use of the Ludlum Model 2221 With 44-10 Detector
- RP-104 - Operation and Use of the Ludlum Model 2360 With 43-93 Detector
- RP-105 – Operation and Use of the Ludlum Model 3030E Alpha-Beta Sample Counter With 43-10-1 Detector
- RP-106 – Collection of Airborne Radioactivity Samples
- RP-107 - Air Sample Analysis and Evaluation

### 14.5.2 Quality Assurance Procedures

- QAIP 2.1 – Activity Plan Preparation
- QAIP 2.2 – Program Change Evaluation Process
- QAIP 4.3 - Quality Assurance Program Plan Training
- QAIP 4.4 – Documentation of Training and Task Qualification
- QAIP 15.1 - Deficiency Reporting and Corrective Action
- QAIP 17.1 - Data Management

### 14.5.3 Sampling and Analysis Procedures

- SAP-101 – Surface Soil Sampling
- SAP-102 – Sediment Sampling
- SAP-103 – Surface Water Sampling
- SAP-104 – Groundwater Sampling
- SAP-105 – Vegetation Sampling
- SAP-106 – Direct Push Soil Sampling
- SAP-107 – Sample Equipment Decontamination
- SAP-108 – Excavation Soil Sampling
- SAP-109 – Subsurface Soil and Bedrock Sampling
- SAP-110 – Monitoring Well Installation, Development, and Abandonment
- SAP-111 – Sample Identification and Control
- SAP-112 – Sample Packaging and Shipping
- SAP-113 – Constant Head Hydraulic Conductivity Testing
- SAP-114 – Aquifer (Pump) Testing
- SAP-115 – Injection Testing
- SAP-116 – Investigation Derived Waste Sampling
- SAP-117 – Slug Testing
- SAP-118 – Treatability Test Resin Sampling
- SAP-119 – Treatability Test Water Transfer
- SAP-120 – Low-Flow Groundwater Sampling
- SAP-121 – HPT-GWS Groundwater Sampling
- SAP-122 – Dye Tracing
- SAP-123 – Subsurface Soil Sampling
- SAP-124 – Lithologic Logging

## 14.6 DESIGN

QAPP Section 6.0 provides requirements for design control. The following topics are addressed:

- Contractor and Subcontractor (Vendor) Design
- Design Interfaces
- Design Inputs and Objectives
- Design Outputs
- Design Review
- Design Changes

## 14.7 PROCUREMENT & CONTROL OF ITEMS AND SERVICES

QAPP Section 7.0 provides the quality requirements for procurement and control of materials, equipment, parts, and services. The following topics are addressed:

- Procurement of Materials, Equipment, and Parts
- Procurement of Services
- Requisition
- Vendor Qualification
- Periodic Vendor Assessment
- Inspection of Materials, Equipment, and Parts (Items)
- Control of Materials

## 14.8 SAMPLING, ANALYSES, MEASUREMENTS, AND PROCESSES

QAPP Section 8.0 provides quality requirements for control of sampling, analyses, measurements, and processes. The following topics are addressed:

- Environmental sampling
- Effluent monitoring systems
- Laboratory quality control
- Construction quality control
- Process control
- Data quality control

## 14.9 CONTROL OF MEASURING AND TEST EQUIPMENT

The QAPP describes the methods and procedures that ensure that only accurate and calibrated test equipment will be used during the decommissioning project. QAPP Section 9.0 includes the following information regarding the test and measurement QA program:

- A summary of the test and measurement equipment used in the program.
- A description of how and at what frequency the equipment will be calibrated.
- A description of the daily calibration checks that will be performed on each piece of test or measurement equipment.
- A description of the documentation that will be maintained to demonstrate that only properly calibrated and maintained equipment was used during the decommissioning.
- A description regarding adjustment of calibrated measuring and test equipment.
- Requirements for equipment inventory.
- Requirements for out-of-service equipment.

## 14.10 HANDLING, STORAGE, AND SHIPPING

QAPP Section 10.0 establishes measures to control the handling, storage, shipping, cleaning, and preservation of material and equipment in accordance with procedures and instructions to prevent damage or deterioration.

## 14.11 CONTROL OF NONCONFORMING ITEMS AND EQUIPMENT

QAPP Section 11.0 provides requirements for control of nonconforming items and equipment. The QAPP addresses control of nonconforming conditions, processes, and performance in addition to items and equipment.

## 14.12 DOCUMENT CONTROL

QAPP Section 12.0 describes how documents associated with the QA program are developed, issued, and revised and includes the following:

- QAPP Sections 12.0, 12.1, and 12.2 include a summary of the types of documents addressed by the QA program.
- QAPP Section 12.3 provides a description of how the licensee develops, issues, and revises QA documents.
- QAPP Section 12.4.4 describes handling of documents and records, including archived documents.

## 14.13 AUDITS AND ASSESSMENTS

QAPP Section 13.0 requires the use of assessments and audits to evaluate the effectiveness of the Cimarron Quality Assurance Program. These include the following regarding audits and surveillances:

- QAPP Section 13.1 includes a description of the audit program, including the procedures for conducting the audits or surveillances.
- A description of the records and documentation generated during the audits and the manner in which the documents are managed is provided in QAPP Sections 12 and 13.3.
- Corrective actions, including a description of all follow-up activities associated with audits or surveillances, are described in QAPP Section 14.0.
- QAPP Section 14.0 provides a description of the trending/tracking that will be performed on the results of audits and surveillances.

## 14.14 CORRECTIVE ACTION

The Site QA program includes adequate procedures and controls to identify and correct conditions that will affect quality. QAPP Section 14.0 includes the following information regarding corrective action:

- A description of the corrective action procedures for the facility, including a description of how the corrective action is determined to be adequate.

- A description of the documentation maintained for each corrective action and any follow-up activities by the QA organization, after the corrective action is implemented.

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# 15.0 FACILITY RADIATION SURVEYS

## 15.1 RELEASE CRITERIA

License Condition 27 stipulates the criteria for unrestricted release for all impacted media at the Site. Unrestricted release criteria are presented in this section by each medium.

### 15.1.1 Facilities and Equipment

License Condition 27(c) lists the unrestricted release criteria for facilities and equipment. This condition cites the August 1987 *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for Byproduct, Source or Special Nuclear Material*. The criteria are:

- 5,000 dpm alpha/100 $cm^2$ (15.5 $in^2$), averaged over 1 $m^2$ (10.8 $ft^2$)
- 5,000 dpm beta-gamma/100 $cm^2$ (15.5 $in^2$), averaged over 1 $m^2$ (10.8 $ft^2$)
- 15,000 dpm alpha/100 $cm^2$ (15.5 $in^2$), maximum over 1 $m^2$ (10.8 $ft^2$)
- 15,000 dpm beta-gamma/100 $cm^2$ (15.5 $in^2$), maximum over 1 $m^2$ (10.8 $ft^2$)
- 1,000 dpm alpha/100 $cm^2$ (15.5 $in^2$), removable
- 1,000 dpm beta-gamma/100 $cm^2$ (15.5 $in^2$), removable

The exposure rate for surfaces of buildings and equipment is 1.3 picocuries per kilogram (pC/kg) (5 μR/hr) above background at 1 m (3.3 ft).

### 15.1.2 Soils and Soil-Like Material

License Condition 27(c) lists the unrestricted release criteria for soils and soil-like material. Unrestricted release criteria for soils and soil-like material are:

- Natural uranium 0.37 Bq/g (10 pCi/g) total uranium
- Enriched uranium 1.3 Bq/g (35 pCi/g) total uranium
- Depleted uranium 1.1 Bq/g (30 pCi/g) total uranium
- Natural thorium 0.37 Bq/g (10 pCi/g) total thorium
- 2.6 pC/kg (10 μR/hr) average above background at 1 m (3.3 ft)
- 5.2 pC/kg (20 μR/hr) maximum above background at 1 m (3.3 ft)

### 15.1.3 Groundwater

For groundwater, the only radioactive COCs that can be detected in groundwater are uranium and Tc-99. Uranium is present both as natural uranium and as licensed uranium in groundwater. Daughters of the uranium isotopes are not detectable in groundwater.

The NRC Criterion is based on a site-specific risk assessment rather than a dose model because the toxicity of purified uranium has a greater effect on human health than its radiological dose. The 1998 *Decommissioning Plan Ground Water Evaluation Report (ML20203M069)* included a dose assessment that reported the dose to a member of the public based on an exposure scenario in which the only pathways for exposure are ingestion of groundwater and dermal contact with the groundwater associated with domestic use. Radiological dose was calculated for both uranium and Tc-99. The U-235 enrichment of uranium was assumed to be approximately 3%. The dose assessment indicated that for uranium, an activity concentration of 188 pCi/L yielded 25 mrem/yr, and for Tc-99, an activity concentration of 3,749 pCi/L yielded 4 mrem/yr.

A 1998 risk assessment established a risk-based limit of 0.11 mg/L for uranium in groundwater based on a drinking water scenario in which exposure consisted solely of ingestion of groundwater, without including exposure due to dermal contact associated with domestic use. A concentration of 0.11 mg/L is approximately equivalent to an activity of 180 pCi/L, assuming an average enrichment of approximately 3%. For groundwater, there is no method for averaging uranium activity in groundwater.

License Condition 27(b) cites the unrestricted release criterion for uranium in groundwater. It also states, "The release criteria for groundwater at the Site is 6.7 Bq/L (180 pCi/L) total uranium. NRC will not terminate Radioactive Materials License SNM-928 until the licensee demonstrates that the total uranium concentrations in all wells have been below the groundwater release criteria for eight consecutive quarterly samples".

Unrestricted release criteria for Tc-99 are not yet stipulated in License SNM-928. The EPA has promulgated a primary drinking water standard of 4 mrem/yr for beta photon emitters. NRC developed a derived concentration limit (DCL) for Tc-99, based on the 4 mrem/yr dose limit, using the ICRP 1982 Publication 30, *Limits for Intakes of Radionuclides by Workers*. The NRC DCL for Tc-99 is 3,790 pCi/L. Post-remediation groundwater monitoring will demonstrate that Tc-99 concentrations in groundwater are less than 3,790 pCi/L to obtain unrestricted release from NRC.

EPA developed a DCL for Tc-99, based on the EPA MCL of 4 mrem/yr, using the ICRP 1959 Publication 2, *Permissible Dose for Internal Radiation*. The EPA DCL for Tc-99 is 900 pCi/L. Tc-99 concentrations in groundwater must be below 900 pCi/L to obtain unrestricted release from DEQ.

## 15.2 CHARACTERIZATION SURVEYS

The former process buildings are located in Subareas I and K, which have been released for unrestricted use. Samples of environmental media, which are collected on an periodic basis throughout the Site, are brought to the Site office, which is located in Subarea I, for packaging and shipping. Two water treatability tests, which involved the processing of uranium-impacted groundwater, were conducted in the Site office. Water storage tanks, which held contaminated groundwater for the tests, were located near the Site office. To maintain confidence that none of these operations impacted the Site office (or surrounding property), radiological surveys have been performed each time such operations were conducted. No evidence of impact from these operations has been observed. Routine radiological surveys performed in accordance with the RPP continue to demonstrate that ongoing activities have not impacted the Site office.

As explained in detail in Section 3.3, “Surface and Subsurface Soil Contamination”, both surface and subsurface soil and residual material such as concrete slabs used for erosion control have been demonstrated to comply with the NRC Criteria in all Subareas. Further characterization of surface and subsurface soil is no longer needed.

When subsurface material is brought to the surface by trenching or drilling the soil is visually examined to identify any non-native material that has been brought to the surface. Non-native material has been encountered during recent excavations (e.g., a piece of the concrete footer, and bags of waste were encountered during the excavation of pilot test Injection Trench GWI-UP1-01). Non-native material scanned for both exposure rate and gamma emissions; if either measurement exceeds criteria specified in the RPP, the material is surveyed for surface contamination or sampled for laboratory analysis for uranium activity. To date, all material that has exceeded unrestricted release criteria has been segregated for disposal as LLRW. This process will continue throughout construction and operation of groundwater remediation operations.

Concrete rubble located in Subareas F, G, and J has been surveyed for release. NRC has performed confirmatory surveys on the rubble and has released Subarea J from license SNM-928. NRC has agreed that the rubble in Subareas F and G are releasable for unrestricted use

Impoundments and lagoons were formerly located in Subareas H, L, M, and O. These were excavated, and the residual soils were surveyed for release. NRC has released all of these Subareas from License SNM-928.

Assessment of the extent of groundwater exceeding the NRC Criterion has been complete. Section 3.5.3 presents the radiological status of uranium in groundwater site wide. Figures 3-3 and 3-4 show the extent of uranium in groundwater exceeding the NRC Criterion. No further characterization for uranium in groundwater is needed.

In response to a February 2019 request for supplemental information, a site-wide groundwater assessment was performed to determine the extent of Tc-99 in groundwater. The results were reported in a January 31, 2020, technical memorandum entitled, "*Technetium-99 Groundwater Assessment*" (Burns & McDonnell, 2020A, ML20178A371). Tc-99 concentrations did not exceed the NRC Criterion anywhere on the Site. No further characterization for Tc-99 in groundwater is needed at the Site.

Uranium and Tc-99 are not co-located at the Site. The liquid waste stream that resulted in concentrations of Tc-99 in groundwater did not result in uranium concentrations in groundwater that exceed the DCGL. The "older" liquid waste stream that resulted in higher concentrations of uranium in groundwater (in the WAA U>DCGL and 1206 NORTH remediation areas) did not contain Tc-99. The solid waste that resulted in higher concentrations of uranium in groundwater in BA1 did not contain Tc-99. Finally, there is no evidence that the three daughters of the purified uranium are present in groundwater. Consequently, no fixed ratio of radionuclides exists; analysis for radionuclides will involve analysis for only uranium, Tc-99, or both as is appropriate for the media being sampled for analysis.

During the performance of work activities addressed in Section 8, "Planned Decommissioning Activities", radiological investigation/characterization will be performed in areas where radiological work is to be performed if such investigation/characterization is needed to demonstrate that there was no impact to the area resulting from work activities.

## 15.3 IN-PROCESS SURVEYS

During groundwater remediation activities, five types of in-process surveys will be performed at the Site.

1. Groundwater sampling and off-site laboratory analysis will be performed to monitor progress in reducing the concentration of uranium in groundwater, and to demonstrate compliance with the NRC Criterion once it has been reached.
2. Influent and effluent sampling and off-site laboratory analysis will be performed to monitor the estimated quantity of uranium retained in the ion exchange resin beds.

3. Packages of spent resin and potentially contaminated material will be surveyed prior to shipment for disposal.
4. Release surveys will be performed to release materials and equipment from radiologically restricted areas.
5. Routine surveys of unrestricted areas will be performed to identify any areas that may become contaminated, or to demonstrate that unrestricted areas are not impacted above unrestricted release criteria.

### 15.3.1 In-Process Groundwater Monitoring

Section 8.6 presents the in-process groundwater monitoring program that will be used to monitor the concentration of uranium in groundwater. Section 8.8 presents the post-remediation groundwater monitoring program that will be implemented to demonstrate that groundwater remediation activities have sufficiently reduced uranium concentrations to justify termination of license SNM-928.

The data quality objective for groundwater monitoring has a 95% level of confidence that the actual concentration is less than the stipulated criterion. The laboratory must report the result as well as the uncertainty, defined as 2 standard deviations. Reported results plus 2 standard deviations must be less than 180 pCi/L for total uranium to conclude that the actual activity is less than the activity limit.

GEL Laboratory has provided reporting limits (also called quantification limits) of 0.2 µg/L for U-238 and 0.07 µg/L for U-235 by the EPA 200.8 (ICP-MS) method. These reporting limit values are equivalent to less than 0.1% of the limit for total uranium. Consequently, this laboratory method is acceptable for analyzing uranium concentration for this sampling effort.

### 15.3.2 Influent and Effluent Monitoring

Section 8.6 describes the influent and effluent monitoring that will be performed to monitor COC concentrations in the influent conveyed to, and effluent discharged from, water treatment facilities.

The OPDES permit authorizing the discharge of treated water (the final effluent) established a limit of 30 µg/L total uranium. GEL Laboratory has provided a reporting limit of 0.2 µg/L for U-238 by EPA 200.8. This is less than 1% of the anticipated discharge limit. Consequently, this laboratory method is acceptable both for analyzing effluent for compliance with permit limits.

### 15.3.3 Shipping Package Surveys

Packages containing spent resin, groundwater sample bottles, and packages of potentially contaminated material will be surveyed for surface contamination and exposure rate readings will be measured at the exterior of the package. Surface contamination measurements will be made using an alpha/beta-gamma survey meter which measures counts per minute per 100 square centimeters. Smears will be collected from external surfaces of packages and counted in an on-site smear counter. Exposure rate measurements will be made at 30 cm from the package surface and on contact with the sides of the drum or package using a micro-R meter. All instruments used for shipping package surveys will have minimum detection limits that are less than 10% of the limits for unrestricted release specified in Section 15.1, above. Survey results will be documented and retained.

A Ludlum Model 2360 rate meter with a Ludlum Model 43-93 detector is typically used for surface contamination measurements. A Ludlum Model 3030E rate meter with a Ludlum Model 43-10-1 detector is typically used to count smears. A Ludlum Model 19 micro-R meter is typically used to measure exposure rate. Equivalent or substitute instruments may be used if sufficiently sensitive, upon approval by the RSO or designee. Source checks will be performed each day these instruments are used.

### 15.3.4 Release Surveys

Before material or equipment is removed from a radiologically restricted area, it will be surveyed for surface contamination. Surface contamination measurements will be made using an alpha/beta-gamma survey meter which measures counts per minute per 100 square centimeters. All instruments used for release surveys will have minimum detection limits that are less than 50% of the limits for unrestricted release specified in Section 15.1, above. Release surveys are documented on Form RP-40.

A Ludlum Model 2360 rate meter with a Ludlum Model 43-93 detector is typically used for surface contamination measurements. Equivalent or substitute instruments may be used if sufficiently sensitive, upon approval by the RSO or designee. Source checks will be performed each day these instruments are used.

### 15.3.5 Routine Surveys

Routine surveys will be performed in the Site office and other areas specified by the RSO and/or designee to demonstrate that these areas remain releasable for unrestricted use. Routine surveys will be performed on a weekly, monthly, or quarterly basis, based upon frequency of use and potential for contamination. Routine surveys may consist of surface contamination scans, small area (100 $cm^2$) smears, large area (up to 1 $m^2$) smears, and exposure rate measurements. RPP Section 10.2, "Routine Surveys" further describe routine surveys. All instruments used for routine surveys will have minimum detection limits that are less than 50% of the limits for unrestricted release specified in Section 15.1, above. Survey results will be documented and retained.

A Ludlum Model 2360 rate meter with a Ludlum Model 43-93 detector is typically used for surface contamination measurements. A Ludlum Model 3030E rate meter with a Ludlum Model 43-10-1 detector is typically used to count smears. A Ludlum Model 19 micro-R meter is typically used to measure exposure rate. Equivalent or substitute instruments may be used if sufficiently sensitive, upon approval by the RSO or designee. Source checks will be performed each day these instruments are used.

## 15.4 FINAL STATUS SURVEY DESIGN

License Condition 27(c) also states, "Buildings, equipment, and outdoor areas shall be surveyed in accordance with NUREG/CR-5849, 'Manual for Conducting Radiological Surveys in Support of License Termination.'"

All processing equipment (e.g., influent tanks, uranium treatment skids, resin processing equipment, piping, etc.) will be demobilized from the Site prior to performing the final status survey. Within the licensed area, only the WATF building and the concrete slabs outside of the WATF building and in the BARF will remain on the Site. The WATF building is an asset to be transferred to a subsequent owner upon disposition of the property by the Trust. A final status survey plan providing a detailed description of the final status survey will be submitted to the NRC during the first year of post-remediation monitoring. The final status survey plan will be prepared in accordance with the guidance presented in NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination." This section provides an overview of the final status survey plan.

### 15.4.1 Affected Areas

NUREG/CR-5849 defines affected areas as "Areas that have potential radioactive contamination (based on plant operating history) or known radioactive contamination (based on past or preliminary radiological surveillance)."

Final status surveys already performed by the licensee and confirmatory surveys performed by NRC personnel or NRC-retained contractors have confirmed that except for groundwater, the entire site currently complies with the NRC Criteria. Post-remediation monitoring will provide the data needed to demonstrate that groundwater complies with the NRC Criterion. Only areas that had the potential to have become contaminated will be considered affected areas. This section generally describes the final status survey that will be conducted for affected areas.

### *Influent Tank and Influent Pump Foundations*

The concrete foundations for the double-walled influent tanks should not become contaminated because leak detection sensors will be installed between the inner and outer walls of the tank. However, the tanks would constitute storage areas per NUREG-5849, so they will be classified as affected areas. The foundations cover approximately 12 $m^2$, but are not rectangular. A systematic radial or circular "grid" will be established so that at least 12 locations receive exposure rate and direct and removable surface contamination measurements.

The concrete foundation for the pumps delivering influent to the dual media filters would only become contaminated if the pumps or fittings leak, but will be classified as affected areas. A 1-meter grid will be established on these rectangular concrete pads, and exposure rate and direct and removable surface contamination will be measured at each grid location.

These locations of these foundations can be seen on Drawings C-110 (Appendix J-2) and C-210 (Appendix J-5).

### *Ion Exchange and Spent Resin Area*

Dual media filters, ion exchange skids, and spent resin processing equipment will be removed from the building as described in Section 8.9 prior to performing the final status survey of these areas. Because this equipment maintains containment of uranium-impacted water, resin, and the resin/absorbent mixture the potential for contamination of the walls or ceiling in this area is negligible. However, that part of the building identified as the "Ion Exchange and Spent Resin Area" on Drawing A-100, Sheet 1 (Appendix J-2) will be considered affected, in accordance with Section 4.2.2 of NUREG-5849. The floor and the bottom two meters of the west, south, and east walls of Ion Exchange and Spent Resin Area will be classified as affected areas. The areas above the bottom two meters of the walls will not require final status survey.

A 1-meter grid will be established on the floor and walls, and exposure rate and direct and removable surface contamination measurements will be recorded at each location.

### *LLRW Storage Area*

The LLRW storage area is designated on Drawing A-100, Sheet 1 (Appendix J-2) as the "Storage Area". All containers, pallets, jersey barriers, etc., will be removed before final status surveys begin in this area. Although the LLRW stored in this area will have been containerized, and the potential for contamination of building walls or ceiling is negligible, the floor of the LLRW storage area, and the bottom two meters of the south and east walls of the LLRW storage area, will be classified as affected areas, in accordance with Section 4.2.2 of NUREG-5849. The same final status survey process described in the Ion Exchange and Spent Resin Area will be performed in the LLRW storage area.

### *Instrument/Sample Packaging Room*

Drawing A-100, Sheet 2 (Appendix J-2) shows the locations of the Instrument Room. The water, resin, and waste samples identified in Tables 8-2, 8-4, 8-5 and 8-6 will be packaged in and shipped from the Instrument Room. Although sample containers will have been sealed prior to entering the Instrument Room, they will be stored in this room during sampling events, so the Instrument Room will be classified as an affected area.

## 15.4.2 Unaffected Areas

NUREG/CR-5849 defines unaffected areas as "All areas not classified as affected." This section generally describes the final status survey that will be conducted for unaffected areas.

### *Concrete Slabs and Tank Foundations*

The concrete slabs that support the injection skid tank and both injection skids, the air handling unit pads, emergency power generators, effluent tanks, the backwash water tank, and the BA1 effluent tank pump in the WATF will be considered unaffected areas. The locations of these foundations are shown on Drawings C-110 (Appendix J-2) and C-210 (Appendix J-5). Due to the small size of the tank foundations (the largest covers approximately 12 $m^2$) and concrete slabs (varying from 6 to 30 $m^2$), a final status survey of these slabs and foundations will consist of establishing a minimum of five systematically spaced locations and collecting exposure rate and surface contamination measurements at each location.

### *Break Room*

During the operating years, routine surveys will be conducted in the break room to monitor for contamination of surfaces and to demonstrate that the building was not contaminated during the operating years. All materials (e.g., desks, chairs, tables, shelves, etc.) will be removed from the instrument/sample preparation room before final status surveys are performed. It is believed that routine surveys conducted during the operating years will not identify radioactive contamination exceeding unrestricted release criteria, so this area will be classified as an unaffected area.

### *Control Room, Electrical Room, Offices, Rest Rooms, and Conference Room*

During the operating years, routine surveys will be conducted in the control room, electrical room, offices, rest rooms, and the conference room to monitor for contamination of surfaces and to demonstrate that the building was not contaminated during the operating years. If the LLRW storage area, the instrument/sample preparation room, and the break room satisfy the requirements described in Section 15.4.1 above, they may also be surveyed as unaffected areas.

For unaffected areas, a grid will be laid out on the floor at a greater spacing than for affected areas (in accordance with NUREG/CR-5849), and exposure rate and direct and removable surface contamination measurements will be recorded at each location.

## 15.4.3 Areas Not Subject to Final Status Survey

### *Land Surface*

All surface and subsurface soil has been demonstrated to comply with license criteria. Radiological surveys will be performed whenever subsurface material is brought to the surface. If previously buried material exceeding license criteria is exhumed, it will be disposed of as LLRW. Consequently, soil will not be subject to final status survey.

### *Monitor Wells*

All monitor wells within the licensed area will be removed and surveyed as described in Section 8.9. Monitor wells outside the licensed area will not be subject to final status survey.

### *Groundwater Extraction Trenches*

The silica gravel in the groundwater extraction trenches will have contained groundwater with uranium concentrations that are less than the NRC Criterion for some time before the last monitor well yields groundwater that complies with the NRC Criterion. If the concentration of uranium on the gravel is in equilibrium with the uranium in the groundwater (based on the $K_d$ of the gravel), then even at 180 pCi/L total uranium in groundwater, the gravel cannot contain sufficient uranium to exceed the 30 pCi/L NRC Criterion for soil or soil-like material. The gravel in groundwater extraction trenches will not be sampled for a final status survey and it will be left in place.

### *Treated Water Injection Trenches, Wells, and Piping*

The treated water injection trenches, wells, and piping will have contained only treated water with uranium concentrations that are less than 30 ug/L. These components will not require final status survey and will be left in place.

### *Utility, Instrumentation, and Control Cables*

Utility, instrumentation, and control cables will not come into contact with licensed material. These components will not require final status survey and will be left in place.

## 15.5 FINAL STATUS SURVEY REPORT

Upon agency approval of the final status survey plan, the final status survey will be performed, and a final status survey report will be submitted to NRC and DEQ. Like the final status survey plan, the final status survey report will be prepared in accordance with the guidance presented in NUREG/CR-5849, “Manual for Conducting Radiological Surveys in Support of License Termination.”

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# 16.0 FINANCIAL ASSURANCE

## 16.1 FUNDING FOR DECOMMISSIONING

The February 14, 2011, Environmental Response Trust Agreement (the Agreement) created the Cimarron Environmental Response Trust in accordance with a Consent Decree and Environmental Settlement Agreement executed by Tronox, Inc. (parent company of Cimarron Corporation, the previous licensee) and numerous federal and state regulatory agencies. The Agreement established the following four accounts:

- Cimarron Trust Federal Environmental Cost Account (the Federal Account)
- Cimarron Trust State Environmental Cost Account (the State Account)
- Cimarron Trust Administrative Account (the Administrative Account)
- Cimarron Standby Trust Fund (the Standby Trust Fund)

Section 2.4.1 of the Agreement states, "… the Cimarron Trustee shall use the Cimarron Trust Environmental Cost Accounts and Cimarron Standby Trust Fund for the Cimarron Site to fund future decommissioning costs, including the preparation and implementation of an NRC-approved decommissioning plan and groundwater remediation plan, Environmental Actions and certain future oversight costs approved by the Lead Agency pursuant to applicable environmental law with respect to the Cimarron Site. The Cimarron Trustee shall use the Cimarron Trust Administrative Account to fund the Administrative Costs of the Cimarron Trust that have been approved by the United States and the State of Oklahoma."

The last financial statement generated prior to the submission of this Plan reported the value of the Federal Account and the State Account at the end of the 2$^{nd}$ quarter of 2022. The value of the Federal Account was $55,260,448.47, and the value of the State Account was $12,557,890.48.

US Bank is the Trustee for the Standby Trust Fund. The total value of the Standby Trust Fund as of June 30, 2022, was $3,644,070.82.

The combined value of the three accounts used to fund decommissioning expenses at the end of the 2$^{nd}$ quarter of 2022 is therefore $71,462,409.77. The DCE presented herein is based on this initial value and costs incurred beginning with the 3$^{rd}$ quarter of 2022.

## 16.2 COST ESTIMATE

Section 4.1 and Appendix A, Section A.3 of NUREG-1757, Volume 3, provide guidance on the preparation of a cost estimate for decommissioning funding purposes. These sections assume the existence of buildings and processing equipment that require decontamination and make little provision for the decommissioning of environmental media. A cost estimate in general conformance with NUREG-1757, given the nature of the decommissioning activities and the current radiological status of the Site, is provided herein. The costs presented in this Plan represent the costs associated with constructing groundwater remediation infrastructure and water treatment facilities, extracting and treating groundwater until the NRC Criterion for groundwater is achieved, conducting post-remediation groundwater monitoring, demobilizing material and equipment, performing final status surveys, and applying for license termination. The estimated cost for activities performed prior to the construction of groundwater remediation facilities is provided in Table 16-1 and the estimated cost for construction is presented in Table 16-2. The estimated cost for groundwater remediation is presented in Table 16-3 and the estimated cost for post-remediation activities (through license termination) is provided in Table 16-4. The estimated cost of future activities presented in Tables 16-1 through 16-4 are in 2022 dollars.

Table 16-5 uses the cost information presented in Tables 16-1 through 16-4 to present life-cycle DCEs for the Cimarron Site. Table 16-5(a) presents the annual cost for major cost categories as well as the total annual cost in 2022 dollars. Table 16-5(b) presents those costs with a 3% per annum escalation rate. Table 16-5(b) also assumes a 1% per annum return on the total available funding. The available funding remaining at the end of each year was calculated by subtracting the total annual cost from (beginning-of-year available funding multiplied by 1.01). Table 16-5(b) does not include any contingency.

Table 16-5(c) provides for the same return on invested funds as Table 16-5(b). However, in accordance with NUREG-1757, Volume 3, Appendix A, a 25% contingency is applied to the annual costs presented in Table 16-5(b). As with Table 16-5(b), the available funding remaining at the end of each year was calculated by subtracting the total annual cost from (beginning-of-year available funding multiplied by 1.01).

The DCE includes anticipated agency fees, and contractor/subcontractor costs for pre-construction design and vendor selection, construction, operation, and maintenance of groundwater remediation and water treatment facilities, in-process and post-remediation monitoring, and demobilization and license termination costs. The estimated costs presented in Table 16-1 through 16-4 were organized so that the highest-level line items correspond to Tasks presented in annual budget submittals. The scope of work represented by each line item is described in the sub-sections presented below. The DCE is based on the anticipated project schedule presented in Section 9.

Changes to the scope, schedule, design, and durations may impact the DCE. The DCE presented herein is based on the experience and judgment of professional consultants combined with information from past projects, vendors, and published sources. Cost and availability of labor, material and equipment, labor productivity, construction contractors' procedures and methods, unavoidable delays (e.g., weather delays), and other factors may impact the DCE, both positively and negatively. It is anticipated that the DCE will be revised periodically throughout the decommissioning process.

### 16.2.1 Pre-Construction Costs

Table 16-1, "Pre-Construction Cost Estimate", presents the cost estimate for work performed from the beginning of the third quarter of 2022 to contractors' mobilization to the site to begin construction.

Costs shown for Line 1, "License Compliance" are the cost of license compliance, radiation protection, and quality assurance support. "EPM" represents Trustee oversight and participation, "Enercon Support" represents the labor and expenses incurred by Enercon Services, Inc. (Enercon), "Burns & McDonnell Support" represents the labor and expenses incurred by Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell). "Annual Environmental" consists primarily of laboratory services and associated expenses (e.g., consumables, shipping, etc.).

Costs shown for Line 2, "NRC Fees" are the estimated cost of NRC fees based on past experience and the support needed for oversight of the anticipated work.

Costs shown for Line 3, "Decommissioning" consist primarily of fees charged by contractors to the Trust for work performed as described in Section 9.1. "EPM" represents Trustee oversight of contractors, review of Contractor deliverables, and participation in the bidding/contract execution process. "Burns & McDonnell" and "Veolia" represent Contractor costs for responding to RAIs, advancing designs and specifications to issue for bidding, preparation of requests for bids and evaluation of bids, etc., as described in Section 9. "Enercon" represents costs for field support provided by Enercon, such as the collection, packaging, and shipping of samples for laboratory analysis.

Costs shown for Line 4, "DEQ Fees" represent DEQ fees charged for project review and oversight.

### 16.2.2 Construction Costs

Table 16-2, "Construction Cost Estimate", presents the cost estimate for work to be performed during construction, beginning with mobilization of contractors through construction of all groundwater remediation infrastructure and water treatment facilities, as well as startup and commissioning of those facilities.

Costs shown for Line 1, "License Compliance" are the cost of license compliance, radiation protection, and quality assurance support. "EPM" represents Trustee oversight and participation, and "Enercon Support" represents the labor and expenses incurred by Enercon, the current provider of these three services. These costs include the cost of radiation protection and quality assurance support during the construction of groundwater remediation infrastructure and treatment facility construction. "Burns & McDonnell Support" represents the labor and expenses incurred by Burns & McDonnell. Other direct costs are minor expenses associated with supplies, sampling equipment, shipping expenses, etc.; these have been incorporated into Trustee and Contractor costs.

Costs shown for Line 2, "NRC Fees" are the estimated cost of NRC fees based on past experience and anticipated work.

Costs shown for Line 3, "Decommissioning" include costs to construct the groundwater remediation infrastructure and the water treatment facilities. Costs shown for Lines 3a through 3d are costs for EPM and Contractor support, respectively. "EPM" represents the Trustee cost for oversight of contractors and the review/approval of Contractor deliverables. "Enercon Support" represents the labor and expenses associated with the provision of field support during the construction of groundwater remediation infrastructure and treatment facility construction. "Veolia Support" represents the labor and expenses associated with construction, fabrication, and startup support for water treatment equipment and processes provided by Veolia Nuclear Solutions – Federal Services (Veolia). "Burns & McDonnell Support" represents the labor and expenses associated with site maintenance and other project management supporting tasks. The itemized categories below describe the capital construction costs for items listed under 3e. These costs were obtained from those entities who prepared the design for these scopes of work.

### *Line 3e.i – Site Civil Construction*

This line includes costs for grading, road improvement, civil survey, installation of BMPs for erosion control, post-construction site restoration, and other site work generally related to providing essential access and utilities to the treatment facilities and managing disturbed areas. It includes the cost of constructing all site piping, trenches, and wells related to both the injection and extraction systems. It includes the construction of the discharge piping and outfall, stormwater piping, the WA injection system, the WATF, and the BA1 injection skid and enclosure. The cost to fabricate, deliver, and install the injection skids is included in this line item.

### *Line 3e.ii – Site Electrical and Controls*

This line includes the proposed electrical construction scope for the entire project detailed in the drawings, including components and infrastructure associated with the treatment system installation. The cost of installing conduit in utility trenches is included in Line 3e.i since conduits will be installed in a common trench with piping.

### *Line 3e.iii – BARF*

This line includes costs for grading, foundations for tanks, buildings, and the injection unit, the installation of TrueGrid® and gravel "paving", and fence installation.

### *Line 3e.iv – WATF*

This line includes the cost of two uranium ion exchange systems for the WATF, including resin vessels (and resin). It includes the cost of the uranium ion exchange resin processing equipment including bulk resin bag unloader, ribbon blender, screw conveyor, drum dumper, and miscellaneous resin handling tanks and equipment.

It includes the cost to construct the WATF including the pre-engineered metal building, heaters, heat pump, exhaust fans, climate control systems, vents, plumbing, electrical and lighting system, septic system, eyewash stations, and miscellaneous furnishings.

### *Line 3e.v – Direct Capital Construction Costs Subtotal*

This line provides the sum of all capital construction items listed above in Lines 4e.i through 4e.iv.

#### *Lines 3e.vi – 4e.ix - Indirect Capital Construction Costs*

These lines add typical construction related costs including general conditions, construction management, engineering during construction, and bonds and permits. Each of these lines represent a typical percentage of the Direct Capital Construction Cost Subtotal.

#### *Line 3e.x – Total Capital Construction Cost*

This line presents the total estimated capital construction cost.

Costs shown for Line 4, "DEQ Fees" are a combination of DEQ fees charged for project review and oversight and the permit application fee for the OPDES permit. These costs are anticipated to be consistent for the duration of project, extending to and potentially beyond license termination.

### 16.2.3 Groundwater Remediation Costs

Table 16-3, "Groundwater Remediation Cost Estimate", presents the estimated cost to perform maintenance and operation of the groundwater remediation, water treatment, and waste processing and shipping operations. This begins with startup of the groundwater extraction, water treatment, and treated water injection systems.

Costs shown for Line 1, "License Compliance" are the cost of license compliance, radiation protection, and quality assurance support. "EPM" represents Trustee oversight and participation. "Enercon" represents the labor and expenses incurred by Enercon Services, the current provider of license compliance, radiation protection, and quality assurance support. These costs include the cost of radiation protection and quality assurance support during the operation and maintenance of groundwater remediation, water treatment, and waste processing and packaging systems. It includes implementation of the material control and accountability system and oversight of LLRW shipping and disposal. "Burns & McDonnell Support" includes the fees and expenses associated with monitoring remediation progress, prescribing adjustments to flow rates, and providing data reviewing and reporting support. Other direct costs are minor expenses associated with supplies, sampling equipment, shipping expenses, etc.

Costs shown for Line 2, "NRC Fees" are the estimated cost of NRC fees based on past experience and anticipated work.

Line 3, "Decommissioning" presents the cost for labor, utilities, materials, and activities performed throughout groundwater remediation activities.

### *Line 3a – EPM Support*

This line presents the estimated fees and expenses associated with oversight of contractors performing groundwater extraction and treatment, treated water injection and discharge, and waste processing, packaging, and shipping. It includes oversight of contractors responsible for implementation of radiation protection, quality assurance, and safety and health programs. It also includes data evaluation and reporting in accordance with permit requirements.

### *Line 3b – Remediation / Treatment Labor and Support*

This line presents the estimated labor cost associated with operating and maintaining the groundwater remediation and water treatment systems. This assumes 3 full-time employees for full-scale operation and maintenance of all groundwater remediation and water treatment systems. This line also includes office support tasks. Operating procedures have not yet been prepared; estimated labor hours and rates are subject to change depending on labor requirements.

### *Line 3c – Treatment Facility Electric*

This line presents the estimated cost of electric service to the groundwater remediation and treatment facilities. This includes the electricity needed for treatment systems, well field remediation components and facilities, climate control systems, and incidental power usage. The power usage estimate assumes the same system operational level as described above.

Current electricity rates provided by the Oklahoma Electric Cooperative were used to determine annual costs based on assumed loads. The rates provided include $0.092 per kilowatt hours (kWh) peak, $0.087 per kWh off peak, and a $1,860 annual service charge. Loads were assumed for constant operation during the treatment period (93% off peak, 7% peak).

### *Line 3d – IX Resin*

This line presents the estimated delivered cost of ion exchange resin required for uranium treatment systems. This cost is based on the rate of exchange indicated in Figure 8-6 and an estimated cost of $516 per cubic foot of resin delivered.

#### *Line 3e – 6M HCl – Uranium System pH Adjustment*

This line presents the estimated delivered cost of the 6-molar hydrochloric acid chemical needed for pH adjustment in the uranium treatment process. This cost is based on a vendor quote of $660 per ton, delivered, and an assumed unit weight of 74.5 pounds per cubic foot.

#### *Line 3f – Spent Resin Disposal*

This line presents the estimated cost for off-site disposal of spent resin, based on the rate of exchange indicated in Figure 8-6. This cost is based on an assumed 42 cubic feet of resin per changeout (including absorbent added to the resin at a volumetric ratio of 1:10) and quoted transportation and disposal prices from Energy Solutions. Transportation cost was estimated at approximately $26,000 per shipment and the quoted disposal price was approximately $240 per cubic foot. One truck is capable of hauling fifty (50) 55-gallon drums.

#### *Line 3g – Maintenance Allowance*

This line provides an annual lump sum placeholder of $80,000 (2022 dollars, escalated as described above) for maintenance of the treatment facilities. This amount is expected to cover such items as equipment repairs, building upkeep, etc.

#### *Line 3h – In-Process Groundwater Monitoring*

This line presents costs for in-process groundwater monitoring. Costs were estimated based on the monitoring locations and analytes listed in Table 8-2. The in-process monitoring costs include labor and consumables, plus shipping costs, assuming all samples can be collected, packaged, manifested, and shipped by a three-man crew in one 40-hour week.

#### *Line 3i – In-Process Treatment Monitoring*

This line presents costs for in-process treatment system monitoring described in Section 8.6 and Table 8-4.

Costs shown for Line 4, “DEQ Fees” are a combination of DEQ fees charged for project review and oversight and the annual permit fee for the OPDES permit.

### 16.2.4 Post-Remediation Monitoring to License Termination

Table 16-4, “License Termination Cost Estimate”, presents costs for work performed during post-remediation monitoring, demobilization, and license termination activities. The post-remediation period begins when the groundwater extraction and injection and water treatment systems used for remediation of groundwater in BA1 are shut down for post-remediation monitoring and ends when the NRC license is terminated.

Costs shown for Line 1, "License Compliance" are the cost of license compliance, radiation protection, and quality assurance support.

### *Line 1a, EPM Support*

This line presents costs for Trustee oversight and participation.

### *Line 1b, Enercon Support*

This line presents the labor and expenses incurred by Enercon Services, the current provider of these three services. These costs are further subdivided into the cost of

- Providing radiation protection and quality assurance support throughout the post-remediation time period
- Preparing a final status survey plan
- Conducting the final status survey
- Preparing a final status survey report
- Preparing a dose model
- Providing support for the application for termination of the license
- Other direct costs; minor expenses associated with supplies, sampling equipment, shipping expenses, etc.

Costs shown for Line 2, "NRC Fees" are the estimated cost of NRC fees based on past experience and anticipated work.

Line 3, "Decommissioning" presents the cost for labor, utilities, materials, and activities performed from shutdown of remediation systems to license termination.

### *Line 3a – EPM Support*

This line presents the estimated fees and expenses associated with oversight of contractors performing demobilization, release surveys, post-remediation groundwater monitoring, preparation of final status survey plan and report, and conducting a final status survey. It also includes providing the dominant role in reporting throughout this phase, and managing the license termination process.

### *Line 3b – Maintenance Allowance*

This line provides an annual lump sum placeholder of $80,000 for maintenance of the remaining facilities. This amount is expected to cover such items as building upkeep.

### *Line 3c – Dismantling and Disposal of Material*

This line presents costs associated with dismantling, transportation, and disposal of water conveyance, treatment, and discharge equipment, as detailed in Section 8.9.1.

### *Line 3d – Post-Remediation Groundwater Monitoring*

This line presents costs for post-remediation groundwater monitoring as presented in Table 8-8. The assumed costs for post-remediation groundwater monitoring were based on 2022 analytical costs, labor for sample collection, packaging, and shipping, and expenses for consumables. The estimated costs are based a quarterly sampling interval conducted for a duration of two years.

Costs shown for Line 4, "DEQ Fees" are DEQ fees charged for project review and oversight. These costs are anticipated to be consistent for the duration of project, extending to the termination of the NRC license.

## 16.2.5 Life-Cycle Decommissioning Cost Estimate

Table 16-5, "Life-Cycle Decommissioning Cost Estimate", provides a summary of annual decommissioning costs beginning with pre-construction activities and ending with termination of the license. This table combines the cost information from Tables 16-1 through 16-4 for each year, beginning July 1, 2022, through license termination.

For 2022, Table 16-5 presents the available funding at the end of the 2$^{nd}$ quarter of 2022, the estimated cost for the work performed during the second half of 2022, and the remaining funding at the end of the year. The available funding at the beginning of 2023 is calculated by multiplying the available funding at the beginning of the 3$^{rd}$ quarter of 2022 by 1.005 (representing an approximate 1% annual return on the investment).

For each subsequent year, Table 16-5a presents the estimated cost for the work performed each year in 2022 dollars. Table 16-5b presents the available funding at the beginning of the year, the estimated cost for the work performed that year, and the remaining funding at the end of the year. The available funding at the beginning of following years is calculated by multiplying the available funding at the beginning of the previous year by 1.01 (representing an approximate 1%

return on the investments). The annual cost for each year in Table 16-5b escalates the cost provided in Table 16-5a at a rate of 3% per year.

### 16.2.6 Contingency Factor

Appendix A to Volume 3 of NUREG-1757, *Consolidated Decommissioning Guidance*, states, “The cost estimate applies a contingency factor of at least 25 percent to the sum of all estimated costs.” The cost of construction for groundwater remediation and water treatment facilities represents a significant portion of the available funding; the application of a 25% contingency has a significant impact on the potential to achieve license termination. Consequently, Table 16-5c presents the estimated funding available at the end of each year after adding a 25% contingency to the total annual cost presented in Table 16-5b.

## 16.3 CERTIFICATION STATEMENT

A certification statement is needed due to the license possession limits for U-235 and the applicable quantities specified in 10 CFR 70.25. Section A.2 of Appendix A, Volume 3 of NUREG-1757, *Consolidated Decommissioning Guidance* (USNRC, 2006), provides a Model Certification of Financial Assurance which must be submitted with a decommissioning funding plan. Certification is provided in Appendix P of this Decommissioning Plan.

## 16.4 FINANCIAL MECHANISM

### 16.4.1 Qualifications of the Trustee

The previous licensee, Cimarron Corporation, was a wholly owned subsidiary of Tronox Worldwide LLC (Tronox). Tronox and its wholly owned subsidiaries, (collectively, the Settlors) filed voluntary petitions for relief under Chapter 11 of the U.S. Bankruptcy Code on January 12, 2009. The Settlors, several Federal regulatory agencies, and multiple State regulatory agencies executed a *Consent Decree and Environmental Settlement Agreement* (Settlement Agreement) on February 14, 2011 (the Effective Date).

The Cimarron Environmental Response Trust (hereafter, the Trust) was established by an *Environmental Response Trust Agreement (Cimarron)* (the Trust Agreement), which was also executed on February 14, 2011. The Trust Agreement designated Environmental Properties Management LLC (EPM) as Trustee. The Trust Agreement defines the responsibility of the Trust and the Trustee.

Paragraph 2.1.4 of the Trust Agreement states, “On or before the Effective Date, with the approval of NRC and in accordance with the Atomic Energy Act, and applicable regulations in 10 C.F.R. Part 70, the Cimarron License shall be transferred to the Cimarron Trust, to be administered by Environmental Properties Management, LLC, not individually but solely in its representative capacity as Cimarron Trustee. The Cimarron Trustee, on behalf of the Cimarron Trust, shall oversee and shall receive communications relating to the transfer of the Cimarron License to the Cimarron Trust.”

Paragraph 4.1.1 of the Trust Agreement states, “Environmental Properties Management, LLC, not individually but solely in its representative capacity, is appointed to serve as the Cimarron Trustee to administer the Cimarron Trust and the Cimarron Trust Accounts, in accordance with the Settlement Agreement and this Agreement, and the Cimarron Trustee hereby accepts such appointment and agrees to serve in such representative capacity, effective upon the Effective Date.”

Paragraph 2.2.1 of the Trust Agreement states, “The exclusive purposes and functions of the Cimarron Trust are to: (i) act as successor to Debtors solely for the purpose of performing, managing, and funding implementation of all decommissioning and/or site control and maintenance activities pursuant to the terms and conditions of the Cimarron License, including the preparation and implementation of an NRC-approved decommissioning plan and groundwater remediation plan, and all Environmental Actions required under federal or state law; (ii) own the Cimarron Site; (iii) carry out administrative functions related to the performance of work by or on behalf of the Cimarron Site …”.

EPM was therefore selected by NRC and DEQ, in consultation with other regulatory agencies, to function as Trustee for the Trust.

### 16.4.2 Level of Coverage

The Trust Agreement provided for the creation of and transfer of assets from the Settlors to the Trust. Paragraph 2.1.1 of the Trust Agreement states, “… Tronox Worldwide LLC hereby transfers, assigns, and delivers, by quitclaim deed and other appropriate instruments, to the Cimarron Trust … all of Settlors’ right, title and interest in and to the Cimarron Trust Assets. Settlors shall retain no ownership or other residual interest whatsoever with respect to the Cimarron trust, the Cimarron Site.”

Paragraph 2.1.2.1 of the Trust Agreement states, “On the Effective Date, the Settlors shall cause to be transferred to or at the direction of the Cimarron Trustee cash in the amount of $8,638,384.00 (the “Funding”).”

Paragraph 2.1.2.2 of the Trust Agreement states, “On the Effective Date, the Settlors shall cancel the Cimarron LOC [Letter of Credit] and remit the funds from the Cimarron LOC to the Cimarron Standby Trust Fund already in existence, or to a new Cimarron Standby Trust Fund that may be established by the Cimarron Trustee in accordance with applicable NRC regulations.” The Cimarron LOC was a letter of credit for $3,600,000.00. These funds were placed in a Standby Trust Fund; U.S. Bank is the Trustee for this Trust Fund.

Paragraph 2.1.5 of the Trust Agreement established and funded the Trust Accounts. It states, “Upon receipt of the Cimarron Site and The Funding and Consideration, the Cimarron Trustee shall create a segregated Cimarron Trust Federal Environmental Cost Account and a Cimarron Trust State Environmental Cost Account and a segregated Cimarron Standby Trust Fund within the Cimarron Trust. The purpose of the Cimarron Trust Environmental Cost Accounts and the Cimarron Standby Trust Fund shall be to provide funding for future Decommissioning Activities, Environmental Actions and certain future regulatory fees and oversight costs of NRC and the State of Oklahoma with respect to the Cimarron Site. Funding for the Cimarron Trust Environmental Cost Accounts shall be held in trust for Environmental Actions with respect to the Cimarron Site and may not be used for any Owned or Non-Owned Site except as expressly provided in Section 2.4.3 below. The NRC shall be the sole beneficiary of the Cimarron Standby Trust Fund. The initial funding of the Cimarron Trust Federal Environmental Cost Account shall be a total of $6,588,381.00. The initial funding of the Cimarron Trust State Environmental Cost Account shall be a total of $746,114.00. The funding of the Cimarron Standby Trust Fund shall be the funds from the Cimarron LOC. The Cimarron Trustee shall also create a segregated Cimarron Trust Administrative Account in the amount of $1,303,889.00. The separate accounts are referred to in this Agreement individually as a “Cimarron Trust Account” and collectively as the “Cimarron Trust Accounts.”

Paragraph 2.1.8 of the Trust Agreement states, “The Cimarron Trustee shall use the Cimarron Trust Federal Environmental Cost Account and the Cimarron Standby Trust to fund future decommissioning costs pursuant to the Atomic Energy Act of 1954, including the preparation and implementation of an NRC-approved decommissioning plan and groundwater remediation plan, and future regulatory fees of NRC with respect to the Cimarron Site. The Cimarron Trustee shall use the Cimarron Trust State Environmental Cost Account to fund Environmental Actions and certain oversight costs of the State of Oklahoma with respect to the Cimarron Site. To the extent any proposed decommissioning or Environmental Actions in the proposed budget entail overlapping work that qualifies for disbursements from both the Cimarron Trust Federal Environmental Cost Account and the Cimarron Trust State Environmental Cost Account, the Lead Agencies (U.S. NRC and DEQ) and the Cimarron Trustee shall determine an equitable allocation between both Environmental Cost Accounts for such proposed work. The Cimarron Trustee shall use the Cimarron Trust Administrative Account to fund the Cimarron Administrative Costs that have been approved by the Lead Agency and Non-Lead Agency."

Paragraph 4.2 of the Trust Agreement states, "The Cimarron Trustee shall have no obligations to perform any activities for which the relevant Environmental Cost Account lacks sufficient funds."

### 16.4.3 Monitoring and Maintenance Funding

The financial assurance coverage provided by the February 14, 2011, *Consent Decree and Environmental Settlement Agreement* (Settlement Agreement) and *Environmental Response Trust Agreement* (the Trust Agreement) for site control and maintenance consists of funds included in the Cimarron Federal Environmental Cost Account.

Paragraph 3.2.4 of the Trust Agreement states, "The Cimarron Trustee shall also notify the Deputy Director … no later than 180 days prior to the anticipated date, that all contractual and other projected obligations will have exhausted 25%, 50%, and 75% of the Cimarron Federal Environmental Cost Account. Upon notification that 75% of the Cimarron Federal Environmental Cost Account has been exhausted, the Cimarron Trustee shall cease remediation work and commence passive maintenance and monitoring only of the Site in order to provide for the protection of public health and safety using the remaining funds in the Cimarron Federal Environmental Cost Account to fund monitoring and maintenance until further order of the NRC; provided however, that no more than 5% of the remaining funds available in the Cimarron Federal Environmental Cost Account shall be spent in any six-month period without NRC approval. The assets of the Cimarron Standby Trust shall not be accessed by the Cimarron Trustee until further order of the NRC."

Subparagraph 55(e)(ii)(b) states, "The Standby Trustee for the Cimarron Standby Trust Fund is authorized, in consultation with the Cimarron Trustee and the approval of NRC, to transfer from time to time any or all of the assets of the Cimarron Standby Trust Fund to any of the Cimarron

Trust Accounts in this Paragraph 55." NRC could therefore authorize the transfer of all or part of the funds from the Standby Trust for decommissioning activities or retain all or part of the funds for site monitoring and maintenance.

### 16.4.4 Trust Agreement

The financial assurance mechanism provided herein consists of several accounts held in Trust; both the amount and the authorized use of these accounts are described in the Trust Agreement. The wording of the Trust Agreement is not identical to the required wording presented in Appendix A of NUREG-1757, because the Trust was not established as a financial assurance mechanism. The Trust was established to create a licensable entity, with an administrative Trustee, to which License SNM-928 could be transferred to complete the decommissioning of the Site.

Section A.4.3 of Appendix A to Volume 3 of NUREG-1757 requires that a decommissioning plan include the following documentation with the Trust Agreement:

- Schedule A – identifying the licensee name and address, site address, required funding, etc.
- Schedule B – listing the property used to establish the fund
- Schedule C – specifying compensation to be paid by the licensee to the Trustee
- Specimen certificate of events – example form to be used to document that decommissioning activities can be commenced
- Specimen certificate of resolution – example form to be used to authorize the performance of decommissioning activities
- Letter of acknowledgement – verifying the Trustee's position and authority to enter into the Trust Agreement

The Trust Agreement was executed by NRC before a decommissioning plan and associated cost estimate could be prepared; the Trust Agreement does not include Schedules A, B, or C. The information that would be provided in Schedule A is presented in the Certification Statement.

Schedule B is intended to list the property (i.e., cash, securities, or other liquid assets) used to establish the Trust Fund (in this case, the Trust Accounts). This information is provided in the Trust Agreement, as described in Section 16.3.2, above.

Schedule C specifies the compensation to be paid by the licensee to the Trustee for its services. US Bank receives $5,000 per year, paid from the assets of the Standby Trust Fund, to function as Trustee for the Standby Trust Fund. EPM submits a proposed budget on an annual basis and is reimbursed for actual costs incurred within the budget approved by the NRC and DEQ as beneficiaries of the Trust. EPM does not charge a fee to function as Trustee.

No specimen certificate of events or certificate of resolution is included in the Trust Agreement. Paragraph 2.1.4.3 of the Trust Agreement states, “Upon NRC and ODEQ approval of the remediation plan, the Cimarron Trustee shall commence remediation of the Cimarron Site pursuant to the terms and conditions of the approved groundwater remediation plan and the Cimarron License.” This paragraph provides both the triggering event (i.e., approval of the remediation plan) that would be presented in a Certificate of Events, and the authority of the Trustee to commence the decommissioning activities that would be presented in a Certificate of Resolution. Consequently, these documents are not needed.

* * * * *

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