environmental
properties management, LLC

CIMMARON ENVIRONMENTAL RESPONSE TRUST

FACILITY DECOMMISSIONING PLAN

Revision 1

Prepared by

Environmental Properties Management LLC

With Consultants

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February 2021

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TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

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
BA1	Burial Area #1
BA2	Burial Area #2
BA3	Burial Area #3
BA4	Burial Area #4
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
COC	contaminant of concern
DAC	Derived Air Concentration
DAP-1	North Stockpile
DAP-2	East Stockpile
DCE	decommissioning cost estimate
DCGL	Derived Concentration Goal Level
DCL	derived concentration limit
DEQ	Oklahoma Department of Environmental Quality
DOT	United States Department of Transportation
dpm	disintegrations per minute
EPA	United States Environmental Protection Agency
EPC	engineering, procurement, and construction
EPM	Environmental Project Management LLC
$Fe(OH)_3$	ferric hydroxide
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
GETR	Groundwater Extraction Trench
gpm	gallons per minute
GWI	Groundwater Injection
HDPE	high-density polyethylene
hp	horsepower
HVAC	heating-ventilation-air conditioning

Acronym/Abbreviation	Term/Phrase/Name
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
KVA	kilovolt-ampere
lb	pound
LLRW	low-level radioactive waste
m	meter
m^2	square meter
m^3	cubic meters
MBBR	Moving Bed Biofilm Reactor
MCL	Maximum Contaminant Level
MDA	minimum detectable activity
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
Nextep	Nextep Environmental, Inc.
NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
OGS	Oklahoma Geological Survey ()
OPDES	Oklahoma Pollution Discharge Elimination System
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
ORP	Oxidation Reduction Potential
OWRB	Oklahoma Water Resources Board
PBA	Process Building Area
pC/kg	picoCuries per kilogram
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
PHMSA	Pipeline and Hazardous Materials Safety Administration
Plan	Final Decommissioning Plan
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
Settlement Agreement	*Plan of Reorganization and a Consent Decree and Environmental Settlement Agreement*
SFC	Sequoyah Fuels Corporation

Acronym/Abbreviation	Term/Phrase/Name
Site	Cimarron site
SNM	Special Nuclear Material
SWPPP	Stormwater Pollution Prevention Plan
Tc-99	technetium-99
TCLP	Toxicity Characteristic Leaching Procedure
TEDE	total effective dose equivalent
Tronox	Tronox Worldwide LLC
Trust	Cimarron Environmental Response Trust
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
UP	Uranium Pond
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WAA	Western Alluvial Area
WATF	Western Area Treatment Facility
wt. %	weight percent
WU	Western Upland

EXECUTIVE SUMMARY

Environmental Properties Management LLC (EPM), Trustee for the Cimarron Environmental Response Trust (the Trust), submits this Decommissioning Plan (this Plan) for the Cimarron site (the Site), located at 100 N. Highway 74, Guthrie, OK.

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 Trust. 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 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. 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. This activity concentration was derived by converting the toxicological risk-based criterion of 110 micrograms per liter (µg/L) at a U-235 enrichment of 2.7%. Uranium presents a greater toxicological risk than a radiological risk, so this NRC Criterion may be lower than a derived concentration goal level (DCGL) based on a 25 millirem per year (mrem/yr) annual dose limit would be.

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 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 therefore 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)".

The primary objective of this Plan is to reduce the activity of uranium in groundwater to less than the NRC Criterion to obtain NRC's release of the Site for unrestricted use and termination of the NRC license. The secondary objective is to remove as great a mass of all COCs as is achievable with available funding. Post-remediation monitoring will be performed to demonstrate compliance with the criteria applicable to the above stated objectives.

This Decommissioning Plan is submitted as a License Amendment Request.

After issuance of this requested license amendment by NRC and approval of this Plan by DEQ, decommissioning activities will begin with the development of specifications and requests for bids from qualified vendors. Contracts will be awarded and executed, and construction will begin. Upon completion of groundwater remediation, a minimum of three years of post-remediation groundwater monitoring will be conducted, and final status surveys will be performed as needed.

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 covers nearly all the property, and two ponds collect surface water from upland areas. Several miles of gravel roads, a gravel parking area, and one office building remain on Trust Property.

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 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 the Subareas for 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 Trust 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 consists only 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 (e.g., 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 which were as of that license amendment 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, 1995). It also added License Condition 27, which specified decommissioning 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 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 Cimarron Environmental Response Trust (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. Due to the fact that 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).

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 performed also 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, 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 Technitium-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 processed uranium-238 has two short-lived beta-emitting daughters and one long-lived alpha emitting daughter. 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), a fission product, in the groundwater.

Discussions were conducted with the Department of Energy, and it was determined that the Tc-99 was received by the Cimarron site as the result of 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 at all times 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 produced via 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 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. 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 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, 1987B) 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 the majority 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 off Site 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 off-site 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). 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 off Site 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). 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 off Site 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 off Site 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 off Site 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). 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 nonnuclear 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 (Cimarron, 1993B). 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). 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). 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 Trust 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 off Site 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 Figure 1-5 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). 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) was a single final status survey plan for Subareas A through E. The August 9, 1995 *Final Status Survey Report, Phase I Areas* (Chase Environmental Group, 1995C) 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) 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) was a single final status survey plan for Subareas F through J.

Final Status Survey Report for Phase II Subarea J (Cimarron Corporation, 1997) 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, 1998A) was submitted November 16, 1998. *Final Status Survey Report, Subarea I* (Cimarron Corporation, 1999B) 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, 1999A) was submitted October 21, 1999. When license SNM-928 was transferred to the Trust, the February 16, 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."

Decommissioning and Final Survey Report for Cimarron Facility Contaminated Waste Burial Ground (Cimarron Corporation, 1991), 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, 1998B) presented final status survey results for concrete slabs which had been removed from buildings and structures in other areas and placed in Subarea F. *Final Status Survey Report for Concrete Rubble in Sub-Area F* (Chase Environmental Group, 1998B) presented final status survey results for concrete slabs which had been removed from buildings and structures in other areas and placed in Subarea F. *Final Status Survey Report, Subarea F* (Nextep Environmental, Inc., 2005) was submitted September 5, 2005, with additional information provided in the November 20, 2007 *Burial Area #1 Subsurface Soil Assessment* (Cimarron Corporation, 2007). Oak Ridge Associated Universities (ORAU) issued a letter report on the analysis of seven confirmatory subsurface soil samples on March 6, 2013; all results were less than one-third of the criteria for unrestricted release. When license SNM-928 was transferred to the Trust, the February 16, 2011 license transfer order 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) 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, 1998D) was submitted March 12, 1998. *Final Status Survey Report, Subarea O (Surface)* (Cimarron Corporation, 1999C) 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) was submitted May 29, 1996. *Final Status Survey Report for Subarea L* (Cimarron Corporation, 1998B) was submitted July 27, 1998.

Final Status Survey Report for Subarea M (Cimarron Corporation, 1998C) 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) 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, 2002) was submitted January 31, 2002. NRC performed an inspection/confirmatory survey for Subarea N. An inspection report dated September 18, 2002 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 Trust, the February 16, 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."

Summary

As a result of all the above-described final status surveys, confirmatory surveys, and license amendments, surface and subsurface soil has been demonstrated to comply with unrestricted release criteria in all Subareas. All Subareas except Subareas F, G, and N have been released for unrestricted use.

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. Figure 1-6 shows the locations of pipeline leaks, spills, and releases which were identified during their excavation and removal.

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.

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 Oak Ridge Institute for Science and Education (ORISE) prior to backfilling (Landis, M.R., 1993). 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

Leaking wastewater from drain lines resulted in the contamination of groundwater in several areas. In the Western Alluvial Area, uranium activity exceeds the NRC Criterion, and uranium, nitrate, and fluoride all exceed their State criteria. 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 Burial Area #1 (BA1) has resulted in uranium concentrations exceeding the NRC Criterion, but nitrate and fluoride concentrations are below the State Criteria, and Tc-99 is not present in BA1.

Burial Area #2 – Leachate from 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 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 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, OK facility. Burial Area #1 (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. From 1986 through 1988, the 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 awaiting 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). 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.

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. Approximately 20,000 ft^3 of material exceeding the BTP Option 2 concentration range were packaged and shipped off the Site for disposal in a licensed LLRW disposal facility. Industrial waste was also packaged and shipped off the Site for disposal in a licensed LLRW waste disposal facility. Excavations were backfilled with soils from unaffected areas, which were sampled and analyzed after placement.

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. BA2 was backfilled with clean soil and final grading was completed in January 1997. BA2 was released for unrestricted use in Amendment17, License Condition 29, issued April 9, 2001.

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. Material and/or soil exceeding the BTP Option 2 concentration range was packaged and shipped off-site for disposal in a licensed LLRW disposal facility. BA3 was released for unrestricted use in Amendment 17, License Condition 29, issued April 9, 2001.

1.5.4 Burial Area #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 off-site 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 off-site for disposal at a licensed disposal facility. For Stockpiles DAP-3 and DAP-4, hot-spot averaging criteria contained in NUREG/CR-5849 was 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 by 425 ft 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 by 470 ft 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 by 470 ft 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 measured 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 the three pits varies from 35.7 to 45.0 pCi/g total uranium. The total quantity 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. All 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. Concrete cairns were placed at the corners of the 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 quantity 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.

* * * * *

2.0 FACILITY DESCRIPTION

2.1 SITE LOCATION AND DESCRIPTION

The Site consists of approximately 503 acres of property located in Logan County, Oklahoma (Figure 1-1). 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 occupied 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 Trust 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, as well as 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, oil and gas production wells, and injection wells associated with oil and gas production. The locations of residences and other facilities were obtained from GoogleEarth®. Table 2-1 lists all 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 wells and injection wells associated with oil and gas production (per the Oklahoma Corporation Commission Oil and Gas Well Data System as of February 8, 20217).

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. Figure 1-3 presents the Site and site features.

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 655,05743,648; 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). 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 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 (Grant, James, 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 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. Monitoring 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 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). This summary report was also published by NRC in 1983 as NUREG/CR-3117.

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 that 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 the portion of the map 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.

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* (Burns & McDonnell, 2018D). This report can be provided upon request.

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, the nitrate treatment system foundations, 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 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. Adams and Bergman (Adams, G.P. and D.L. Bergman, 1995) reported a low-water median flow rate of approximately 100 cubic feet per second (cfs) and a high-water median flow rate of 600 cfs. From 1990 to 2017, the Guthrie gage, located approximately 10 miles east of the Site, recorded from 287.1 to 3,695 cfs average annual flow rates (USGS water data website).

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 occurred during May 2019 when flood waters inundated the alluvial areas of the Site but stopped short of reaching the upland area.

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 lakes 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 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 (Grant, James, 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 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 (Grant, James, 1989).

2.7 GROUNDWATER HYDROLOGY

Groundwater in the Permian-age Garber Formation is found in the Garber Sandstones and the underlying Wellington Formation in the Site 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.

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 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 (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 Trust 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.

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 completed by J.L. Grant and Associates (Grant, James, 1989) yielded a geometric mean hydraulic conductivity of 1.03 x 10^{-3} centimeters per second (cm/s) with a range from 2.41 x 10^{-4} cm/s to 5.7 x 10^{-3} cm/s. The geometric mean for transmissivity was 33.4 square feet/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 x 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.

Figures 2-9, 2-10, and 2-11 present potentiometric surface maps for the Site.

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 in the area of 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 (Grant, James, 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). Those flow models were revised in 2013 and again in 2016, based on information obtained from additional COC delineation and aquifer testing performed in 2013 and additional groundwater assessment performed in 2014. Flow models were revised in 2019 in response to issues raised during NRC's acceptance review of *Cimarron Facility Decommissioning Plan – Rev 1*, (EPM, 2018). A final revision of the groundwater flow models was prepared in 2020 to evaluate and depict the first phase of the phased remediation approach described in Section 8 of this plan. The groundwater flow models incorporate area-specific lithologic and hydraulic detail to describe groundwater gradients and flows and assist in determining the locations and probable production of groundwater from groundwater extraction technologies such as groundwater recovery wells and groundwater extraction trenches.

Burial Area #1

The model domain for BA1 is shown on Figure 2-12. There are twelve layers in the model. This complex model layering system setup was initially described in the *2006 Groundwater Flow Modeling Report* (ENSR, 2006B). Flow into the model domain is from recharge both from upgradient and from precipitation, and general head boundaries and flow out of the model is to the Cimarron River. Figure 2-12 also shows the simulated potentiometric surface based on static groundwater elevations (i.e., not influenced by extraction or injection).

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 (*Conceptual Site Model* [ENSR, 2006A]).

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 (*Conceptual Site Model* [ENSR, 2006A]).

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 the 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

Previously reports used K_d values averaging 3 mL/g (*3/31/2004 Travel time estimate*). Using samples of soil and groundwater from the site, column tests were conducted by Hazen Research, Inc. (Johnson, Dennis and Kenney, Charles, 2006). K_d values were calculated and reported in (*Conceptual Site Model* [ENSR, 2006A]).

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 the site-specific values for K_d was provided in a letter dated July 5, 2016.

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 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]). Kc 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 Kd values for uranium in Hanford soils varying from 1.9 ± 0.1.4 to 2.4 ± 0.6 ml/g. Because the Kd 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 Kd 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 minutes (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.

* * * * *

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.

3.2 CONTAMINATED SYSTEMS AND EQUIPMENT

A trash incinerator, located south of Burial Ground #3, 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.

The radiological status of systems and equipment that may become contaminated during groundwater decommissioning activities is addressed in Section 8, "Planned Decommissioning Activities".

3.3 SURFACE AND SUBSURFACE SOIL CONTAMINATION

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.

In all three Burial Areas, the former burial trenches were excavated, scanned, and sampled. Soil containing less than 30 pCi/g total uranium was returned to the trenches. Soil exceeding 30 pCi/g was removed.

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.

All excavated soil (and other buried material) which exceeded the Option 2 criterion (100 pCi/g total uranium) was packaged and shipped to off-site 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. Both surface and subsurface soil now comply with license criteria for unrestricted release 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.

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, but it is not present at concentrations that exceed NRC Criterion.

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
- September 24, 2002, *Tc-99 Site Impact Evaluation and Proposed Groundwater Assessment Work Plan*, Chase Environmental Group
- December 12, 2002, *Well 1319 Area Groundwater Assessment Work Plan*, Cimarron Corporation
- January 29, 2003, *Burial Area #1 Ground Assessment Report*, Cimarron Corporation
- December 30, 2003, *Draft Tc-99 Groundwater Assessment Report*, Chase Environmental Group
- December 30, 2003, *Assessment Report for Well 1319 Area,* Cimarron Corporation
- August 10, 2005, *Site-Wide Groundwater Assessment Review,* Cimarron Corporation
- November 5, 2005, *Refined Conceptual Site Model,* ENSR International
- October 19, 2006, *Conceptual Site Model (Revision- 01),* ENSR International
- October 23, 2006, *Groundwater Flow Modeling Report,* ENSR International
- March 3, 2013, *Pneumatic Slug Testing Memorandum,* Burns & McDonnell Engineering Company, Inc.

- March 15, 2013, *Hydrogeological Pilot Test Report,* Burns & McDonnell Engineering Company, Inc.
- January 6, 2014, *Groundwater Flow Modeling Report,* Burns & McDonnell Engineering Company, Inc.
- July 22, 2014, *Hydrogeological Testing Memorandum,* Burns & McDonnell Engineering Company, Inc.
- May 8, 2015, *Report on 2014 Design Investigation,* Burns & McDonnell Engineering Company, Inc.
- July 5, 2016, *Distribution Coefficient Determination for the Cimarron Site,* EPM
- January 25, 2017, *Groundwater Flow Model Update,* Burns & McDonnell Engineering Company, Inc.
- May 19, 2017, *Vertical Distribution of Uranium in Groundwater*, Burns & McDonnell Engineering Company, Inc.
- August 22, 2017, *Determination of Conservative U-235 Enrichment Levels for Groundwater at Cimarron Site*, Enercon Services
- March 28, 2018, *1206 Drainage Sediment Assessment and Remedial Alternative Evaluation*, Burns & McDonnell Engineering Company, Inc.
- March 28, 2018, *Groundwater Data Evaluation*, Burns & McDonnell Engineering Company, Inc.
- April 12, 2018, *Determination of Maximum Conservative U-235 Enrichment Levels for Groundwater at Cimarron Site*, Enercon Services
- March 28, 2018, *2018 Groundwater Data Evaluation*, Burns & McDonnell Engineering Company, Inc.
- April 6, 2018, *Environmental Sequence Stratigraphy (ESS) and Porosity Analysis, Burial Area 1*, Burns & McDonnell Engineering Company, Inc.
- June 28, 2019, *2019 Groundwater Data Evaluation*, Burns & McDonnell Engineering Company, Inc.
- January 31, 2020, *Tc-99 Groundwater Assessment*, Burns & McDonnell Engineering Company, Inc.
- March 24, 2020, *BA#1 Redox Evaluation*, Burns & McDonnell Engineering Company, Inc.
- April 3, 2020, *Vertical Profiling and Monitor Well Abandonment Report*, Burns & McDonnell Engineering Company, Inc.

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
- January 24, 2005, letter proposing a Well 1319 Area post-decommissioning groundwater monitoring plan
- 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.
- August 31, 2007, letter requesting that NRC provide closure on Well 1319 Area groundwater remediation
- June 2, 2008, *Groundwater Decommissioning Plan*, ARCADIS
- March 26, 2009, license amendment request included *Groundwater Decommissioning Plan*, ARCADIS
- June 30, 2011, *Evaluation of Potential Alternative Groundwater Remediation Technologies,* Environmental Properties Management LLC
- March 19, 2014, *Treatability Study Report*, Clean Harbors
- October 30, 2015, *Groundwater Treatability Tests*, Kurion, Inc.
- May 25, 2018, *Explanation of 1206 Drainage Remediation Plan and Cost Impact at the Cimarron Site*, Environmental Properties Management LLC
- June 1, 2018, *Pilot Test Report,* Burns & McDonnell Engineering Company, Inc.
- November 2018, *Cimarron Facility Decommissioning Plan – Rev 1,* Environmental Properties Management LLC

3.5.3 Current Extent of COCs in Groundwater

The 2015 *Cimarron Facility Decommissioning Plan* 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 requested 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). 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 to treatment trains. Consequently, the decision was made to determine the concentration of each COC at each location at the 95% upper confidence level, based on data obtained from 2011 through the second quarter of 2017. For locations for which the 95% upper confidence level was greater than the maximum concentration, the maximum concentration was used. For locations for which less than 4 data points were available, the average concentration was used.

Figures 3-1 through 3-4 present isoconcentration contours (isopleths) for each COC, based on the results of these calculated concentrations. Figure 3-1 presents an isopleth map for nitrate in the Western portion of the Site. Figure 3-2 presents an isopleth map for fluoride in the Western portion of the Site. Figure 3-3 presents an isopleth map for uranium in the Western portion of the Site. As shown on Figure 3-3, representative uranium concentrations in the Western Area range from 0.63 to 875 µg/L. 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
Sandstone B	38.0	5.43
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	165	85.0
1206-NORTH	527	333
WU-BA3	875	203

Western Area remediation areas are depicted on figures presented in Section 8.0. Iso-concentration contours depicting the magnitude and extent of uranium contamination are shown on Figure 3-3. Representative uranium concentrations for each Western Area monitor well are also presented in table form on Figure 3-3, and wells with concentrations exceeding NRC or DEQ criteria are indicated on the table via color coding.

Figure 3-4 presents an isopleth map for uranium in BA1. As shown on the figure, 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 is 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. Iso-concentration contours depicting the magnitude and extent of uranium contamination are shown on Figure 3-4. Representative uranium concentrations for each BA1 monitor well are also presented in table form on Figure 3-4, and wells with concentrations exceeding NRC or DEQ criteria are indicated on the table via color coding.

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 (see Figure 3-1). The maximum and average fluoride concentrations observed in Western Area are 48.9 mg/L (Monitor Well 1313) and 3.1 mg/L, respectively (see Figure 3-2). 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 remediation criterion, assuming remediation in each area is discontinued once the respective DCGL is achieved, is as follows:

- BA1-A: 393 kg (achieved in 150 months)
- BA1-B: 137 kg (achieved in 45 months)
- WAA U>DCGL: 16 kg (achieved in 38 months)
- 1206-NORTH: 1.0 kg (achieved in 5 months)
- WU-BA3: 12 kg (achieved in 49 months)
  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*** 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). 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. Groundwater samples were collected from all monitor wells located in areas where groundwater will be extracted for treatment, as well as areas from which groundwater will be driven to extraction components by the injection of treated water. 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. 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.

* * * * *

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 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* (USNRC, 1987B). 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 microroentgen/hour (μR/hr) above background at 1 m (3.3 ft.)

4.2 UNRESTRICTED RELEASE CRITERIA FOR SURFACE 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.)

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 BTP Option 1 (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 off-site to a licensed low-level radioactive waste disposal site.

4.3 UNRESTRICTED RELEASE CRITERIA FOR GROUNDWATER

The only radioactive COCs in groundwater are uranium and technetium-99. Uranium is present both as natural uranium and as licensed uranium in groundwater. In addition, nitrate and fluoride are the two non-radioactive contaminants for which groundwater remediation is required to obtain unrestricted release from DEQ.

4.3.1 Uranium

License Condition 27(b) cites the unrestricted release criterion for uranium in groundwater. The NRC Criterion is based on a site-specific risk assessment rather than a dose model; and the risk of toxicity from ingestion of purified uranium is greater than its radiological dose risk. A 1998 risk assessment established a risk-based limit of 0.11 mg/L for uranium in groundwater (Roberts Schornick & Associates, Inc., 1998). That 0.11 mg/L is approximately equivalent to an activity of 180 pCi/L, assuming an average enrichment of approximately 2.7%, so 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 2.9% enrichment is 119 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 Technitium-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. 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. Tc-99 will be accumulated in ion exchange resin during the groundwater remediation process; the quantity of Tc-99 that will accumulate in resin cannot be definitively determined. However, several times the licensable quantity of Tc-99 are expected to be generated in the resin vessels that will be used to treat Western Area groundwater. The license does not specifically authorize possession of Tc-99, and a request to amend the license to authorize the possession of Tc-99 is included in Section 6 of this Plan. The NRC requires that post-remediation groundwater monitoring demonstrate that Tc-99 concentrations in groundwater are less than 3,790 pCi/L to obtain unrestricted release from NRC.

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. Tc-99 concentrations in groundwater must be below 900 pCi/L to obtain unrestricted release from DEQ.

4.3.3 Nitrate

DEQ formalized the remediation goals for groundwater in a letter dated August 4, 2015. The concentration of nitrate in groundwater in the Process Building Area must be remediated to less than 52 mg/L. This is a risk-based concentration for a trespasser or an agricultural worker, which was deemed appropriate for a commercial operator obtaining drinking water from a public water supply.

The concentration of nitrate in groundwater in all other areas must be reduced to less than the State Criterion of 22.9 mg/L. This represents the maximum nitrate concentration, at a 95% level of confidence, in groundwater collected from monitor wells located upgradient of impacted areas.

4.3.4 Fluoride

The State Criterion for fluoride in groundwater site-wide is the MCL of 4 mg/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 COCs 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 and removal of nitrate by biodenitrification. A portion of the treated water will be re-injected into upland areas to flush contaminants to groundwater extraction components located in the floodplain. 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 complete the remaining decommissioning activities needed for NRC to release the Site for unrestricted use and to terminate Materials License SNM-928. License termination is a separate action that requires an NRC finding that the Site meets the criteria for unrestricted release.

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 of effort and future potential conflicts between different sections of this Plan.

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 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 some soil were excavated and packaged for shipment and disposal under License Conditions 18 and 20 of SNM-928 through its 1983 renewal. After excavation of the sanitary lagoons and trenches of 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 responses 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* (Grant, James, 1998), 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. NRC approved the use of the decommissioning plan (with the eight additional submittals) 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 and termination of Radioactive Materials License SNM-928 by implementation of the groundwater remediation program proposed herein. 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 and/or biodenitrification. Treated water will be disposed of in one of two ways:

- A portion of the treated water will be reinjected into upland fractured sandstone to drive impacted groundwater 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.

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. Once spent resin is processed and compliance with the fissile exception criteria is verified, the U-235 in that material will no longer be constrained by that possession limit. Spent resin will be processed, packaged, and shipped to a licensed disposal facility as LLRW. If a biodenitrification system is installed, biomass generated by the system will be processed, packaged, and shipped to either a waste disposal facility authorized by the OPDES permit or to a licensed LLRW disposal facility.

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 COC 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 12 quarters, treatment for uranium may be discontinued in all areas and the licensee will apply for termination of the license. It is anticipated that a demonstration that residual dose is less than 25 mrem/yr will expedite the license termination process; treatment for uranium may be continued to provide assurance that residual dose will be less than 25 mrem/yr.

5.5 ALTERNATIVES TO THE PROPOSED ACTION

Two alternatives to the active remediation presented in this Plan were considered: no action, and "passive" groundwater remediation by monitored natural attenuation.

5.5.1 No Action Alternative

Two alternatives to the implementation of this Plan were considered: no action, and "passive" groundwater remediation by monitored natural attenuation. No action would mean:

- Concentrations of licensed material in groundwater would not be reduced to levels that would provide for unrestricted release of the Site.
- License conditions currently in effect would need to be maintained indefinitely.
- Portions of the former Site in which the concentration of uranium in groundwater exceeds unrestricted release criteria would remain released from the license.
- Portions of the Site which are releasable for unrestricted use would remain under license.

There is no immediate 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. However, not remediating groundwater at the site would require maintenance of the NRC license and control of access to areas where the concentration of uranium in groundwater exceeds the NRC Criterion.

Funding for decommissioning is limited to the amount available to the Trust. If groundwater is not remediated, funding may not be sufficient to maintain license controls indefinitely. Loss of control over residual licensed material could result in unacceptable exposure to licensed material in the future.

5.5.2 Monitored Natural Attenuation

Monitored natural attenuation (MNA) is a process whereby natural processes such as dispersion and dilution reduce the concentration of contaminants in groundwater over time. Long-term sampling and analysis of groundwater monitors the reduction in concentration. Should MNA be implemented at the site, license controls would remain in effect while periodic sampling and analysis of groundwater, followed by evaluation of the data, would enable the licensee to monitor the natural decline in concentration until groundwater concentrations are below unrestricted release criteria Site-wide.

As with the "No Action" alternative, funding for decommissioning is limited to the amount available to the Trust. If groundwater is not remediated, funding may not be sufficient to maintain the NRC license and control of access to areas where the concentration of uranium in groundwater exceeds the NRC Criterion indefinitely. Loss of control over residual licensed material could result in unacceptable exposure to licensed material in the future.

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 remain under license.

Figure 5-1 shows how the nearly 800-acre site was divided into 17 areas for final status surveys, labeled Subarea A through Subarea O in Figure 1-2. Subareas A, B, C, D, and E were released for unrestricted use in License Amendment 13, issued April 23, 1996. These were all considered "unimpacted" areas.

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 G and N, demonstrating that those areas comply with decommissioning criteria. Confirmatory surveys for both areas were performed by ORAU; 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 5-2). 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 LLC in April 2015 (see Figure 5-2). 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 5-2). 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 5-2). 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.

If funding provides for the full implementation of the groundwater remediation program in all remediation areas, groundwater remediation infrastructure will span several hundred acres of Trust property. The vast majority of this infrastructure will be for the extraction and treatment of groundwater which already complies with decommissioning criteria, but which exceeds State Criteria for uranium, Tc-99, nitrate, or fluoride.

Groundwater remediation infrastructure associated with achieving the decommissioning criteria 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 6 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 A and I.
- Treated water will be injected into an injection trench located in Subarea M.
- BA1 groundwater extraction and treated water injection infrastructure will consist of four groundwater extraction wells, two groundwater extraction trenches, three treated water injection trenches, and (if proceeding to full implementation) a small treatment facility, altogether occupying approximately 4 acres in portions of Subareas C and F.

Once decommissioning activities have been completed, the property still owned by the Trust may be divested in accordance with the Trust Agreement. Portions of the site which will include the building constructed for the Western Area 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 5-3. 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 heavily loaded 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 minimal increase in truck traffic. The Trust 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 could likely be expected 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 between 1 to 3 workers using POVs. The direction of their daily travel is unknown but could likely be expected 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 site hours for construction are anticipated to be between the hours of 6 AM and 7 PM. The site hours for 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 and 8.3.3

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, as well as 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.

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. Without this groundwater remediation effort, groundwater would otherwise migrate untreated to the river. Removal of contaminants from groundwater treatment will prevent future adverse impact to surface water.

During construction of groundwater remediation and water treatment facilities, surface water will be protected from impact from 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 (Appendix B). 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 5-4 shows the locations of injection and extraction trenches that have been or may 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 also shows the location of the discharge piping leading to Outfall 001. The area within which excess spoils (displaced by imported silica gravel) will be placed is also shown on Figure 5-4. The approximate locations of BMPs installed to prevent migration of sediment to surface water (e.g., silt fence) are also shown on Figure 5-4.

Figure 5-5 shows the locations of injection and extraction trenches that have been or will be constructed in the eastern portion of the site. It also shows the location of the BA1 Treatment Facility and the trenches through which utilities, control wiring, and piping will run from extraction wells to the BA1 Treatment Facility and from the BA1 Treatment Facility to injection trenches. It also shows the location of the discharge piping leading to Outfall 002, should that discharge line and discharge structure be constructed during Phase II. The approximate locations of BMPs installed to prevent migration of sediment to surface water (e.g., silt fence) are also shown on Figure 5-5.

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 and extraction 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 5-4 and 5-5 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 extraction and injection trenches is provided in Sections 8.2.2 and 8.4.1. 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 makes no provision for 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 the same chemical characteristics as 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 only for janitorial functions and sanitation; 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 5-4 and 5-5, groundwater remediation infrastructure associated with achieving the decommissioning criteria will be contained within approximately 12 acres of property owned by the Trust. This includes construction of up to two outfalls (Outfalls 001 and 002) 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 receipt 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 BA1 uranium treatment system.

- Operation: Over-the-road trucks will transport chemicals, drums of biomass and LLRW, and other supplies. Over-the-road trucks delivering bulk liquid chemicals will use equipment to fill treatment 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 to tow resin vessels between the BA1 treatment area and the WAA treatment facility, as well as for daily operation and maintenance.

In addition to air quality impacts from construction and operations equipment, low concentrations of nitrogen will be released to the atmosphere during the denitrification process. The extraction and treatment of groundwater, and the subsequent injection and/or discharge of treated water will have no impact on air quality.

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 on site 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 offsite 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 13 historic places are located in Logan County:

- Guthrie, Oklahoma
    - Carnegie Library
    - Co-Operative Publishing Company Building
    - Guthrie Armory
    - Guthrie Historic District
    - Logan County Courthouse
    - Scottish Rite Temple
    - St. Joseph Convent and Academy

- Langston, Oklahoma
  - Langston University Cottage Row
  - Morris House
- 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 9 miles from the Site. Several other historical and cultural resources were reviewed in March 2015. Appendix E contains a memorandum summarizing this research. From this research, no specific cultural or historical sites were identified on the Project 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 5-6.

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 conveyance piping, electrical, and controls infrastructure. The groundwater remediation and treatment facilities presented on Figure 5-6 include those that may be constructed and operated during both Phase I and Phase II (see Section 8). However, only portions of the areas of potential land disturbance presented on Figure 5-6 will be disturbed during Phase I. Figure 5-6 shows the extent of construction activities in relation to the locations of the potential historic resources. Appendix E includes both the 2018 request for SHPO consultation and the 2020 report on the Cultural Resources Survey.

5.6.9 Visual/Scenic Resources

The Site has been essentially dormant for decades. The former process buildings had been removed and were deteriorating, with 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 have 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 improved; ongoing landscaping efforts have ceased since the owner's bankruptcy filing in mid-2020. These portions of the Site are significantly more appealing to the community as well as to people driving past the facility on Highway 74.

Viewshed analysis has been conducted to establish the areas in which the proposed site's 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.

Decommissioning activities already completed 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 Trust, there were no full-time workers at the site.

Proposed decommissioning activities will require support of approximately three operations and maintenance and health physics personnel. Decommissioning will therefore not significantly impact employment.

Approximately 24 acres containing the former process buildings has been sold, and that property has been used for industrial/commercial operations. The beneficial re-use of these facilities created several jobs and improved the security of the Site.

Approximately 117 acres of property west of Highway 74 has been sold and remains fallow.

Upon completion of decommissioning, the remaining approximately 500 acres of property will be sold. It is presumed that a significant portion of this property will be used for agriculture and 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 90% 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, with subsequent packaging, transportation, and disposal at a licensed facility. 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 As Low As Reasonably Achievable (ALARA) principle. It is not anticipated that any worker will receive a total effective dose equivalency (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 50 and 60 ft^3 of waste after blending with sufficient absorbent material to comply with the licensed disposal facility's waste acceptance criteria (WAC). During the first year of operation, as many as ten exchanges may occur, yielding between 500 and 600 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 that is sufficiently concentrated that it could exceed release criteria. The packaging, transportation, and disposal of this waste will be the same as for spent resin, as described in Section 13.1.1.

Waste – Solid Waste

If treatment for nitrate is added to the remediation infrastructure during a second phase of operation, nitrate treatment processes will produce biomass which must be disposed of offsite.

Groundwater will be routed through uranium treatment systems prior to nitrate treatment, so this waste should not accumulate uranium. If the biomass does not contain detectable uranium or Tc-99 it will be shipped to disposal facility in accordance with the OPDES permit. No blending with inert material is expected for this material unless absorbent must be added to reduce the liquid content. The biodenitrification system is expected to produce approximately 80 tons of waste (prepared for disposal) per year.

Upon demobilization of the treatment facility equipment used in these processes, 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 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

The following sections of the DP describe the chemicals used in and waste generated by the following operations and/or processes:

- Section 8.3.2, "Uranium Treatment Systems"
- Section 8.3.3, "Biodenitrification Systems"
- Section 8.7.6, "Biomass Processing"

The May 25, 2017 response to agency RAIs stated that chemicals used to treat water for injection and to process spent resin would be addressed in this Plan. The current plans are to use inorganic absorbent to process spent resin. Although the water treatment systems are expected to generate water that can be discharged to the Cimarron River without the addition of chemicals, treatment of water used for re-injection may be required to prevent mineral scaling and fouling of the injection system infrastructure and subsurface formation. The water injection systems are detailed further in Section 8.4.3.

Descriptions of chemicals to be used include:

- Expected quantity
- Storage method
- Transportation mode
- Frequency of use/replacement

- For waste, the regulatory classification (LLRW or non-LLRW, hazardous or non-hazardous)

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.

5.6.13 Permits

Stormwater Permit

A Notice of Intent to comply with OPDES General Permit OKR10 was submitted to the DEQ on November 6, 2017. The DEQ authorized the discharge of stormwater in accordance with the general permit in a letter dated June 25, 2018. Due to the time gap between this Notice of Intent and the beginning of construction, this will be renewed after approval of this Plan and prior to construction.

As part of the OPDES General Permit requirements, a 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. A Notice of Termination for the OPDES General Permit will be submitted following establishment of a minimum 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 was submitted to Logan County on February 9, 2017. Logan County issued Floodplain Development Permit LG-17-01 on February 28, 2017. A copy of the permit 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 permit will be submitted after approval of this Plan and prior to construction.

The United States Corps of Engineers approved the construction of two water discharge outfalls under the Nationwide Permit for Utility Line Activities (NWP-12) in a letter dated November 9, 2015. This permit expired on March 18, 2017 and an application for permit extension was submitted on June 18, 2018. A historical and cultural resources survey was submitted to the Oklahoma Historic Preservation Office in June 2020. A Section 106 review of that submittal must be performed by the Oklahoma Historical Preservation Office before the United States Corps of Engineers can approve the permit extension request. Due to the time gap between the application for an extension of the permit and the beginning of construction, a new application for a permit will be submitted after approval of this Plan and prior to construction.

Discharge Permit

Effluents will be discharged to the Cimarron River via 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 12.2.2.

Underground Injection Permit

Injection of treated water must comply with DEQ's Underground Injection Control (UIC) program. A request for approval to inject treated water was submitted to DEQ on May 6, 2016, and the DEQ approved the injection of treated water in a letter dated June 13, 2016. A revised inventory detailing injection locations and quantities was submitted August 14, 2018. The DEQ approved the injection of treated water in a letter dated September 11, 2018. With the elimination of biodenitrification during Phase I remediation, treated water injected into the Western Area will contain a higher concentration of nitrate than was listed in the 2016 request for approval. However, the concentration of nitrate in treated water will be lower than the concentration of nitrate in the formation. This will be described in a revised injection well inventory prior to construction. The quantity of treated water injected into each injection trench will be reported to the DEQ on a monthly basis.

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 will require mitigation.

Contamination Control

Day-to-day contamination control will be managed and monitored in accordance with the Radiation Protection Program (RPP). Rigorous implementation of the RPP will eliminate onsite and offsite radiological contamination impacts.

Airborne Contamination

Airborne radioactive contamination is unlikely because radioactively contaminated materials are either water, moist resin, or wet biomass. However, airborne radioactive contamination may be encountered in the form of a solid, liquid or particulates suspended in air. In accordance with the RPP, proper personnel practices and engineering controls will mitigate onsite and offsite impacts 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 as stipulated in the OPDES permit.

Civil Engineering Controls

Civil engineering controls will be required if excavation activities are required during removal of the groundwater treatment system. Standard measures will be implemented to prevent impacts due to potential radioactivity in excavated materials. These measures may include:

- Diversion of surface water away from work areas
- Covering un-active waste stockpiles
- Use of silt fence and/or filter socks
- Control and management of groundwater encountered in excavations

Accidents

There is a slight potential for radiological accidents during the decommissioning activities resulting from the uncontrolled release of radioactive materials to the work area or environment.

These releases would most likely be associated with inadvertent mismanagement of contaminated liquids in the treatment tanks and pipes. Full-time monitoring, in accordance with the RPP, will be conducted during removal of all systems. Draining of tanks and pipes before removal (or moving) will be sufficient to prevent uncontrolled release.

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

A 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 on Site will be radiologically unimpacted. Potentially contaminated combustibles may include dry active waste such as personnel protective clothing, rags and towels used for site cleanup and decontamination. The radioactivity contained in these materials would not be high enough to result in a significant 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 will require mitigation.

Fugitive Dust

Fugitive dust is particulate matter discharged into the atmosphere due to a construction activity such as dismantling of treatment components, 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:

- If needed (as determined by the Trustee Project Manager [PM] or Activity Lead), unpaved areas subject to vehicle traffic will be stabilized by being kept wet, treated with a chemical dust suppressant, or covered.
- The speed of any vehicles and equipment traveling across unpaved areas will be no more than 15 miles per hour.
- Storage piles 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.
- If needed (as determined by the Trustee PM or Activity Lead), prior to any ground disturbance, including grading, excavating, and land clearing, sufficient water will be applied to the area to be disturbed to prevent dust emissions from crossing the boundary line.
- As necessary, construction vehicles leaving the site will be cleaned to prevent dust, silt, mud, and dirt from being released or tracked off site.
- 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 as stipulated in the OPDES permit.

Civil Engineering Controls

If construction or demobilization activity results in a ground disturbance 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

The decommissioning work to be completed to achieve release of the Site for unrestricted release and license termination is expected to achieve with the decommissioning criteria in 10 CFR 20, Subpart E. 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 result in the beneficial use of a site that has not 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 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."

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 to License SNM-928 that applies to packaged waste that meets the requirements for transportation as "fissile exempt" material in 10 CFR 71.15.

Tc-99 is present in groundwater only in western remediation areas. The ion exchange resin used to treat groundwater for uranium will capture some or all of the Tc-99. The highest Tc-99 concentrations in groundwater are found in the uranium waste pounds upgradient from the WAA-BLUFF remediation area. If groundwater from the WAA-BLUFF remediation area were to be treated by ion exchange, the maximum concentration of Tc-99 in the groundwater extracted from those wells is estimated to be less than 15 nanograms per liter (ng/L). The maximum flow capacity of the ion exchange vessels 125 gpm, and resin vessels will be changed out approximately every

100 days. If the resin captured 100% of the Tc-99, approximately 1 gram of Tc-99 would accumulate in the resin.

The maximum concentration of Tc-99 in influent to the WA treatment system (during Phase II) is estimated to be less than 15 ng/L. If all of the Tc-99 in groundwater containing 15 ng/L was adsorbed to the resin for 100 days (at which time the resin would need to be changed) with a continuous flow rate of 250 gpm (feeding both skids), a total mass of slightly over 2 grams of Tc-99 would be accumulated. Drums containing the spent resin – absorbent mixture will be stored in the storage area until a full shipment is accumulated. If all the resin from two exchanges from both WA skids were in storage while both operating skids were also fully saturated, there would be a total of approximately 6 grams of Tc-99 on site. Even providing for a small mass of Tc-99 in lag and polishing vessels, a mass possession limit of 10 grams of Tc-99 would not be exceeded; a possession limit of 10 g of Tc-99 is therefore 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. *Uranium enriched to > 5.0 wt. % in U-235*	*B. Any compound*	*B. 100 grams of contained U-235 (Note 2)*
C. Natural and depleted uranium source material	*C. Any compound*	*C. 2,000 kilograms of uranium*
D. Thorium source material	*D. Any compound*	*D. 6000 kilograms of Thorium*
E. Uranium enriched to ≤ 5.0 wt. % in U-235	*E. Any compound as packaged waste in containers that meet the transportation requirements in 10 CFR 71.15*	*E. (Notes 1 and 3)*
F. Technitium-99	*F. Any compound*	*F. 10 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: 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.

Note 3: 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 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 (since incorporated into Item 6 of the license), the site 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:

- Retain the document citation in License Condition 10, or
- Move the document citation to another License Condition, or
- Delete the document citation from the license.

<u>November 19, 1985</u> – This letter from Kerr-McGee Corporation 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 6(D) to authorize possession of 6,000 kg of thorium. This authorization is still present in Item 6(D) of the current license. <u>EPM requests that License Condition 10 be amended to delete the reference to this document.</u>

<u>March 3, 1986</u> – This letter 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 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 6(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. EPM requests that License Condition 10 be amended to delete this document, and that Item 6(A) maintain the authorized possession limit of up to 1,200 grams of <5 wt. % U-235.

September 4, 1987 – This letter from Sequoyah Fuels Corporation 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") on site 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

November 2, 1989 – This submittal from Cimarron Corporation included results of the final release surveys of the MOFF facility. Subarea I, in which the MOFF plant is located, was released for unrestricted use in License Amendment No. 17, issued April 9, 2001. EPM requests that License Condition 10 be amended to delete the reference to this document.

August 22, 1990 and September 14, 1990 – The August 1990 letter 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, 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. EPM requests that License Condition 10 be amended to delete the references to these documents.

June 24, 1992 – This letter from Cimarron Corporation requested information from 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

February 25, 1993 – This letter from Kerr-McGee Corporation responded to an NRC 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. Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. The required 5-year monitoring period expired several years ago. There is no reason to maintain this tie-down in the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

April 19, 1994 – This letter from Kerr-McGee Corporation 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. 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

May 31, 1994 – This letter from Kerr-McGee Corporation responded to an NRC 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. 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

July 20, 1994 – This letter from Kerr-McGee Corporation responded to an NRC request for additional information dated July 18, 1994. It addressed how to collect soil samples and determine 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. 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

September 21, 1994 – This letter from Cimarron Corporation responded to an NRC 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. 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

November 3, 1994 – This letter from Cimarron Corporation 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. 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

November 15, 1994 – This letter from Cimarron Corporation 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 site

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. EPM requests that License Condition 10 be amended to delete the reference to this document.

December 16, 1994 – This letter from Cimarron Corporation requested a license amendment to designate Karen Morgan as radiation safety officer (RSO). Ms. Morgan has not been RSO for the Cimarron site since 2007. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

April 12, 1995 – This letter from Cimarron Corporation responded to an NRC 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

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, needed be referenced in the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

July 5, 1995 – This letter from Cimarron Corporation 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

July 25, 1995 – This document is the *Final Status Survey Plan for Phase II Areas* (Chase Environmental Group, 1995B). Subarea F is a Phase II area and is the only area in which NRC has not yet 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. However, because this Phase II area remains under license, this tie-down should be retained in the license.

August 9, 1995 and November 13, 1995 – The August 9 document is the *Final Status Survey Report, Phase I Areas* (Cimarron Corporation, 1995C). The November 13 letter 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 D-Plan, submitted as part of this license amendment request. Portions of Subareas C, D, and E will be drawn back under the license; those areas that should be licensed will be defined in Section 6.3 of this license amendment request. However, 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. EPM requests that License Condition 10 be amended to delete the references to these documents.

January 23, 1996 – This letter from Cimarron Corporation 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 presented in the Radiation Protection Program. This tie-down does not reflect the current licensee's organization and is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

April 25, 1996 (Listed twice) and June 10, 1996 – The April 25 letter from Cimarron Corporation proposed an Option 2 material disposal procedure change from stockpiling to direct transportation to the on-site disposal cell. The June 10 letter from NRC approved this procedural change. Decommissioning of soil and closure of the on-site disposal cell is complete. NRC has agreed 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. EPM requests that License Condition 10 be amended to delete the references to these documents.

August 28, 1996 – This letter from Cimarron Corporation 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. 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

September 20, 1996 – This letter from Cimarron Corporation 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 Radiation Protection Plan (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). 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

November 20, 1996 – This letter from Cimarron Corporation 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. Subarea N, which contains the on-site disposal cell, is releasable for unrestricted use. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

January 2, 1997 – This letter from Cimarron Corporation responded to 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

January 28, 1997 – This letter from Cimarron Corporation responded to 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 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. Because this Phase II area is still under license, this tie-down should be retained in the license.

May 6, 1997 – This letter from Cimarron Corporation responded to NRC's February 25, 1997 comments on the site decommissioning plan. This response addressed volumetric averaging at Uranium Ponds 1 and 2, volumetric characterization of concrete in drainage and spillways, and the State's classification of groundwater. 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

May 16, 1997 – This letter from Cimarron Corporation responded to 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

December 5, 1997 – This letter from Cimarron Corporation responded to 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

February 10, 1998 – This letter from Cimarron Corporation served as a 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 NRC. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

June 26, 1998 – This letter from Cimarron Corporation responded to NRC's February 9, 1998 comments on 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 NRC. This submittal is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

July 2, 1998 – This letter from Cimarron Corporation responded to 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 agreed that all Phase II soils 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. This tie-down regarding the traceability of the soil counter is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

February 15, 2000 – This document was the *Final Status Survey Report, Subarea K* (Cimarron Corporation, 2000). 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

February 20, 2001 – This letter from Cimarron Corporation responded to 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. EPM requests that License Condition 10 be amended to delete the reference to this document.

April 17, 2002 – This letter from Cimarron Corporation proposed a decommissioning schedule based on information available at that time. That schedule is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

May 10, 2002 – This letter from Cimarron Corporation revised the decommissioning schedule, revising the assumptions behind the April 17, 2002 schedule. That schedule is no longer relevant to the license. EPM requests that License Condition 10 be amended to delete the reference to this document.

In summary, only two of the 39 documents listed in License Condition 10 are still relevant to the licensing and decommissioning of the Cimarron site. Those documents are the July 25, 1995 *Final Status Survey Plan for Phase II Areas* (Chase Environmental Group, Inc., 1995B) and the January 28, 1997 response to NRC comments on that final status survey plan. License Condition 27(a) references those documents that address all other aspects of site decommissioning. EPM requests that License Condition 10 be deleted and the references to the July 25, 1995 and January 28, 1997 submittals be added to License Condition 27(a).

6.4 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.

6.5 LICENSE CONDITION 26 – RADIATION PROTECTION PROGRAM

License Condition 26 requires the licensee to implement a version of the Radiation Protection Plan (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 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.

In addition, license amendment No. 15, issued August 20, 1999, added License Condition 27(e), which provides for licensee revision of the Decommissioning Plan and RPP without NRC approval, provided certain conditions are met. Periodic changes have been made to the RPP each year, and annual reports of all changes made under License Condition 27(e) have been submitted to NRC, usually with complete copies of the 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 in accordance with License Condition 27(e).

EPM requests that License Condition 26 be amended to read, "The Licensee shall conduct a radiation protection program in accordance with the Radiation Protection Plan (RPP) submitted as Appendix M to the February 26, 2021 *Facility Decommissioning Plan – Rev 2*, as amended in accordance with License Condition 27(e)."

6.6 LICENSE CONDITION 27 – SITE DECOMMISSIONING

6.6.1 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, particularly addressing the characterization and remediation of Site groundwater. EPM believes this license condition needs to be amended incorporate the site 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 or retained from the license. It also discusses several other submittals which EPM believes should be included in this license condition.

April 19, 1995 – This submittal was the *Decommissioning Plan for Cimarron Corporation's Former Nuclear Fuel Fabrication Facility* (Chase Environmental Group, Inc., 1995A). This document provided for the decommissioning of buildings, materials, and soil Site-wide. It also assumed that active groundwater remediation would not be required. Because active groundwater remediation is required, this decommissioning plan is no longer relevant. EPM requests that License Condition 27(a) be amended to delete the reference to this document.

September 10, 1996 – This letter from Cimarron Corporation 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. EPM requests that License Condition 27(a) be amended to delete the reference to this document.

May 6, 1997 – This letter from Cimarron Corporation responded to NRC's February 25, 1997 comments on Cimarron's September 10, 1996 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. EPM requests that License Condition 27(a) be amended to delete the reference to this document.

August 26, 1997 – This letter from Cimarron Corporation responded to NRC's July 1, 1997 comments on open issues related to Cimarron's September 10, 1996 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. EPM requests that License Condition 27(a) be amended to delete the reference to this document.

March 10, 1998 – This submittal was *Final Status Survey Report for Concrete Rubble in Sub-Area F* (Chase Environmental Group, 1998B). 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. EPM requests that NRC amend License Condition 27(a) to delete the reference to this document.

March 12, 1998 – This submittal was *Final Status Survey Report for Phase III Subarea O, Uranium Waste Ponds #1 and #2 (Subsurface)* (Cimarron Corporation, 1998D). 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. EPM requests that License Condition 27(a) be amended to delete the reference to this document.

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, 1998B). For the same reasons described in the above paragraph on the

March 10, 1998 report, EPM requests that License Condition 27(a) be amended to delete the reference to this document.

October 6, 1998 – This letter from Cimarron Corporation responded to NRC's September 10, 1998 comments on residential inhalation dose from concrete rubble in Subarea F. For the same reasons described in the above paragraph on the March 10, 1998 report, EPM requests that License Condition 27(a) be amended to delete the reference to this document.

March 4, 1999 – This letter from Cimarron Corporation responded to NRC's January 19, 1999 comments on *Decommissioning Plan Groundwater Evaluation Report* (Chase Environmental Group, 1998A), 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. EPM requests that License Condition 27(a) be amended to delete the reference to this document.

License Condition 27(a) Summary – EPM requests that License Condition 27(a) be amended to read, "The licensee is authorized to remediate the Licensee facility in accordance with the "Facility Decommissioning Plan – Rev 2", dated February 26, 2021.

6.6.2 License Condition 27(b)

License Condition 27(b) establishes the radiological release criterion for uranium in groundwater, establishes a monitoring requirement to demonstrate that groundwater complies with the criterion, requires that the licensee retain control of the property until groundwater release criteria are met, and acknowledges that DEQ may require monitoring of non-radiological components of groundwater.

At the time this license condition was incorporated into the license, it was believed that uranium exceeding the license release criterion was present in groundwater in only a very limited area. It was also believed that natural attenuation would reduce the concentration of uranium in groundwater to less than the release criterion within a few years. Consequently, License

Condition 27(b) required that ALL wells yield less than the groundwater release criteria for eight consecutive quarters.

Subsequent 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. The substantial groundwater assessment performed at the site has resulted in the installation of over 230 monitor wells at the site, many of which do not yield groundwater exceeding the release criterion for uranium.

The decommissioning plan submitted as part of this license amendment request includes a comprehensive groundwater remediation plan designed to reduce the concentration of both radiological and non-radiological COCs to less than their respective release criteria. Because the primary objective is to first remediate groundwater only in areas in which uranium exceeds the NRC Criterion, the post-remediation groundwater remediation program addresses only uranium and Tc-99 (the other radionuclide of interest to the NRC).

The requirement to collect and analyze groundwater samples from ALL wells for eight quarters is no longer appropriate. Incorporation of this Plan into License Condition 27(a) will eliminate the need to specify groundwater monitoring requirements in License Condition 27(b).

EPM requests that License Condition 27(b) be amended to read, "The release criteria for groundwater at the Cimarron site is 6.7 becquerel per liter (Bq/l) (180 pCi/L) total uranium. Compliance with release criteria must be demonstrated over a period of 12 calendar quarters as described in the post-remediation monitoring plan described in "Facility Decommissioning Plan – Rev 2" dated February 26, 2021.

6.6.3 License Condition 27(c)

License Condition 27(c) includes one paragraph specifying survey methods for Waste Ponds 1 and 2 in Subarea O. 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.

EPM requests that the license be amended to remove this 3-line paragraph from License Condition 27(c).

6.6.4 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 those areas that will be designated 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 Bq/L (180 pCi/L) for uranium in groundwater. However, DEQ requires that shallow groundwater undergoing remediation must be treated to comply with lower State Criteria to obtain unrestricted release from DEQ. For uranium, this is 30 μg/L, which will vary from 30 – 40 pCi/L as the enrichment of the uranium in groundwater varies.

No unrestricted release criterion for Tc-99 is stipulated in License SNM-928. EPA has promulgated a primary drinking water standard of 4 mrem/yr for beta photon emitters. As discussed in Section 4.3.2, NRC developed a derived concentration level of 3,790 pCi/L for Tc-99, based on the 4 mrem/yr dose limit.

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. As part of the decommissioning evaluation process specified in 10 CFR 20.1402, an ALARA analysis of the decommissioning effort must show that anticipated residual radioactivity levels are ALARA. 10 CFR 20.1402 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."

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 for the Site 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 TiO2 and MOFF buildings may lead an estimated 24 workers assigned to the site. This scenario provides a site population density of 2.78 x10^{-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 4.37×10^5 m^2. For the purposes of the ALARA calculation, the area being evaluated is 4.37×10^5 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.

λ = Radiological decay constant for the radionuclide in units per year. The radiological decay constant for uranium-234 is 2.77×10^{-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 is far in excess of the NRC approved limit of $2,000 per person-rem averted, thus no further remediation to achieve additional averted dose is justified when 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 the 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 decommissioning criteria 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 all that is required to complete site decommissioning and obtain unrestricted release from the NRC. However, the concentration of all COCs must be reduced to State Criteria to obtain release without restrictions from the DEQ. The groundwater remediation plan presented in this section is based on the results of groundwater assessment and aquifer testing, groundwater flow modeling, treatability tests conducted in 2013 and 2015, and a pilot test conducted in 2017 and 2018. Construction and installation of systems presented in this section 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.

On February 28, 2019; the NRC issued a request for supplemental information based on the acceptance review of *Facility Decommissioning Plan - Rev 1* (Burns & McDonnell 2018E). Responding to the request for supplemental information required conducting additional groundwater assessment and evaluating the impact of Tc-99 on the disposal of waste. A preliminary decommissioning cost estimate was prepared based revised disposal costs and a revised decommissioning schedule based on information provided by the NRC. It was determined that available funding would not be sufficient to obtain license termination if all groundwater remediation and treatment systems were installed and operated as outlined in *Facility Decommissioning Plan - Rev 1* (Burns & McDonnell 2018E).

The DEQ requested that the Trustee consider a phased remediation approach, in which Phase I consists of constructing and operating facilities needed to remediate groundwater in only those areas in which uranium concentrations in groundwater exceed the NRC Criterion. Reducing the quantity of groundwater extracted for treatment to only those areas is expected to eliminate the need for biodenitrification during Phase I. Existing funding may be sufficient to achieve license termination in Phase I of this phased approach.

Phase I will end when the concentration of uranium is less than the DCGL in all monitor wells. Should sufficient funding remain at the end of Phase I, some or all of the additional infrastructure presented in this Plan may be constructed and operated, or the operation of Phase I facilities may continue to further reduce the concentration of uranium in groundwater.

The groundwater remediation and treatment facilities presented in this Plan include those that may be constructed and operated both during Phase I and Phase II.

Design drawings related to groundwater extraction, treated water injection, and treated water discharge are provided in Appendix I, and are referenced in the D-Plan sections presenting detailed descriptions of those portions of the remediation program. Drawings were modified or added to define Phase I versus potential Phase II infrastructure. 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 and are referenced in the sections presenting detailed descriptions of groundwater treatment processes. Drawings were modified or added to define Phase I versus potential Phase II facilities and systems. Appendix J has been subdivided into Appendices J-1 through J-7; 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 – Secured Storage Facility
- Appendix J-6 – Biodenitrification System and Solids Handling
- Appendix J-7 – Burial Area #1 Treatment Facility

8.1 GROUNDWATER REMEDIATION OVERVIEW

This Section provides an overview of the groundwater remediation process. Sections 8.2 through 8.10 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 three areas: BA1, the WAA, and the WU. Several "remediation areas" are located within each one of these broad portions of the Site, with one small area (1206-NORTH) that doesn't fit into any of the three. Each remediation area will have area-specific groundwater remediation infrastructure to reduce COC concentrations based on the COC concentrations and the hydrogeological environment within that remediation area.

BA1 has been subdivided into the following remediation areas:

- 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)
- BA1-C (the area in which uranium exceeds the DEQ Criterion in alluvial material)

The WAA has been subdivided into the following remediation areas:

- WAA U>DCGL (the area in which uranium exceeds the NRC Criterion in alluvial material)
- WAA-WEST (one of three areas in which uranium is less than the NRC Criterion in alluvial material)
- WAA-EAST (one of three areas in which uranium is less than the NRC Criterion in alluvial material)
- WAA-BLUFF (one of three areas in which uranium is less than the NRC Criterion in alluvial material)

The WU has been subdivided into the following remediation areas:

- WU-UP1 (the area surrounding and including the former Uranium Pond #1)
- WU-UP2-SSA (the Sandstone A portion of the area surrounding and including the former Uranium Pond #2)

- WU-UP2-SSB (the Sandstone B portion of the area surrounding and including the former Uranium Pond #2)
- WU-PBA (the Process Building Area)
- WU-BA3 (the area surrounding former Burial Area #3, and the only WU remediation area in which uranium exceeds the NRC Criterion)
- WU-1348 (the area downgradient from a former pipeline leak near Monitor Well 1348)

The 1206 Drainage consists of a western branch, an eastern branch, and a confluence area. The 1206 Drainage formation consists of saturated sediments deposited in channels cut through Sandstone A. This area is not hydrologically considered an upland area. The confluence portion of the 1206 Drainage serves as a transition between the WU sandstone formations and the WAA alluvium formation; consequently, the deposits within the 1206 Drainage are referred to as the Transition Zone formation. Groundwater extraction for remediation will only be conducted in the northern (confluence) portion of the 1206 Drainage and this area will be referred to as:

- 1206-NORTH

Remediation areas located in the Western Areas (WA) are shown on Figures 8-1(a) and 8-1(b); remediation areas located in BA1 are shown on Figures 8-2(a) and 8-2(b). Figures 8-1(a) and 8-2(a) present the remediation areas for during Phase I operation; the elimination of several remediation components (e.g., groundwater extraction wells) resulted in the modification of the WAA U>DCGL, BA1-B, and BA1-C Areas that were presented in the 2018 *Facility Decommissioning Plan – Rev 1*. Figures 8-1(b) and 8-2(b) present the remediation areas that would be addressed during operation of all remediation components, should Phase II involve the construction and operation of all infrastructure presented in this Plan.

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 remediation components depicted for each remediation area are designed to mitigate COC groundwater impacts within the corresponding boundaries of the remediation area. The distinguishing characteristic of each remediation area is not the shape, as defined in this Plan, but the remediation strategy and infrastructure proposed to address groundwater impacts.

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 through the installation and operation of extraction wells and/or trenches. The groundwater extraction infrastructure and operations are addressed in detail in Section 8.2, Groundwater Extraction.

During Phase I, 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.

During Phase II, groundwater produced by extraction systems will be treated to reduce the concentration of uranium and may include treatment for nitrate to less than discharge permit limits. Treatment for uranium will consist of removal by ion exchange. If needed, treatment for nitrate will be accomplished through a biodenitrification process facilitated by anoxic bioreactors. The treatment systems are not designed to reduce the concentrations of fluoride or Tc-99 because the concentration of fluoride in the treatment system influent will be less than the current discharge permit limit of 10 mg/L and the concentration of Tc-99 in the treatment system influent will be less than the MCL of 900 pCi/L. However, the ion exchange resin is expected to remove some Tc-99, in addition to uranium, from the influent groundwater. Groundwater treatment is addressed in detail in Section 8.3, Groundwater Treatment.

Treated water will be injected into select areas to flush contaminants in upland sandstone units and transition zone units to groundwater extraction trenches and wells located in downgradient areas. During Phase I, treated water will only be injected into the WU-BA3 and BA1-A remediation areas. During Phase II, treated water may be injected into additional remediation areas. The 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.

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. This Plan presents monitoring programs for Phase I and for Phase II, assuming that Phase II consists of installing extraction and injection components in all remediation areas. In-process monitoring is described in more detail in Section 8.6, In-Process Monitoring.

8.1.4 Treatment Waste Management

During Phase I operation, groundwater treatment will generate one primary type of waste – spent ion exchange resin removed from the uranium treatment systems. Should Phase II include biodenitrification, groundwater treatment will generate two primary types of waste: spent ion exchange resin removed from uranium treatment systems, and biomass removed from the nitrate treatment system. In-process monitoring will provide the data needed to determine when spent resin in the ion exchange systems require replacement. Biomass from the biodenitrification system would be continuously separated from the treated effluent and transferred to a solids handling system for further water removal and subsequent packaging for disposal. The management and disposal of these waste streams is addressed in more detail in Section 8.7, Treatment Waste Management.

8.1.5 Post-Remediation Monitoring

Post-remediation monitoring of groundwater will be performed to demonstrate compliance with the NRC Criteria of 180 pCi/L for total uranium, and 3,790 pCi/L for 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. However, remediation may continue beyond this period to further reduce COC concentrations prior to initiating post-remediation monitoring. 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

Demobilization of treatment systems will occur after post-remediation monitoring is concluded. If funding is sufficient to continue groundwater remediation (and treatment for uranium is still required), uranium treatment systems will not be demobilized until treatment for uranium is terminated. All uranium treatment systems will be demobilized prior to requesting termination of the NRC license. Demobilization of groundwater extraction and injection infrastructure will be performed in each area if post-remediation monitoring demonstrates compliance with State Criteria, or upon approval by the DEQ.

Demobilization will include a final status survey of the WAA treatment system building. Release surveys and final status surveys are addressed in Section 13, Facility Radiation Surveys. Demobilization is addressed in more detail in Section 8.9, Demobilization.

NRC license termination will be requested prior to demolition and demobilization of the well field facilities described above since these components may be used to achieve State Criteria after license termination.

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

Phase I operation will include four groundwater extraction wells (GE-WAA-01 through GE-WAA-04) screened in alluvial material in the WAA U>DCGL remediation area and four groundwater extraction wells (GE-BA1-02 through GE-BA1-05) screened within alluvial material in BA1. Should Phase II involve installation of remediation components in additional areas, up to 11 additional WAA groundwater extraction wells (GE-WAA-05 through GE-WAA-15) screened in alluvial material will be installed. Should Phase II involve installation of additional remediation components in BA1, up to three additional groundwater extraction wells (GE-BA1-07 through GE-BA1-09) screened in alluvial material will be installed. In addition to these alluvial extraction wells, one groundwater extraction well (GE-WU-01), screened in the Sandstone B formation, will be installed in the WU-PBA area. 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).

In June 2017, 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 below ground surface (bgs).

To further evaluate the non-uniform vertical distribution of uranium (and nitrate in the WAA) in groundwater, additional vertical profiling data consisting of HPT logs and depth-discrete groundwater samples were collected in 2019 and 2020 at each proposed alluvial extraction well location. Additionally, soil samples were collected for grain size distribution (GSD) analysis at select alluvial groundwater extraction well locations to provided 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 also selected based on the vertical profiling results. In general, the 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 will 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, 2020B).

Borings for extraction wells installed in the alluvium will be advanced using standard drilling methods to the base of the alluvium. 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 hydrogeologist on drilling log forms. The boring will then be reamed to a nominal 10” diameter.

If installed during Phase II, the boring for GE-WU-01, located in the WU-PBA, will be advanced by air rotary or other standard drilling methods through Sandstone B. Upon reaching total depth, the boring shall be reamed to a nominal diameter of at least 10 inches. Subsurface lithology will be recorded by the field hydrogeologist on drilling log forms.

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 GSD data evaluation, 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 submersible pump installed in each well will include a shroud that will cause water to be drawn from above 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 top 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. Specific submersible pump installation locations for each alluvial well are presented in the *Vertical Profiling and Monitor Well Abandonment Report* (Burns & McDonnell, 2020B) and listed on Drawing M203 (Appendix I-3).

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 will occur until the well produces clear water. 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. Well development information shall be recorded on the well installation diagrams.

A typical groundwater extraction well installation is depicted on Drawings M101 and M102 (Appendix I-3). As shown on the drawings, each well will be equipped with a 4" electric submersible pump installed a minimum of 24 inches from the bottom of the well. Extraction well 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 well casing, approximately 2 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 24-inch diameter by 24-inch-deep steel vault, set in a 48-inch diameter by 24-inch deep concrete pad, will be installed over each extraction well. A capped 1-inch galvanized steel pipe shall extend through the concrete pad to approximately 5 ft above grade. A bolt shall be placed in the concrete pad to serve as a reference point for location and elevation, and a metal tag displaying the sump identification will be fastened to the steel pipe.

After all groundwater extraction wells have been installed and developed, groundwater samples will be collected for laboratory analysis. Groundwater samples collected from extraction wells in the WAA will be analyzed for uranium, nitrate, and fluoride. Additionally, samples collected from GE-WAA-03 will be analyzed for Tc-99. Should GE-WAA-06 through GE-WAA-12 be installed during Phase II, samples collected from these extraction wells will also be analyzed for Tc-99. Groundwater recovered from extraction wells in BA1 will be analyzed for uranium only. 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 95% upper confidence level (95% UCL) COC concentrations used to estimate initial treatment system influent concentrations for uranium, nitrate, and fluoride are higher than actual COC groundwater concentrations.

8.2.2 Groundwater Extraction Trenches

The Phase I groundwater remediation system will include a total of 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-WWU-02 will be installed in transition zone material in the 1206-NORTH area.

Should Phase II include remediation of the WU-1348 area, GETR-WU-01 will be installed in the WU-1348 Area. This extraction trench will be installed in Sandstone A.

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" until permanent vegetation is established. The stormwater permit and SWPPP are provided in Appendix B.

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.

Trench GETR-WU-02 will be located within the 100-year floodplain. Both excavated and imported material will be staged outside of the 100-year floodplain if remaining above grade overnight. Trench GETR-WU-02 will be excavated to a minimum width of 2 ft using a tracked excavator. Excavation of this trench will be accomplished using standard excavation and earthmoving construction equipment. Excavation will extend to the base of the transition zone material, generally located at the bedrock interface. The trench may be over-excavated to allow sumps and gravel backfill to extend deeper than the invert elevation of the lateral trench drainpipe. 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 installed within the WU-1348 area during Phase II, Trench GETR-WU-01 will be excavated to the base of Sandstone A, or to a depth of approximately 30 ft, whichever is shallower. Excavation of this trench will be accomplished using standard excavation and earthmoving construction equipment, as well as excavator-mounted pneumatic hammers or other rock excavation equipment as needed to achieve the required depths. Following excavation, the bedrock walls may be cleaned using a high-pressure water jet or other means to improve hydraulic connection between the trench and the formation.

Trench GETR-BA1-02 will be located within the 100-year floodplain. Both excavated and imported material will be staged outside of the 100-year floodplain if remaining above grade overnight. Excavation of this trench will be accomplished using standard excavation and earthmoving construction equipment. Excavation will extend to the base of the transition zone material, generally located at the bedrock interface. The trench may be over-excavated to allow sumps and gravel backfill to extend deeper than the invert elevation of the lateral trench drainpipe. 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.

For both GETR-WU-02 and GETR-BA1-01, frac tanks will be staged outside of the 100-year floodplain. Slurry will be mixed and stored in these frac tanks for use in trench excavation. A second disturbed area will be associated with each of these trenches both to stage frac tanks and to stage excavated soil that will be returned to the trench. BMPs will be installed on the downhill side of both 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 not be stockpiled within the disturbed area associated with the trench; it will be transported to a designated fill area. 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. All spoils excavated from the trenches that will be returned to the excavation will be stockpiled within the disturbed area associated with the trench unless the disturbed area is within the 100-year floodplain. BMPs installed downslope from the disturbed area will protect areas downhill/downstream from the disturbed area from being impacted by stormwater-transported sediment.

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

- GETR-WU-02 – Approximately 275 ft by 75 ft (an additional disturbed area 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 (an additional disturbed area 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-WU-01 (if installed) – Approximately 160 ft by 100 ft.

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 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 groundwater or 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 then be placed on top of the drainage layer before backfilling the trench to grade with clean, native 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.

The groundwater extraction trenches will also require development. Trench development information shall be documented by the field geologist or engineer in a field logbook.

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 a minimum of 24 inches from the bottom of the sump casing. The pump inlet will be set 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 24-inch diameter by 24-inch-deep steel vault, set in a 48-inch diameter by 24-inch deep concrete pad, will be installed over each trench sump. A capped 1-inch galvanized steel pipe shall extend through the concrete pad to approximately 5 ft above grade. A bolt shall be placed in the concrete pad to 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 extraction trenches

GETR-WU-01 (if installed during Phase II) and GETR-WU-02 will be analyzed for uranium, nitrate, and fluoride and the sample collected from GETR-BA1-02 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 that the 95% UCL COC concentrations used to estimate initial treatment system influent concentrations are higher than actual COC groundwater concentrations.

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). Extraction well/trench groupings by trunk line, treatment influent tank, and treatment train are depicted on Figures 8-3(a) and 8-3(b), the Well Field and Water Treatment Line Diagram, for Phase I and Phase II, respectively. 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 WU

Partial site plans depicting detailed layouts for Phase I and Phase II 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, WU, 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. For Phase I, a single trunk line will convey groundwater to TK-101. Phase II may include multiple trunk lines combining near the WATF, prior to terminating at TK-101.

The general groundwater extraction branch line configuration for the WAA, WU 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 WU extraction components. General quantities and subsurface configurations for piping and conduits associated with extraction well utilities are shown on Drawings C105 and C106 (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. Should Phase II involve installation of all WAA extraction components, dedicated conduits will be provided for fiber optic communication cables used for the transmission of signals between control systems located in the WATF and the Remote Terminal Unit (RTU) cabinet located in the WAA (see Drawing C003, Appendix I-2).

General design information for the electrical power and control system serving WAA, 1206-NORTH and WU groundwater extraction pumps is provided on single-line diagrams presented on Drawings E101 and E102 (Appendix I-5). Additional cable and conduit design details for WAA and WU electrical service, instrumentation, control, and communication feeds are provided on Drawings E104 through E105 and E107 through E203 (Appendix I-5). Finally, the WAA and WU 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 Phase I and Phase II 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 BA1 Treatment Facility 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). During Phase I, 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. Should Phase II involve installation of all BA1 infrastructure, a treatment facility will be installed at BA1, as depicted on the drawings referenced above.

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 C106 (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 BA1 groundwater extraction pumps is provided on the single-line diagram presented on Drawing E103 (Appendix I-5). Additional cable and conduit design details for BA1 electrical service, instrumentation, and communication feeds are provided on Drawings E104 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 Figures 8-1(a) and 8-1(b) and extraction components located in BA1 are shown on Figure 8-2(a) and 8-2(b). Figures 8-3(a) and 8-3(b), the Well Field and Water Treatment Line Diagrams for Phase I and Phase II, respectively, present nominal flow rates for each remediation component. Additionally, the anticipated COC concentrations for the combined groundwater influent associated with the Phase I treatment system are also depicted on Figure 8-3(a). Groundwater extraction flow rates for each extraction well and trench are also summarized on Drawing P205 (Appendix I-3).

The groundwater flow models were updated to evaluate changes in the revised groundwater remediation strategy and design. The modeling effort completed in 2016 included extensive model updates and calibration checks. The calibration of both models was confirmed using comprehensive groundwater elevation data collected in August 2016. The groundwater flow modeling results, assuming installation and operation of all Phase I and Phase II infrastructure, are presented in Appendix L. Since 2016, the following revisions to the flow models were completed:

- In 2018, the groundwater flow models were revised to incorporate the remediation components presented in this Decommissioning Plan. These revisions included:
  - Well and trench location revisions,
  - Pumping and injection rate revisions,

  - Forward and reverse particle tracking analyses to depict capture zones and optimize operating scenarios to eliminate potential stagnation zones; and,
  - One extraction well was eliminated in BA1.

- In February 2020, the groundwater flow models were updated for the purpose of evaluating the impact of partially penetrating extraction wells on hydraulic capture. The models were revised to increase the vertical resolution of hydraulic conductivity within the models. This was accomplished by dividing the WAA alluvial aquifer model layer into two layers and updating hydraulic conductivity values associated with BA1 and WAA alluvial aquifers to reflect a fining upward grain size distribution. The results of this modeling effort indicate that differentiating layers within the alluvial aquifer and reducing extraction well screen lengths have no adverse impact on groundwater recovery by extraction wells within the alluvial aquifer.
- The groundwater flow models were updated again in late 2020 for the purpose of evaluating phased remediation alternatives. The flow model updates generally included developing new forward and reverse particle tracking analyses to depict capture zones and optimizing operating scenarios to eliminate potential stagnation zones for the Phase I alternative.

As discussed in the Basis of Design presented in Appendix K, several performance objectives and design criteria were considered in determining groundwater extraction component locations and pumping rates. Component locations were initially selected based on COC distribution (i.e., plume extent), with the objectives of capturing uranium impacts exceeding the NRC criterion and maximizing capture of COC concentrations exceeding State Criteria. Results from the 2017/2018 Pilot Test were then used to revise WA and BA1 extraction component locations, dimensions, and design parameters to maximize contaminant mass removal, minimize remediation duration, and optimize the overall design. Finally, the updated groundwater models (see above) were used to simulate and optimize the performance of extraction components located in alluvial areas (i.e., the WAA and BA1 alluvium). This included confirmation that remediation components will provide sufficient capture of injected water and groundwater contamination exceeding remediation criteria.

No extraction or injection component locations or flow rates were altered for the phased remediation approach; however, groundwater extraction and/or treated water injection rates may be increased to expedite the remediation of groundwater, based on in-process groundwater monitoring results.

BA1

The technical memorandum *Environmental Sequence Stratigraphy (ESS) and Porosity Analysis, Burial Area 1* (Burns & McDonnell, 2018C) 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 makes three-dimensional groundwater flow modeling impractical for this area. However, that evaluation, in conjunction with results from pilot testing conducted from September 2017 through February 2018, provided sufficient data to support the re-location of extraction trench GETR-BA1-02 and to establish appropriate injection and extraction rates for BA1 injection and extraction trenches. As shown on Figures 8-2(a) and 8-2(b), the extraction of groundwater and injected water from the BA1-A area (including SSB and fine-grained transition zone materials) will be accomplished through the operation of extraction trenches GETR-BA1-01 and GETR-BA1-02.

A particle tracking analysis supported by the site groundwater flow model was conducted to optimize positions and flow rates for extraction wells located in the BA1 alluvium. Appendix K includes figures presenting the output of the particle tracking analysis and demonstrating capture of groundwater exceeding the NRC and State Criteria. Extraction flow rates presented on Drawing P205 (Appendix I-3) for each BA1 extraction well were used in the particle tracking model. Under the Phase I pumping scenario depicted in the model, groundwater is extracted from the BA1-A and BA1-B areas (includes SSB, transition zone, and alluvium) at a combined rate of approximately 80 gpm, and from the BA1-C area (alluvium only) at a rate of approximately 20 gpm.

Should Phase II include installation and operation of GE-BA1-07 through GE-BA1-09, uranium concentrations in groundwater near GE-BA1-09 are expected to decrease to less than the State Criterion before groundwater near GE-BA1-08, both because the uranium concentration in groundwater near GE-BA1-09 is lower, and because GE-BA1-08 will be drawing groundwater from upgradient areas with higher uranium concentrations. Once in-process monitoring demonstrates that uranium concentrations near GE-BA1-09 have remained below the State Criterion for at least three consecutive months, operation of extraction well GE-BA1-09 will be discontinued and operation of GE-BA1-07 will begin.

Eventually, operation of GE-BA1-08 will be discontinued and GE-BA1-06 will begin. This sequence will continue as the BA1-C plume retreats to the south.

Figure 8-4 presents the Phase I results of a BA1 particle tracking analysis conducted for BA1 alluvial material. The particle tracking analysis demonstrates that particles placed at the boundary of the plume, defined by the 30 μg/L uranium concentration isopleth, are captured by operating extraction wells GE-BA1-02 through 06. The "Nominal Pumping Scenario" shows the capture of all plume boundary particles with the wells operating at the pumping rates shown in Figure 8-3(a) and Drawing P205 (Appendix I-3). Due to the spacing of particles at the plume boundary, gaps between particle flow lines appear midway between extraction wells, implying that constant-rate pumping from groundwater extraction components may create stagnation zones within the plume. If persistent stagnation zones were to develop within the flow field, groundwater within these zones may not be captured, resulting in incomplete remediation.

Following remediation system startup, a pumping optimization program will be implemented to address agency concerns that steady-state pumping conditions may create stagnation zones between extraction wells. The optimization program will be implemented for groundwater extraction wells GE-BA1-02 through GE-BA1-04 and will include alternating increases/decreases in pumping rates for adjacent extraction wells on a specified time schedule.

To demonstrate the effects of the optimization program on potential BA1 stagnation zones, the Nominal Pumping Scenario shown in Figure 8-4 was annotated by placing an additional particle in the middle of each apparent stagnation zone. Particle tracking analyses were then conducted using both the original plume boundary particles and the additional apparent stagnation zone particles. The model outputs for optimized BA1 pumping scenarios denoted "Operating Scenario 1" and "Operating Scenario 2" are also presented on Figure 8-4. As shown on the figure, not only are all the plume boundary particles captured under both optimization scenarios, it is apparent from the stagnation zone particle paths (identified on the figure with yellow lines) that the pumping optimization program succeeds in eliminating the apparent stagnation zones. Some of the stagnation zone particles report to different extraction components under each operating scenario, illustrating a change in groundwater flow direction within the apparent stagnation zone and complete groundwater capture. As the figure legend explains, the distance between arrows on the particle flow lines represents the distance the particle will travel in 60 days; therefore, the operational time required for each optimized pumping scenario to achieve complete capture of the apparent stagnation zones can be estimated using the model.

Operation of the groundwater extraction wells and trenches in the BA1-A area will continue until in-process monitoring indicates that uranium concentrations throughout BA1 have remained below the NRC Criterion for at least three consecutive monitoring events.

Groundwater Extraction Trench GETR-BA1-01 was constructed within the transition zone formation in BA1 in 2017. GETR-BA1-01 was excavated using an organic polymer (i.e., biopolymer) slurry to prevent collapse of the unconsolidated material and to maintain a positive head (relative to the water table elevation) in the trench to prevent uranium-contaminated groundwater from entering the trench during construction. Following construction of GETR-BA1-01, uranium concentrations significantly decreased in monitor wells located near and downgradient of the trench. Evaluation of uranium and oxidation-reduction (redox) parameter data collected during subsequent sampling events suggested that the uranium concentration reductions were caused by the establishment of reducing (low redox) conditions in the aquifer near GETR-BA1-01, presumably caused by biodegradation of biopolymer slurry introduced to the formation during trench construction.

An evaluation of BA1 aquifer redox conditions and uranium groundwater concentration trends in the vicinity of GETR-BA1-01 was conducted in 2019 and 2020. The results of the evaluation are documented in *Burial Area #1 Redox Evaluation* (Burns & McDonnell, 2020A). The evaluation confirmed that the introduction of organic biopolymer slurry to the BA1 aquifer during GETR-BA1-01 construction caused a significant shift in redox conditions in, near, and downgradient of the trench, resulting in the precipitation of uranium and significant reductions in aqueous uranium concentrations. The available data also indicate that aquifer redox potential in the affected area is increasing toward levels representative of pre-construction conditions and, as a result, the precipitated uranium is re-oxidizing and aqueous uranium concentrations are increasing. Data collection and evaluation will continue in 2021 to monitor observed redox and uranium concentration trends.

WAA U>DCGL and 1206-NORTH

Phase I operation will include groundwater remediation in the WAA U>DCGL and 1206-North Areas. Groundwater recovered by extraction components located in these areas will be delivered to the WATF as a single influent stream. The nominal flow rates for these extraction components are as follows:

- 99 gpm from WAA U>DCGL – extraction wells GE-WAA-01 through GE-WAA-04

8 gpm from 1206-NORTH – extraction trench GE-WU-02A particle tracking analysis supported by the site groundwater flow model was conducted to optimize the positions and flow rates of extraction wells located in the WAA U>DCGL area. Appendix K includes figures presenting the output of the particle tracking analysis and demonstrating capture of groundwater exceeding the NRC Criterion. Figure 8-5 presents the Phase I results of the particle tracking analysis for the WAA U>DCGL plume. The analysis demonstrates that particles placed at the boundary of the plume, defined by the 30 µg/L uranium concentration isopleth, are captured by the operation of extraction wells GE-WAA-01 through 04.

The "Nominal Pumping Scenario" shows the capture of all plume boundary particles with the wells operating at the pumping rates shown in Figure 8-3(a) and Drawing P205 (Appendix I-3). Due to the spacing of particles at the plume boundary, gaps between particle flow lines appear midway between extraction wells, implying that constant-rate pumping from groundwater extraction components may create stagnation zones within the plume. If persistent stagnation zones were to develop within the flow field, groundwater within these zones may not be captured, resulting in incomplete remediation.

Following remediation system startup, a pumping optimization program will be implemented to address agency concerns that steady-state pumping conditions may create stagnation zones between extraction wells. The optimization program will be implemented for groundwater extraction wells GE-WAA-01 through GE-WAA-04 and will include alternating increases/decreases in pumping rates for adjacent extraction wells on a specified time schedule.

To demonstrate the effects of pumping optimization on potential WAA U>DCGL stagnation zones, the Nominal Pumping Scenario shown in Figure 8-5 was annotated by placing a particle in the middle of each apparent stagnation zone. Particle tracking analyses were then conducted using both the original plume boundary particles and the additional apparent stagnation zone particles. The model outputs for optimized WAA U>DCGL scenarios denoted "Operating Scenario 1" and "Operating Scenario 2" are also presented on Figure 8-5. As shown on the figure, not only are all the particles around the plume boundary captured under both scenarios, it is apparent from the stagnation zone particle paths (identified on the figure with yellow lines) that the pumping optimization program succeeds in eliminating the apparent stagnation zones. The stagnation zone particles report to different extraction components under each operating scenario, illustrating a change in groundwater flow direction within the apparent stagnation zone and complete groundwater capture. As the figure legend explains, the distance between arrows on the particle flow lines represents the distance the particle will travel in 60 days; therefore, the operational time required for each optimized pumping scenario to achieve complete capture of the apparent stagnation zones can be estimated using the model.

Operation of the groundwater extraction wells in the WAA U>DCGL area will continue until in-process monitoring indicates that uranium concentrations have remained below the NRC Criterion for at least three consecutive monitoring events. However, operation of WAA U>DCGL extraction wells may continue until in-process monitoring indicates that uranium, nitrate, and fluoride concentrations have remained below State Criteria for at least three consecutive monitoring events, or until or until WA remediation operations are terminated, whichever comes first.

Uranium in groundwater exceeds the NRC Criterion within the 1206-NORTH area and the State Criteria for uranium, nitrate, and fluoride. Impacted groundwater in this area will be recovered by extraction trench GETR-WU-02 (see Figure 8-1(a)). GETR-WU-02 will also capture seepage from the WU-BA3 area resulting from the injection of treated water in that area (see below). GETR-WU-02 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. Operation of GETR-WU-02 may continue during Phase II until in-process monitoring indicates that uranium, nitrate, and fluoride concentrations have remained below State Criteria for at least three consecutive monitoring events, or until WA remediation operations are terminated, whichever comes first.

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), 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. Because the sediment contains concentrations of uranium that are near the EPA screening level for residential soil, the sediment will be mixed with excess spoils generated during trench excavation and placed in a soil laydown area. Following mixing and placement, the material will be covered with topsoil and vegetated.

To facilitate the transfer of seepage from WU-BA3 to GETR-WU-02, a slotted pipe will be installed in the east branch of the 1206 Drainage to convey the seepage directly to the transition zone material in which GETR-WU-02 is constructed. 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).

WU-PBA, WU-1348, and WAA-WEST

Phase II may include installation of all remediation infrastructure in the WU-PBA, WU-1348, and WAA-WEST remediation areas. Since submission of the 2015 *Cimarron Facility Decommissioning Plan*, the decision was made to eliminate much of the infrastructure in the WAA-WEST area and install a single extraction well (GE-WAA-05) near Monitor Well T-97 (see Figure 8-1(b)). The reduced remediation and water treatment infrastructure resulting from this decision enabled longer operation of WA groundwater remediation facilities and greater total contaminant mass removal. The nominal flow rates for groundwater extraction components in these areas are as follows:

- 5 gpm from WU-PBA – extraction well GE-WU-01
- 4 gpm from WU-1348 – extraction trench GETR-WU-01
- 10 gpm from WAA-WEST – extraction well GE-WAA-05

The WU-PBA area addressed by GE-WU-01 requires remediation for uranium and nitrate. Operation of this groundwater extraction well will continue until WU-PBA in-process monitoring indicates that uranium and nitrate concentrations have remained below the State Criteria for at least three consecutive monitoring events, or until WA remediation operations are terminated, whichever comes first.

The WU-1348 area being addressed by GETR-WU-01 requires remediation for uranium and fluoride. Operation of the groundwater extraction wells in the WU-1348 area will continue until in-process monitoring indicates that uranium and fluoride concentrations have remained below the State Criteria for at least three consecutive monitoring events, or until WA remediation operations are terminated, whichever comes first.

Figure 3-3 shows a 30 µg/L concentration isopleth for uranium that extends south of Monitor Well 1348 to include the area surrounding Monitor Well 1353. The screen interval for Monitor Well 1353 is located within a zone of perched groundwater in Sandstone A. The screen interval for this well is also higher in elevation than the screen intervals associated with Monitor Wells 1348 and 1350. The groundwater elevation in this perched zone is sufficiently high that it was not used to contour groundwater elevations in Sandstone A. From 2013 through 2017, the concentration of uranium in groundwater samples collected from Monitor Well 1353 has varied from greater than 40 µg/L to less than 5 µg/L. This wide variability caused the 95% UCL value for this location to exceed the maximum concentration, so the maximum concentration was used as the "representative value" for uranium at this location. Groundwater migrating from Monitor Well 1353 will either report to extraction trench GETR-WU-01 or to the 1206 Drainage. The decision was made to designate the area within which both uranium and fluoride exceed State Criteria as the WU-1348 Area.

The WAA-WEST area being addressed by GE-WAA-05 requires remediation for uranium. Operation of the groundwater extraction wells in the WAA-WEST area will continue until in-process monitoring indicates that uranium concentrations have remained below the State Criterion for at least three consecutive monitoring events, or until WA remediation operations are terminated, whichever comes first.

Groundwater remediation may be terminated at any time after achieving the NRC Criterion for uranium in all WA in-process monitoring wells, should this be necessary to maintain sufficient funding to achieve the NRC Criterion in BA1.

WAA-BLUFF and WAA-EAST

Phase II may include installation of some or all of the remediation infrastructure in the WAA-BLUFF and WAA-EAST remediation areas.

The nominal flow rates for groundwater extraction components in these areas are as follows:

- 104 gpm from WAA-BLUFF – extraction wells GE-WAA-06 through GE-WAA-13

- 20 gpm from the WAA-EAST – extraction wells GE-WAA-14 and GE-WAA-15

The WAA-BLUFF extraction system will recover nitrate and fluoride impacted groundwater within the alluvium and groundwater discharging from WU-UP1 and WU-UP2 as treated water is injected into those areas. Groundwater extraction wells GE-WAA-06 through GE-WAA-08 are expected to capture groundwater flushed from the WU-UP1 area while GE-WAA-09 through GE-WAA-13 are expected to capture groundwater flushed from WU-UP2. WAA-BLUFF extraction wells will continue to operate until groundwater in their respective upland areas, as well as the areas surrounding the WAA-BLUFF extraction wells, complies with the State Criteria, or until flow from these wells is longer needed to maintain the minimum WATF influent flow rate, whichever comes first. For the purposes of this Plan, it has been assumed that the WAA-BLUFF extraction wells will operate until WATF operations are discontinued.

The WAA-EAST area being addressed by GE-WAA-14 and GE-WAA-15 requires remediation for uranium and nitrate. Operation of the groundwater extraction wells in the WAA-EAST area will continue until in-process monitoring indicates that uranium and nitrate concentrations have remained below the State Criterion for at least three consecutive monitoring events, or until WA remediation operations are terminated, whichever comes first.

Once in-process monitoring demonstrates that nitrate concentrations in the treatment system influent have remained below the MCL for four consecutive weeks (or for two consecutive months, should the time between in-process monitoring samples be extended), the nitrate treatment system, if installed, will be bypassed, and nitrate treatment will be discontinued. Uranium treatment must precede treatment for nitrate, or the biomass generated during biodenitrification may accumulate sufficient uranium to require disposal as LLRW.

8.3 GROUNDWATER TREATMENT

As previously stated, and shown on Drawing C002 (Appendix I-2), Phase I will include installation of a groundwater treatment system in the WATF; Phase II may include installation of a smaller treatment system in BA1. During Phase I, groundwater recovered from BA1 will be conveyed to the WATF for treatment. The WATF will be constructed southeast of the former location of UP1 and the BA1 Treatment Facility will be constructed at the southern end of BA1. The WATF will include a permanent building, housing uranium treatment systems, as well as the ion exchange resin processing equipment needed to process and package spent resin generated by the uranium treatment systems.

If a biodenitrification system is installed during Phase II, the equipment associated with this system will also be installed in the WATF treatment building. Implementation of the biodenitrification system during Phase II may require construction of a separate "secure storage" building (the Secure Storage Facility) for storing drums of LLRW prior to shipment. The location of the Secure Storage Facility, relative to the WATF treatment building is shown on Drawings C006 and C007 (Appendix I-2).

If Phase II requires installation of a treatment system at BA1, the BA1 treatment system will be housed in a modular enclosure. This treatment system will only contain equipment needed to treat groundwater for uranium. Excluding acid for water treatment, all materials required for BA1 treatment system operation will be supplied from the WATF, and all waste generated in BA1 will be transferred to the WATF for storage and/or disposal.

Drawings C007 (Appendix I-2) and C-113 (Appendix J-1) provide utility site 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.

Drawings C006 (Appendix I-2) and C-110 and C-130 (Appendix J-1) present the site layout and facility elevations for the Phase I WATF, respectively. The WATF water treatment systems for Phase I are comprised of uranium ion exchange t trains as shown on the Process Flow Diagrams, P-115 and P-111 (Appendix J-3). Major WATF components include the following:

8.3.1 Phase I

- One (1) 5,000-gallon, double-walled acid tank (TK-103)
- One (1) 700-gallon scrubber (TK-104)
- One (1) 15,000-gallon, double-walled influent tank (TK-101)
- One (1) 12,000-gallon, double-walled influent tank for BA1 water (TK-105 BA1 Influent Tank)
- Two (2) back flushable multimedia particulate filters (FLT-121/122123 and FLT-131/132/133)

- Two (2) uranium ion exchange (UIX) treatment trains (UIX WA Train and UIX BA1 Train)
- One (1) 9,000-gallon single-walled backwash collection tank (TK-106)
- One (1) 15,000-gallon, single-walled effluent tank (TK-102)

8.3.2 Phase II

In the addition to the above equipment, Phase II may include:

- One (1) 15,000-gallon, single-walled buffer tank located between the UIX and biodenitrification systems (TK-1000)
- A biodenitrification system containing:
- Two (2) 18,000-gallon, single-walled Stage 1 moving bed biofilm reactor (MBBR) tanks (TK-1050A and TK-1050B)
  - One (1) 18,000-gallon, single-walled Stage 2 MBBR tank (TK-1100)
  - One (1) 1,250-gallon, single-walled flocculation tank (TK-1150)
  - One (1) drum filter (F-1200)
- One (1) 6,000-gallon, double-walled methanol tank (TK-2000)

One (1) 40-horsepower (hp) air compressorEach uranium treatment train will contain three 48" diameter resin vessels designed for flow rates varying from 100 to 125 gpm. If installed for Phase II, the biodenitrification system,will accommodate a flow rate of up to 250 gpm.

Drawing C009 (Appendix J-2) shows the site grading and utility plan for the BA1 Treatment Facility. As shown on the drawing, the uranium treatment system will require electric utility service and a fiber optic communication line (to facilitate communications between the BA1 and WATF control systems).

For Phase II, drawings G-200 and G-220 (Appendix J-7) present general arrangement plan and sections for the BA1 Treatment Facility, respectively. The BA1 Treatment Facility for Phase I will include tanks and a pumping skid to transport recovered groundwater to WATF for processing as shown on drawings C-210 and P-215 (Phase I). If Phase II is implemented, the BA1 Treatment Facility may include a single uranium treatment train as shown on Process Flow Diagram Drawing P-210 (Appendix J-7). Major BA1 Treatment Facility components include the following:

8.3.3 Phase I

- One (1) 12,000-gallon, double-walled influent tank (TK-201)

- One (1) transfer pump skid
- One 12,000-gallon, single-walled effluent tank (TK-202)

8.3.4 Phase II

- One (1) 5,000-gallon, double-walled acid tank (TK-203) and scrubber (TK-204)
- One (1) water particulate filter (FLT-221/222/223)

One (1) UIX treatment train (will replace transferShould a uranium treatment train be required for Phase II, it will contain three 48" diameter resin vessels designed for flow rates varying from 100 to 125 gpm.

In both areas, connections from the influent tank to the treatment process, and from the treatment process to the effluent tank, will require above ground piping. Heat trace and insulation will be installed on this and other exterior process piping, as required, for freeze protection. The WATF building and the BA1 treatment system enclosure (if installed) will be equipped with heating and ventilation to protect interior process components (piping and equipment) from freezing and overheating.

8.3.5 Uranium Treatment Facilities

In 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. Concrete foundations will include:

Phasc I

- An approximately 115 ft by 160 ft foundation for the treatment building
- Two approximately 13 ft diameter ring foundations for the 15,000-gallon influent and effluent tanks
- One (1) approximately 13 ft diameter ring foundation for the 12,000-gallon BA1 influent tank
- One (1) approximately 13ft 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 effluent discharge pump
- An approximately 31 ft by 11 ft foundation for the WA Injection Skid
- An approximately 8 ft by 20 ft foundation for the emergency generator

- Two approximately 18 ft by 16 ft pads, and one approximately 9 ft by 12 ft pad for the three air handling units
- One (1) approximately 6 ft by 10 ft foundation for the BA1 effluent water return pump

Phase II

- An approximately 32 ft by 32 ft foundation for the Secure Storage Facility
- Four (4) approximately 15 ft diameter foundations for biodenitrification process in the biodenitrification area
- One (1) approximately 9 ft diameter foundation for the Flocculation Tank in the biodenitrification process area
- One (1) 6 ft by 6 ft pad for the methanol dosing pump
- An approximately 8 ft by 20 ft foundation for the 6,000-gallon methanol storage tank
- Foundations for biodenitrification and biomass processing systems, should nitrate treatment be needed

A Truegrid® permeable paving system will surround the concrete foundations, creating a total area of approximately 275 ft by 300 ft, as shown on Drawings C006 (Appendix I-2) and C-110 (Appendix J-1). As depicted on Drawing C006 (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 J-2). Following construction of the facility, the topsoil will be spread over disturbed soil and in the surrounding area, and vegetation will be established.

In 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. Concrete foundations will include:

- An approximately 47 ft by 11 ft foundation for the transfer pump skid and for the Phase II uranium treatment enclosure
- Two approximately 13 ft ring foundations for the 12,000-gallon influent and effluent tanks
- An approximately 47 ft by 11 ft foundation for the BA1 Injection Skid
- An approximately 12 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-7). 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-7). 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.

8.3.6 Uranium Treatment Systems

Drawing M-110 (Appendix J-3) shows the configuration of a typical UIX treatment train. The components of the Phase II BA1 uranium treatment train are essentially identical to the WA treatment trains; however, during Phase II, the BA1 system would be housed within a modular enclosure along with a filtration system (see Drawing M-210, Appendix J-7).

For Phase I, the WA and BA1 UIX trains each includes a feed pump that transfers groundwater from their respective influent tank through separate multimedia filters, , and then through the respective UIX treatment train consisting of 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 skid, and a portion of the BA1 treated water is directed to a pumping station to be sent to the BA1 injection skid. The remaining treated water from both uranium treatment skids is combined and directed to the WATF effluent tank for discharge through Outfall 001.

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 standard units. 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 efficiently.

The rate of groundwater flow through the resin vessels will be measured by a flowmeter. Each resin vessel will contain approximately 50 ft^3 of anion exchange resin that will exchange the 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 usage of these consumables for the BA1 and WATF systems for Phase I:

- Hydrochloric Acid: Usage is anticipated to be approximately 35 gallons/day, supplied from the 5,000-gallon, doubled walled tank located next to the treatment enclosure. The tank will be refilled approximately every 3 months by a chemical delivery truck to the WATF.
- Resin: From WA treatment, usage is anticipated to be approximately 117 cu ft/yr (just over 3 vessels per year). Fresh resin will be loaded into vessels in the WATF building. Resin is expected to be delivered in drums on pallets by a delivery truck once every 4-5-months.
- Resin: From BA1 treatment, usage is anticipated to be approximately 278 cu ft/yr (just over 7 vessels per year)

Because the adsorption capacity of the ion exchange resin declines as the uranium concentration in influent groundwater declines, current estimates indicate that no resin vessel will ever accumulate more than 500 grams of U-235. Consequently, a single resin vessel will be unable to adsorb sufficient uranium to exceed 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 all treatment trains combined is not expected to exceed 800 grams at any given time.

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) and P-215 (Phase II) (Appendix J-7) is the same for all UIX treatment trains. Using the valve numbering for the UIX WA Train and the UIX BA1 Train (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 polish 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, the lead vessel will be removed from service and the resin will be processed as though it is spent. In-process monitoring data will provide the information needed to determine the duration of the shutdown requiring implementation of this procedure.

During Phase I operations, effluent from the UIX WA Train will be split and routed to the WA injection skid and the effluent tank (TK-102). The effluent from the UIX BA1 Train (located at WATF) will be split and routed to the BA1 effluent tank (TK-202) and to effluent tank TK102.

If biodenitrification is implemented during Phase II, effluent from the two WA uranium treatment trains (UIX Train 1 and UIX Train 2) will be combined and routed to the Nitrate Treatment System Buffer Tank shown on Drawing P-200 (Appendix J-5). Should the nitrate concentration in the blended WATF influent decline to less than 10 mg/L, the effluent from the uranium treatment system will be pumped directly to the WATF effluent tank (TK-102), bypassing the nitrate treatment system.

8.3.7 Biodenitrification Systems – Phase II

Biodenitrification may be implemented during Phase II remediation for the removal of nitrate from groundwater recovered from WA remediation areas. Biological denitrification occurs when molecular oxygen (O_2) is not sufficient for bacterial respiration and bacteria utilize combined oxygen in nitrate (NO_3^-) as an oxygen source. In an anoxic process, bacteria obtain oxygen from nitrate. Nitrate is thereby converted to nitrite and then molecular nitrogen. Oxidation Reduction Potential (ORP) is monitored to control the anoxic conditions. As depicted in Figure 8-7, an anoxic process takes place, when ORP is -50 mV to +50 mV. Blowers and air diffusers provided with the bioreactors control the ORP and prevent the system from going septic or anaerobic. The blowers will only operate when the ORP of the water drops to levels below -100mV.

The nitrate treatment (biodenitrification) system is designed to accommodate the combined flow rate of 250 gpm from the two WATF uranium treatment trains (UIX Train 1 and UIX Train 2). The biological denitrification design is based on a MBBR system operated under anoxic conditions. The MBBR is followed by a filtration system which separates suspended solids (biomass) from the treated water. Separated solids are sent to a solids handling system described further in Section 8.7.6. All nitrate treatment system components, except the methanol feed tank and dosing pump, are located within the WATF Building as shown on Drawings G-140 and G-141 (Appendix J-5). An overview of the biodenitrification treatment process follows.

Communities of microorganisms that grow on surfaces are called biofilms. Microorganisms in a biofilm are more resilient to process disturbances than the types of biological communities developed by other treatment processes. In the MBBR technology, the biofilm grows within engineered carriers designed to provide high internal surface area. Because the microorganisms are well protected, they remain in the system longer than suspended-growth microorganisms. This makes the process more tolerant of variations and disturbances. A large, protected surface area makes it possible to utilize a more compact treatment system. The process is also easy to maintain, and the amount of active biomass is self-regulating, dependent on the incoming nitrate load and the hydraulic retention time (HRT). A chemical oxygen demand (COD) concentration greater than 50 mg/l should be maintained within the system and a HRT greater than 30 minutes is required to maintain biofilm on the media. These should be the only criteria needed to maintain biofilm development within the system.

The biofilm carriers are kept in the reactor by a sieve(s) assembly at the outlet of the reactor. Anoxic reactors require the use of flat panel sieves. The sieve design provides structural strength while maintaining high flow capacity. Treated water passes through the outlet sieves to the solids separation equipment.

For anoxic processes, the MBBR carriers are kept in complete mix conditions, meaning the mixers keep them uniformly suspended throughout the tank. The media will occupy 45% fill of the working volume of the tank. This gives the design flexibility because the media fill can be increased up to 55% of the working volume. Additional media (10% more fill) can be added to increase the surface area, should greater nitrate removal be needed.

The denitrification process involves the biological reduction of nitrate (and/or nitrite) to N_2O, NO, and N_2. Since N_2O, NO, and N_2 are all gaseous, they can easily be lost to the environment. In the absence of dissolved oxygen, the bacteria use nitrate (and nitrite) to respire, while consuming the available carbon. Entrainment of air does not have a significant impact on the performance of anoxic systems in open top tanks. The reactors in the system are also open top for ease of media loading, less expensive fabrication, and minimal risk to the system.

The Biodenitrification Process Flow Diagram is shown on Drawing P100 (Appendix J-5). The nitrate treatment process is comprised of the following major components:

- 15,000-gallon Buffer Tank TK-1000: This tank receives the effluent from the uranium treatment systems, as well as internal recycle streams from the nitrate treatment and solids handling processes.
- 18,000-gallon MBBR Reactors 1A and 1B (TK-1050A and TK-1050B): These tanks, equipped with mixers, provide first-stage biodenitrification.
- 18,000-gallon MMBR Second Stage Reactor TK-1100: This tank, equipped with a mixer, provides second-stage biodenitrification to meet effluent treatment criteria.
- Chemical addition systems for methanol, phosphoric acid, and micronutrients.
- 1,250-gallon Flocculation Tank TK-1150: This tank, equipped with a mixer, incorporates a polymer to assist in the filtration process, separating biomass from treated water.
- Drum Filter F-1200: This is a pre-engineered unit that separates suspended solids from treated water pumped from the flocculation tank. The solids generated by the drum filter are periodically discharged to the Solids Handling System.

Because there will not be sufficient organic matter in the influent stream to sustain the nitrate-degrading microorganisms, an external carbon source (methanol) will be fed into the MBBR as an electron donor to support denitrification. Methanol demand is a function of the measured level of nitrate fed to the reactor, the target effluent nitrate level, dissolved oxygen (DO) and flow rate. The current design includes the equipment required for automatic methanol dosing, namely: an influent flowmeter and nitrate analyzers for influent and effluent flows. The process will also require addition of ortho-P (as a nutrient) to provide optimal conditions for bacterial growth. The design includes the equipment required for automatic dosing of the appropriate amount of ortho-P (as phosphoric acid). Provisions to feed a micronutrient blend are included since the uranium ion exchange system may remove trace metals needed for microbial growth. The design incorporates the flexibility to dose the MBBR chemicals automatically or manually. The following is a summary of the chemical usage for the biodenitrification treatment process, based on a 250-gpm flow with an influent nitrate concentration of 150 mg/L NO_3-N:

- Methanol: Usage is anticipated to be approximately 200 gallons/day, supplied from an 8,000-gallon, double-walled tank located outside the WATF building. The tank will be refilled once every 2 months by a chemical delivery truck.
- Phosphoric Acid: Usage is anticipated to be approximately 2.5 gallons/day, supplied from a 55-gallon drum located within the WATF building on a feed pump station equipped with secondary containment. The drum will be replaced every three weeks with a new drum delivered to the WATF building by truck. Interim storage is not expected to be more than 1-2 weeks. Phosphoric acid will be stored in a designated area with appropriate controls to limit interaction with other chemicals.
- Micronutrients: Micronutrients consist of primarily metal compounds in a liquid solution which maintain a healthy biomass. The micronutrients which will be injected into the influent to the bioreactors consist of ferric sulfate, manganese sulfate, cobalt sulfate, boric acid, nickel chloride, sodium selenite, zinc sulfate, coper sulfate, and sodium molybdate. Usage is anticipated to be less than a half-gallon/day, supplied from a 55-gallon drum located within the WATF building on a feed pump station equipped with secondary containment. The drum will be replaced once every 6 months with a new drum delivered to the WATF building by truck. Interim storage is not expected to be more than 1-2 weeks. Micronutrients will be stored in a designated area with appropriate controls to limit interaction with other chemicals.
- Emulsion Polymer (for Flocculation Tank): Usage is anticipated to be just over one gallon/day, supplied from a 55-gallon drum located within the WATF building on a feed pump station equipped with secondary containment. The drum will be replaced once every 2 months with a new drum delivered to the WATF building by truck. Interim

storage is not expected to be more than 1-2 weeks. Emulsion polymer will be stored in a designated area with appropriate controls to limit interaction with other chemicals.

Once the initial microorganism culture is established, normal operation of the biodenitrification system is expected to occur as described in the following paragraph. Component sizes and discussed instrumentation are also shown on P&ID Drawings P200, P201, P203, P204, P206, P207, and P210 (Appendix J-5).

Water from the uranium treatment system is transferred to a 15,000-gallon buffer tank, providing approximately 60 minutes of retention time based on the incoming flow. The motive force for this transfer is provided by the uranium treatment system. This tank also receives internal recycle streams from the nitrate treatment system, including sludge thickener overflow, filter press filtrate, and effluent recycle (which may occur in the case of plant shutdown or detection of off-spec effluent). The tank will normally be maintained at a fluid level of 50% or less of capacity to provide buffering of these intermittent streams. A transfer pump controlled by a variable frequency drive (VFD) will forward flow to the MBBR tanks based on the fluid level in the buffer tank or a pre-set flow rate. The buffer tank will be equipped with a level sensor; in the event of high levels, the flow to the uranium treatment system will be reduced or stopped.

The flow through the first- and second-stage reactors into the drum filter is by gravity. In the reactors, microorganisms will remove oxygen from nitrate molecules, converting the nitrate into nitrogen gas that will be released to the atmosphere. This process requires anoxic conditions, where there is an absence of dissolved oxygen. Mechanical mixers will maintain suspension of the MBBR media in the reactors to ensure that there is effective contact between the microbial film on the MBBR media and the substrate in the water.

A two-stage reactor system (with the first stage comprised of two bioreactors) was selected based on a design flow rate of 250 gpm and inlet nitrate concentration of 100 mg/L. The bioreactors can be built off-site, transported, and then installed in the WATF building. Piping and valving are provided to enable reactors to be taken off-line as the inlet nitrate concentration decreases (which requires less biofilm to achieve the treated effluent nitrate target of less than 10 mg/L). The configurations identified for a 250-gpm system as nitrate concentration declines are:

- Two first-stage reactors followed by the second-stage reactor: Inlet nitrate concentration between 100 and 150 mg/L

- One first-stage reactor followed by the second-stage reactor: Inlet nitrate concentration between 50 and 100 mg/L
- Second-stage reactor only: Inlet nitrate concentration less than 50 mg/L

A high-level switch provided in each of the first MBBR tanks will stop forward flow to the MBBRs if alarmed. If the nitrate concentration measured in the effluent (via effluent nitrate probe) is above the permitted limit (10 mg/L), the effluent from the treated water sump will be directed back to the buffer tank, and troubleshooting will commence. Once the effluent nitrate concentration returns to less than 10 mg/L, recycle will stop and forward flow will resume. These start/stop conditions are not expected to occur once the system is acclimated and operating in a steady state conditions; however, these provisions have been developed in the event the system or components experiences a malfunction or other unexpected loss of performance.

The effluent from the MBBR system, containing the sloughed and detached biomass to be removed from the system along with any inert TSS transported with the influent groundwater, will flow by gravity to the flocculation tank. Polymer will be dosed into the tank, based on the influent flow rate, and a mixer will agitate the water to encourage flocculation of the biosolids. Flocculation should occur almost instantaneously. If polymer dosing and/or mixing fails, filtration will still occur, but it will be less effective.

The water will flow by gravity from the flocculation tank to the drum filter. The self-contained Hydrotech drum filter package unit is sized for the peak flow and peak solids load. The drum filter unit consists of filter panels mounted on a drum installed within a covered tank. The filter unit is equipped with an integral backwash strainer and pump, piping and associated nozzles, and the required instrumentation and controls. The package also includes nozzles for chemical cleaning of the filter media if required. A chemical cleaning trolley, including a fully mounted magnetic driven pump, chemical storage container, and controls is included for periodic cleaning of the filter panels.

Influent flows by gravity from the flocculation tank into the center of the drum. Solids are separated from the water by a microscreen cloth mounted on the drum. A 40-micron cloth was chosen for this project because the solids will primarily consist of biomass, which is typically larger than 40 microns. Any particle with a sphericity greater than 0.95 and larger than 40 microns will be captured by the filter.

The buildup of captured solids increases the head loss across the drum filter causing the inlet water level to rise. At a pre-determined level, a backwash cycle is initiated, which involves rotating the drum, placing clean filter elements into the flow path, and cleaning the filter elements with high-pressure jets. The backwash water is collected in a trough in the center of the drum and flows away by gravity. After the backwash cycle, the rotation of the drum and the backwash pump are stopped. Filtration is continuous even during the backwash cycle. The clean filtrate that leaves the drum filter gravity flows to the treated wastewater sump from which it is pumped to Effluent Tank TK-102 for discharge or injection.

If the drum filter unit were to stop functioning, meaning the drum ceased to rotate and/or the backwash pump did not work, some of the water would pass through the filter, and the excess would overflow into the backwash sump. From there, it would be routed through the solids handling system and recycled to the buffer tank.

The drum filter backwash water will flow by gravity to a sump/pump station. The volume of backwash water from the drum filter is anticipated to range from 1% – 3% of the influent flow. Under normal conditions, this is an intermittent flow. If the backwash sump level alarms high, the forward flow to the MBBR will be shut off. This is not expected to happen, but provisions are included for safety.

8.3.8 Western Area Groundwater Treatment

Figures 8-3(a) and 8-3(b), Well Field and Water Treatment Line Diagram, illustrate 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 generated by each WA remediation area. The WATF includes one influent tank (TK-101) that will receive groundwater from all WA remediation areas and one influent tank (TK-105) that will receive groundwater from all BA1 remediation areas during Phase I remediation.TK-101 will serve as the influent tank for the UIX WA Treatment Train during Phase I, and for Trains 1 and 2 during Phase II. Based on an evaluation presented to the NRC and the DEQ in August 2017, the enrichment of the uranium in groundwater recovered from WA remediation areas is estimated (at the 95% UCL) to be approximately 2.6%. 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 enrichment value based on groundwater data will be replaced by more accurate values derived from isotopic laboratory analytical results. 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 through the next batch of ion exchange resin for that treatment train.

WAA U>DCGL, WAA-WEST, WU-PBA, 1206-NORTH, and WU-1348

As discussed above and depicted on Figure 8-3(a), Phase I operation will include groundwater remediation in the WAA U-DCGL and 1206-NORTH Areas. Phase II may include groundwater remediation in the WAA-WEST, WU-PBA, and WU-1348 Areas (see Figure 8-3(b)).,

Based on historical data, groundwater conveyed to Influent Tank TK-101 from these components is anticipated to initially contain uranium at a concentration that exceeds the NRC Criterion, nitrate that exceeds the State Criterion, and fluoride at a concentration below the OPDES permit discharge limit.

WAA-BLUFF and WAA-EAST

Phase II remediation may include the recovery of groundwater from the WAA-BLUFF and WAA-EAST remediation areas.

Based on historical data, groundwater conveyed to Influent Tank TK-101 from these components may initially contain concentrations of nitrate and fluoride exceeding State Criteria.

Treatment for uranium will continue until the concentration of uranium in TK-101 is less than the MCL for a minimum of two consecutive months. At that time, the flow from TK-101 will bypass the UIX treatment skid. A portion of the treated water will be directed to the WA injection skid; the rest will be directed to Effluent Tank TK-102.

8.3.9 Burial Area #1 Treatment System

Groundwater recovered from BA1 will be pumped to the BA1 influent tank (TK-201). During Phase I remediation, water will be transferred from TK-201 to WATF Tank TK-105 for subsequent treatment by the BA1 UIX treatment train, also located at the WATF (see Figure 8-3(a)). If Phase II remediation includes the installation and operation of a dedicated UIX treatment system in BA1, water will be transferred from TK-201 through the UIX treatment train located at the BA1 Treatment Facility. Both BA1 treatment trains (Phase I and Phase II) are designed to accommodate flow rates between 100 and 125 gpm.

Based on historical data, groundwater conveyed to Influent Tank TK-201, and subsequently to TK-105 (during Phase I), will initially contain uranium at a concentration exceeding the NRC Criterion, and background concentrations of nitrate and fluoride. During Phase I, 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 Outfall 001. If Phase II includes the installation and operation of a dedicated UIX treatment system in BA1, groundwater will be treated via the UIX Treatment System and discharged to TK-202 for injection and/or discharge via Outfall 002.

Based on historical data, 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 enrichment value based on groundwater data will be replaced by more accurate values derived from isotopic laboratory analytical results. The enrichment values for each batch of ion exchange resin will be used to estimate the content of U-235 accumulating in the next batch of ion exchange resin.

Removal of 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 discharging to TK-201 will bypass UIX treatment and be routed directly to TK-102 (Phase I) or TK-202 (Phase II).

8.3.10 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, and 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. If biodenitrification is added during Phase II, the WATF UIX system start-up requires coordination with the nitrate treatment system since the UIX system is upstream of the biodenitrification system. For BA1, start-up activities should be able to commence as soon as leak testing of field piping connections is complete.

8.4 TREATED WATER INJECTION

In several locations at the Site, treated groundwater will be injected into the Sandstone A and/or Sandstone B formations to enhance the hydraulic gradient and drive impacted groundwater to downgradient areas where it will be captured by groundwater extraction components. Treated water will be delivered to the subsurface via gravity flow 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. The injection wells and trenches will not be pressurized. 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 BA1-A, WU-UP1, and WU-UP2 remediation areas, within Sandstone A, 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. In response to NRC comments regarding the orientation and dimensions of injection trenches in WU-UP1, this trench network was modified following a field assessment of the lineation of joints evident in Sandstone A outcrops. The WU-UP2 trench network configuration was also reviewed following the bedrock lineament investigation but no design modifications were warranted.

The injection pilot tests conducted in WU-UP1 and WU-UP2 provided sufficient information to not only confirm the efficacy of the modified WU-UP1 trench network configuration, but to develop updated, and significantly higher, achievable water infiltration rate estimates for the WU-UP1 and WU-UP2 injection trench networks. Based on these higher infiltration rate estimates and other data obtained from the pilot tests, WU-UP1 and WU-UP2 injection trench network optimization measures, including the shortening and/or elimination of several trench segments, were implemented. Design implications resulting from the pilot test program are detailed in Section 8.0 of the Remediation Pilot Test Report.

This section presents the detailed design for the groundwater injection infrastructure, equipment, and associated controls, as well as the rationale for operation of the system. The locations of groundwater injection wells and trenches are depicted on Drawings C002, C004 and C005 (Appendix I-2).

8.4.1 Water Injection Trenches

A total of three treated water injection trenches will be installed at the Site for Phase I remediation. Injection trenches to be constructed during Phase I are:

- 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-WU-01 – This trench will be approximately 225 ft long. It will be installed in Sandstone A in the WU-BA3 area.

Up to three additional treated water injection trenches may be installed as part of Phase II. One existing injection trench (GWI-UP2-01) may also be lengthened. Injection trenches that may be installed during Phase II include:

- GWI-UP1-03 – This trench will be approximately 125 ft long. It will be installed in Sandstone A in the WU-UP1 area.
- GWI-UP1-04 – This trench will be approximately 125 ft long. It will be installed in Sandstone A in the WU-UP1 area.
- GWI-UP2-01 – This trench will be approximately 475 ft long. Approximately 175 ft of this trench was constructed during the 2017/2018 Pilot Test, so approximately 300 ft of this trench will be constructed during the full-scale program. It will be installed in Sandstone A in the western portion of the WU-UP2 area.
- GWI-UP2-04 – This trench will be approximately 330 ft long. It will be installed in Sandstone A in the eastern portion of the WU-UP2 area.

The following three treated water injection trenches were installed during the 2017/2018 Pilot Test:

- GWI-BA1-01 – This trench is approximately 175 ft long. It was installed in Sandstone B at the southern end of the BA1-A area.

- GWI-UP1-01 – This trench is approximately 185 ft long. It was installed in Sandstone A in the WU-UP1 area.
- GWI-UP1-02 – This trench is approximately 210 ft long. It was installed in Sandstone A in the WU-UP1 area.

Although injection trenches will not be installed in the WU-UP1 or WU-UP2 areas during Phase I, groundwater injection trench subsurface profiles for all injection trenches are depicted on Drawings C102 through C104. 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 at the surface both to provide a level working surface for the excavator, and to enable the excavator to reach the required maximum trenching depths (up to 30 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. Due to the weathered nature of Sandstone A bedrock in the WU, and Sandstone B bedrock in BA1, the use of 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 at site during the 2017/2018 Pilot Test. Soil excavated from the injection trenches will be stockpiled with the soil that was removed for the access trenches.

If injection trenches are installed in the WU-UP1 and WU-UP2 areas during Phase II, special conditions in these areas will require the use of additional measures during the excavation process. License Condition 27(c) stipulates the use of volumetric averaging in Subarea O in accordance with *Method for Surveying and Averaging Concentrations of Thorium in Contaminated Subsurface Soils* (USNRC, 1987A). This volumetric averaging of uranium in subsurface soil was used in the WU-UP1 and WU-UP2 Areas to demonstrate that the areas were releasable for unrestricted use. Review of the final status survey data for subsurface soil in these areas indicated that subsurface soil "at depth" contains uranium with an average concentration above the 30 pCi/g limit for uranium in soil elsewhere on site. In WU-UP1, the average concentration of uranium in soil exceeds 30 pCi/g from 6 ft in depth to the top of rock (auger refusal), typically at 9 to 10 ft below grade. In WU-UP2, the average concentration of uranium in soil exceeds 30 pCi/g from 5 ft. in depth to the top of rock (auger refusal), also typically 9 to 10 ft below grade. Within the footprint of the former ponds, soil excavated from the subject depth intervals will be stockpiled separately from other excavated soil; BMPs will be installed around the downslope sides of these potentially impacted soil stockpiles, and the stockpiles will be covered to prevent migration via stormwater runoff. These potentially impacted soils will be returned to the same depth intervals when the trench is backfilled.

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.

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 dry detention basin and/or 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.

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.

Following excavation of each injection trench, the bedrock 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 trench 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. At least 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 disturbed area associated with the construction of GWI-WU-01 is anticipated to be approximately 270 ft by 50 ft. The disturbed area associated with the construction of GWI-UP1-03 and GWI-UP1-04 will be managed as a single disturbed area. The disturbed area associated with the construction of GWI-UP2-01 is anticipated to be approximately 350 ft by 50 ft. The disturbed area associated with the construction of GWI-UP2-04 is anticipated to be approximately 350 ft by 50 ft. The disturbed area associated with the construction of GWI-BA1-02 and GWI-BA1-03 will be managed as a single disturbed area.

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. Bi-weekly inspection of BMPs will trigger improvement of BMP installation if evidence of migration is noted in inspections. Additional inspections will be performed following precipitation events exceeding 0.5 inches.

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 C104 (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.

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 C103 (Appendix I-4). In this area, a depth of 25 ft should fully penetrate Sandstone A. The trench will be positioned and oriented to achieve maximum penetration and interconnection of the former BA3 waste disposal trenches. Uranium impact is likely to reside within the backfill of the former disposal trenches. In addition, the former disposal trenches are likely to provide a preferential flow path for injected water. Observations from test trenches conducted during field construction activities will be used to determine the final location and orientation of GWI-WU-01. A nominal 8 gpm of treated water will be injected into this trench.

WU-UP1

Injection trenches GWI-UP1-01 and GWI-UP1-02 were installed during the 2017/2018 Pilot Test. These trenches consisted of north-south and northeast-southwest trending segments to achieve maximum communication with the Sandstone A formation, as well as interconnection of secondary porosity features. The orientation and dimensions for remaining injection trenches, if installed in WU-UP1 (GWI-UP1-03 and GWI-UP1-04) during Phase II, were developed based on the results of the Pilot Test. The WU-UP1 injection trench network is intended to maximize injected water distribution over the relatively large WU-UP1 remediation area, aiding distribution of the significant volume of treated water required for remediation of the Sandstone A formation underlying the former WU-UP1. The total combined length of the four WU-UP1 trench segments is approximately 645 ft.

If installed during Phase II, one injection well will be installed in GWI-UP1-03 and another will be installed in GWI-UP1-04. These wells will provide even distribution of treated water throughout each of the trenches. A cross-sectional depiction of the GWI-UP1-03 and GWI-UP1-04 and the associated wells are shown on Drawing C103 (Appendix I-4). In this area, full penetration of Sandstone A would require trenching to depths greater than 25 ft bgs; a minimum Sandstone A penetration depth of 10 ft is required for the WU-UP1 injection trench system. A nominal 7 gpm of treated water will be injected into each these trenches (GWI-UP1-03 and GWI-UP1-04) and a nominal 44 gpm will be injected into the WU-UP1 injection trench network.

WU-UP2

Approximately 175-ft of injection trench GWI-UP2-01 was constructed during the 2017/2018 Pilot Test; approximately 300 additional ft of GWI-UP2-01 may be constructed during Phase II. This trench is oriented east-west to achieve maximum communication with the Sandstone

A formation and interconnection of secondary porosity features. One additional injection well may also be installed in GWI-UP2-01 during Phase II and a nominal 35 gpm of treated water will be injected into the trench.

If installed during Phase II, injection trench GWI-UP2-04 will have a total length of approximately 330 ft. This trench system consists of two segments designed to drive flow to the north-northwest. This design is intended to maximize injected water distribution over the relatively large WU-UP2 remediation area. Two injection wells will be installed in GWI-UP2-04 and a nominal 21 gpm of treated water will be injected into the trench.

An impervious barrier consisting of geosynthetic clay liner will be installed on the upgradient walls of the WU-UP2 injection trenches to minimize the flow of water to the south and southeast. The liner will be installed prior to placement of trench backfill material. Cross-sectional depictions of the WU-UP2 injection trenches and wells are shown on Drawing C102 (Appendix I-4). In the WU-UP2 area, a depth of 25 ft should nearly penetrate Sandstone A.

8.4.2 Water Injection Wells

Fourteen groundwater injection wells listed on Drawing M202 (Appendix I-4) will be screened in Sandstone A and B formations within WU and BA1 remediation areas (four were installed during the 2017/2018 Pilot Test). Only three of the wells listed (GWI-BA1-02A, GWI-BA1-03A, and GWI-WU-01A) will be installed for Phase I remediation. The injection well installed in BA1 during the Pilot Test (GWI-BA1-01A) will also be utilized during Phase I. The remaining wells may be installed during Phase II. All but two of the wells (GWI-UP-02 and GWI-UP2-03) will be installed within injection trenches and screened within the trench drainage layer. Injection wells GWI-UP-02 and GWI-UP-03 will be installed upgradient of an isolated zone of Sandstone B contamination characterized by nitrate and fluoride MCL exceedances. 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.

Borings for injection wells GWI-UP-02 and GWI-UP-03, installed in the Sandstone B formation, will be advanced by air rotary to the specified total depth. Following achievement of total depth, the boring shall be reamed by air rotary to a nominal diameter of at least 10 inches. Cuttings will be logged, and lithology will be recorded by the field hydrogeologist on drilling log forms.

Groundwater injection wells GWI-UP-02 and GWI-UP2-03 will be constructed, as detailed on Drawing M202 (Appendix I-4), using 6-inch PVC well casing with 6-inch PVC wire-wrapped screen. Injection well screens will extend no higher than 5 ft bgs. The annular filter pack for GWI-UP-02 and GWI-UP-03 will consist of 10-20 sand. For wells installed within injection trenches the trench drainage material is anticipated to provide an adequate well filter pack. The surface seal for each injection well will be comprised of hydrated bentonite and a bentonite/cement grout, as necessary. The 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 groundwater injection well installations. As shown on the drawing, each well will be equipped with a pitless adapter, connected to the well casing approximately 2 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 24-inch diameter by 24-inch-deep steel well vault, set in a 48-inch diameter by 24-inch deep concrete pad will be installed over each well. A capped 1-inch galvanized steel pipe shall extend through the concrete pad to approximately 5 ft above grade. A bolt shall be placed in the concrete pad to serve as a reference point for location and elevation, and a metal tag displaying the well identification will be fastened to the steel pipe. Groundwater injection well construction information shall be recorded on well installation diagrams.

8.4.3 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. The injection system serving the WU injection wells and trenches will consist of a self-contained unit housed in a modular enclosure and installed adjacent to the WATF building. The system serving the BA1 injection trenches will consist of a self-contained unit housed in a modular enclosure and installed adjacent to the BA1 Influent Tank (TK-201) and BA1 Effluent Tank (TK-202). The location of the WU injection system is depicted on several design drawings, including Drawing C-110 (Appendix J-1) and Drawings C006 and C007 (Appendix I-2). The location of the BA1 injection system is depicted on Drawing C-210 (Appendix J-7) and Drawing C009 (Appendix I-2).

A P&ID for the WU water injection system is provided on Drawings P103 and P104 (Appendix I-4). These drawings depict Phase I equipment and infrastructure and all the potential equipment and infrastructure that may be installed during Phase II. As shown on the drawings, treated groundwater is supplied to an injection feed tank (TK-001) from the WA UIX Treatment Train. An actuated valve (MOV-012) controls the flow of water to prevent overfilling of 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.

Actuated valves on the injection manifold control the flow of water to each injection trench/well based on water levels continuously monitored via transducers installed in injection wells. The pumping pressure and injection flow rate for each injection manifold line is also monitored by the control system and individual injection lines 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 Drawings M103 and M104 (Appendix I-4). Phase I will include one dedicated injection manifold line that will deliver treated groundwater to GWI-WU-01A. Should the additional WU injection wells be installed during Phase II, up to 10 dedicated injection lines will be added to the manifold.

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 M105 (Appendix I-4).

8.4.4 Piping and Utilities

Locations of water conveyance piping runs, and other well field utilities associated with the groundwater 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). Drawings C006 and C007 (Appendix I-2) include partial plans for the WATF where the injection system delivering treated groundwater to WU injection wells and trenches is located.

The general groundwater injection water conveyance piping configuration for the WU is depicted on Drawings C004 (Appendix I-2) and M103 (Appendix I-4). During Phase I, injection piping will convey treated groundwater from the WU injection system to WU-BA3. Should Phase II include installation of additional WU injection components, multiple water injection piping runs will convey treated groundwater from the WU injection system to WU-UP1 and/or WU-UP2. A maximum of 11 dedicated injection piping runs may be installed to deliver treated groundwater to WU injection wells.

These drawings also show the general arrangement of instrumentation service runs for the WU injection wells, and the general arrangement of electrical power, instrumentation, and communication services for the WU injection system located adjacent to the WATF. General quantities and subsurface configurations for instrumentation conduits associated with the injection wells are shown on Drawing C106 (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 WU groundwater 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 E104 through E106 (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 BA1 Treatment Facility 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 three BA1 injection wells/trenches.

The general groundwater injection water conveyance piping configuration for the BA1 is depicted on Drawings C005 (Appendix I-2) and M105 (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 C106 (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 groundwater injection system is provided on the single-line diagram presented on Drawing E103 (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 E104 through E106 (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 groundwater 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.

WU Injection Systems

During Phase I, treated water will be injected into the WU-BA3 area. During Phase II, injection into additional wells and/or trenches may be performed in the WU-UP1 and WU-UP2 areas. For all three areas, treated water will be injected into the Sandstone A formation via injection trenches listed in Section 8.4.1, Injection Trenches. Trenches are 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 both the WU-BA3 and the 1206-NORTH areas have remained below the NRC Criterion for at least three consecutive monitoring events. However, operation of the WU-BA3 injection trench may continue until in-process monitoring indicates that uranium, nitrate, and fluoride concentrations have remained below State Criteria for at least three consecutive monitoring events, or until WA remediation operations are terminated, whichever comes first.

Should the WU-UP1 and WU-UP2 injection trenches be installed during Phase II, these trenches will continue to operate until in-process monitoring indicates that COC groundwater concentrations within the targeted remediation area have remained below their respective State Criteria for at least three consecutive monitoring events, or until WA remediation operations are terminated, whichever comes first. 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.

Should Phase II include the installation of WU-UP2 injection components, treated water will be injected into the Sandstone B formation via two injection wells (GWI-UP2-01 and GWI-UP2-02). Injection wells were selected for use in this application because the depth of Sandstone B in the WU-UP2 area makes injection trench excavation unfeasible. In addition, the lateral extent of the relatively isolated area of impact requiring remediation in Sandstone B in the WU-UP2 area is compatible with injection wells. Water delivery to the injection wells will only be permitted if the extraction component(s) responsible for capture of the injected water are operating and maintaining sufficient capture.

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 through GWI-BA1-03). As with Sandstone A injection in the WU areas, 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). The BA1 injection trenches will continue to operate until in-process monitoring indicates that uranium groundwater concentrations in all 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.

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.

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) at the site. Should Phase II include construction and operation of all remediation components and treatment infrastructure, an application for modification of the permit may be needed if a second outfall (Outfall 002) needs to be constructed for discharging BA1 Treatment Facility effluent. Locations of the two outfalls (Outfall 001 and Outfall 002) are shown on Drawings C002, C003, and C005 (Appendix I-2). Outfall details are presented on C107 (Appendix I-6).

The DEQ issued an OPDES permit providing for the discharge of treated water in accordance with the 2018 *Facility Decommissioning Plan – Rev 1* (Burns & McDonnell, 2018E). That permit will expire in 2022, before the construction activities described in this Plan begin. An application for a new OPDES permit will be submitted approximately one year prior to the expected start of groundwater treatment and discharge. Communications with DEQ indicate that with groundwater extraction generally limited to areas in which uranium exceeds the DCGL, and the elimination of nitrate treatment, permit limits for COCs are likely to remain at 30 μg/L for uranium and 10 mg/L for fluoride. The permit will require effluent pH to remain between 6.5 and 9.0 standard units, and although there will be no permit limit for nitrate, of the permit will require reporting of effluent nitrate concentrations. Discharge monitoring results will be reported on Discharge Monitoring Report forms on a monthly basis.

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.

8.5.1 Outfall 001

As discussed previously, groundwater recovered from BA1 will be conveyed to the WATF for treatment during Phase I. Following treatment, a portion of the treated water will be directed to BA1 for injection and the remainder will be discharged through Outfall 001. If all WA and BA1 groundwater extraction systems operate at nominal capacity and no treated water were injected during Phase I operations, a maximum of 207 gpm of treated water would be discharged to the Cimarron River through Outfall 001. Should Phase II include construction and operation of all remediation components and treatment infrastructure, a maximum of 250 gpm of treated water would be discharged through Outfall 001, and groundwater recovered from BA1 would be discharged through Outfall 002 (see below).

As previously stated, groundwater extracted from the WAA, 1206-NORTH, and WU 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, as this is likely to be stipulated in the OPDES permit.

8.5.2 Outfall 002

Should Phase II include construction and operation of all remediation components and treatment infrastructure, an additional outfall (Outfall 002) will be constructed for the BA1 Treatment Facility discharge. Assuming all BA1 groundwater extraction and injection systems operate at nominal capacity and no treated water is injected, a maximum of 100 gpm of treated water would be discharged to the Cimarron River through Outfall 002 during Phase II.

Groundwater extracted from BA1 will be treated to reduce the concentration of uranium to less than the stipulated permit limit. it is anticipated that samples of discharged water will be collected for analysis twice monthly, as this is likely to be stipulated in the OPDES permit.

8.6 IN-PROCESS MONITORING

This section addresses the in-process monitoring that will be performed to optimize the groundwater extraction and treatment processes, to determine when remediation can be discontinued, and to identify when groundwater extraction and treatment can cease, and post-remediation monitoring can begin. 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 extraction systems will consist of recording, logging, and evaluating well field data including pumping rates and pressures, groundwater elevations in extraction trenches and wells, and pump run times. Transducers will be installed in all groundwater extraction wells and trench sumps to monitor the drawdown achieved at the initial extraction rates. This well field instrumentation will provide real-time measurements and the control system will store the data.

In-process groundwater monitor wells for each remediation area are listed on Table 8-2. Figure 8-8 shows the locations of in-process monitor wells in the western remediation areas for Phase I. Figure 8-9 similarly shows the locations of in-process monitor wells in BA1 for Phase I.

Groundwater elevations will be measured manually in those monitor wells scheduled to be sampled on a quarterly basis (see Table 8-2). Groundwater elevation measurements will be recorded 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, groundwater elevation will be recorded on a quarterly basis for all monitor wells which remain on site. 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 used 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 also be adjusted to maintain the influent flow rates required for proper operation of the groundwater treatment systems.

In-process groundwater elevation 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 maintain plume capture.

In both the WAA U>DCGL and BA1-B areas, the "groundwater extraction" issue of greatest concern is the potential to create stagnation zones between extraction wells, in which COC concentrations decline very slowly or not at all. In-process groundwater monitoring will provide the data needed to confirm that the concentration of uranium declines in these apparent stagnation zones at approximately the same rate as in other monitor wells located at similar distances from extraction wells.

If Phase II includes injection of treated water into the WU-UP1 and WU-UP2 areas with extraction of groundwater from the WAA-BLUFF area, the "groundwater extraction" issue of greatest concern would be the potential inability of extraction wells to effectively capture the impacted water being driven to the alluvium by the injection of treated water in WU-UP1 and WU-UP2 areas. Groundwater elevation data may be measured in Monitor Wells T-85 through T-88, and in monitor wells spaced between Extraction Wells GE-WAA-06 through GE-WAA-13, should Phase II include injection of treated water in the WU-UP1 and WU-UP2 areas. If the groundwater elevations in the second set of wells is lower than the groundwater elevation in currently-downgradient Monitor Wells T-85 through T-88, groundwater must be moving toward the bluff, and not away from the bluff through the line of extraction wells.

8.6.2 Water Treatment Monitoring

In-process monitoring of the groundwater treatment processes will provide information needed to monitor the effectiveness of the treatment systems, determine when ion exchange resin vessels require replacement/reconfiguration, maintain compliance with license possession limits, determine when accumulated biomass requires removal from denitrification bioreactors (if installed in Phase II), 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 following wastes:

- Spent resin/absorbent mixture packaged for disposal (upon each changeout)
- Biomass generated during the biodenitrification process (if installed during Phase II remediation)

Uranium Treatment Monitoring

Pumping rates, pressures, and level switches will be continuously monitored to maintain a nominal flow of no more than 125 gpm to each uranium treatment skid in the WATF, and no more than 125 gpm to the uranium treatment skid in BA1 (if installed during Phase II remediation).

The pH of the influent coming from TK-101 and TK-105 (Phase I) 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, . After the mixer, the pH is continuously monitored to verify that the influent to the ion exchange vessels is 6.8 – 7.0 standard units. A sample port is in the process line both upstream and downstream of the in-line mixer to enable 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 (Appendix J-3) for the specific location of sample ports; the configuration of this UIX treatment system is representative of all UIX treatment systems. Samples will 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. The data obtained through the first two changeouts of each treatment train may indicate that the frequency of sampling may be reduced to every two weeks instead of weekly. 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 generated for disposal.

Calculations indicate that no resin vessel will ever accumulate more than 500 grams of U-235, because as the uranium concentration of influent groundwater declines, the adsorption capacity of the resin declines. Consequently, a single resin vessel will not be able to adsorb sufficient uranium to contain 1,200 grams of U-235. 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.

Nitrate Treatment Monitoring (if implemented during Phase II)

The design includes provision for addition of a nitrate source (such as sodium nitrate solution) into the MBBR system to establish the initial microorganism culture. This start-up period is expected to take four to eight weeks depending on the specific commercial denitrification microorganism culture selected and the rate at which nitrate, and other nutrients are added.

During the start-up and throughout normal operation, nitrate is continuously monitored via a probe immersed in a sample sink (see Drawing P200 in Appendix J-5). A slip stream from the process continuously overflows into the area sump. The currently identified probe, which is not suitable for placement in the process pipe, provides feedback to the control system to adjust the feed rate of methanol addition. A similar arrangement is used after the drum filter to check that the treatment goal for nitrate has been met (see Drawing P207 in Appendix J-5). Should measurement indicate the effluent goal has not been met, the flow is directed back to the Buffer Tank for re-processing instead of sending the flow to the Effluent Tank. Table 8-3 identifies the in-line sensors that provide data to control the treatment system.

Samples of influent to the uranium treatment system, influent to the biodenitrification system, and effluent from the biodenitrification system, will be collected on a weekly basis, and analyzed for nitrate/nitrite. Evaluation of the data obtained over time may justify reducing the frequency of sampling to once every two weeks. Table 8-4 shows the locations from which samples will be collected.

Sample points are provided at multiple locations along the biodenitrification treatment process as shown on the various P&ID drawings provided in Appendix J-5.

An external source of water and nitrate will be used to establish a sufficient biomass; uranium treatment will not begin until this inoculation is complete. In-process monitoring of the ion exchange systems will begin when uranium treatment begins.

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 and biomass to assess compliance with license-stipulated possession limits. Radiological monitoring is addressed 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 WU-BA3 (Phase I), and WU-UP1, and WU-UP2 (Phase II) 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 level 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 bi-weekly 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 groundwater 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 groundwater injection wells and/or trenches; however, these measurements will be recorded manually. The data described above will be used to adjust groundwater injection rates to maximize the flushing of COCs from the targeted upland sandstone units.

Transducers will be installed in all treated water injection wells to monitor the potentiometric head maintained at the initial injection rates. Phase I in-process groundwater monitor wells for each remediation area are listed on Table 8-2 and Figures 8-8 and 8-9 show the locations of in-process monitor wells.

Groundwater elevations will also be measured manually in those monitor wells scheduled to be sampled on a quarterly basis (see Table 8-2). Groundwater elevation measurements will be recorded 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, depth to groundwater measurements will be recorded on a quarterly basis for all monitor wells on-site.

In-process groundwater elevation data will be used to maximize the driving head from areas of upland COC impact toward groundwater extraction features, while minimizing the potential for contaminant displacement to areas outside the boundaries of capture zones.

Discharge Monitoring

The flow rate to each operational outfall will be recorded, and samples of treated water being discharged via each outfall 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

Concentrations of groundwater COCs requiring remediation will be monitored to evaluate progress toward remediation goals and to determine when remediation within a given area should be discontinued and post-remediation groundwater monitoring should begin. In-process monitor wells used to evaluate remediation progress are the same as those previously specified for groundwater extraction and injection performance monitoring. Locations of Phase I in-process monitor wells are depicted on Figures 8-8 and 8-9. Table 8-2 lists the wells by remediation area and identifies the COCs to be analyzed for groundwater samples collected from each well during Phase I.

In-process monitoring of COC concentrations in groundwater will consist of the sampling and analysis of select monitor wells in each subarea. Monitoring COC concentrations within each remediation area will provide the information needed to adjust remediation process parameters, primarily extraction and injection flow rates, assess progress toward remediation goals, evaluate when operation of specific wells or trenches can be discontinued, and determine when remediation in a specific area can cease and post-remediation monitoring can begin. Post-remediation groundwater monitoring is addressed in more detail in Section 8.8, Post-Remediation Groundwater Monitoring.

In-process groundwater monitoring will provide several years of data which can be used to evaluate the rate of decline of COC 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 wells yield uranium concentrations below 180 pCi/L. 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.

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 efforts on areas with higher levels of impact, maximizing COC mass recovery and concentration reduction, while remediation efforts in areas of lesser impact may be reduced. The data will 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).

Groundwater remediation monitoring samples will be collected immediately prior to startup of groundwater extraction and injection. The quarterly analysis of specific COCs for groundwater samples collected at specific locations will be discontinued once the concentration of that COC is below the corresponding State Criterion for four consecutive quarters. For example, groundwater from Monitor Well T-63 will be analyzed for uranium, nitrate, and fluoride each quarter. Should the concentration of fluoride be the first to drop below its State Criterion for four consecutive quarters, analysis for fluoride will be discontinued; analysis for uranium and nitrate would continue until one of these constituents has dropped below the respective State Criterion.

The same procedures will apply for the analysis of COCs in groundwater collected from monitor wells on an annual basis, except that annual analysis will be discontinued once the COC concentration is below the corresponding State Criterion for two consecutive years.

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.

Section 8.3.3, Biodenitrification Systems, describes the process whereby, should biodenitrification and biomass processing system be installed during Phase II, nitrate is removed from groundwater through an anoxic reaction. This section describes the packaging of biomass that is generated in the bioreactors. The influent to the biodenitrification system will consist of groundwater that has already been treated for uranium and Tc-99. The influent should contain non-detectable concentrations of uranium; it is not yet known if the resin will adsorb all of the Tc-99, and it is assumed that detectable Tc-99 may be present in the influent to the biodenitrification system. The biomass filtered from the effluent of the biodenitrification system will be processed and packaged for disposal in accordance with the OPDES permit unless it contains detectable uranium or Tc-99. The disposal of radioactive waste 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. If Phase II includes treatment for uranium in BA1, spent resin vessels from BA1 will be transported to the WATF for processing.
- The ion exchange vessel will be moved to the Spent Resin Handling Area (see Drawing G-120).
- Resin will be sluiced out of the vessel and dewatered using a scrolling centrifuge. The water discharged from the scrolling centrifuge will then be routed back to the influent tank for the relevant UIX WA Train.
- Solids (i.e., dewatered resin) from the centrifuge will be transferred by gravity to a ribbon blender. The ribbon blender is sized to blend the contents of a resin vessel plus the amount of inert material (absorbent) needed to meet the transportation and waste acceptance criteria. The ribbon blender will produce a uniform final mixture that complies with the fissile exempt and waste acceptance criteria. 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 absorbent is the only consumable material used in the Resin Handling System. Current calculations indicate that the WATF uranium concentration is such that the resin capacity is not great enough to reach the fissile exception limit for transportation. For BA1, the initial four to five resin vessels are projected to require early replacement to remain below the fissile 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). Although the resin is expected to remove Tc-99 from the WA groundwater influent, the extremely small mass of Tc-99 in groundwater is not sufficient to impact the resin's adsorption.

Absorbent will be added to a hopper of that directly feeds into the ribbon blender. Usage is anticipated to be approximately 45 55-lb 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 change out.

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 TK-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 is 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 is continued until visual observations into HPR-301 show that the tank 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 (FLT-121/122/123) for processing. Once filled, the vessel will be stored in a designated area in the Resin Handling Area until needed.

The Resin Handling Area will be in the northeast corner of the WATF as shown on Drawing G-120. 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. Using a single station for both the removal of spent resin and the addition of fresh resin minimizes vessel movement.

8.7.3 Resin Packaging and Storage

Resin from the treatment of BA1 groundwater will be removed from service before it accumulates sufficient uranium to exceed the fissile exception criterion. As the concentration of uranium in groundwater declines, and the adsorption capacity of the resin decreases, resin will not contain enough uranium to require the addition of more absorbent than will be needed to ensure that free liquid will not be present upon delivery to the licensed disposal facility. The resin without the addition of absorbent will meet the fissile exception criterion.

The blended resin/absorbent mixture will be transferred from the ribbon blender to 55-gallon drums equipped with a plastic liner. The liner provides contamination control and allows for transfer of material in a way that minimizes the potential for airborne suspension of particulates and does not expose the worker to direct contact with the material.

A sample collected from each drum will be analyzed for isotopic mass concentration for uranium and activity concentration for Tc-99. The collection of multiple samples from a single batch provides 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. Analytical data will be the basis for shipping papers and manifests and will provide the data needed to document that transportation and disposal criteria have been met. Table 8-6 presents the sample identification and analytical method information for samples of processed resin.

During Phase I operations, 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. During Phase I, the spent resin storage area will be located in the southern portion of the WATF as shown on Drawing G-100 [Appendix J-2].

Should a biodenitrification system be installed during Phase II, filled drums will be labeled and placed within a Secured Storage Facility located east of the WATF Building (see Drawing C-110, Appendix J-1), pending receipt of analytical results. The Secured Storage Facility is a Metal Building with a single roll-up door that will have removable bollards to additionally restrict access to the interior of the facility (see Drawings A-170 [Appendix J-6] and KC-110 [Appendix J-1], respectively).

Disposal of processed resin is addressed in Section 13.1, Solid Radioactive Waste. The yearly quantity of spent resin (including absorbent) projected to be generated is about 745 ft^3 (BA1 ~375 ft^3; WATF ~371 ft^3), or approximately one hundred 55-gallon drums per year.

8.7.4 Biomass Solids Processing

Biodenitrification will not be included in Phase I activities. However, if additional funding provides for the installation of a biodenitrification system during Phase II, biomass solids will be generated prior to termination of the license. This section and Section 8.7.5 describe the processing, packaging, and disposition of biomass that would be generated if a biodenitrification system is installed.

Unless otherwise noted, drawings referenced in this section are in Appendix J-5. The drum filter within the biodenitrification system described in Section 8.3.3 will wash solids off the filter into a backwash sump. From the backwash sump, the water will be pumped to a sludge thickener tank, TK-1250 (see Drawings P210 and P211). Coagulant and polymer will be added in line with a static mixer. This will condition the solids as they enter the thickener. The chemical dosing of the coagulant and polymer will turn on and off with the backwash sump pump. If either chemical dosing system fails due to equipment malfunction or lack of chemical, the dewatering process will continue but will be less efficient.

An air sparging system in the thickener will operate intermittently. This will both prevent the wastewater from becoming septic and reduce the potential for odors. The thickener has a capacity of three days' sludge production to enable the system to continue working throughout the weekend without dependence upon an operator. The overflow from the thickener will flow by gravity to the Area Sump, from where it will be routed back to the buffer tank in front of the MBBRs. A scraper at the bottom of the thickener will move the sludge toward the center, from where it will be pumped to the filter press.

At the beginning of each filter press cycle, before sludge is pumped to the filter press, perlite will be mixed with water in TK-2300 to create a slurry. The slurry will be pumped into the filter press, creating a pre-coat layer on the cloth filter of each plate. The pre-coat minimizes the potential for blinding of the filter press cloths, resulting in more efficient dewatering and dryer sludge cake. Pre-coat also enhances the release of the sludge cake from the filter cloth. The filtrate during this step will be recycled to the perlite feed tank.

The valves will then pump sludge from the bottom of the thickener. Solids will be captured between the plates; the filtrate will discharge to the Area Sump. At the end of each press cycle, compressed air will be blown through the filter press to remove most of the remaining water. The plates of the filter press will be separated, and the filter cake will be dropped into a sludge cart (or equivalent) for transfer to the disposal container. Each filter press cycle takes two to four hours.

The perlite precoat will increase solids capture as well as help produce drier sludge cake. If the perlite system does not work, the filter press cycle can be delayed for maintenance. If the filter press fails due to mechanical reasons, the water in the press will go to the Area Sump, and the ample storage time in the thickener should be sufficient to perform the required maintenance. Again, this is not expected to occur frequently, but the provision is in place to ensure the smooth operation of the plant.

The following is a summary of the chemical usage for the biomass solids process, based on a 250 gpm flow rate and an inlet nitrate concentration of 150 mg/L NO_3-N:

- Emulsion Polymer (for Thickener Tank): Usage is anticipated to be less than one tenth of a gallon/day, supplied by a drum, which will be replaced every 6-months by delivery to the WATF by truck. Storage of replacement drums of polymer is not expected to be more than 1-2 weeks and will be in a designated area with appropriate controls to limit any interaction with other chemicals.
- Ferric chloride (for Thickener Tank): Usage is anticipated to be approximately 30 gallons/day, fed from a 320-gallon double-walled tote, which will be co-located with its feed pump on a skid within the WATF near TK-1250. The tote is expected to be refilled

twice a month via chemical tote delivered by truck. The new tote will be stacked on the empty supply tote to gravity fill it.

- Perlite (for filter press): Usage is anticipated to be about 60 pounds/cycle. Perlite will be received on pallets as dry material in bags that can be handled by an operator. Delivery frequency will be approximately monthly, with a storage location to be determined within the WATF for the perlite pallets.

8.7.5 Biomass Packaging and Storage

The sludge cart will be emptied into a disposal container that complies with transportation requirements. Solids remaining in the sludge cart may be washed out with a hose and drained into the Area Sump to prevent biogrowth on the cart. The performance criterion for the sludge dewatering process is “no free liquids”, (based on the paint filter test) for landfill disposal.

The maximum daily sludge production is anticipated to be approximately 600 lbs. (dry solids), or approximately 1.5 tons of wet cake (at 20% solids content). The filter press has a volume of 30 ft^3, which is adequate to dewater the amount of sludge produced each day in a single cycle. Additional cycles can be run within a day if sludge accumulates in the thickener over several days.

The disposal container is anticipated to be removed on a weekly basis. This is both a function of the biomass solids generation rate and requirements of the disposal facility. As nitrate concentrations decline, waste generation will decline. Biomass solids will be analyzed for uranium and Tc-99 as shown in Table 8-6. If the biomass does not contain detectable uranium or Tc-99, it will be disposed of in accordance with the OPDES permit. If it does contain detectable uranium or Tc-99, biomass will be mixed with an inert absorbent material to reduce the moisture content to comply with the licensed disposal facility’s WAC. It will then be re-analyzed. If it still contains detectable uranium or Tc-99, it will be packaged and disposed of as radiologically contaminated waste at an appropriately licensed facility. The management and disposal of radiologically contaminated waste is further discussed in Section 13.

8.8 POST-REMEDIATION GROUNDWATER MONITORING

Post-remediation groundwater monitoring will be performed to demonstrate compliance with NRC Criteria required for license termination. Post-remediation groundwater monitoring will also provide COC concentration data for areas that have been remediated and may also demonstrate compliance with State Criteria for specific COCs in some areas. This section describes the groundwater sampling and analysis that will be performed in each area requiring groundwater remediation.

In areas where drawdown due to extraction is significant (i.e., extraction trenches in transition zone material), COCs sorbed to unsaturated soil above the drawdown cone may be released into solution, increasing COC concentrations in the groundwater (i.e., rebound). Groundwater extraction and injection will therefore be terminated prior to initiating post-remediation monitoring. Twelve quarters of post-remediation monitoring will identify rebound if it occurs after the cessation of pumping and injection.

If the uranium concentration rebounds above the NRC Criterion in a post-remediation monitoring well, remediation will resume in that remediation area. If the concentration of a given COC rebounds above other remediation objectives (i.e., State Criteria) in a post-remediation monitoring well, remediation may or may not resume in that area. If remediation resumes in a given area, post-remediation monitoring would then start over when in-process monitoring indicates the remediation objective has been achieved.

Post-remediation groundwater monitoring will consist of at least 12 consecutive quarters of groundwater sampling and analysis for each remediation area. To demonstrate compliance with NRC Criteria within any remediation area, the concentration of uranium must be less than 180 pCi/L in every post-remediation monitoring well for 12 consecutive quarters. To demonstrate compliance with State Criteria within any remediation area, the concentrations of uranium, nitrate, and fluoride must be less than the State Criteria in every post-remediation monitoring well for 12 consecutive quarters. Additionally, post-remediation monitoring will include sampling and analysis for Tc-99. Tc-99 concentrations already comply with the NRC Criterion (3,790 pCi/L), but post-remediation monitoring will be performed to confirm that Tc-99 concentrations are below the EPA-stipulated criterion of 900 pCi/L.

Locations of post-remediation monitor wells are depicted on Figures 8-10 (WA) and 8-11 (BA1). Table 8-7 list the wells by remediation area and identifies the COCs to be analyzed for groundwater samples collected from each well for each phase. The following subsections detail the post-remediation monitoring approach and criteria for various portions of the site.

8.8.1 Western Alluvial Areas

WAA U>DCGL Area

Uranium, nitrate, and fluoride are the COCs for which groundwater samples will be analyzed in this remediation area. Analysis of groundwater samples for Tc-99 will not be performed in this area because Tc-99 did not exceed 900 pCi/L prior to groundwater remediation.

It is anticipated that in-process remediation monitoring will have demonstrated that groundwater outside of the centerline of the uranium plume complies with NRC Criterion for uranium prior to the conclusion of remedial operations in this area. Post-remediation monitor wells are located between extraction wells, where the potential for stagnation zones is greatest.

It is not anticipated that drawdown (and consequent rebound) will be an issue in alluvial remediation areas because planned pumping rates will produce minimal drawdown in the highly permeable sands.

WAA-WEST Area (Phase II Remediation)

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium concentrations did not exceed the NRC Criterion, and Tc-99 did not exceed 900 pCi/L prior to groundwater remediation.

Analysis for fluoride will not be performed in this area because fluoride concentrations in groundwater did not exceed 4 mg/L in this area prior to groundwater remediation. Uranium has never exceeded 30 µg/L in Monitor Well T-97, and nitrate has never exceeded 10 mg/L in Monitor Well T-98. Consequently, samples from Monitor Well T-97 will be analyzed only for nitrate, and samples from Monitor Well T-98 will be analyzed only for uranium for evaluation relative to DEQ Criteria.

It is not anticipated that drawdown (and consequent rebound) will be an issue in alluvial remediation areas because planned pumping rates will produce minimal drawdown in the highly permeable sands.

WAA-EAST Area (Phase II Remediation)

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed their NRC Criteria.

Analysis for Tc-99 will not be performed in this area because Tc-99 concentrations in groundwater did not exceed 900 pCi/L prior to groundwater remediation. Analysis for fluoride will not be performed in this area because fluoride concentrations in groundwater did not exceed 4 mg/L in this area. Post-remediation groundwater samples will be analyzed for uranium and nitrate for evaluation relative to DEQ Criteria.

It is not anticipated that drawdown (and consequent rebound) will be an issue in alluvial remediation areas because planned pumping rates will produce minimal drawdown in the highly permeable sands.

WAA-BLUFF Area (Phase II Remediation)

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed NRC Criteria.

Analysis for uranium will not be performed in this area because uranium concentrations in groundwater did not exceed 30 µg/L prior to groundwater remediation. Although Tc-99 concentrations in groundwater did not exceed 900 pCi/L prior to groundwater remediation, samples will be analyzed for Tc-99 because groundwater discharging to the alluvium from UP1 and UP2 areas has yielded Tc-99 concentrations above 900 pCi/L.

Post-remediation groundwater samples will be analyzed for nitrate, fluoride, and Tc-99 for evaluation relative to DEQ Criteria. Post-remediation monitor wells are located between extraction wells, where the potential for stagnation zones is greatest.

8.8.2 Western Upland Areas

WU-BA3

Analysis for Tc-99 will not be performed in this area because Tc-99 concentrations in groundwater did not exceed 900 pCi/L prior to groundwater remediation.

Analysis for fluoride will not be performed in this area because fluoride concentrations in groundwater did not exceed 4 mg/L in this area prior to groundwater remediation. Analysis for nitrate will not be performed for Monitor Wells 1356 and 1360 because nitrate concentrations in groundwater did not exceed 10 mg/L in these wells prior to groundwater remediation.

Post-remediation groundwater samples will be analyzed for uranium for all wells, and nitrate for Monitor Well 1351.

WU-UP1 (Phase II Remediation)

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed NRC Criteria prior to groundwater remediation. Analysis for uranium will not be performed in this area because uranium concentrations in groundwater did not exceed 30 µg/L in this area prior to groundwater remediation.

Post-remediation groundwater samples will be analyzed for nitrate, fluoride, and Tc-99 for evaluation relative to DEQ Criteria.

WU-UP2-SSA (Phase II Remediation)

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed NRC Criteria prior to groundwater remediation. Post-remediation groundwater samples will be analyzed for uranium, nitrate, fluoride, and Tc-99 for evaluation relative to DEQ Criteria.

WU-UP2-SSB (Phase II Remediation)

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed NRC Criteria prior to groundwater remediation. Analysis for uranium will not be performed in this area because uranium concentrations in groundwater did not exceed 30 µg/L in this area prior to groundwater remediation.

Post-remediation groundwater samples will be analyzed for nitrate, fluoride, and Tc-99 for evaluation relative to DEQ Criteria.

WU-PBA (Phase II Remediation)

Post-remediation groundwater monitoring for compliance with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed NRC Criteria prior to groundwater remediation. Analysis for Tc-99 will not be performed in this area because Tc-99 concentrations in groundwater did not exceed 900 pCi/L prior to groundwater remediation. Analysis for fluoride will not be performed in this area because fluoride concentrations in groundwater did not exceed 4 mg/L in this area prior to groundwater remediation.

Post-remediation groundwater samples will be analyzed for uranium and nitrate.

WU-1348 (Phase II Remediation)

Post-remediation groundwater monitoring for with NRC Criteria will not be required for this area, because uranium and Tc-99 concentrations did not exceed NRC Criteria prior to groundwater remediation.

Analysis for nitrate will not be performed in this area because nitrate concentrations in groundwater did not exceed 10 mg/L in this area prior to groundwater remediation. Analysis for Tc-99 will not be performed in this area because Tc-99 concentrations in groundwater did not exceed 900 pCi/L prior to groundwater remediation.

Post-remediation groundwater samples will be analyzed for uranium and fluoride for evaluation relative to DEQ Criteria.

8.8.3 1206-NORTH

The 1206-NORTH area is unique in that it is the only area on site in which uranium exceeds the NRC Criterion, all COCs exceed State Criteria, and Tc-99 has exceeded 900 pCi/L. Post-remediation groundwater samples will be analyzed for uranium, nitrate, fluoride, and Tc-99.

8.8.4 Burial Area #1

Uranium is the only COC for which groundwater samples will be analyzed in BA1. Analysis of groundwater samples for Tc-99 will not be performed in this area because Tc-99 has never been identified in groundwater in BA1. Analysis for nitrate and fluoride will not be performed in this area because nitrate and fluoride concentrations in groundwater have never exceeded the MCL in BA1.

It is anticipated that in-process remediation monitoring will have demonstrated that groundwater outside of the centerline of the uranium plume complies with NRC Criterion for uranium prior to discontinuing remedial operations in this area. Post-remediation monitoring locations were selected to demonstrate compliance with the NRC Criterion at locations selected as described below.

In BA1-A, post-remediation monitor wells in SSB are located where uranium concentrations are currently elevated. In the transition zone, post-remediation monitor wells are located where drawdown near extraction trenches (and the potential for rebound) is greatest.

In BA1-B and BA1-C post-remediation monitor wells are located between extraction wells, where the potential for stagnation zones is greatest, along with several locations where current uranium concentrations are relatively high.

It is not anticipated that drawdown (and consequent rebound) will be an issue in alluvial remediation areas because planned pumping rates will produce minimal drawdown in the highly permeable sands. Sampling of post-remediation Monitor Wells 02W43 and 1415 may be discontinued once uranium concentrations are below the NRC Criteria for 12 consecutive quarters (including in-process monitoring results).

8.9 DEMOBILIZATION

Demobilization of remediation and water treatment equipment will not be performed until post-remediation monitoring demonstrates that the NRC Criterion has been achieved in the WAA U>DCGL, WU-BA3, 1206-NORTH, BA1-A, and BA1-B remediation areas. The WATF Building and secure storage facility will remain on Site following the completion of groundwater remediation activities. The WATF Building and the secure storage facility 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.

8.9.1 Sequence of Demobilization

The general sequence of groundwater remediation and treatment system shutdown, demobilization, and NRC license compliance is as follows:

Once post-remediation monitoring in the WAA U>DCGL, WU-BA3, 1206-NORTH, BA1-A, and BA1-B remediation areas confirms achievement of the NRC Criterion, all treatment systems will be demobilized from the WATF and BA1. The following sections detail demobilization activities associated with all Phase I remediation equipment described above as well as the BA1 Treatment Facility and WATF biodenitrification system, should those be installed during Phase II. A final status survey for these facilities will be completed. All groundwater extraction and injection equipment and controls will remain.

The estimate presented in Section 16, Financial Assurance, does not include costs associated with groundwater remediation that may continue without treatment (if influent concentrations no longer require treatment), or costs associated with removal of injection or extraction components or monitor wells that remain after license termination.

8.9.2 Uranium Treatment Systems

Prior to demobilization of each uranium treatment train, six samples of fresh resin will be analyzed for uranium concentration to develop a background concentration for resin. The maximum value for unused resin will represent the upper limit for unimpacted resin. The resin in all three vessels (lead, lag, and polishing) will be sampled and analyzed for uranium concentration. Resin yielding a total uranium concentration of less than this maximum value will be disposed of as 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 unrestricted release will be packaged and shipped for disposal as LLRW. Empty resin vessels and process equipment that can be surveyed for unrestricted release will be surveyed and either released, decontaminated for release (if practical), or packaged and shipped for disposal as LLRW.

8.9.3 Nitrate Treatment Units

If a biodenitrification system is installed before applying for license termination, biomass will be removed from the bioreactor and placed in containers prior to demobilization of each nitrate treatment train. The biomass will be processed as described in Section 8.7.6, Biomass Solids Processing. If the biomass contains detectable concentrations of uranium or Tc-99, it will be packaged for disposal in accordance with Section 13, Radioactive Waste Management; if not, it will be disposed of in accordance with the OPDES permit.

Once all biomass has been removed from the bioreactor, all process equipment that cannot be surveyed for unrestricted release will be packaged and shipped for disposal as LLRW. Empty vessels and all process equipment that can be surveyed for unrestricted release will be surveyed and either released, decontaminated for release (if practical), or packaged and shipped for disposal as LLRW.

8.9.4 Resin Processing System

The resin processing system will not be demobilized until all uranium treatment systems and biodenitrification skids have been demobilized. Once all processed resin or biomass has been removed from the system and disposed of as described in Sections 8.9.2 and 8.9.3, all process equipment that cannot be surveyed for unrestricted release will be packaged and shipped for disposal as LLRW. Process equipment that can be surveyed for unrestricted release will be surveyed and either released, decontaminated for release (if practical), or packaged and shipped for disposal as LLRW.

8.9.5 Groundwater Extraction and Injection Infrastructure

If final status survey measurements demonstrate that they are releasable for unrestricted use, groundwater extraction and injection wells, trenches, piping, and other utilities and equipment will remain in place after NRC license termination to facilitate additional remediation activities required for the achievement of DEQ-stipulated criteria.

As previously stated, groundwater extraction and injection wells will be shut down during the post-remediation monitoring period for the area in which groundwater remediation is believed to be complete. Upon achievement of final (both NRC and State) remediation criteria, groundwater extraction and injection sumps and wells for each area will be removed, plugged, and abandoned. All groundwater extraction and injection wells will be plugged and abandoned in accordance with Oklahoma Water Resources Board (OWRB) regulations.

Groundwater extraction and injection trenches will not be excavated or removed. The subsurface components including drain piping, gravel backfill, and geotextile will remain in place. Only the extraction trench sumps will be removed, plugged, and abandoned. Prior to abandonment, extraction trench sumps will be used as access points during the in-place plugging and abandonment of extraction trench drainpipes.

Ancillary demobilization and demolition activities such as power and control cable removal/reclamation, well control and cleanout vault removal and backfilling, well pad bollard removal, etc. will also be conducted once these facilities are no longer needed. If final status survey measurements indicate that it is releasable for unrestricted use, subsurface piping and conduits will be cut/capped and abandoned in place. If it is not releasable for unrestricted use, it will either be decontaminated and resurveyed or removed and disposed of as LLRW. Detailed depictions of subsurface well field piping, conduits, and structures are presented in Drawings C105, C106, and C108 (Appendix I-6), M101 and M102 (Appendix I-3). Plugging reports for all well and sump abandonments will be filed with OWRB, and copies of plugging reports will be retained in the document repository.

8.9.6 Monitor Wells

Like groundwater extraction and injection wells, monitor wells will be removed by area once remediation in that area is complete and approval from both agencies has been obtained. The groundwater monitor wells in each area will be removed, plugged, and abandoned in accordance with OWRB regulations. Plugging reports will be filed with OWRB, and copies of plugging reports will be retained in the document repository.

8.9.7 Utilities

Electric power lines, control wiring, and piping will be removed from each area in conjunction with the removal of groundwater extraction and/or injection infrastructure. Wire, cables, and piping will be run in trenches which are above the water table, and in soil that has been demonstrated to comply with decommissioning criteria (for unrestricted release). Wire and cables will be considered releasable for unrestricted use, and will be removed for recycling, salvaged, or disposition as solid waste.

Piping will have carried groundwater with concentrations of uranium that have declined over time until the water being pumped through the piping complies with drinking water standards. Accessible piping will be considered releasable for unrestricted use, and will be removed for recycling, salvaged, or disposition as solid waste. Subgrade piping will be cut, capped, and abandoned in place.

8.10 ONGOING REMEDIATION

As stated in Section 8.1, Phase I remediation ends when all in-process monitoring wells yield concentrations of uranium that are less than the DCGL. Post-remediation groundwater monitoring and license termination may immediately follow Phase I. Based upon residual funding at the conclusion of Phase I, the NRC and the DEQ may agree to continue groundwater remediation, either utilizing the existing facilities or expanding infrastructure into other remediation areas until funding requires pursuing termination of the license.

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9.0 SCHEDULE

This section presents the schedule upon which the decommissioning cost estimate is based. The schedule and cost presented in this Plan are based upon performing the minimum amount of work required to achieve license termination. It is therefore assumed in Sections 9 and 16 that post-remediation monitoring and license termination immediately proceed Phase I remediation. Figures presenting the schedule are broken into four components:

- A pre-construction schedule (Figure 9-1) presents activities that begin with the submittal of this Plan and conclude with the start of construction.
- A construction schedule (Figure 9-2) presents a conceptual schedule for the fabrication of water treatment and waste processing systems, construction of groundwater remediation infrastructure, and treatment facility construction. 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.

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 complete its detailed technical review of the decommissioning plan and issue RAIs by the end of July 2021.
- RAIs will not require additional field work, pilot testing, substantial re-design, or resubmission of the DP; therefore, EPM will respond to RAIs by the end of October 2021.
- The NRC will review the responses to RAIs and prepare a draft Environmental Assessment, a draft Safety Evaluation Report, and a draft license amendment, for

internal review and revision, and send a draft license to the CERT by the end of September 2022.

- EPM will submit a request for funding for fabrication, construction, and installation for Phase I to the NRC by the end of September 2022.
- EPM comment on the draft license, NRC response, and EPM concurrence, will be completed by the end of November 2022.
- NRC will issue the amended license by the end of February 2023.

Concurrent to NRC technical review of the decommissioning plan, individual design packages will be prepared and submitted to prospective bidders to begin the bidding process. This process will generally include soliciting bids, responding to requests for information, negotiating terms and conditions, and evaluating individual bids. Once the successful bidders are selected, the NRC and the DEQ will be advised of vendor selection and the basis for the selection.

Vendor bids will provide the cost information needed to prepare a request for additional funding needed for construction of groundwater remediation infrastructure and groundwater treatment systems and facilities. The basis for vendor selection and a request for construction funding will be submitted to the NRC and the DEQ at least three months prior to issuance of the amended license so that funding can be approved. Once funding is approved, requests for best and final pricing will be issued to selected vendors. Contracts will not be executed until issuance of the license amendment and will be executed as needed based on the construction schedule.

Pre-mobilization activities consist of site orientation, safety training, submittal review, etc., after which construction subcontractor personnel and equipment will be mobilized to the Site. Pre-mobilization activities will be completed by the end of June 2023.

9.2 CONSTRUCTION

A conceptual construction schedule for Phase I implementation is provided on Figure 9-2. Descriptions of construction task durations, sequencing, and interdependencies are provided below. As indicated by Task 50 on Figure 9-2, the construction schedule includes a 30-day allowance for weather delays.

9.2.1 Groundwater Remediation Infrastructure

Mobilization and site work, including clearing, grubbing, road improvements, and installation of BMPs, will be completed by mid/late July 2023.

As shown on Figure 9-2, the following activities will not begin until BMP installation is complete:

- Extraction well installation
- Slurry trench excavation (beginning with GETR-WU-02)
- Rock trench excavation (beginning with GWI-BA1-02)
- Utility routing/construction in both the WA and BA1
- Grading at both the WATF and BA1 facility locations

Following initiation of these activities, slurry trench and rock construction will continue to completion – scheduled for September 2023 and November 2023, respectively. 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-02 in the 1206-NORTH remediation area. All remediation well field infrastructure and 1206 Drainage construction activities are scheduled to be completed by the end of December 2023 (see Figure 9-2).

9.2.2 Water Treatment Facilities

Fabrication and factory testing of uranium treatment skids will begin immediately upon execution of contracts. Procurement of resin processing equipment will also begin immediately upon execution of contracts.

As depicted on Figure 9-2, site grading at both the WATF and BA1 facility locations will begin following utility routing at each site. Utility interfaces at the WATF and BA1 facility locations will be completed following grading at each site, and this will be followed by 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. All water treatment facility construction, including public utility routing, is scheduled to be completed by early February 2024 (see Figure 9-2).

As shown on Figure 9-3, startup and commissioning activities are scheduled to occur in early February 2024 and last approximately 10 days.

9.3 GROUNDWATER REMEDIATION

A summary schedule for groundwater remediation is presented on Figure 9-3.

9.3.1 Startup

At the WATF, the uranium treatment vessels will be filled with new resin, groundwater remediation system controls will be tested, and flow rates will be set in accordance with final design requirements. Groundwater from BA1 and WA influent tanks will be circulated through the treatment trains located in the WATF to adjust flow rates and pressures.

At both the WATF and BA1 facilities, treated water injection systems will be tested during startup and flow rates will be set in accordance with final design requirements.

Upon completion of startup activities, full-scale groundwater extraction, treatment, and injection and discharge will begin. Treated water injection will not begin until full-scale operation of groundwater extraction treatment systems is underway and hydraulic capture has been established in areas downgradient of injection wells and trenches. Assuming the full duration of weather delays (30 days) is needed during construction, full-scale groundwater remediation activities are anticipated to begin in both areas in April 2024.

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. The only WA remediation areas in which uranium in groundwater exceeds the NRC Criterion (i.e., the areas targeted for Phase I) are the WAA U>DCGL, 1206-NORTH, and WU-BA3. Of these, remediation duration estimates indicate that groundwater in WAA U>DCGL will take the longest to achieve the NRC Criterion.

WAA U>DCGL Area

During Phase I, four extraction wells will be installed in the WAA U>DCGL area to extract groundwater with uranium concentrations exceeding the NRC Criterion. Remediation duration calculations indicate that it will require slightly more than 12 years to reduce the uranium concentration in groundwater to less than the NRC Criterion (see Figure 9-3). Groundwater extraction, treatment, and discharge/injection will continue until uranium remediation in BA1 is discontinued, or as long as funding allows, whichever comes first (see below).

1206-NORTH Area

One extraction trench will be installed in the 1206-NORTH area to extract groundwater that contains uranium concentrations exceeding the NRC Criterion. Remediation duration calculations indicate that the uranium concentration in this area will be reduced to less than the NRC Criterion within approximately 5 months (see Figure 9-3). Although all remediation criteria are anticipated to be met in the 1206-NORTH area within one year, groundwater extraction is anticipated to continue for approximately 7 years, provided funding allows WA remediation to continue, to provide capture of water injected into the WU-BA3 area (see below). At a minimum, groundwater extraction is expected to continue in 1206-NORTH for approximately 49 months, the length of time required for the NCR Criterion to be achieved in WU-BA3.

WU-BA3 Area

One injection trench will be installed in the WU-BA3 area to inject treated water into Sandstone A, flushing impacted groundwater to the 1206 drainage infrastructure. Groundwater in the WU-BA3 area contains uranium concentrations that exceed the NRC Criterion. Remediation duration calculations indicate that uranium concentrations in this area will be reduced to less than the NRC Criterion in just over four years, and to below the State Criterion in approximately seven years (see Figure 9-3).

Current schedule and cost estimates assume that WA extraction components and water treatment systems will continue to operate until in-process monitoring indicates that all monitor wells within BA1 have remained below the NRC Criterion for at least three consecutive monitoring events. Continuing to remediate groundwater in the WA as long as remediation continues in BA1 would provide for the greatest removal of contaminant mass.

9.3.3 Burial Area #1 Remediation

Groundwater extraction, water treatment, and treated water injection and discharge will begin in BA1 upon completion of startup activities. These processes will continue as long as in-process monitor wells in the BA1-A or BA1-B areas yield uranium concentrations exceeding the NRC Criterion. In-process monitoring will be performed as described in Section 8.6. Treatment of

BA1 groundwater may be terminated before extraction and injection and discharge are terminated if the concentration of uranium in the influent is less than the State Criterion.

Based on nitrate and fluoride groundwater concentrations that are consistently within the range of background (upgradient) groundwater quality, the waste buried in BA1 does not appear to have contained nitrate or fluoride. Consequently, uranium is the only COC in BA1.

BA1-A Area

Three treated water injection trenches and two groundwater extraction trenches will be installed in the BA1-A area to remediate groundwater containing uranium concentrations that exceed the NRC Criterion. Remediation duration calculations indicate that it will require approximately 150 months (12.5 years) to reduce the uranium groundwater concentrations to less than the NRC Criterion. This is the longest estimated remediation timeframe for any site remediation area (BA1 or WA). As such, the reduction of uranium concentrations in BA1-A is the "critical path" activity that establishes the time required to achieve license termination.

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, indicate that in-process monitoring data may provide evidence to revise the estimated time required to reduce uranium concentrations below the NRC Criterion in this area.

BA1-B Area

Three extraction wells will be installed in the BA1-B area to extract groundwater that contains uranium concentrations exceeding the NRC Criterion. Remediation duration calculations indicate that it will require approximately three years to reduce the uranium concentration in groundwater below the NRC Criterion.

BA1-C Area

Although uranium groundwater concentrations in BA1-C currently do not exceed the NRC Criterion, two extraction wells will be installed for the purpose of extracting groundwater that contains uranium concentrations exceeding the State Criterion.

Following achievement of the State Criterion for uranium in BA1-C, groundwater extraction capacity allocated to the two BA1-C extraction wells will be reallocated to the BA1-B extraction wells. The rate that treated water is injected into Sandstone B may be increased (if feasible) to create a greater head differential to drive impacted groundwater toward the extraction trenches in BA1-A. If the rate of groundwater flux and extraction in BA1-A can be increased, this may reduce the time required to achieve license termination.

9.3.4 Post-Remediation Groundwater Monitoring

The following may be conducted independently in the WA and BA1 if the funding required to continue remediation in the WA until the NRC Criterion is achieved in BA1 is not available. However, for the purposes of this Plan, it is assumed that post-remediation monitoring will be conducted in all WA and BA1 areas concurrently, following achievement of the NRC Criterion in BA1 (estimated to require 150 months), as depicted on Figure 9-4.

After the concentration of uranium has declined below the NRC Criterion for at least three consecutive monitoring events, all groundwater remediation and water treatment systems will be shut down. Post-remediation will be performed on a quarterly basis for a period of three years.

During the post-remediation monitoring timeframe, a final status survey plan will be prepared and submitted for agency review and approval. Should six post-remediation monitoring events indicate that there is minimal probability for the resumption of remediation and treatment to be required, demobilization of treatment systems and performance of the final status survey may be conducted during the third year of post-remediation monitoring (see Figure 9-3).

9.4 LICENSE TERMINATION ACTIVITIES

"License Termination Activities", as used in this plan, involve the decontamination, dismantling, and demobilization of groundwater treatment facilities, as well as 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 RAIs involving the termination of the license. Should available funding enable the continuation of groundwater treatment (if required) during Phase II, license termination activities will begin at the conclusion of Phase II. The schedule and cost estimates prepared for this Plan assume that post-remediation monitoring and license termination activities occur at the end of Phase I.

9.4.1 Decontamination and Dismantling

When post-remediation groundwater monitoring demonstrates that groundwater in the WAA U>DCGL, WU-BA3, 1206-NORTH, BA1-A, and BA1-B areas complies with the NRC Criterion, decontamination and dismantling activities will commence. As stated in Section 9.3.4, these activities may begin during the second or third year of post-remediation groundwater monitoring. Ion exchange resin and biomass will be removed from treatment systems (see Figure 9-4). Ion exchange resin that exceeds the maximum concentration of uranium in unused resin will be processed, packaged, and shipped for disposal as LLRW. All other resin will be disposed of in accordance with the OPDES permit.

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 regulatory requirements. Only influent and effluent tanks and well field controls will be retained.

9.4.2 Residual Dose Model

A residual dose model will be prepared using data from the final post-remediation groundwater monitoring sampling event. Representative surface and subsurface soil samples will be collected from borings located near post-decommissioning monitoring locations in 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. These soil samples will be collected because, although all surface and subsurface soil has already been demonstrated to comply with decommissioning criteria, it is anticipated that the desorption of uranium from saturated soil during groundwater remediation will further reduce the concentration of uranium in subsurface soil. This will enable the dose model to reflect more accurately the radiological status of the site at license termination.

The residual dose model will be prepared using a reasonable exposure scenario and will include the results of the final status survey of the groundwater treatment buildings and equipment that will remain at the time of license termination. It is anticipated that the dose model will demonstrate that the residual dose is less than 25 mrem/yr.

9.4.3 Final Status Survey

A final status survey plan will be prepared and submitted for approval during post-remediation monitoring (see Figure 9-4). The final status survey will be performed after all treatment system equipment slated for removal has been demobilized. Submittal of the final status survey report is anticipated to occur before post-remediation monitoring concludes.

9.4.4 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. 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 ONGOING REMEDIATION WITHOUT TREATMENT

After license termination, DEQ and the Trustee will determine if sufficient funding remains to conduct additional groundwater remediation. Any ongoing groundwater remediation would involve the movement of groundwater but not the treatment of groundwater by any method that would result in the accumulation of uranium. This information is provided in this Plan for the sole purpose of assuring the NRC that any ongoing activity will not result in the accumulation of licensable material.

9.6 SCHEDULE CHANGES

The schedules provided in this section are presented as reasonable estimates. However, significant experience with groundwater remediation shows that the inputs for cost and schedule estimates (e.g., groundwater flow models, distribution coefficients, and pore volume estimates) are at best approximations of highly complex and variable natural systems. Groundwater remediation often progresses more slowly than even the most sophisticated and well-calibrated numerical models would suggest. As remediation progresses, and both operating costs and estimates of remediation duration are refined, it may be determined that shutting down remediation systems in the WA is necessary to ensure sufficient funding remains to achieve license termination. This Plan provides the flexibility to do this if necessary.

The schedules presented herein do not comply with the two-year time frame for decommissioning specified in 10 CFR 70.38(g)(4)(vii). 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 this alternative schedule.

* * * * *

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 activities
- Construction and startup
- Remediation operations
- Post-remediation monitoring and license termination

Throughout the decommissioning of the Site, the individuals 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 throughout the decommissioning of the site.

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 site 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 PM is responsible for overseeing the construction and operation of decommissioning systems and the implementation of the radiation safety, health and safety, quality assurance, and environmental compliance programs. 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 functions 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 radiation protection, quality assurance, and safety & health programs. The Trustee PM is a permanent member of the site 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 site 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 responsibility for the implementation and review of the Material Control and Accountability program is assigned to the RSO for the Cimarron site. 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 RSO must have the following qualifications:

- Knowledgeable of potential radiological hazards and emergency preparedness associated with decommissioning activities at the Cimarron Site
- Completed educational courses related to ionizing radiation safety, or a radiation safety officer course, or maintains designation as a Certified Health Physicist
- Experience managing and implementing radiation protection programs at decontamination and decommissioning sites

- Background in license compliance
- Familiarity with license and regulatory requirements
- Familiarity with site-specific radiation protection, quality assurance, health and safety, and sampling and analysis programs
- Experience in performing ALARA evaluations
- Overseeing radiological characterization and final status surveys
- Experience in decontamination and decommissioning projects

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 site 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 is 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 include:

- Ensuring that ALARA policy and regulatory compliance are integrated into all site work activities as appropriate
- Reviewing and approving ALARA goals for the Cimarron Site (if individual monitoring is required)
- Reviewing the effectiveness of the ALARA Program (if individual monitoring is required)
- Reviewing plans for new activities to ensure that ALARA principles have been considered
- Annual review of the RPP to ensure compliance and to incorporate any necessary changes
- Evaluate and approve changes to the Decommissioning Plan or the RPP in accordance with License Condition 27(e)

ALARA Committee meetings will include reports on the following aspects of decommissioning work:

- Radiological exposures
- Compliance with license possession limits
- Active activity plans
- Quality control / quality assurance performance issues
- Chemical concerns
- Health and safety performance and issues
- Radiological waste characterization and disposal

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

Activity Leaders (ALs) are supervisors over non-routine work as well as work performed under standard operating procedures at the Site. ALs are responsible for the preparation of activity plans and procurement of services and materials. 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 all the training needed and are qualified to perform the tasks for which they are responsible to perform. ALs are responsible for monitoring the schedule, cost, and quality of project work.

Activity Leaders typically report directly to the Trustee PM. Should construction work be performed, ALs may report directly to a Construction PM as described in Section 10.4. They are indirectly responsible to the RSO and QAC. ALs 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. 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 prepare activity plans and 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

The construction, installation, and startup of groundwater remediation systems will be managed as a project, or a combination of projects, directed by an engineering, procurement, and construction (EPC) Contractor. The individuals identified in Section 10.1 will maintain responsibility for the management of these activities. Figure 10-2 depicts the organization and reporting hierarchy of subcontractors and suppliers that will be engaged in the construction and installation of groundwater remediation and water treatment facilities.

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, as well as the execution of projects related to utility infrastructure, remediation well field systems, and water treatment facilities. Each construction project (e.g., groundwater remediation infrastructure installation, water treatment system fabrication, and water treatment facility construction) will be managed by a Construction Project Manager (PM) who will be responsible for execution of project elements including equipment design and fabrication, material procurement, subcontractor procurement, and field construction activities, as appropriate. The Construction PM role is discussed in further detail in Section 10.4.2.

10.4.2 Construction Project Managers

Construction PMs will be responsible for the procurement of services and materials, and the execution of decommissioning construction projects in accordance with project documents including plans and specifications. Construction PMs will confirm that all personnel working on projects have received the appropriate training and are qualified to perform the tasks they have been assigned. Construction PMs will also be responsible for monitoring the schedule, cost, and quality of their respective projects.

Construction PMs will report directly to the EPC Lead and they will be indirectly responsible to the RSO and QAC. PMs must meet the following qualifications:

- Experience managing environmental assessment and remediation projects
- Familiarity with license and regulatory requirements
- Familiarity with site-specific radiation protection, quality assurance, health and safety, and sampling and analysis programs
- 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

The construction project will be broadly broken into three separate but interrelated projects:

- Fabrication, delivery, and startup of water treatment systems, including systems which process wastes generated by those treatment systems
- Construction of groundwater remediation infrastructure, including well field utilities and extraction and treated water conveyance, injection, and discharge systems
- Construction of water treatment facilities and site-wide infrastructure such as roads and utilities

These construction activities will not involve working with radioactive material or work in radiologically restricted areas. Most groundwater extraction and injection wells and trenches, as well as most piping and utility runs and both water treatment facilities, will be constructed in areas that have already been released for unrestricted use. Both surface and subsurface soils have been demonstrated to comply with license criteria for unrestricted use.

Upon completion of construction activities, the EPC Lead will be responsible for compiling documentation demonstrating conformance with design requirements. The RSO will be responsible for compiling documentation demonstrating compliance with license and regulatory requirements related to protection from radiation and radioactive materials. The QAC will be responsible for the compilation of documents verifying that quality requirements were complied with.

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 these activities.

Operation and maintenance of groundwater extraction, water treatment systems, waste processing systems, 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 systems, and precise definition of "who is doing what" cannot be defined at this time. Radiation protection and quality assurance activities will be performed by personnel independent of those performing the work.

10.5.1 Front-Line Supervisor

Front-Line Supervisors will be responsible for the procurement of services and materials and the performance of decommissioning operations. Front-Line Supervisors will ensure that all personnel performing work are familiar with the procedures governing the work to be performed, and that they have received all the training needed 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 the project work.

Activity Leaders and front-line supervisors report directly to the Trustee PM and indirectly to the RSO and QAC. 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. Font-Line Supervisors 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 prepare operating procedures or other work instructions and manage work performed in accordance with those procedures or instructions
- Experience managing resources to perform work within schedule and budget, while maintaining quality and regulatory compliance

Groundwater extraction and transfer operations, water treatment, resin and biomass processing and packaging, treated water injection and discharge, and in-process monitoring will be performed in accordance with operating procedures. Should the need for a non-routine activity arise, an activity plan will be prepared to provide work instructions covering that activity. Activity Leaders will typically be assigned to oversee work performed for a non-routine activity, but a Front-Line Supervisor may function as an Activity Leader. Examples of non-routine activities that may be performed during remediation operations include:

- Modification of the groundwater extraction or injection infrastructure
- Demobilization of a uranium treatment or biodenitrification system
- Plugging and abandonment of monitor wells and/or groundwater remediation infrastructure in discrete areas

10.6 LICENSE TERMINATION

Demobilization of water treatment and waste processing systems will be managed as a project. A PM will oversee the demobilization activities. Post-remediation monitoring and other license termination activities will be managed in the same manner as pre-construction activities. 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 health and safety program, the quality assurance program, and the sampling and analysis plan, as appropriate. Personnel performing decommissioning activities will be task-qualified for the activities they will perform (e.g., trained on those procedures associated with groundwater sampling, documentation, and packaging and shipping if performing groundwater sampling). 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 taken to improve safety, quality, or efficiency will be recorded. At a minimum, daily review of Pre-Task Safety Analysis and the record of weekly (e.g., tailgate) meetings will be documented and maintained in the site files.

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 shall not assume that radiation safety training has been adequately covered by prior employment or academic training.

Radiological Orientation is provided for individuals performing routine activities that do not require access into Restricted Areas, including general office work, housekeeping, tours and inspections of the property, annual environmental monitoring campaigns, and installation of new monitor wells. Radiological Orientation is required prior to unescorted access to the Cimarron Site. Radiological Orientation is typically included in safety and health orientation for the Site.

General Worker Radiological Training is required for workers who require unescorted access to Restricted Areas. This training will include the principles and practices of radiation protection, the purpose and functions of protective and monitoring devices that will be used (if applicable), and protection for the embryo/fetus (if applicable).

10.8 RADIATION WORKERS ARE INDIVIDUALS WHO IN THE COURSE OF EMPLOYMENT ARE LIKELY TO RECEIVE AN ANNUAL RADIATION DOSE GREATER THAN 100 MREM, OR WHOSE DUTIES REQUIRE THEM TO ROUTINELY WORK IN A RESTRICTED AREA OR ROUTINELY HANDLE RADIOACTIVE MATERIAL. THE CONTENT OF RADIATION WORKER TRAINING IS PROVIDED IN THE RPP.CONTRACTOR SUPPORT

All decommissioning tasks not performed by Trustee employees will be performed by contractors. The Trust Administrator and the Trustee PM 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.

All contractors will report directly to the Trustee PM. Contractor managers (e.g., RSO, QAC, EPC Lead, PMs, and ALs) 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 the working practices threaten the safety or quality of the work.

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11.0 RADIATION PROTECTION PROGRAM

The Site Radiation Protection Plan (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 for workers. The licensee implemented a RPP that was approved by the NRC in Amendment 15 to the Site's 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 4 of the RPP is included as Appendix M of this Plan.

11.1 AIR SAMPLING PROGRAM

The air sampling program for the Cimarron Site is described in in Section 10.8 of the RPP. The RPP provides the following information:

- A demonstration that the air sampling program is representative of the workers' breathing zones and will be initiated whenever a worker's intake is likely to exceed the criteria in 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.
- Aa 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 constant air monitors (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 a 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 to evaluate process or operation changes to determine if a Respiratory Protection Program needs to be implemented. If implemented the program 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 RPP discusses air sampling that will be conducted to confirm that internal monitoring is not needed. However, if internal monitoring is needed, the RPP commits to providing 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:
  - How frequencies for bioassay measurements for baseline, periodic, special, and termination assays are assigned.
  - How radioactivity measured in the human body by bioassay techniques are converted into worker intake.
  - 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:
  - How airborne concentrations of radioactivity are measured.
  - How airborne concentrations are converted to determine intakes.
  - Action levels for a worker's intake based on dose, and actions to be taken when they are exceeded.
  - Action levels for a worker's intake based on chemical toxicity if soluble uranium is present in the work area.
  - 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.
  - 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 exceed. However, if external monitoring is needed, the RPP 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 external monitoring is not envisioned. The RPP provides 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 Section 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.
- A description of surveys to supplement personnel monitoring for workers during routine operations, maintenance, clean-up activities, and special operations.
- 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.
- 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 proposed 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.

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 Minimum Detectable Activity (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.
- A description of air sampling calibration procedures or a statement that the instruments will be calibrated by an accredited laboratory.

Analytical laboratory measurements are performed by others. For field measurements, evaluations of uncertainty are not important unless the measurements are used as part of the final status survey documentation. 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 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. Operation Nuclear Criticality Safety is implemented by maintaining knowledge and control of the mass and concentration of SNM on the site. 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 a critical condition related to the storage, transportation or disposal of the spent resin mixture is not credible.

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 to describe the assessments of 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 RSO 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 SPECIAL NUCLEAR MATERIAL 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 by the groundwater treatment operations on the Cimarron site will be included. This includes all treatment system components subsequent to the groundwater extraction wells. 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 provides the "Maximum Amount the Licensee May Possess at Any One Time Under This License". The procedures for nuclear material inventory control and accounting will assure 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.

12.0 ENVIRONMENTAL MONITORING AND CONTROL

The July 1999 Environmental Assessment and August 1999 Safety Evaluation Report 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 Environmental Assessment and Safety Evaluation Report discuss the use of environmental air sampling and thermoluminescent dosimeters to monitor for releases and exposure in the environment. With the termination of decommissioning activities that could result in airborne suspension of particulates or airborne effluents, environmental air sampling has been 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 current air sampling program and radiation monitoring program that 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 Environmental Assessment and Safety Evaluation Report. 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 has 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

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. 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 site 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 a change to tests, the Decommissioning Plan, or the Radiation Protection Plan require NRC approval. If not, the ALARA Committee can approve the 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. 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.

12.2 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 has begun, effluents will consist of extracted groundwater containing less than permit limits for each COC. Effluents will be discharged to the Cimarron River via DEQ-permitted Outfall 001. The locations of Outfall 001 are 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 (discharging to Outfall 001). 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.

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.

In this Plan, it is assumed that samples will be collected twice monthly and analyzed for uranium, nitrate, and fluoride. Samples will be 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, which is significantly less than the MCL of 30 μg/L. Discharge samples will only be analyzed for Tc-99 if the OPDES permit requires it; Tc-99 is expected to be present in the influent at a small fraction of its MCL.

The OPDES permit is expected to specify daily maximum concentration limits of 30 μg/L for uranium and 10 μg/L for fluoride. The permit will require the pH of discharged water to remain between 6.5 and 9.0 standard units. The permit is not expected to stipulate a limit for nitrate; however, the permit is expected to require reporting of effluent nitrate concentrations.

The OPDES permit is issued for a five-year period. If the OPDES permit contains the same provisions for additional sampling, during the fifth year, ten samples will be collected each of ten months from each effluent tank's sample port for analysis for manganese, arsenic, chromium, copper, lead mercury, selenium, thallium, zinc, cyanide, and barium. In addition, one surface water sample will be collected the Cimarron River from an upstream location; these samples will be analyzed for mercury and thallium. 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

Releases of radioactive material to the environment can occur during groundwater remediation through:

- A leak or leaks in well heads or piping
- A release of contaminated water from influent tanks
- Failure of an ion exchange vessel that has processed impacted groundwater

Piping conveying impacted groundwater is routed through areas containing impacted groundwater. A release from a leaking pipe would simply return the impacted water to its source.

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.

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.

There is no release of impacted water to a sewer system, so the requirements of 10 CFR 20.2003 do not apply to this decommissioning operation.

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 was submitted to the DEQ on November 6, 2017. The DEQ authorized the discharge of stormwater in accordance with the general permit in a letter dated June 25, 2018. 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

Solid radioactive waste generated by groundwater remediation activities will fall into one of several categories:

- Spent anion resin
- Potentially contaminated material
  - Solids generated in and removed from the biodenitrification system (if biodenitrification is installed during Phase II)
  - 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

Anion resin beds will contain approximately 750 kg resin. Estimates based on concentrations in groundwater indicate that no resin vessel will ever accumulate more than 500 grams of U-235, because as the uranium concentration of influent groundwater declines, the adsorption capacity of the resin declines. Consequently, a single resin vessel will be unable to adsorb sufficient uranium to exceed the U-235 possession limit of 1,200 g. The total mass of U-235 in all treatment trains combined is not expected to exceed 800 grams at any given time. In addition, the processed spent resin will contain less than one-gram U-235 per 2 kg non-fissile material.

The resin processing operation involves blending spent resin with non-fissile material in a ribbon blender. No chemicals will be used, as the non-fissile material will consist of an inorganic absorbent. This will result in 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 consignment activities in the processed resin waste will exceed DOT's 49 CFR 173.436 threshold for radioactive material (i.e., Class 7) and will therefore 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, therefore, will be considered fissile excepted (i.e., the resin waste will be Class A, fissile excepted, low level radioactive waste (LLRW).

Initially, a sample collected from each drum will be analyzed for isotopic concentration. The collection of multiple samples from a single batch provides the data needed to assess the homogeneity of the mixture. Analytical data will be the basis for shipping papers and will provide the data needed to document that transportation and disposal criteria have been met. Table 8-6 presents the identification and analytical method 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. Multiple random samples will be taken from each batch of spent resin (typically one sample from each drum). Student's t-test will be used as the statistical measurement of homogeneity. If the individual sample results are not significantly different from the average for all the samples at the 90% level ($\alpha = 0.05$) for all the samples, the process will be qualified as producing a homogenous mixture.

During Phase I operations, four 55-gallon drums will be loaded onto a pallet and the drums will be strapped together. Prior to the installation of a biodenitrification system, the spent resin storage area will be located in the southern portion of the WATF.

Should a biodenitrification system be installed, pallets of filled drums will be labeled and placed in a designated area within the Secured Storage Facility located east of the WATF Building (see Drawing C-110, Appendix J-1) pending receipt of analytical results. The Secured Storage Facility is a Metal Building with a single roll-up door that will have removable bollards to additionally restrict access to the interior of the facility (see Drawings A-170 [Appendix J-6] and C-110 [Appendix J-1], respectively).

Palleted drums will be stored in the storage area until enough drums have been stored 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 excepted, low level radioactive waste.

The blended waste will be analyzed and certified 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, a hydrocarbon material. This material is considered soil-like but is not a SiO_2 matrix.
- The waste form will be in containers which will be disposed at the licensed disposal site in accordance with license requirements for containerized waste for the disposal site.

Discussions have been held with the proposed waste disposal site to confirm that the packaged waste will conform with the 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 Biomass Solids

Should a biodenitrification system be installed and operated, biomass solids are anticipated to contain approximately 20% solids and 80% water. Biomass solids will be tested for free liquid using the SW-846 test method 9095B, known as the paint filter test. If the biomass solids do not pass the paint filter test, they will be mixed with sufficient inert absorbent material to pass the paint solids test. Biomass solids that pass the paint filter test will be analyzed for uranium and Tc-99.

If the biomass does not contain detectable uranium or Tc-99, it will be packaged in supersacks or a covered roll-off container and disposed of in accordance with the OPDES permit. If it does contain detectable uranium or Tc-99, biomass solids will be mixed with additional inert absorbent material to sufficiently reduce the moisture content to comply with the licensed disposal facility's WAC (typically a moisture content not exceeding 30%). It will be re-analyzed after mixing with the additional absorbent.

If the final mixture no longer contains detectable uranium or Tc-99, it will be disposed of in accordance with the OPDES permit. If the final mixture still contains detectable uranium or Tc-99, it will be packaged in drums or supersacks and disposed of at a licensed disposal facility.

13.1.3 Potentially Contaminated Material

Small diameter tubing, in-line filters, and other materials which may become contaminated during groundwater processing are not expected to absorb sufficient uranium to exceed surface contamination limits. However, since these cannot be surveyed practically to demonstrate this, they may be assumed to be radioactively contaminated and segregated from other solid waste for disposal as radioactive waste. Alternately, these materials may be bulk surveyed for release. Potentially radioactively contaminated material will be packaged and shipped to a licensed disposal facility for disposal as Class A fissile excepted waste. This waste is estimated to be less than 15% of the total volume of radioactively contaminated waste.

13.1.4 Storage of Solid Radioactive Waste

During Phase I, spent anion resin and potentially contaminated material will be stored in designated areas in the southern portion of the WATF. Three areas will be designated for the storage of packaged (i.e., drummed) waste:

- One area in which initial batches of spent resin/absorbent from the BA1 area will be stored until laboratory data is received.
- One area for resin which has been sampled, but for which analytical data has not been received. Initially this will only be used for drums or spent resin/absorbent from the western area treatment system, but eventually will include resin from both BA1 and western area treatment systems.
- One area where packaged resin waste is ready to ship. In this case "ready to ship" indicates surveys and waste characterization have been conducted, and the containers have been certified as meeting all transportation regulations and the disposal site waste acceptance criteria.

These dedicated areas will be clearly delineated with postings and physical barriers (e.g., jersey barriers).

If a biodenitrification system is installed, spent anion resin, and potentially contaminated material will be stored in sealed 55-gallon drums (or other strong tight transportation container) in a Secure Storage Facility until sufficient material has been accumulated to comprise a full shipment for disposal. The Secure Storage Facility will also be divided into designated areas as described above. The location of the Secure Storage Facility is shown on numerous drawings in Appendix J.

13.2 LIQUID RADIOACTIVE WASTE

All effluents 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. Effluents from the groundwater treatment processes will either be injected into impacted areas in accordance with Oklahoma's Underground Injection Control 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 neither pH adjustment (for both uranium and nitrate treatment) nor nutrient addition (for nitrate treatment) will 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 the Site decommissioning.

The current revision of the Cimarron Site Quality Assurance Program Plan (QAPP) is included as Appendix O. The QAPP establishes a Quality Assurance Program meeting the applicable requirements of the following:

- NRC Regulatory Guide 1757, *Consolidated Decommissioning Guidance, Decommissioning Process for Material Licensees* (USNRC, 2006)
- NRC Regulatory Guide 4.15 (NUREG 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. Where applicable, revisions to the QAPP will be managed in accordance with License Condition 27(e).

14.1 QUALITY ASSURANCE PROGRAM

QAPP Section 1.0 provides a description of the Quality Assurance Program. The QAPP includes the following information regarding the CERT Quality Assurance Program:

- QAPP Section 1.1 includes the Trust commitment that decommissioning, and remediation activities will be in accordance with all license and regulatory requirements.

QAPP Section 1.1 requires the development and implementation of a Quality Assurance Program that provides for the assurance of the required level of planning, execution, and documentation of quality-critical work performed at the site.

- QAPP Section 1.1 provides a brief summary of the company's corporate QA provisions.

- QAPP Sections 1.3 and 1.4 include a description of provisions to ensure that technical and quality assurance procedures required to implement the QA program are consistent with regulatory, licensing, and QA program requirements and are properly documented and controlled.
- QAPP Section 1.1 provides a description of the management reviews, including the documentation of concurrence in these quality-affecting procedures.
- QAPP Section 1.1 includes a description of the quality-affecting procedural controls of the principal contractors, including documentation of the acceptance of the controls before the initiation of activities affected by the program.
- QAPP Section 5.6 provides a description of how the NRC will be notified of changes. QAPP Section 13.2 contains a description of how management (above or outside the QA organization) regularly assesses the scope, status, adequacy, and compliance of the QA program.
- QAPP Section 5.0 provides a description of the procedures to ensure that instructions, procedures, and drawings include quantitative and qualitative acceptance criteria for determining that important activities have been satisfactorily performed. QAPP Section 6.1 includes requirements for design control.

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.
- QAPP Section 3.2 provides descriptions of the duties and responsibilities within the organization and how delegation of responsibilities is managed within the decommissioning program.
- A description of how work performance is evaluated is provided in QAPP Section 4.5.

- A description of the authority of each unit[1] within the QA program.
- An organization chart of the QA program organization is provided in QAPP Section 3.1.
- QAPP Section 3.2.2 includes 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.

14.4 QUALIFICATIONS AND TRAINING OF PERSONNEL

QAPP Section 4.0 provides personnel qualification, training, self-assessment, and documentation.

- QAPP Section 4.0 includes 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.
- QAPP Section 4.1 provides the content and frequency of QAPP training.
- QAPP Section 4.2 provides a description of the training and qualifications of personnel verifying activities affecting quality in the principles, techniques, and requirements of the activity being performed.
- QAPP Section 4.4 requires, for formal training and qualification programs, documentation including attendees, date of attendance, and the objectives and content of the program.
- QAPP Section 4.3 includes a description of the self-assessment program to confirm that activities affecting quality comply with the QA program.
- QAPP Section 4.3 provides a commitment that people performing self-assessment activities are not to have direct responsibilities in the area they are assessing.

14.5 OPERATING PROCEDURES AND INSTRUCTIONS

QAPP Section 5.0 provides that requirements for Cimarron project activities are defined in written operating procedures and instructions. These include, but are not limited to, the following:

- Radiation Protection Program Procedures
- Health and Safety Plan
- Quality Assurance Program Plan
- Independent Review

[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".

- Responsibility for approval of plans and procedures
- Program change

14.6 DESIGN

QAPP Section 6.0 provides requirements for design control. These design control requirements include:

- Contractor and Subcontractor (Vendor) Design
- Design Interfaces
- Design Inputs and Objectives
- Design Outputs
- Design Review
- Design Changes

14.7 PROCUREMENT AND CONTROL OF MATERIALS, EQUIPMENT, PARTS, AND SERVICES

QAPP Section 7.0 provides the quality requirements for procurement and control of materials, equipment, parts, and services. The requirements include:

- Control of Purchased Materials, Equipment, Parts, and Services
- 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. These requirements include:

- Radiation protection
- 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 implementation of the QAPP describes the methods and procedures that are used to 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.

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 QA documents included in the 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 retired 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 with regard to 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.

A description of the trending/tracking that will be performed on the results of audits and surveillances.

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*. 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 1.3 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) 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 (1070 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 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 elements of concern are uranium and technetium-99. Uranium is present both as natural uranium and as licensed uranium in groundwater.

License Condition 27(b) cites the unrestricted release criterion for uranium in groundwater. It 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 (the past 2 years). The Licensee will retain control of the property licensed under NRC Radioactive Material License SNM-928 until the groundwater release criteria are met."

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. A 1998 risk assessment established a risk-based limit of 0.11 mg/L for uranium in groundwater based on a drinking water scenario. 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.

Unrestricted release criteria for Tc-99 are not 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 this 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 episodic 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), each time such operations are conducted, building surfaces and equipment are surveyed after operations are completed. No evidence of impact from these operations has been observed.

Burial trenches located in Subareas F, L, and M were excavated and surveyed for release. NRC has released Subareas L and M from license SNM-928 and has performed confirmatory surveys for both surface and subsurface soil in Subarea F, finding no indication that the soils in this subarea would not be releasable for unrestricted use.

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 but will not release Subarea G until a plan for groundwater remediation is approved.

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.

The extent of licensed material in groundwater has been assessed, and the extent of groundwater exceeding the NRC Criterion has been determined site wide. No further characterization surveys are needed at the Site.

Figure 1-2 shows the locations of the various Subareas, and Figure 1-3 shows the locations of buildings, burial areas, and lagoons and impoundments. Figures 3-3 and 3-4 show the extent of uranium in groundwater exceeding the NRC Criterion.

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, "*Technitium-99 Groundwater Assessment*" (Burns & McDonnell, 2020). Tc-99 concentrations did not exceed the NRC Criterion anywhere on site. No further characterization survey for Tc-99 is needed at the site.

15.3 IN-PROCESS SURVEYS

During groundwater remediation activities and post-remediation activities, five types of in-process surveys will be performed at the Site. 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 decommissioning criteria once the NRC Criterion has been reached. Influent and effluent sampling and off-site laboratory analysis will be performed to monitor the estimated quantity of uranium retained in the anion resin beds. Packages of spent resin and potentially contaminated material will be surveyed prior to shipment for disposal. Release surveys will be performed to release materials and equipment from radiologically restricted areas. 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 reduced uranium concentrations sufficiently low to justify termination of license SNM-928.

Groundwater samples will be analyzed for uranium and/or nitrate and/or fluoride based on location and which COCs are present. For the purpose of this section, only isotopic analysis for uranium for comparison with the NRC Criterion will be discussed.

The data quality objective for groundwater monitoring has been a 95% level of confidence that the actual concentration is less than the stipulated criteria. 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 assert 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

Sections 8.3 and 8.6 describe 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 samples 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 10% 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. All instruments used for routine 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.

15.4 FINAL STATUS SURVEY DESIGN

It is anticipated that all potentially contaminated equipment will have been demobilized from the site. It is assumed that by the time all monitor wells yield uranium concentrations of less than 180 pCi/L, all the pretreatment and discharge piping will be releasable for unrestricted use. Only the

Western Area Treatment Facility will remain on site, as an asset to be transferred to a subsequent owner upon disposition of the property by the Trust.

Prior to the performance of a final status survey, a final status survey plan will be submitted to NRC (for approval) and DEQ. It is anticipated that the WATF and the BA1 Treatment Facility will require a final status survey, as well as sufficient radiological surveys of piping to demonstrate that subsurface material complies with surface contamination limits. The final status survey plan will include information on the prior surveys performed to demonstrate compliance with license criteria in all other areas still under license. 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."

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 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 needed. The costs presented in this Plan represent the costs associated with implementing Phase I remediation, terminating groundwater treatment, performing post-remediation monitoring immediately following the conclusion of remediation and treatment, and applying for license termination after 12 quarters of post-remediation monitoring. Estimated costs (in 2021 dollars) for activities performed prior to the construction of groundwater remediation facilities, for construction, and for post-construction activities (through license termination) are provided in Tables 16-1 through 16-3. Table 16-4 combines information provided the first three tables to present a total decommissioning cost estimate (DCE) for the Cimarron site. The total estimated cost to decommission the site is $67,708,547.

The DCE includes administrative costs, 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 DCE was formatted to arrange major line items that correspond to the major Tasks included in annual budget submittals. The scope of work represented by each line item is described in the sub-sections presented below. The DCE is presented in calendar years based on the anticipated project schedule, as presented in Section 9.

The DCE is based on the design and implementation plan presented in this Plan. 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 impact the DCE, both positively and negatively. It is anticipated that a revised DCE will be produced periodically throughout the decommissioning process. Because neither cost escalation nor return on invested Trust funds can be accurately predicted, neither is provided for in this DCE. All costs are estimated in 2021 dollars for direct comparison with the present-day value of the Trust Accounts.

16.1.1 Pre-Construction Costs

Table 16-1 presents the cost estimate for work performed from the beginning of 2021 through pre-mobilization activities.

Costs shown for Line 1, "Administration" are administrative costs which are expected to remain essentially consistent throughout the decommissioning of the site. "EPM (fee)" represents the Trustee cost for financial tracking and reporting, reviewing, and approving invoices, maintaining the site, conducting teleconferences with trust beneficiaries, maintaining the document management system, etc. "EPM (Other Direct Costs)" are utilities, taxes, office supplies, repairs, etc. "Outside Services" represents support provided by multiple contractors, including clerical and legal support.

Costs shown for Line 2 "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, "Burns & McDonnell Support" represents the labor and expenses incurred by Burns & McDonnell. "Annual Environmental" consists primarily of laboratory services and associated sampling expenses.

Costs shown for Line 3, "NRC Fees" are the estimated cost of NRC fees based on past experience and anticipated work.

Costs shown for Line 4, "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 Support" and "Veolia Support" 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 Support" consists primarily of Contractor costs for field support, such as the collection, packaging, and shipping of samples for laboratory analysis.

Costs shown for Line 5, "ODEQ Agency Fees" are a combination of DEQ fees charged for project review and oversight and the annual permit fee for the OPDES permit.

16.1.2 Construction Costs

Table 16-2 presents the cost estimate for work performed beginning with mobilization of contractors through construction of all groundwater remediation infrastructure and water treatment facilities and startup and commissioning of those facilities.

Costs shown for Line 1, "Administration" are administrative costs which are expected to remain essentially consistent throughout the decommissioning of the site. "EPM" represents the Trustee cost for financial tracking and reporting, reviewing, and approving invoices, maintaining the site, conducting teleconferences, maintaining the document management system, etc. "Outside Services" represents support provided by multiple contractors, including clerical and legal support. "Other Direct Costs" are utilities, taxes, office supplies, repairs, etc. These costs are anticipated to remain relatively consistent.

Costs shown for Line 2 "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 Services, 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 3, "NRC Fees" are the estimated cost of NRC fees based on past experience and anticipated work.

Costs shown for Line 4, "Decommissioning" include costs to construct the groundwater remediation infrastructure and the water treatment facilities. Costs shown for Lines 4a through 4d 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. "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 4e. These costs were obtained from those entities who prepared the design for these scopes of work.

Line 4e.i. - Site Civil Construction

This line includes costs for grading, road improvement, civil survey, installation of best management practices (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 Western Area injection system, the Western Area Treatment Facility, and the BA1 injection skid and enclosure. The cost to fabricate, deliver, and install the injection skids was added into this line item.

Line 4e.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 4e.i since conduits will be installed in a common trench with other piping.

Line 4e.iii - BA1 Facility

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 4e.iv - WA Treatment Facility

This line includes the cost of two uranium ion exchange systems for the Western Area Treatment Facility, 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 Western Area Treatment Facility 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 4e.v – Startup

This line includes costs associated with groundwater pumping, treatment, and injection systems testing, startup, and commissioning.

Line 4e.vi – Direct Capital Construction Costs Subtotal

This line provides the sum of all capital construction items listed above in Lines 4e.i through 4e.v.

Lines 4e.vii – 4e.x - 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 4e.xi - Total Capital Construction Cost

This line presents the total estimated capital construction cost.

Costs shown for Line 5, "ODEQ Agency Fees" are a combination of DEQ fees charged for project review and oversight and the annual permit fee for the OPDES permit. These costs are anticipated to be consistent for the duration of the site decommissioning, extending to and potentially beyond license termination.

16.1.3 Groundwater Remediation Costs

Table 16-3 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, "Administration" are administrative costs which are expected to remain essentially consistent throughout the decommissioning of the site. "EPM" represents the Trustee cost for financial tracking and reporting, reviewing, and approving invoices, maintaining the site, conducting teleconferences, maintaining the document management system, etc. "Outside Services" represents support provided by multiple contractors, including clerical and legal support. "Other Direct Costs" are utilities, taxes, office supplies, repairs, etc. These costs are anticipated to remain relatively consistent.

Costs shown for Line 2 "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 these three services. 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 3, "NRC Fees" are the estimated cost of NRC fees based on past experience and anticipated work.

Line 4, "Decommissioning" presents the cost for labor, utilities, materials, and activities performed through license termination.

Line 4a – 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 4b – Remediation / Treatment Labor and Support

This line presents the estimated labor cost associated with operating and maintaining the remediation systems from 2nd Quarter 2024 through 3rd Quarter 2036. This assumes 2 full-time employees for full-scale operation and maintenance of all treatment trains. 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 of the operating procedures.

Line 4c – 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 \$0.041 per kilowatt hours (kWh) peak, \$0.036 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 4d – 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 Dow Chemical Company's 2020 quote of \$275 per cubic foot of resin and estimated delivery cost of \$1,200 per 202-cubic foot shipment.

Line 4e – 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 4f – 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 50 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 \$25,000 per shipment and the quoted disposal price was approximately \$230 per cubic foot. One truck is capable of hauling (50) 55-gallon drums.

Line 4g – Maintenance Allowance

This line provides an annual lump sum placeholder of \$80,000 for maintenance of the treatment facilities. This amount is expected to cover such items as equipment repairs, building upkeep, etc.

Line 4h – 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 4i – In-Process Treatment Monitoring

This line presents costs for in-process treatment system monitoring described in Section 8.6 and Table 8-3. The assumed costs for monitoring of nitrate treatment trains include one sample for each train and shipping per sampling event.

16.1.4 Post-Remediation Monitoring, Demobilization and License Termination

Although Table 16-3 is titled "Groundwater Remediation Cost Estimate", it includes costs for work performed during the performance of post-remediation monitoring, demobilization, and license termination activities. The post-remediation period begins when groundwater extraction and injection and water treatment systems are shut down for post-remediation monitoring and ends when the NRC license is terminated.

Line 4j – Post-Remediation Groundwater Monitoring

This line presents costs for post-remediation groundwater monitoring as presented in Table 8-7. The assumed costs for BA1 post-remediation groundwater monitoring were based on 2021 analytical costs, labor for sample collection, packaging, and shipping, and expenses for consumables. The sampling interval is to be quarterly for three years.

Line 4k – Final Status Survey Plan

This line presents the estimated cost to develop a plan detailing final status survey activities.

Line 4l – Final Status Survey

This line presents the estimated cost to perform a final status survey. These costs will be incurred following completion of demobilization activities.

Line 4m – Final Status Survey Report

This line presents estimated costs associated with developing a final status survey report.

Line 4n – License Termination

This line presents the estimated costs associated with the submittal of a residual dose model, a report on post-remediation monitoring results, and preparation of a request to terminate the license.

16.1.5 Contingency Factor

Table 16-4 provides a decommissioning cost estimate summary. This table combines the cost information from Tables 16-1 through 16-3 for each year, beginning January 1, 2021, through license termination. Table 16-4 shows a total cost of $67,708,547 to achieve license termination. Addition of a 25% contingency ($16,927,137) to this value results in a DCE of $84,635,684.

16.2 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.

16.3 FINANCIAL MECHANISM

16.3.1 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 entered into a *Plan of Reorganization and 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.

16.3.2 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."

16.3.3 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.

16.3.4 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.

* * * * *

17.0 REFERENCES

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APPENDIX A - GEOTECHNICAL INVESTIGATION REPORT

APPENDIX B - STORMWATER PERMIT AND STORMWATER POLLUTION PREVENTION PLAN

APPENDIX C - ECOLOGICAL RESOURCES DOCUMENTATION

APPENDIX D - NOISE LEVEL REPORT

APPENDIX E - HISTORICAL AND CULTURIAL RESOURCES DOCUMENTATION

APPENDIX F - VISUAL AND SCENIC RESOURCE ASSESSMENT

APPENDIX G - FLOODPLAIN DEVELOPMENT PERMIT

APPENDIX H - EXEMPTION OF PACKAGED FISSILE EXEMPT MATERIAL FROM U-235 POSSESSION LIMIT

APPENDIX I - REMEDIATION INFRASTRUCTURE DESIGN DRAWINGS

I-1: DRAWING INDEX, NOTES, AND LEGENDS

I-2: SITE PLANS

I-3: EXTRACTION SYSTEM DETAILS

I-4: INJECTION SYSTEM DETAILS

I-5: ELECTRICAL DRAWINGS

I-6: WELL FIELD DETAILS

APPENDIX J - GROUNDWATER TREATMENT SYSTEM DESIGN DRAWINGS

J-1: INDEX AND GENERAL SYMBOLS

J-2: WESTERN AREA TREATMENT FACILITY

J-3: WESTERN AREA ION EXCHANGE TREATMENT

J-4: SPENT RESIN HANDLING

J-5: SECURED STORAGE AREA

J-6: BIODENITRIFICATION AND SOLIDS HANDLING SYSTEMS

J-7: BURIAL AREA #1

APPENDIX K - GROUNDWATER REMEDIATION BASIS OF DESIGN

APPENDIX L - 2020 GROUNDWATER FLOW MODEL UPDATE REPORT

APPENDIX M - RADIATION PROTECTION PLAN

APPENDIX N - CRITICALITY AND URANIUM LOADING CALCULATIONS

APPENDIX O - QUALITY ASSURANCE PLAN

APPENDIX P - CERTIFICATION STATEMENT