40 CFR Part 191
Subparts B and C
Compliance Recertification Application 2026
for the
Waste Isolation Pilot Plant

Waste Characterization
(40 CFR 194.24)

United States Department of Energy
Waste Isolation Pilot Plant

Carlsbad Field Office
Carlsbad, New Mexico

Compliance Recertification Application 2026
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ACRONYMS AND ABBREVIATIONS

AK	acceptable knowledge
AKA	Acceptable Knowledge Assessment
AKSR	Acceptable Knowledge Summary Report
ATWIR	Annual Transuranic Waste Inventory Report
BoK	Basis of Knowledge
CBFO	Carlsbad Field Office
CCA	Compliance Certification Application
CCE	chemical compatibility evaluation
CFR	Code of Federal Regulations
CH	contact-handled
Ci	curie(s)
CPR	cellulose, plastic, and rubber
CRA	Compliance Recertification Application
CY	calendar year
DBR	Direct Brine Release
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FRPAIR	Full Repository Performance Assessment Inventory Report
INL	Idaho National Laboratory
ISPAIR	Interim State Performance Assessment Inventory Report
IWMDL	Interface Waste Management Documents List
kg	kilogram(s)
LANL	Los Alamos National Laboratory
LWA	Land Withdrawal Act
m^3	cubic meter(s)
NDA	nondestructive assay
NDE	nondestructive examination
PA	performance assessment
PAIR	Performance Assessment Inventory Report
PDP	Performance Demonstration Program
RH	remote-handled

RL	Hanford (Richland) Site
RPPCR	Replacement Panels Planned Change Request
RTR	Real Time Radiography
SRS	Savannah River Site
STSM	Senior Technical Safety Manager
TRU	transuranic
VE	Visual Examination
VOR	volume of record
WAC	Waste Acceptance Criteria
WCP	WIPP Certified Program
WDS	Waste Data System
WIPP	Waste Isolation Pilot Plant

ELEMENTS AND CHEMICAL COMPOUNDS

Np	neptunium
Pu	plutonium
U	uranium

24.0 WASTE CHARACTERIZATION (40 CFR 194.24)

24.1 Requirements

194.24 Waste Characterization

(a) Any compliance application shall describe the chemical, radiological and physical composition of all existing waste proposed for disposal in the disposal system. To the extent practicable, any compliance application shall also describe the chemical, radiological and physical composition of to-be-generated waste proposed for disposal in the disposal system. These descriptions shall include a list of the waste components and their approximate quantities in the waste. This list may be derived from process knowledge, current non-destructive examination/assay, or other information and methods.

(b) The Department shall submit in the compliance certification application the results of an analysis which substantiates:

(1) That all waste characteristics influencing containment of waste in the disposal system have been identified and assessed for their impact on disposal system performance. The characteristics to be analyzed shall include, but shall not be limited to: Solubility; formation of colloidal suspensions containing radionuclides; production of gas from the waste; shear strength; compactability; and other waste-related inputs into the computer models that are used in the performance assessment.

(2) That all waste components influencing the waste characteristics identified in paragraph (b)(1) of this section have been identified and assessed for their impact on disposal system performance. The components to be analyzed shall include, but shall not be limited to: metals; cellulosics; chelating agents; water and other liquids; and activity in curies of each isotope of the radionuclides present.

(3) Any decision to exclude consideration of any waste characteristic or waste component because such characteristic or component is not expected to significantly influence the containment of the waste in the disposal system.

(c) For each waste component identified and assessed pursuant to paragraph (b) of this section, the Department shall specify the limiting value (expressed as an upper or lower limit of mass, volume, curies, concentration, etc.), and the associated uncertainty (i.e., margin of error) for each limiting value, of the total inventory of such waste proposed for disposal in the disposal system. Any compliance application shall:

(1) Demonstrate that, for the total inventory of waste proposed for disposal in the disposal system, WIPP complies with the numeric requirements of §194.34 and §194.55 for the upper or lower limits (including the associated uncertainties), as appropriate, for each waste component identified in paragraph (b)(2) of this section, and for the plausible combinations of upper and lower limits of such waste components that would result in the greatest estimated release.

(2) Identify and describe the method(s) used to quantify the limits of waste components identified in paragraph (b)(2) of this section.

(3) Provide information that demonstrates that the use of acceptable knowledge to quantify components in waste for disposal conforms with the quality assurance requirements of §194.22.

(4) Provide information which demonstrates that a system of controls has been and will continue to be implemented to confirm that the total amount of each waste component that will be emplaced in the disposal system will not exceed the upper limiting value or fall below the lower limiting value described in the introductory text paragraph (c) of this section. The system of controls shall include, but shall not be limited to: Measurement; sampling; chain of custody records; record keeping systems; waste loading schemes used; and other documentation.

(5) Identify and describe such controls delineated in paragraph (c)(4) of this section and confirm that they are applied in accordance with the quality assurance requirements found in §194.22.

(d) The Department shall include a waste loading scheme in any compliance application, or else performance assessments conducted pursuant to §194.32 and compliance assessments conducted pursuant to §194.54 shall assume random placement of waste in the disposal system.

(e) Waste may be emplaced in the disposal system only if the emplaced components of such waste will not cause:

(1) The total quantity of waste in the disposal system to exceed the upper limiting value, including the associated uncertainty, described in the introductory text to paragraph (c) of this section; or

(2) The total quantity of waste that will have been emplaced in the disposal system, prior to closure, to fall below the lower limiting value, including the associated uncertainty, described in the introductory text to paragraph (c) of this section.

(f) Waste emplacement shall conform to the assumed waste loading conditions, if any, used in performance assessments conducted pursuant to §194.32 and compliance assessments conducted pursuant to §194.54.

(g) The Department shall demonstrate in any compliance application that the total inventory of waste emplaced in the disposal system complies with the limitations on transuranic waste disposal described in the WIPP LWA.

(h) The Administrator will use inspections and records reviews, such as audits, to verify compliance with this section.

24.2 Background

The Waste Isolation Pilot Plant (WIPP) was initially certified as a repository consisting of 10 panels, which were excavated for the long-term disposal of transuranic (TRU) waste (U.S. EPA 1998). However, due to operational constraints, the entire volume of the 10 panels is no longer available for waste disposal. In March 2024, the U.S. Department of Energy (DOE) submitted the Replacement Panels Planned Change Request (RPPCR) to the U.S. Environmental Protection Agency (EPA) for approval of waste disposal in two new panels. These panels, referred to as Replacement Panels 11 and 12, are located to the west of the existing repository. The EPA approved the DOE's RPPCR in July 2025 (U.S. EPA 2025).

The addition of the two replacement panels is not expected to provide adequate space for the disposal of the total waste volume designated for WIPP, as authorized under the Land Withdrawal Act (LWA); thus, the 12-panel configuration is regarded as an interim state of the repository. The DOE may pursue approval for waste disposal in additional panels to accommodate the full allowable volume of waste. This hypothetical configuration is considered the expected final state of the repository.

The criteria in 40 Code of Federal Regulations (CFR) 194.24 (U.S. EPA 1996) require the DOE to identify and describe quantitative information on those physical, chemical, and radiological characteristics of the TRU waste that can impact disposal system performance at the WIPP. The DOE is required to establish limits on the quantities of different waste components (e.g., metals, cellulosics, radionuclides, etc.). These limits must be established based on the total inventory proposed for disposal such that when used in performance assessment (PA), the

results comply with the containment requirements of 40 CFR 191.13 (U.S. EPA 1993) and with the limitations on TRU waste as identified in 40 CFR 194.24 (U.S. EPA 1996). The EPA may use audits and inspections described in 40 CFR 194.22 to verify compliance with the requirements of 40 CFR 194.24.

When used in PA modeling, the DOE has typically applied a scaling methodology to the projected inventory (i.e., not yet generated). Combined with the stored (i.e., already generated) and emplaced (i.e., already in WIPP) inventories they simulate that the WIPP repository is filled to its authorized capacity of 6.2 million cubic feet (175,564 cubic meters [m^3]) of TRU waste, as identified in the WIPP LWA (U.S. Congress 1996). However, it is recognized that the LWA volume cannot be accommodated by the physical space provided by the approved panels in the WIPP repository. For PA modeling of the interim state of the repository, the DOE recommends a LWA total inventory of 157,832 m^3 (Ward 2025). The scaled inventory used in the 2026 Compliance Recertification Application (CRA-2026) interim state repository (12-panels) PA is published in the "Interim State Performance Assessment Inventory Report (ISPAIR) – 2024" (Van Soest 2025a). Additionally, CRA-2026 includes a supplemental analysis for the expected final state of the repository, which is designed to accommodate the entire regulatory limit of waste as identified in the WIPP LWA and as specified in 40 CFR 194.24(g). Detailed information regarding the supplemental analysis is provided as an attachment to Appendix PA-2026 (Attachment Supplemental Final State). The scaled inventory for the final state of the repository is published in the "Full Repository Performance Assessment Inventory Report (FRPAIR) – 2024" (Van Soest 2025b).

24.3 Changes or New Information since the CRA-2019

24.3.1 40 CFR 194.24(a)

To meet the requirements of 40 CFR 194.24(a), the DOE described and categorized the TRU waste inventory emplaced in the WIPP repository, as well as the waste that existed or was expected to be generated at TRU waste sites since the CRA-2019, which was based on the inventory with a cutoff date of December 31, 2016 (U.S. DOE 2017). An updated inventory with a cutoff date of December 31, 2017, was used for the CRA-2019 deferred PA, which is based on the Annual Transuranic Waste Inventory Report (ATWIR) - 2018 (U.S. DOE 2018a). The TRU waste inventory used in the CRA-2026 is based on the ATWIR-2024 (U.S. DOE 2024) inventory data with a cutoff date of December 31, 2023.

Volumes and characteristics (radiological and non-radiological) of waste that a TRU waste generator site may report as coming to the WIPP facility depend on factors that vary over time. Changes to the TRU waste inventory may be attributed to:

- Availability and confidence in supplemental characterization information or process knowledge.
- Site estimates of projected TRU waste stream volumes.

- Continuing waste emplacement at the WIPP facility.
- Regulations on the federal and state levels.
- Waste program management decisions at the generator site, the WIPP facility, and the national level.
- Site funding for waste management on sites.
- Recharacterization as waste other than TRU waste.

The data presented in Tables 24-1 through 24-5 are obtained from documents cited in the table footnotes. However, in some cases the data were supplemented by database queries or reports to present them in the appropriate units or totals. To discuss changes in the inventory, the unscaled values are presented in the subsequent sections, as applicable, since scaled values do not provide a one-to-one comparison with the existing waste. Actual numeric values in these tables are rounded to three significant figures for presentation purposes. In sections 24.3.1.1 through 24.3.1.4, all aggregate sums and calculations using raw values are determined before rounding to three significant figures for presentation purposes to maintain high precision. As such, manual verification of aggregate calculations using the rounded values may not be reconcilable.

24.3.1.1 TRU Waste Volume

In June 2018, the DOE provided the EPA with a planned change notice documenting changes to the methodology for calculating the WIPP LWA volume of record (VOR) for disposal of contact-handled (CH)-TRU waste at the WIPP facility (U.S. DOE 2018b). In January 2019, the DOE issued a memorandum (Shrader 2019) establishing the methodology for calculating TRU waste volume for reporting purposes. In this policy, the DOE established the TRU waste volume to be the gross internal volume of the disposal container for direct-loaded containers and the innermost disposal container volume for overpacked containers.

Tables 3-1 and 3-2 of the ATWIR-2024 (U.S. DOE 2024) list the stored and projected volumes of CH-TRU and remote-handled (RH)-TRU waste by TRU waste site, respectively. Table 24-1 lists the total (sum of stored, projected, and emplaced) volumes by waste handling designation for the CRA-2019, CRA-2019 deferred PA, and CRA-2026.

Table 24-1. Total CH- and RH-TRU Waste Volumes (m^3)

	CRA-2019[1] (cutoff 12/31/2016)	**CRA-2019 Deferred PA[2]** (cutoff 12/31/2017)	**CRA-2026[3]** (cutoff 12/31/2023)
CH	166,000	154,000	113,000
RH	3,400	2,980	1,800

[1]U.S. DOE 2017; [2]U.S. DOE 2018a; [3]U.S. DOE 2024

Since the CRA-2019, the inventory volume for CH-TRU and RH-TRU waste has decreased by approximately 54,700 m^3. The change in CH-TRU waste is based on:

- The decrease in total volume of approximately 36,500 m^3, due to the implementation of the VOR methodology used for calculating TRU waste volume for reporting purposes in the ATWIR-2024;
- A volume decrease of approximately 18,400 m^3 at Savannah River Site (SRS), of which approximately 10,400 m^3 can be attributed to the VOR methodology change and approximately 8,040 m^3 is due to the removal of three CH-TRU waste streams (SR-T001-WSB-1, SR-W026-MFFF-1, and SR-W026-WSB-2) that were projected to be generated from the canceled Mixed Oxide Fuel Fabrication Facility Project;
- A volume decrease at Idaho National Laboratory (INL) of approximately 15,700 m^3 primarily due to the VOR methodology change; and
- A volume decrease at the Hanford (Richland) Site (RL) of approximately 8,620 m^3 due to significant reductions in waste volume for several waste streams, most notably from RLPFP-01 for which a significant portion of waste was recharacterized as low-level.

The most significant decrease in RH-TRU waste volume was at RL, with a decrease of approximately 1,000 m^3. This decrease was mainly due to reductions in the number of containers planned to repackage stored waste for waste streams RL105-08 and RL105-09. For more details on the specific volume changes, refer to the ATWIR-2017 (U.S. DOE 2017) for the CRA-2019, the ATWIR-2018 (U.S. DOE 2018a) for the CRA-2019 deferred PA, and the ATWIR-2019 through ATWIR-2024 (U.S. DOE 2019a, U.S. DOE 2020, U.S. DOE 2021a, U.S. DOE 2022a, U.S. DOE 2023, and U.S. DOE 2024) for the CRA-2026.

Table 3-3 of the ATWIR-2024 (U.S. DOE 2024) lists the emplaced and temporary storage volumes of CH-TRU and RH-TRU waste. Table 24-2 lists the emplaced and temporary storage volumes of CH-TRU and RH-TRU by TRU waste site and waste handling designation for the CRA-2026. The values presented in Table 24-2 are based on a query of the WIPP Waste Data System (WDS) with a data cutoff date of December 31, 2023.

Table 24-2. Total Emplaced and Temporary Storage CH- and RH-TRU Waste Volumes by TRU Waste Site (m^3).

Site Name	CRA-2026 CH	CRA-2026 RH
Argonne National Laboratory	91.4	73.5
Bettis Atomic Power Laboratory	--	3.15
GE - Vallecitos Nuclear Center	--	19.7
Hanford (Richland) Site	3,940	--
Idaho National Laboratory	38,700	177

Site Name	CRA-2026 CH	CRA-2026 RH
Lawrence Livermore National Laboratory	320	--
Los Alamos National Laboratory	7,750	14.2
Nevada National Security Site	391	--
Oak Ridge National Laboratory	1,470	46
Rocky Flats Environmental Technology Site	11,400	--
Sandia National Laboratories	--	5.83
Savannah River Site	11,300	25.4

24.3.1.2 Radionuclide Activity

Tables 3-8 and 3-9 of the ATWIR-2024 (U.S. DOE 2024) list the anticipated (sum of stored and projected) CH-TRU and RH-TRU radionuclide activities (decay and buildup corrected through 2023) by site and radionuclide, respectively. Table 24-3 lists the total (sum of stored, projected, and emplaced) CH and RH activities for the CRA-2019, CRA-2019 deferred PA, and CRA-2026, which have different decay periods. The CRA-2019 total activity was decayed to the common year of 2016, the CRA-2019 deferred PA was decayed to the common year of 2017, and the CRA-2026 was decayed to the common year of 2023.

Table 24-3. Total CH- and RH-TRU Activity (Ci)

	CRA-2019[1] (cutoff 12/31/2016)	CRA-2019 Deferred PA[2] (cutoff 12/31/2017)	CRA-2026[3] (cutoff 12/31/2023)
CH	6,390,000	5,480,000	5,730,000
RH	1,180,000	1,070,000	673,000

[1]U.S. DOE 2017; [2]U.S. DOE 2018a; [3]U.S. DOE 2024

Since the CRA-2019, the generator sites have reported a decrease in total activity of approximately 663,000 curies (Ci) for CH-TRU waste and 506,000 Ci for RH-TRU waste. These decreases can be attributed to adjustments made to inventory generation projected in the reporting term of each report as well as re-evaluations of waste stream characterization data at RL and SRS for CH-TRU waste and INL, Oak Ridge National Laboratory, and RL for RH-TRU waste. For more details on these changes, refer to the ATWIR-2017 (U.S. DOE 2017) for the CRA-2019, the ATWIR-2018 (U.S. DOE 2018a) for the CRA-2019 deferred PA, and the ATWIR-2024 (U.S. DOE 2024) for the CRA-2026.

24.3.1.3 Waste and Packaging Materials

Table 3-4 of the ATWIR-2024 (U.S DOE 2024) lists the stored and projected waste and packaging components of the CH-TRU and RH-TRU waste inventory. Table 24-4 provides the total mass of non-radiological waste materials (iron, aluminum-based metal/alloys, other metal/alloys, other inorganic materials, cellulosic, rubber, plastics, cement, solidified inorganic and organic

materials, and soils) in the TRU waste containers and packaging materials (cellulose, plastic, rubber, steel, and lead) associated with WIPP-approved containers for the CRA-2019, CRA-2019 deferred PA and CRA-2026. Table 24-4 lists the total (sum of stored, projected, and emplaced) CH/RH waste and packaging materials for the CRA-2019, CRA-2019 deferred PA, and CRA-2026.

Table 24-4. Total Waste and Packaging Materials (kg)

	CRA-2019[1] (cutoff 12/31/2016)	**CRA-2019 Deferred PA[2]** (cutoff 12/31/2017)	**CRA-2026[3]** (cutoff 12/31/2023)
Waste Materials	56,600,000	52,700,000	47,700,000
Packaging Materials	41,100,000	46,800,000	44,300,000

[1]U.S. DOE 2017; [2]U.S. DOE 2018a; [3]U.S. DOE 2024

Since the CRA-2019, the total mass of waste materials has decreased by 8.84 million kilograms (kg) and the total mass of packaging materials has increased by 3.25 million kg. The largest waste material decrease was from RL waste stream RL200-02 as a result of an updated query methodology. The second largest decrease in waste material is primarily due to the removal of the three SRS waste streams discussed in section 24.3.1.1. Of the 8.84 million kg decrease in waste material, approximately 3.35 million kg is attributed to RL and 1.81 million kg is attributed to SRS. The largest packaging materials increase was 1.64 million kg from Los Alamos National Laboratory (LANL), primarily from waste stream LA-MHD01-Pits, which is a new waste stream since the CRA-2019 that is projecting a large amount of waste planned to be packaged in pipe overpack containers. For more details on the waste and packaging material parameter changes, refer to the ATWIR-2017 (U.S. DOE 2017) for the CRA-2019, the ATWIR-2018 (U.S. DOE 2018a) for the CRA-2019 deferred PA, and the ATWIR-2024 (U.S. DOE 2024) for the CRA-2026.

24.3.1.4 Scaled Volume and Waste Characteristics Used in Performance Assessment

Pursuant to 40 CFR 194.24 (g), the volume and waste characteristics are scaled to simulate a full WIPP repository at closure. Table 24-5 lists the total (CH/RH) scaled volume and the waste characteristics as presented in the Performance Assessment Inventory Report (PAIR) - 2018 (Van Soest 2018) for the CRA-2019 deferred PA, the ISPAIR-2024 (Van Soest 2025a) for the Interim State of the Repository, and FRPAIR-2024 (Van Soest 2025b) for the Final State of the Repository for the CRA-2026 PA. Operational materials presented in Table 24-5 are not scaled because they are not considered TRU waste. Scaled volume and waste characteristics are not available for the CRA-2019 as a PAIR was not performed for the March 2019 submittal. Scaling factors change with each CRA, so the scaled values do not provide a one-to-one comparison.

Table 24-5. Volume and Waste Characteristics Reported in the PAIR (Scaled)

	CRA-2019 Deferred PA[1] PAIR-2018 (cutoff 12/31/2017)	**CRA-2026[2] ISPAIR-2024, Interim State of Repository** (cutoff 12/31/2023)	**CRA-2026[3] FRPAIR-2024, Final State of Repository** (cutoff 12/31/2023)
Volume (m^3)	176,000	158,000	176,000
Radionuclide Activity (Ci)	6,140,000	8,050,000	9,680,000
Waste Materials (including Cement) (kg)	62,700,000	60,100,000	65,600,000
Packaging Materials (kg)	66,200,000	63,200,000	87,500,000
Emplacement Materials (kg)	1,770,000[4]	2,410,000[5]	2,760,000[6]
Operational Materials (kg)	9,720[4]	10,600[5]	10,600[6]
Organic Ligands (kg)	55,400[7]	60,100[8]	62,300[9]
Oxyanions (kg)	2,420,000[7]	2,330,000[8]	2,370,000[9]

[1]Van Soest 2018; [2]Van Soest 2025a; [3]Van Soest 2025b; [4]Callicoat 2018; [5]Lopez 2025; [6]Lopez 2024; [7]Young 2018; [8]Callicoat 2025; [9]Callicoat 2024

Organic ligands, oxyanions, cements, and emplacement materials are not tracked in the WDS; therefore, analyses are performed to account for their emplaced masses. The PAIR-2018 total radionuclide activity was decayed to calendar year (CY) 2033, and the ISPAIR-2024 and FRPAIR-2024 were decayed to CY 2083. The most significant factors affecting scaled values between the CRA-2019 deferred PA and CRA-2026 include the changes to the VOR methodology, increasing the projected inventory reporting term from CY 2033 to CY 2083, and the inclusion of waste streams that have recently been designated as WIPP-bound. Although the scaled volume is smaller in the ISPAIR-2024 than what is used in the PAIR-2018, the radionuclide activity, emplacement materials, operational materials, and organic ligands increased. Increases to radionuclide activity in the ISPAIR-2024 is primarily due to the inclusion of WIPP-bound waste streams SR-KAC-PuOx-2 and SR-CH-PP. The increase in organic ligands in the ISPAIR-2024 can be largely attributed to RL waste stream, RL200-02, which had new estimates calculated after it was determined that chemical constituents may be present in the TRU waste that is projected to be generated.

Based on the information above, the DOE continues to demonstrate compliance with 40 CFR 194.24(a).

24.3.2 40 CFR 194.24(b)(1)

There were no significant changes in waste characteristics between the CRA-2019 deferred PA and the CRA-2026, but the DOE updated waste component information and inventory parameters used in the WIPP PA (Appendix TRU WASTE-2.0). Updated parameters include the masses of waste and packaging materials, solubilities calculated using multiples of the minimum brine volume required for a Direct Brine Release (DBR) to occur, assumed distribution

of actinide oxidation states, and parameters used in the biodegradation reactions implemented in the repository chemical conditions model. Waste characteristic and component changes are summarized in Table 24-6 for both the Interim State and Final State analyses, and parameter changes are discussed in the appropriate subsections below. Additional information relating waste characteristics and components to disposal system performance is found in Appendix TRU WASTE-2.0.

Based on the information above, the DOE continues to demonstrate compliance with 40 CFR 194.24(b)(1).

Table 24-6. Significance and Changes in Components and Characteristics

Waste Component or Characteristic Used in PA	Increase or Decrease From CRA–2019 deferred PA to CRA–2026 Interim State	Increase or Decrease From CRA–2019 deferred PA to CRA–2026 Final State	Significance
Radioactivity (Ci)	Increase (Van Soest 2025a)	Increase (Van Soest 2025b)	Required to calculate potential releases and compliance release limits
Solubility	Increase or decrease, depending on species and oxidation state (Tables SOTERM-21 & 22, Domski 2025a)	Increase or decrease, depending on species and oxidation state (Tables SOTERM-21 & 22; Domski 2025b)	Higher solubility of radionuclides can lead to higher releases
Organic Ligands—Complexing Agents	Increase (Van Soest 2025a)	Increase (Van Soest 2025b)	Higher concentrations of organic ligands could increase actinide solubility
Amount of Ferrous Metals	Increase (Van Soest 2025a)	Increase (Van Soest 2025b)	Maintains a reducing environment; increased amounts may increase potential gas generation
Lead Inventory	Decrease (Van Soest 2025a)	Decrease (Van Soest 2025b)	May impact actinide solubilities
Amount of Cellulose, Plastic, and Rubber (CPRs)	Increase or decrease depending on component (Van Soest 2025a)	Increase (Van Soest 2025b)	May increase gas generation from microbial processes
Oxyanions: Nitrate, Sulfate, and Phosphate	Increase or decrease depending on oxyanion (Van Soest 2025a)	Increase or decrease depending on oxyanion (Van Soest 2025b)	May impact actinide solubility via microbial nutrients that lead to higher gas generation rates
Cement	Decrease (Van Soest 2025a)	Decrease (Van Soest 2025b)	Significant increase in cement/CPR ratio may lead to increase in actinide solubilities

Waste Component or Characteristic Used in PA	Increase or Decrease From CRA–2019 deferred PA to CRA–2026 Interim State	Increase or Decrease From CRA–2019 deferred PA to CRA–2026 Final State	Significance
Formation of Colloidal Suspensions	Increase or decrease depending on species and oxidation state (Table GEOCHEM-26; Tables SOTERM-5 and 6; Appendix SOTERM-3.5.1)	Increase or decrease depending on species and oxidation state (Table GEOCHEM-30; Tables SOTERM-5 and 6; Appendix SOTERM-3.5.1)	Increases in colloidal content of the actinide source term will increase DBR release and may facilitate transport in the far field
Redox State	Increased number of realizations with IV redox state; decreased number of realizations with III redox state (Table SOTERM-13; Appendix SOTERM-6.4)	Increased number of realizations with IV redox state; decreased number of realizations with III redox state (Table SOTERM-13; Appendix SOTERM-6.4)	Impacts which actinide solubility is assumed for a given realization

24.3.2.1 Assessment of Waste Characteristics and Performance Assessment Input Parameters

The CRA-2026 identified the same important characteristics as in the CRA-2019 and RPPCR (Appendix TRU WASTE-2026). As was first done in the CRA-2004, the CRA-2026 continues to assert that organic ligands can be important to solubility and therefore should be included in the solubility calculations (Domski 2025a, Appendix GEOCHEM-3.1). Additionally, to account for their large inventories in the repository, lead and iron chemical systems were added to the solubility calculations in the CRA-2019, thus accounting for their impacts on actinide solubility (Appendix GEOCHEM-3.1). The inclusion of these systems has impacted the chemical conditions process model for the CRA-2026; however, no changes have been made to the conceptual models. Finally, brine radiolysis was included as a contributor to gas generation in the waste in the CRA-2019 PA after a reassessment of the potential consequence to disposal system performance (Day 2019).

24.3.2.2 CRA-2026 Radionuclide Activity in Curies

The DOE uses the information from the ISPAIR-2024 (Van Soest 2025a) as the basis for the PA radionuclide inventory for the interim state of the repository in the CRA-2026 and the FRPAIR-2024 (Van Soest 2025b) as the basis for the PA radionuclide inventory for the final state of the repository in the CRA-2026. The CRA-2026 radionuclide inventory screening analyses (Kicker 2025a and 2025b) discuss the methodology used by the DOE to determine the radionuclide inventory for the WIPP repository for use in CRA-2026 PA calculations. The parameters for the initial radionuclide inventory were decayed to the WIPP facility closure date. Parameters calculated from the initial radionuclide inventories, such as the Waste Unit Factor, and the initial lumped radionuclide inventories were updated for use in the CRA-2026 PA (Kicker 2025a, Kicker 2025b, Kim and Kicker 2025, and Feng and Kicker 2025).

24.3.2.3 CRA-2026 Solubility

The CRA-2026 includes new solubility values for An(III), An(IV), An(V), and An(VI) (Domski 2025a, Domski 2025b, and Kaplan et al. 2025), and new solubility uncertainty factors (Domski 2025c). The DOE utilized EQ3/6, Version 8.0A, and the thermodynamic database DATA0.FM6 (Domski 2023). The organic ligand inventories from the ISPAIR-2024 (Van Soest 2025a) and the FRPAIR-2024 (Van Soest 2025b) were used in the solubility calculations. More details are provided in CRA-2026 Appendix GEOCHEM-4.0 on the refinement of the baseline solubilities and solubility uncertainties and in Appendix GEOCHEM-1.1.1 on the implementation of variable brine volume.

There are three actinides assumed to exist in multiple oxidation states under WIPP conditions: plutonium (Pu), neptunium (Np), and uranium (U) (Appendix PA-2004, Attachment SOTERM 4.0). The oxidation states that control the solubility of these actinides significantly impact actinide mobilization. Since the Compliance Certification Application (CCA), the uncertainty in these oxidation states has been incorporated by giving each possible oxidation state an equal probability (i.e., 50%/50% distribution). However, for the CRA-2026, Kaplan et al. (2025) recommended a new distribution for Pu based on experimental results showing the +IV oxidation state was more likely under WIPP conditions than the +III state (i.e., 75%/25% distribution). The two oxidation states of Np and U remain at equal probability for controlling solubilities.

24.3.2.4 CRA-2026 Organic Ligands

In the CRA-2014, the DOE implemented a new method for calculating organic ligand concentrations for multiples of the minimum brine volume in a DBR by adding additional parameters (Appendix GEOCHEM-1.1.1). This method was also used for the CRA-2026. The CRA-2026 used the organic ligand inventory described in the ISPAIR-2024 (Van Soest 2025a) and the FRPAIR-2024 (Van Soest 2025b) to calculate baseline solubilities.

24.3.2.5 CRA-2026 Parameters Related to Metals, CPR, and Oxyanions

The CRA-2026 used the inventory described in Tables 5-5, 5-7, and 5-8 of the ISPAIR-2024 (Van Soest 2025a) and the FRPAIR-2024 (Van Soest 2025b) to update the parameters for metals, CPR, and oxyanions. The ISPAIR-2024 and the FRPAIR-2024 report the masses of the waste and packaging materials.

24.3.2.6 CRA-2026 Production of Gas from the Waste

The only change to gas generation from waste in the CRA-2026 was a new methodology for calculating the iron-based metal surface area. This change is discussed below.

24.3.2.6.1 CRA-2026 Methodology for Calculating Iron Surface Area

The iron corrosion reaction rate modeled in the WIPP PA depends on the iron surface area. Since the CCA, the iron surface area has been estimated using an approximation of the average iron surface area per equivalent drum and an optimal loading of drums in the repository. This methodology for calculating iron surface area eliminates the dependence of iron mass in the inventory on iron surface area. This disconnect between iron mass and iron surface area has been questioned during the CRA-2019 completeness determination (U.S. EPA 2020, completeness comment CC6-GEOCHEM-32).

A new methodology for calculating iron surface area as a function of iron mass was implemented in the CRA-2026. An estimate of the surface area per kilogram of iron was calculated using data on currently emplaced TRU waste (Table 24-7). This conversion factor is then multiplied by the iron mass in the inventory to determine the iron surface area (King 2021).

Table 24-7. Gas Generation Parameters Added or Modified

Property	Description
REFCON:FESAPKG	Iron surface area per kilogram of iron (m^2/kg)

24.3.2.7 CRA-2026 Formation of Colloidal Suspensions

The colloid enhancement parameters were reexamined for the CRA-2026 (Appendix GEOCHEM-5.2) and discussed in SOTERM-2026 (Appendix SOTERM-3.5.1 and Appendix SOTERM-5.2 through -5.6 for individual actinides). In response to the EPA's comments as part of the CRA-2019 completeness review (U.S. EPA 2022) and based on the recommendations of Kaplan et al. (2025) and Mariner (2025a and 2025b), the DOE has updated the PA colloid parameters. Specifically, the PA parameter properties CONCINT, PROPMIC, CAPMIC, PHUMCIM, and PHUMSIM were changed. These values are shown in Appendix GEOCHEM-5.3 and Appendix SOTERM-2026, Tables SOTERM-5 and SOTERM-6.

24.3.2.8 CRA-2026 Compactability (Waste Compressibility)

The waste compactability/compressibility model has been reassessed as part of work completed to update the waste porosity surface (Vignes et al. 2023). The compaction model update is based on compaction experiments performed on containers filled with surrogate, non-degraded, waste (Jensen et al. 2023). The new waste material model's predictions are in closer alignment with the experimental measurements than the legacy model's predictions.

24.3.3 40 CFR 194.24(b)(2) and (b)(3)

The CRA-2026 identifies the same waste components as in the CCA, and identifies waste components of organic ligands, iron, and lead as being potentially important to PA via the actinide solubility calculations (Appendix TRU WASTE-2.4.1, Domski 2025a, and Domski 2025b). Most of the inventory amounts of the listed components have changed since the CRA-2019 deferred PA; these are described in the ISPAIR-2024 (Van Soest 2025a) and the FRPAIR-2024 (Van Soest 2025b) and are reflected in the solubility calculations (Domski 2025a and Domski 2025b). Therefore, the DOE continues to demonstrate compliance with provisions of 40 CFR 194.24(b)(2) and (b)(3).

24.3.4 40 CFR 194.24(c)(1), (e)(1), and (e)(2)

The rationale for establishing or not establishing limits for the waste components identified as potentially significant in the CCA has not changed since the CRA-2019. The limits for mass of ferrous metals (iron), mass of CPR materials, and volume of observable liquid (i.e., free water) emplaced with waste have changed, but their implementation into the CRA-2026 PA has not changed.

The minimum emplacement value for ferrous metals was established in the CCA based on the mass of steel in 50-gallon drums of CH-TRU waste and an optimal loading of drums in the repository. For the CRA-2026, the minimum emplacement value for ferrous metals is the sum of the masses of iron-based materials in the waste and various waste containers, for both CH-TRU and RH-TRU wastes, assumed in the ISPAIR-2024 inventory (Kicker 2025a).

The maximum emplacement value for CPR materials was established in the CCA based on the mass of cellulosics, plastics, and rubber assumed to be emplaced in the repository at closure. For the CRA-2026, the maximum emplacement value for CPR materials is the sum of the masses of cellulosics, plastics, and rubber in the waste, waste containers, and emplacement materials, for both CH-TRU and RH-TRU wastes, assumed in the ISPAIR-2024 inventory (Kicker 2025a).

The maximum emplacement value for free water in the waste was established in the CCA based on the WIPP Waste Acceptance Criteria (WAC) requirement of less than one percent of the waste volume, based on a design basis value for CH-TRU volume of 168,485 m^3. For the CRA-2026, the maximum emplacement value for free water in the waste materials is assumed to be one percent of the CH-TRU waste volume of 156,247 m^3, based on the total inventory volume assumed for the ISPAIR-2024 inventory of 157,832 m^3 (Ward 2025).

The minimum emplacement value for nonferrous metals was established in the CCA as the minimum amount needed to bind to organic ligands, thereby reducing the impact of organic ligands on the solubility of radionuclides (the effects of organic ligands were not included in the CCA PA). Since the CRA-2004, the effect of organic ligands on actinide solubility has been included in the PA. The minimum emplacement limit is no longer necessary to eliminate the effect of organic ligands on the actinide solubility in the PA; however, the mass of nonferrous metals will continue to be tracked as part of the DOE TRU waste inventory.

In its evaluation of the CCA, the EPA concluded that while there is no limit for the radionuclide inventory, the EPA considers the radionuclide inventory used in the PA to be a de facto upper bound (U.S. EPA 2010, Section 24.5.3). Therefore, the inventory used in PA calculations to determine compliance with release standards resets the limits on radionuclide emplacement at the WIPP. Thus, the DOE is proposing a new upper bound for the radionuclide inventory by including the most recent DOE inventory data from the ISPAIR–2024 (Van Soest 2025a) in the CRA–2026 PA. Emplacement limits for waste components are found in Appendix TRU WASTE-3.0.

Based on the information above, the DOE continues to demonstrate compliance with 40 CFR 194.24(c)(1), (e)(1), and (e)(2).

24.3.5 40 CFR 194.24(c)(2)

Nondestructive examination (NDE) techniques allow for quantification of waste contents. Visual Examination (VE) and Real Time Radiography (RTR) are the two methods of NDE that can be performed. The VE and RTR procedures are designed to include breakdowns of the waste-material volumes associated with each category described in 40 CFR 194.24(b)(2). The VE technique monitors waste packaging in real time, with operators recording the waste materials and their approximate volumes/masses for each container for CH waste. Alternatively, VE of record can also be completed using records, either videos or documentation of previous packaging. To use VE of record, the certified program must demonstrate that the process to be used will meet the quality assurance requirements for VE and the acceptable knowledge (AK) requirements specified in the WIPP WAC. The RTR technique verifies the physical form of the waste and allows operators to estimate approximate volumes/masses of waste materials based on radiography, video, and narration. During both methods of NDE, operators verify that quantity of liquids, including water, comply with the WIPP WAC. All operators are trained and qualified to produce Acceptable Knowledge Summary Reports (AKSRs) for specific waste streams prior to NDE. Acceptable knowledge documents, including AKSRs, chemical compatibility evaluations (CCEs), Interface Waste Management Documents List (IWMDL), Acceptable Knowledge Assessments (AKAs), and Basis of Knowledge (BoK) for Evaluating Oxidizing Chemicals in TRU Waste, are utilized to characterize and quantify potential chemicals and other waste materials in the waste stream as trace, minor, or dominant components.

For CH waste, nondestructive assay (NDA) is typically used for radiological characterization. The NDA utilizes gamma and neutron spectroscopy to characterize the quantity of the 10 radionuclides outlined in the WIPP WAC, as well as any other pertinent radionuclides present that collectively contribute to 95% of the total radiological hazard for the payload container. The concentration of each radionuclide is utilized to calculate the activity in curies of each radioisotope present in the waste. The DOE Carlsbad Field Office (CBFO) utilizes the Performance Demonstration Program (PDP) to ensure the certified program is effectively and accurately characterizing radionuclides via NDA. For RH waste, the dose-to-curie method is typically used in which a model is built to estimate the activity of each radionuclide present in the waste. Other methods used for radiological characterization of RH waste include

dimensional and gravimetric measurements, AK, modeling, and NDA. The method used for each waste stream is reviewed and approved by CBFO and the EPA.

Based on the information above, the DOE continues to demonstrate compliance with 40 CFR 194.24(c)(2).

24.3.6 40 CFR 194.24(c)(3)

The AKSRs compile the historical information pertinent to a waste stream including, but not limited to: facility description, operational timeframe, general description of the waste generating processes, final physical form of the waste, and any historical packaging or shipment information. This information is used for waste stream delineation and categorization, and to train and qualify NDE operators for a specific waste stream.

The CCEs summarize the composition of the chemicals likely to be present in each waste stream and consider the range of possible chemical combinations that could occur. The CCE summarizes the quantities of the chemicals in the waste stream by trace (<1%), minor (1%-10%), and dominant (>10%). All CCEs require CBFO review and approval through CBFO procedure MP 4.10 – The Processing of WIPP Certified Program (WCP) Documents.

The IWMDL is used to assess active waste management practices for containers currently being generated or repackaged by assessing on-going packaging, repackaging, and remediation activities. The purpose of the IWMDL process is to identify container specific generator documents associated with current TRU waste management and packaging to be reviewed before TRU waste stream payload containers are added to an active, proposed, or preliminary waste stream.

The BoK evaluates the concentration of oxidizers in the presence of other waste materials in the waste stream and provides guidance on treatment methods for ensuring the waste with oxidizing chemicals is acceptable at the WIPP. The BoK documents are reviewed by the Senior Technical Advisor within the CBFO Office of the Manager and approved by the CBFO Manager.

The AKAs are reviews of AK documentation associated with waste containers packaged and/or characterized prior to the implementation of the IWMDL. The AKA ensures that all containers within a waste stream meet the requirements of the WIPP WAC, including enhanced AK, on an individual basis.

Waste Stream Profile Forms contain a description of the waste stream and a characterization information summary. In conjunction with the AKSR, this acts as the final piece of AK in the characterization process.

When the required AK and characterization techniques are complete and approved for a specific waste stream, an approval to ship and emplace notification is sent from a qualified CBFO Senior Technical Safety Manager (STSM) to the President and Program Manager of the WIPP Management and Operating contractor for that waste stream characterized and certified

by a WCP (Central Characterization Program or Advanced Mixed Waste Treatment Project), indicating shipment and emplacement of the specific certified TRU waste stream may begin. This final step is when the qualified CBFO STSM verifies all approvals of AK documents.

Based on the information above, the DOE continues to demonstrate compliance with 40 CFR 194.24(c)(3).

24.3.7 40 CFR 194.24(c)(4)

The WIPP Waste Information System was retired in December 2009, and replaced with the WDS to provide the DOE with a modern approach to process controls and data sharing as described in CRA-2019, Section 24.3.4. The WDS used the Oracle Version 12c database management system at the time of the CRA-2019, as described in CRA-2019, Section 24.3.4. The WDS now uses Oracle DB 19c and a web interface for user access. The EPA has access to the WDS with their own specialized dashboard. The WDS Data Dictionary (U.S. DOE 2025a) is a separate document from the WDS User's Manual (U.S. DOE 2025b), and is included as a reference to this section for consistency with previous CRA submissions. Appendix MON-3.5 briefly describes the WDS and its function for the monitoring program.

Based on the information above, the DOE continues to demonstrate compliance with 40 CFR 194.24(c)(4).

24.3.8 40 CFR 194.24(c)(5)

Since the CRA-2019, the DOE has issued the PDP Plan for Criticality Control Overpacks (U.S. DOE 2021b). Concurrently, the PDP Plan for Boxed Wastes (U.S. DOE 2022b) and Drummed Wastes (U.S. DOE 2022c) have been updated to Revision 8 within the TRU Waste Characterization Program.

The PDP Plan for Criticality Control Overpacks was implemented to support long-term activities for the disposal of down-blended Pu-containing materials at the WIPP. Significant changes to the PDP include initiating a tailgate briefing before loading each cycle configuration. Additionally, the non-interfering matrix standard waste box, the non-interfering matrix drum, and their associated scoring criteria have been removed from their respective PDP plans (U.S. DOE 2022b and U.S. DOE 2022c).

Also incorporated in subsequent revisions to the PDP documents were editorial changes, updates to the CBFO organizational structure, incorporating a List of Figures and List of Tables in the Table of Contents, and minor changes to the configuration forms. The DOE confirms that the PDP directly assesses NDA data quality attributes in 40 CFR 194.22, notably data accuracy, data precision, representativeness, completeness, and comparability. Therefore, the DOE continues to demonstrate compliance with 40 CFR 194.24(c)(5).

24.3.9 40 CFR 194.24(d) and (f)

The CRA-2026 waste loading scheme has not changed since the CRA-2019. The DOE did not use a performance-based waste loading scheme for waste emplacement in the WIPP repository, and it assumed random distribution of waste emplacement in its performance and compliance assessment. Therefore, the DOE continues to demonstrate compliance with 40 CFR 194.24(d) and (f).

24.3.10 40 CFR 194.24(g)

The CRA-2026 inventory has changed from the CRA-2019 inventory and is described in Section 24.3.1. The WDS tracks compliance with the limitations on CH- and RH-TRU waste described in the WIPP LWA (U.S. Congress 1996). Therefore, the DOE continues to demonstrate compliance with 40 CFR 194.24(g).

24.3.11 40 CFR 194.24(h)

Since the CRA-2019, the DOE has successfully completed 60 waste generator-site assessments listed in Appendix AUD-2026, Tables AUD-1 through AUD-8. Therefore, as discussed in Section 22 of this application, the DOE continues to demonstrate compliance with the inspection and records-review requirements of 40 CFR 194.24(h).

In conclusion, the DOE continues to demonstrate compliance with 40 CFR 194.24.

24.4 References

(*Indicates a reference that has not been previously submitted.)

Callicoat, J. 2018. Estimation of Cellulose, Plastic, and Rubber Emplacement and Operational Materials in the Waste Isolation Pilot Plant. Carlsbad, NM: Los Alamos National Laboratory Carlsbad Operations. INV-SAR-51, Revision 0. LA-UR-18-31878.*

Callicoat, J. 2024. Chemical and Cement Components 2023 Inventory Estimates. Carlsbad, NM: Los Alamos National Laboratory Carlsbad Operations. INV-SAR-79, Revision 0. LA-UR-25-26033.*

Callicoat, J. 2025. Chemical and Cement Components 2023 Inventory Estimates for the Interim State Performance Assessment of the Waste Isolation Pilot Plant. Carlsbad, NM: Los Alamos National Laboratory Carlsbad Operations. INV-SAR-81, Revision 0. LA-UR-25-26083.*

Day, B.A. 2019. Reassessment of Need and Parameter Justification for Modeling Gas Generation due to Radiolysis of Brine and Cellulose/Plastic/Rubber in WIPP for CRA-2019. (February 12, 2019). Carlsbad, NM: Sandia National Laboratories. ERMS 570873.

Domski, P. 2023. An Update to the WIPP EQ3/6 Database DATA0.FM1 with the Creation of DATA0.FM6. Carlsbad, NM: Sandia National Laboratories. ERMS 579370.*

Domski, P. 2025a. Prediction of Baseline Actinide Solubilities for the 2026 Compliance Recertification Application Performance Assessment: Interim State Repository. Carlsbad, NM: Sandia National Laboratories. EIMS-0004838025.*

Domski, P. 2025b. Prediction of Baseline Actinide Solubilities for the 2026 Compliance Recertification Application Performance Assessment: Final State Repository. Carlsbad, NM: Sandia National Laboratories. EIMS-0004800911.*

Domski, P. 2025c. Uncertainty Analysis of Actinide Solubilities for the 2026 Compliance Recertification Application (CRA-2026). Carlsbad, NM: Sandia National Laboratories. EIMS-0004446576.*

Feng, M. and D. Kicker. 2025. Input Parameter Report for the 2026 Compliance Recertification Application Performance Assessment: Interim State and Final State Repositories. Carlsbad, NM: Sandia National Laboratories.*

Jensen, R.P., S.T. Broome, C.G. Herrick, and B. Reedlunn. 2023. Improved Compaction Experiments and Modeling of Waste Isolation Pilot Plant Standard, Non-degraded, Waste Containers. Albuquerque, NM: Sandia National Laboratories. SAND2023-04823.*

Kaplan, U., J. Swanson, and C. Kutahyali-Aslani. 2025. LANL ACRSP Parameter Recommendations for CRA-2026 Performance Assessment. (Revision 1). Carlsbad, NM: Los Alamos National Laboratory. LA-UR-25-25192.*

Kicker, D. 2025a. Analysis Report for Radionuclide Inventory Screening in the 2026 Compliance Recertification Application Performance Assessment: Interim State Repository. Carlsbad, NM: Sandia National Laboratories. EIMS-0004832100.*

Kicker, D. 2025b. Analysis Report for Radionuclide Inventory Screening in the 2026 Compliance Recertification Application Performance Assessment: Final State Repository. Carlsbad, NM: Sandia National Laboratories. EIMS-0004799526.*

Kim, S. and D. Kicker. 2025. Analysis Report for Inventory EPA Units in the 2026 Compliance Recertification Application Performance Assessment: Interim State Repository. Carlsbad, NM: Sandia National Laboratories.*

King, S. 2021. Recalculating of Iron Surface Area for Iron Corrosion in the WIPP PA Calculation. Carlsbad, NM: Sandia National Laboratories. ERMS 576428.*

Lopez, A. 2024. Estimation of Cellulose, Plastic, and Rubber Emplacement and Operational Materials in the Waste Isolation Pilot Plant for 2023 Inventory. Carlsbad, NM: Los Alamos National Laboratories Carlsbad Operations. INV-SAR-78, Revision 0. LA-UR-25-25644.*

Lopez, A. 2025. Cellulose, Plastic, and Rubber Emplacement and Operational Materials 2023 Estimates for Interim State Performance Assessment of the Waste Isolation Pilot Plant.

Carlsbad, NM: Los Alamos National Laboratories Carlsbad Operations. INV-SAR-80, Revision 0. LA-UR-25-25778.*

Mariner, P. 2025a. CRA-2026 FS updates to the WIPP humic colloids models for An(III) and An(IV). Carlsbad, NM: Sandia National Laboratories. EIMS-0004800929.*

Mariner, P. 2025b. CRA-2026 IS updates to the WIPP humic colloids models for An(III) and An(IV). Carlsbad, NM: Sandia National Laboratories. EIMS-0004838142.*

Nemer, M. and W. Zelinski. 2005. Analysis Report for BRAGFLO Modeling Results with the Removal of Methanogenesis from the Microbial-Gas-Generation Model. Carlsbad, NM: Sandia National Laboratories. ERMS 538748.

Shrader, T. 2019. Letter to Office of National TRU Program and Office of Environmental Protection Division. Subject: Tracking and Reporting the Defense-Related Transuranic Waste Volume Against the Waste Isolation Pilot Plant Land Withdrawal Act Total Capacity Limit for Defense-Related Transuranic Waste. 16 January 2019. Carlsbad, NM: Carlsbad Field Office.*

U.S. Congress. 1996. Waste Isolation Pilot Plant Land Withdrawal Act, As Amended Through Public Law 104-201. 23 September 1996.

U.S. DOE. 2017. Annual Transuranic Waste Inventory Report–2017. Carlsbad, NM: Carlsbad Field Office. DOE/TRU-17-3425, Revision 0.

U.S. DOE. 2018a. Annual Transuranic Waste Inventory Report – 2018. Carlsbad, NM: Carlsbad Field Office. DOE/TRU-18-3425, Revision 0.*

U.S. DOE. 2018b. Letter to Ms. Lee Ann B. Veal, Director, Radiation Protection Division, Environmental Protection Agency. Subject: Plans to Change the Methodology for Calculating the Volume of Record for Disposal of Transuranic Waste at the Waste Isolation Pilot Plant. 22 June 2018. Carlsbad, NM: Carlsbad Field Office.*

U.S. DOE. 2019a. Annual Transuranic Waste Inventory Report – 2019. Carlsbad, NM: Carlsbad Field Office. DOE/TRU-19-3425, Revision 0.*

U.S. DOE. 2020. Annual Transuranic Waste Inventory Report – 2020. Carlsbad, NM: Carlsbad Field Office. DOE/TRU-20-3425, Revision 0.*

U.S. DOE. 2021a. Annual Transuranic Waste Inventory Report – 2021. Carlsbad, NM: Carlsbad Field Office. DOE/TRU-21-3425, Revision 0.*

U.S. DOE. 2021b. Performance Demonstration Program Plan for Nondestructive Assay of Criticality Control Overpacks for the TRU Waste Characterization Program. 27 July 2021. Carlsbad, NM: Carlsbad Field Office. DOE/CBFO-21-3630, Revision 0.*

U.S. DOE. 2022a. Annual Transuranic Waste Inventory Report – 2022. Carlsbad, NM: Carlsbad Field Office. DOE/TRU-22-3425, Revision 0.*

U.S. DOE. 2022b. Performance Demonstration Program Plan for Nondestructive Assay of Boxed Wastes for the TRU Waste Characterization Program. May 24, 2022. Carlsbad, NM: Carlsbad Field Office. DOE/CBFO-01-1006, Revision 8.*

U.S DOE. 2022c. Performance Demonstration Program Plan for Nondestructive Assay of Drummed Wastes for the TRU Waste Characterization Program. 31 March 2022. Carlsbad, NM: Carlsbad Field Office. DOE/CBFO-01-1005, Revision 8.*

U.S. DOE. 2023. Annual Transuranic Waste Inventory Report – 2023. Carlsbad, NM: Carlsbad Field Office. DOE/TRU-23-3425, Revision 0.*

U.S. DOE. 2024. Annual Transuranic Waste Inventory Report – 2024. Carlsbad, NM: Carlsbad Field Office. DOE-TRU-2024-3425.0.*

U.S. DOE. 2025a. Waste Data System Data Dictionary. 31 March 2025. Carlsbad, NM: Carlsbad Field Office.*

U.S. DOE. 2025b. Waste Data System User's Manual. 13 March 2025. Carlsbad, NM: Carlsbad Field Office. DOE/WIPP-09-3427, Revision 24.*

U.S. Environmental Protection Agency (U.S. EPA). 1993. 40 CFR Part 191: Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes; Final Rule. 20 December 1993. *Federal Register*, vol. 58, pp. 66398–416.

U.S. EPA. 1996. 40 CFR Part 194: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations; Final Rule. 9 February 1996. *Federal Register*, vol. 61, pp. 5223–5245.

U.S. EPA. 1998. 40 CFR Part 194: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations: Certification Decision; Final Rule. 18 May 1998. *Federal Register*, vol. 63, pp. 27353-406.

U.S. EPA. 2010. 2009 Compliance Recertification Application (2009 CRA) Compliance Application Review Document (CARD) No. 24, Waste Characterization. Washington, DC: Office of Radiation and Indoor Air.

U.S. EPA. 2020. Letter to M. Brown, U.S. DOE. Subject: EPA Completeness Comments #6 on the CRA-2019. 13 November 2020. EPA-HQ-OAR-2019-0534-0010.

U.S. EPA. 2022. Technical Support Document for Section 194.24 Evaluation of the Compliance Recertification Application (CRA-2019) Actinide Source Term, Gas Generation, Backfill Efficacy,

Water Balance, and Culebra Dolomite Distribution Coefficient Values. EPA-HQ-OAR-2019-0534.*

U.S. EPA. 2025. Letter to M. Bollinger, U.S. DOE. Subject: EPA's Review and Approval of DOE's RPPCR for Waste Panels 11 and 12 at WIPP. 31 July, 2025.*

Van Soest, G.D. 2018. Performance Assessment Inventory Report – 2018. Carlsbad, NM: Los Alamos National Laboratory Carlsbad Operations. INV-PA-18, Revision 0. LA-UR-18-31882.*

Van Soest, G.D. 2025a. Interim State Performance Assessment Inventory Report – 2024. Carlsbad, NM: Los Alamos National Laboratory Carlsbad Operations. INV-IPA-24, Revision 0. LA-UR-25-24935.*

Van Soest, G.D. 2025b. Full Repository Performance Assessment Inventory Report – 2024. Carlsbad, NM: Los Alamos National Laboratory Carlsbad Operations. INV-FPA-24, Revision 0. LA-UR-25-20761.*

Vignes, C., J.E. Bean, and B. Reedlunn. 2023. Improved Modeling of Waste Isolation Pilot Plant Disposal Room Porosity. Carlsbad, NM: Sandia National Laboratories. SAND2023-04826.*

Wang, Y., and L. Brush. 1996. Memorandum to M.S. Tierney. Subject: Estimates of Gas-Generation Parameters for the Long-Term WIPP Performance Assessment. Sandia National Laboratories. Albuquerque, NM. ERMS 231943.

Ward, A. 2025. Letter to Mr. B. McInroy. Subject: Performance Assessment Inventory for Analysis of a 12-Panel Repository Configuration. 18 March 2025. Carlsbad, NM: Carlsbad Field Office. CBFO:ERCD:AW:RS:25-0197.*

Young, J. 2018. Chemical and Cement Components 2017 Inventory Estimates. Carlsbad, NM: Los Alamos National Laboratory Carlsbad Operations. INV-SAR-50, Revision 0. LA-UR-18-31876.*