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JUN 2 2 2018

Ms. Lee Ann B. Veal, Director
Radiation Protection Division
Environmental Protection Agency
Center for Federal Regulation
Arial Rios Building
1200 Pennsylvania Ave. N.W.
Washington, DC 20460

Subject: Plans to Change the Methodology for Calculating the Volume of Record for Disposal of Transuranic Waste at the Waste Isolation Pilot Plant

Dear Ms. Veal:

The purpose of this letter is to inform the U.S. Environmental Protection Agency (EPA) that the U.S. Department of Energy (DOE) plans to change the methodology for calculating the WIPP Land Withdrawal Act (LWA) volume of record (VOR) for disposal of contact-handled (CH) transuranic (TRU) waste at the Waste Isolation Pilot Plant (WIPP) facility. Historically, the DOE has determined the volume of CH TRU waste disposed, for comparison to the total capacity limit of transuranic waste for the LWA, based on the volume of the outermost container emplaced in the WIPP repository. The historical approach overestimates the volume of CH TRU waste because the method includes the void space inside an overpack as CH TRU waste volume.

In the future, DOE will determine the VOR for emplaced CH TRU waste as follows:

1. If the waste is not overpacked, the VOR will be based on the volume of the WIPP-approved container;
2. If the waste is overpacked, the VOR will be based on the sum of the volumes of the containers inside the overpack container;
3. For pipe overpacks and criticality control overpacks, the VOR will be based on the inner container volume of the (single) pipe component.

This approach provides a more appropriate estimate of the volume of TRU waste emplaced in the WIPP repository. The WIPP Waste Data System (WDS) will be used to track the VOR for waste emplaced at the WIPP facility. The WDS meets the requirements of the DOE's *Quality Assurance Program Document*, as implemented by Nuclear Waste Partnership LLC (NWP). Any future changes to the WDS that may be required for the new methodology for CH TRU waste will be performed and verified using the relevant procedures in the NWP Quality Assurance Programs.

The DOE has conducted a qualitative assessment to address the potential impacts of changing the methodology for tracking waste volume on long-term repository performance. The assessment in Enclosure A documents that the potential release of radionuclides with respect to legislated limits in the LWA is not expected to be substantially different under the proposed change to the volume of record.

If you have any questions concerning the planned change to the methodology for tracking the volume of TRU waste in the repository, per the LWA, please contact Michael R. Brown at (575) 234-7476.

Sincerely,

Todd Shrader, Manager
Carlsbad Field Office

Enclosure

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Date: April 24, 2018

To: Records Center

From: Todd R. Zeitler and Dwayne C. Kicker

Subject: CH TRU Waste Volume of Record Impact Assessment

Summary

This paper provides the technical basis to support a position that the proposed change to the methodology of calculating the volume of record (VOR) against the Waste Isolation Pilot Plant (WIPP) Land Withdrawal Act (LWA) defense-related transuranic (TRU) waste capacity limit will not substantially impact the ability to show compliance with regulatory release limits as outlined in 40 CFR 191. The proposed VOR methodology deviates from the historical approach by utilizing the inner container volumes physically available to accommodate TRU waste, rather than the outermost container volumes, to establish the contact-handled (CH) TRU waste volumes. The reasoned arguments proposed in this paper consider the impact of the proposed waste VOR methodology change on the standard methodology for accounting for waste volume on a waste stream basis, the legislated approach to establishing release limits, and the typical release mechanisms assessed in WIPP performance assessment (PA) calculations that estimate the probability and consequence of potential radionuclide releases from the repository to the accessible environment for a regulatory period of 10,000 years after facility closure.

The proposed change would impact the waste stream volumes and radionuclide activities that are used as PA inputs. Using the standard waste stream volume scaling methodology, in which total inventory volume is made equal to the legislated limit, an overall greater number of containers and radionuclide activity (in curies) would be assumed at the time of closure. Although the overall repository activity would increase due to the proposed VOR methodology, the legislated method for calculating releases to the accessible environment considers a normalization of releases by the total inventory. Thus, the normalized release of radionuclides with respect to legislated limits is not expected to be substantially different under the proposed scenario.

1. Introduction

The U.S. Department of Energy (DOE) has proposed a change to the methodology of calculating the VOR against the WIPP LWA defense-related TRU waste capacity limit. The proposed change

WIPP:4.0.1:PA:QA-L:508737

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impacts the current practice of using the volume of the outermost emplacement container ("overpack") in calculating the total volume of waste (determined on a waste-stream basis) for disposal at WIPP. Under the proposed methodology, the volume of the innermost emplacement container would be used to calculate waste volume. The methodology change is applicable to contacted-handled (CH) waste due to the fact that remote-handled (RH) waste has historically been counted on an innermost emplacement container basis.

The DOE demonstrates compliance with the containment requirements according to the Certification Criteria in Title 40 CFR Part 194 by means of PA calculations performed by Sandia National Laboratories (SNL). WIPP PA calculations estimate the probability and consequence of potential radionuclide releases from the repository to the accessible environment for a regulatory period of 10,000 years after facility closure. The models used in PA are maintained and updated with new information as part of an ongoing process. Improved information regarding important WIPP features, events, and processes typically results in refinements and modifications to PA models and the parameters used in them. Planned changes to the repository and/or the components therein also result in updates to WIPP PA models. WIPP PA models are used to support the repository recertification process that occurs at five-year intervals following the receipt of the first waste shipment at the site in 1999.

Waste stream and nonradioactive waste (e.g., Fe, CPR, organic ligands) inventory information (e.g., volumes, activities, masses) are inputs to PA calculations. The proposed VOR methodology change would in a change to the waste stream volumes and activities as well as nonradioactive waste masses considered in long-term PA calculations. Because the change is not expected to have significant impact on PA results, PA calculations have not been performed. Instead, a qualitative assessment has been undertaken. The assessment below addresses the potential impacts of the proposed change on the predicted long-term performance of the WIPP based on the expected changes to initial radionuclide and nonradioactive inventories.

2. Technical Assessment

Below is a technical assessment of the potential impacts to the long-term performance of the WIPP based on the proposed change in methodology for calculating CH waste volume. Broadly, the assessment considers: 1) how waste stream volumes are calculated prior to becoming input for PA calculations; 2) how waste stream volumes are used in PA calculations; 3) how release limits are related to the assumed inventory at closure; 4) an example of potential changes to waste stream volumes; and 5) potential impacts to PA calculations.

2.1. Development of Waste Stream Information for PA Calculations

The term "waste stream volume" refers to the volume of waste assumed to be disposed of in the WIPP for a given waste stream. For PA purposes, SNL requests a PAIR (PA inventory report) from the Los Alamos National Laboratory (LANL) inventory group that contains waste stream volume (m^3) and activity (Ci) for specific radionuclides on a waste-stream basis. LANL collects inventory data and projected estimates on an annual basis. Waste that is incorporated into a typical PAIR is separated into three categories: "emplaced," "stored," and "projected". The PAIR produced for the current analysis (Van Soest 2018) defines these terms as such:

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- Emplaced: Permanently disposed underground at WIPP, stored above ground at WIPP, in temporary storage at WCS [Waste Control Specialists], or in transit to WCS/WIPP as of the inventory date (December 31, 2016) for this [PA inventory] report.
- Stored: Already generated; not yet shipped to the WIPP.
- Projected: Not yet generated; estimated as future generation.

Effort has been made in this memo to use identical definitions for emplaced, stored, and projected waste.

Prior to performing PA calculations, SNL typically requests that LANL apply a scaling methodology to their inventory data, such that the waste stream volumes reported in the PAIR sum to the legislated capacity specified in the LWA (175,564 m^3 (6,200,000 ft^3) total waste and 7,079 m^3 (250,000 ft^3) for RH; the difference of 168,485 m^3 (5,950,000 ft^3) is therefore assumed as the CH waste volume limit) (U.S. Congress 1992 and 1996). Scaling for CH and RH waste is done separately; because RH waste is not impacted by the proposed change in waste volume calculation methodology, the discussion will focus on scaling of CH waste.

The currently employed scaling methodology entails scaling of only the projected waste, while emplaced and stored waste volumes are not scaled (Equation 1). Because the volume of anticipated (stored plus projected) and emplaced waste is below the volume limit noted above for CH waste, a scaling factor greater than 1 is used. The scaling factor calculated from Equation 1 is applied to each waste stream (projected component only) in order to calculate a waste stream volume for use in PA (Equation 2). Activity for each radionuclide in each projected waste stream is scaled by the same factor as waste volume (Equation 3). Additionally, nonradioactive inventories (e.g., Fe, CPR) for projected waste streams are scaled by the same factor (Equation 4).[1]

CH waste volume used in PA = 168,485 m^3 = (Emplaced CH volume) + (Stored CH volume) + (CH scaling factor)*(Projected CH volume) (1)

Waste stream CH volume used in PA = (Emplaced waste stream CH volume) + (Stored waste stream CH volume) + (CH scaling factor)*(Projected waste stream CH volume) (2)

Waste stream CH activity used in PA = (Emplaced waste stream CH activity) + (Stored waste stream CH activity) + (CH scaling factor)*(Projected waste stream CH activity) (3)

Nonradioactive mass used in PA = (Emplaced nonradioactive mass) + (Stored nonradioactive mass) + (CH scaling factor)*(Projected nonradioactive mass) (4)

Scaling factors from recent PAIRs are presented in Table 1. A higher scaling factor value means that the total projected component of the inventory reported to LANL is scaled to a higher degree in order to reach the limit for CH waste volume (the volume assumed for PA calculations).

[1] Inventory estimates for oxyanions, complexing agents, cement, and emplacement materials are handled with supplemental analyses as described in Van Soest (2018).

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Table 1. Inventory information for selected PA analyses

PA Analysis Name	Inventory Name	CH Scaling Factor	Waste Unit Factor (WUF)	Total Inventory Contributing to WUF (Ci)[a]	Total Inventory in PA (EPA units)	Inventory References
CCA	TWBIR Revision 2	2.05	4.07	4.07×10^6	10,120	DOE (1995, Appendix BIR Revision 2); Crawford et al. (2009, Section 5.1); Sanchez et al. (1996)
PAVT	TWBIR Revision 3	2.05	3.44	3.44×10^6	10,100	DOE (1996a Appendix BIR Revision 3); Sanchez et al. (1997); Martell and Tisinger (2000)
CRA-2004	TWBID Revision 2.1 Version 3.12, Data Version D.4.08	2.11	2.48	2.48×10^6	10,100	LANL (2003); Fox (2003); DOE (2004)
PABC-2004	TWBID Revision 2.1, Version 3.13, Data Version D.4.15	1.48	2.32	2.32×10^6	10,170	Crawford et al. (2009, Section 5.1); LANL (2005); Leigh and Fox (2005)
CRA-2009	TWBID Revision 2.1, Version 3.13, Data Version D.4.15	1.48	2.32	2.32×10^6	10,170	DOE (2009, Appendix DATA-7.1); Fox and Clayton (2010)
PABC-2009	PAIR-2008	5.72	2.60	2.60×10^6	10,080	Crawford et al. (2009); Fox et al. (2009); Fox and Clayton (2010)
CRA-2014	PAIR-2012	2.66	2.06	2.06×10^6	10,197	Van Soest (2012); Kicker and Zeitler (2013)
VOR_BL[b]	VORPAIR-2017	1.08	3.30	3.30×10^6	10,155	Van Soest (2018); current memo
VOR_PR[c]	VORPAIR-2017	2.46	5.31	5.31×10^6	10,088	Van Soest (2018); current memo

[a] Consists of inventory from α-emitting radionuclides with half-lives greater than 20 y.
[b] Volume of record "baseline case;" inventory using outer container volume; analysis does not include PA results.
[c] Volume of record "proposed case;" inventory using inner container volume; analysis does not include PA results.

Under the proposed change to using inner container volumes in the counting of CH waste volume, emplaced and stored waste volumes would decrease, since the same number of containers will yield smaller waste volumes.[2] For the total CH waste volume to be equal to the maximum assumed CH volume, projected waste volumes must increase and thus, the CH scaling factor applied to projected waste volume must also increase (Equation 1). Overall, the relative contribution to total CH waste volume would be decreased for emplaced and stored waste, and increased for projected waste under the proposed change to the waste volume calculation (Table 2).

Although the emplaced and stored components of waste stream volume would decrease, the activity for those components would be assumed to stay the same—this would lead to increased

[2] For some container types, volumes will stay the same, but in no case will emplaced and stored waste volumes increase solely due to the proposed change to the methodology of calculating the VOR.

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"activity concentration" (activity per volume). Because the projected component of waste stream activity is scaled by the same factor as waste stream volume, the amount of radionuclide activity assumed for PA calculations would increase for projected waste by the same proportion as volume—activity concentration would stay the same. The impact to overall activity assumed for PA calculations would be increased activity and activity concentration (since the overall CH waste volume would be unchanged).

Table 2. Summary of impacts of proposed change on selected inventory characteristics

Item	**Impact of Proposed Change to Volume Calculation**
Total inventory volume used in PA	No change
Emplaced waste volume	Decrease (or no change for some container types)
Stored waste volume	Decrease (or no change for some container types)
Projected waste volume	Increase
Emplaced waste activity	No change
Stored waste activity	No change
Projected waste activity	Increase
Emplaced waste activity concentration[a]	Increase
Stored waste activity concentration[a]	Increase
Projected waste activity concentration[a]	No change
CH scaling factor	Increase
RH scaling factor	No change
Waste unit factor (WUF)	Depends on relative activities of individual emplaced, stored, and projected waste stream volumes
Total Inventory in EPA units	Depends on relative activities of individual emplaced, stored, and projected waste stream volumes, but remains approximately 10,000
Nonradioactive inventory (e.g., Fe, CPR)	Depends on relative activities of individual emplaced, stored, and projected waste stream volumes, but increased due to increased number of assumed waste containers

[a] Activity per volume.

2.2. Use of Inventory Information in PA Calculations

The WIPP PA methodology includes the assessment of potential radionuclide releases via various release mechanisms (primarily those associated with drilling intrusions into repository waste regions), including: cuttings and cavings, spallings, direct brine releases (DBRs), and releases from the Culebra (DOE 2014, Appendix PA). Each release mechanism is impacted separately by changes to initial inventory.

Cuttings and cavings releases are calculated based on the volume of solids brought to the surface due to the direct intersection of the drill bit (cuttings) and the erosion of particulate waste from the borehole wall by drilling fluids (cavings) during a hypothetical future intrusion event combined with a radionuclide concentration (DOE 2014, Appendix PA). In WIPP PA, an intrusion that results in the intersection of CH waste assumes that three waste containers are encountered (based

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on the assumption of three-high stacks of waste containers), each of which may be from a different waste stream.[3] The three waste streams that are chosen for a given intrusion event are selected at random, with the probability of intersection for a given waste stream that is equal to the ratio of the waste stream volume to the total volume of all waste streams (Equation 5). The activity concentration (activity per unit volume) for a radionuclide in a given waste stream is calculated as the ratio of its activity in the waste stream to the waste stream volume and is used in determining cuttings and cavings releases (Table 3). The activity of CH waste radionuclides released as cuttings and cavings is the product of the volume of material and the average activity of the three waste streams selected.

Probability of intersecting a CH waste stream = (Waste stream CH volume) / (Total CH volume) = (Waste stream CH volume) / 168,485 m^3 (5)

Table 3. Summary of inventory bases by release mechanism

Release Mechanism	**Inventory Basis**
Cuttings and cavings	Waste stream basis (3 selected for CH intrusion)
Spallings	Volume average of all CH waste streams
Direct brine	Mobilized portion of total inventory
From Culebra	Mobilized portion of total inventory

Spallings releases result as a special case of the drilling intrusion event in which the repository contains gas at high pressure that causes: 1) localized shear failure of the waste material surrounding the borehole; and 2) entrainment of the failed waste material into and up the borehole, carried ultimately to the ground surface. Spallings releases, unlike releases from cuttings and cavings which occur with every modeled borehole intrusion, can only occur if pressure in the waste-disposal region is sufficiently high (greater than 10 megapascals (MPa)) (DOE 2014, Appendix PA) and are only assumed to occur for CH waste intrusions. At these high pressures, gas flow toward the borehole may be sufficiently rapid to cause additional solid material to enter the borehole. The activity of radionuclides released as spalled material is the product of the volume of spalled waste and its activity. Because spalling may occur at a greater distance from the borehole than cuttings and cavings, spalled waste is assumed to have the volume-averaged activity of CH waste streams, rather than the sampled activities of individual waste streams.

Direct brine releases (DBRs) account for radionuclides that may be released to the accessible environment if repository brine enters the borehole during drilling and flows to the ground surface (DOE 2014, Appendix PA). The activity of radionuclides released by direct brine flow depends on the volume of brine reaching the ground surface and the concentration of radionuclides contained in the brine. DBRs will not occur if repository pressure is below the hydrostatic pressure in the borehole, assumed to be 8 MPa in the WIPP PA. Actinides may be mobilized (i.e., available for transport via DBR) in repository brine in two principal ways: 1) as dissolved species; and 2) as colloidal species. The CH waste is assumed to contain organic ligands that serve to increase actinide solubility by forming complexes with dissolved actinide species. Radionuclide solubilities are calculated prior to each PA calculation whenever inventory information (including organic ligand inventory) has changed. Activity concentration in repository brine is dependent on:

[3] For the purposes of calculating cuttings and cavings releases, an intrusion that intersects RH is assumed to encounter one RH waste stream.

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1) radionuclide inventory; 2) radionuclide solubility; 3) repository oxidation conditions; 4) brine type; and 5) available brine volume.

Releases to the Culebra member of the Rustler formation may occur due to brine flow up the borehole following borehole plug degradation if sufficient brine is available in the repository and if pressure in the repository is higher than in the overlying units (DOE 2014, Appendix PA). Releases from the Culebra may occur following intrusion as radionuclides transport laterally to the site boundary as outlined in the LWA (U.S. Congress 1992 and 1996). Mobilized radionuclides in repository brine are assumed to transport to the Culebra—mobilization is based on the total repository radionuclide inventory.

Nonradioactive inventory waste indirectly impacts the amount of activity released via the mechanisms discussed above (except for cuttings and cavings releases). The quantity of nonradioactive waste used in PA calculations is impacted by waste stream volumes via the CH scaling factor (Equation 4). The impacts of nonradioactive inventory components are summarized in Table 4.

Table 4. Impact on PA calculations by nonradioactive waste components

Nonradioactive waste component	**Impact on PA calculations (release mechanism impacted)**
Iron/steel	Iron corrosion produces gas that increases repository pressure (spallings, DBRs, from Culebra)
Cellulosics, plastic, and rubber (CPR), sulfate, nitrate	Microbial degradation produces gas that increases repository pressure (spallings, DBRs, from Culebra)
Organic ligands	Complexing of organic ligands affects radionuclide solubility (DBRs, from Culebra)

2.3. Relationship between regulatory release limits and radionuclide inventory (conversion of releases in curies to EPA units)

The WIPP was certified in 1998 based on Compliance Certification Application (CCA) and Performance Assessment Verification Test (PAVT) PA calculations (DOE 1996b, DOE 1997, EPA 1998). The WIPP has been recertified by the EPA since then on three occasions (2006, 2010, 2017) based on additional PA calculations (Leigh et. al. 2005, Clayton et. al. 2010, DOE 2014). In each case, the long-term performance of the WIPP has been assessed using regulatory release limits as specified in 40 CFR 191 (EPA 1993). Part 191 Subpart B describes containment requirements (EPA 1985):

§ 191.13 Containment Requirements:
(a) Disposal systems for spent nuclear fuel or high-level or transuranic radioactive wastes shall be designed to provide a reasonable expectation, based upon performance assessments, that cumulative releases of radionuclides to the accessible environment for 10,000 years after disposal from all significant processes and events that may affect the disposal system shall:
(1) Have a likelihood of less than one chance in 10 of exceeding the quantities calculated according to Table 1 (Appendix A); and
(2) Have a likelihood of less than one chance in 1,000 of exceeding ten times the quantities calculated according to Table 1 (Appendix A).

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Section 191.13 (a) refers to "quantities calculated according to Table 1 (Appendix A)," which means a normalized radionuclide release to the accessible environment based on the type of waste being disposed, the initial waste inventory, and the size of release that may occur (EPA 1985, Appendix A). Table 1 of Appendix A specifies allowable releases (i.e., release limits) for individual radionuclides and is reproduced here as Table 5. The WIPP is a repository for TRU waste, which is defined as "waste containing more than 100 nanocuries of alpha-emitting TRU isotopes, with half-lives greater than twenty years, per gram of waste" (EPA 1985). The normalized release R for TRU waste is defined by:

$$R = \sum_i \left(\frac{Q_i}{L_i}\right)\left(\frac{10^6 Ci}{W_i}\right) \tag{6}$$

where Q_i is the cumulative release of radionuclide i to the accessible environment during the 10,000-year period following closure of the repository (Ci), L_i is the release limit for radionuclide i (Ci/unit of waste), and W_i is the activity (Ci) at the time of closure for alpha-emitting TRU radionuclides with half-lives greater than 20 years. Thus, releases in curies are normalized by the overall inventory—for a larger inventory, an equivalent release in EPA units is equivalent to an increased number of released curies. This concept may be clarified by defining a waste unit factor (WUF) and the "EPA unit."

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Table 5. Release Limits for the Containment Requirements (EPA 1985, Appendix A, Table 1)

Radionuclide	**Release Limit L_i per 1000 MTHM[a] or Other Unit of Waste[b]**
Americium-241 or -243	100
Carbon-14	100
Cesium-135 or -137	1,000
Iodine-129	100
Neptunium-237	100
Pu-238, -239, -240, or -242	100
Radium-226	100
Strontium-90	1,000
Technetium-99	10,000
Thorium (Th) -230 or -232	10
Tin-126	1,000
Uranium (U) -233, -234, -235, -236, or -238	100
Any other alpha-emitting radionuclide with a half-life greater than 20 years	100
Any other radionuclide with a half-life greater than 20 years that does not emit alpha particles	1,000

[a] Metric tons of heavy metal (MTHM) exposed to a burnup between 25,000 megawatt-days (MWd) per metric ton of heavy metal (MWd/MTHM) and 40,000 MWd/MTHM.
[b] An amount of TRU waste containing one million Ci of alpha-emitting TRU radionuclides with half-lives greater than 20 years.

The WUF, also referred to as the "unit of waste," is defined in the CCA as the number of millions of curies of alpha-emitting TRU radionuclides with half-lives longer than 20 years destined for disposal in the WIPP repository (DOE 1996b). Computation of a new waste unit factor is done for each update to repository inventory information and is required for PA calculations. This computation is performed using Equation 7 (Sanchez et al.1997) to define the WUF:

$$WUF = \frac{\sum W_i}{10^6\ Ci} \tag{7}$$

where W_i is defined as above. With this definition of the WUF, Equation six may be rewritten as:

$$R = \sum_i \left(\frac{Q_i}{L_i}\right)\left(\frac{1}{WUF}\right) = \left(\frac{1}{WUF}\right)\sum_i \left(\frac{Q_i}{L_i}\right) \tag{8}$$

The release of radionuclide i in EPA units, R_i, is therefore:

$$R_i = \left(\frac{1}{WUF}\right)\left(\frac{Q_i}{L_i}\right) \tag{9}$$

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Similarly, the activity for radionuclide i in EPA units, E_i, is:

$$E_i = \left(\frac{1}{WUF}\right)\left(\frac{w_i}{L_i}\right) \tag{10}$$

where w_i is the inventory activity for that radionuclide in curies. The EPA release limit for all radionuclides that contribute to the WUF is L_i = 100 Ci/unit of waste. If all radionuclides in a given inventory were to contribute to the WUF, then the WUF would increase linearly with total activity (WUF = 10^{-6} · total activity) and the total inventory in EPA units (E) would be equal to:

$$E = \sum_i E_i = \sum_i \left(\frac{1}{WUF}\right)\left(\frac{w_i}{L_i}\right) = \left(\frac{1}{100 \cdot WUF}\right) \cdot \sum_i w_i = \left(\frac{1}{100 \cdot WUF}\right) \cdot \sum_i W_i \tag{11}$$
$$= \left(\frac{1}{100 \cdot WUF}\right) \cdot (WUF \cdot 10^6) = 10{,}000$$

using the relationship $w_i = W_i$ for radionuclides that contribute to the WUF. Because there are some radionuclides that do not contribute to the WUF (by definition, they must be alpha-emitting radionuclides with half-lives greater than 20 years), but are accounted for in the total repository inventory, the total inventory in EPA units does exceed 10,000. However, those radionuclides typically only account for about 1-2 % of the EPA units available in the repository inventory for release during PA calculations (Table 1). As the total inventory increases, the WUF value also increases (Table 1). However, Table 1 shows that, despite substantial changes to the inventory activity in curies, the number of EPA units is relatively unchanged—this is due to the normalization of inventory activities as defined by 40 CFR 191.

2.4. An example of potential inventory changes due to change in CH waste volume calculation methodology

To facilitate an analysis of the impacts to repository inventory based on the proposed change in the CH waste volume calculation methodology, the LANL inventory group produced a PA inventory report (VORPAIR-2017) for inventory data compiled through December 31, 2016 (Van Soest 2018). The VORPAIR-2017 compared two inventories, one calculated using the typical waste stream volume calculation methodology for CH waste (based on outermost container; "baseline" or VOR_BL case) and one using the proposed methodology (based on innermost container; "proposed" or VOR_PR case). The standard scaling methodology (Equations 1-4) was employed for both inventories.

Waste stream volumes are composed of emplaced, stored, and projected components. Under the proposed scenario, volumes of all three components are subject to change depending on the container type used (or assumed to be used, in the case of projected waste components) for a given waste stream (Table 2). For some container types, those with no "inner container," emplaced and stored waste volumes will not change (projected waste volumes would increase for those container types in any case due to the increased CH scaling factor).

The CH scaling factor increased (from 1.08 to 2.46) between the baseline and proposed cases, as expected due to the decreased emplaced and stored components of waste stream volumes (Table

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1 and Equation 1). The WUF increased from 3.30 to 5.31 due to the increased repository activity derived from the increased CH scaling factor (see Appendix A for calculation). By reducing waste stream volumes (i.e., container volumes) prior to scaling and keeping activities the same, activity and activity concentration has increased overall—the total volume of waste assumed for the repository has stayed the same. However, due to normalization by the EPA release limit and WUF (Equation 10) the initial number of EPA units available for release from the repository in PA calculations does not change much and in fact decreases from 10,155 to 10,088—the decrease is due to the mix of radionuclide content following scaling of projected waste stream activities and could not be predicted a priori.

Of the 506 CH waste streams in the VORPAIR-2017, 270 waste streams (accounting for approximately 15% of the total CH waste volume) showed no change between the baseline and proposed cases, 32 showed increased volumes, and 204 showed decreased volumes (Table B1 in Appendix B). Table 6 summarizes the observed changes in waste volume for the 506 CH waste streams. Those waste streams that showed overall increased waste stream volumes increased in relative contribution to the overall inventory from 25% to 47%. Those waste streams that showed overall decreased waste stream volumes decreased in relative contribution to the overall inventory from 60% to 38%.

Individual waste streams may show no change due to the entire waste stream being emplaced and stored (no projected component) in containers for which there was no change to assumed waste volume (i.e., no "inner container"). Waste streams may show overall increased or decreased volume due to a combination of: 1) assumed container type; and 2) the relative amount of each waste stream in the emplaced, stored, and projected categories (Table 2). Nonradioactive inventory components all showed increased masses under the proposed scenario (Appendix C).

Table 6. Summarized CH waste stream volume information for baseline and proposed inventories in VORPAIR-2017

Waste Stream Category	Number	Baseline Volume (m^3)	Proposed Volume (m^3)	Volume Change (m^3)	Average Volume Change (m^3)	% of Total CH volume		
						Baseline Volume	Proposed Volume	Volume Change
Same Volume	270	24,969	24,969	0	0	15	15	0
Increased Volume	32	41,852	79,441	37,588	1,175	25	47	22
Decreased Volume	204	101,664	64,076	-37,588	-184	60	38	-22
Total	506	168,485	168,485	0	-	100	100	-

2.5. Potential impacts of proposed change to waste volume calculation on PA calculations

Section 2.2 above discusses how PA inventory, in different forms, is used in calculating releases for the release mechanisms considered in WIPP PA. This section discusses potential impacts to PA calculations based on the expected changes to inventory due to the proposed change to the methodology of calculating the VOR. In general, because inventory is "normalized" by the WUF in translating activity in curies to EPA units, substantial impacts to releases are not expected. However, some generally expected impacts to releases can be discussed based on the proposed change to the waste volume calculation.

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The radionuclide activity associated with cuttings and cavings releases is calculated on a waste stream basis. Because the probability of intersecting a given waste stream is proportional to its waste stream volume, those waste streams that increase in volume under the proposed change to methodology of calculating the VOR would be selected at a higher rate and thus their activity concentrations would have an increased impact on overall cuttings and cavings releases (Table 7). Similarly, those waste streams for which volume decreases would have a reduced impact on overall cuttings and cavings releases.

Activity concentrations ($Ci/m^3/WUF$) for the baseline and proposed scenarios are plotted in Figure 1. The figure shows waste stream activity concentrations with the probability of encountering a given waste stream during a CH intrusion event based on its volume (Equation 5).[4] Concentrations have been normalized by the appropriate WUF value to facilitate an accurate comparison in mimicking the EPA unit-based activity concentration used in PA calculations (Equation 10). The proposed scenario shows increased activity concentration in only about 20% of the total waste volume (from those waste streams with the lowest ~10%, between ~30-40%, and the highest ~1% of activity concentrations). Thus, cuttings and cavings releases would be expected to be increased in the proposed scenario for only about 20% of intrusions and decreased for about ~80% of intrusions. Under the proposed scenario, higher probability releases would be decreased, while lower probability releases would show some increase. In PA calculations, total releases are typically dominated by cuttings and cavings at higher probabilities and by DBRs at lower probabilities, so total releases would be expected to decrease at high probabilities and not be impacted much at low probabilities due to changes in cuttings and cavings releases.

Table 7. Summary of impact of proposed change by release mechanism

Release Mechanism	**Impact of Proposed Change to Releases**
Cuttings and cavings	Increased selection rate for waste streams that show increased volume
Spallings	Increased activity in Ci, but not substantially different activity in EPA units
Direct brine	Potentially increased solubility, but not substantially different activity in EPA units
From Culebra	Potentially increased solubility, but not substantially different activity in EPA units

[4] Activity concentration was calculated using the activity and waste stream volumes from Table B1 (Appendix B) and WUF values from Table 1. To generate the probabilities for Figure 1, Waste streams were ordered by activity concentration and assigned a relative probability based on the waste stream volume divided by total waste volume.

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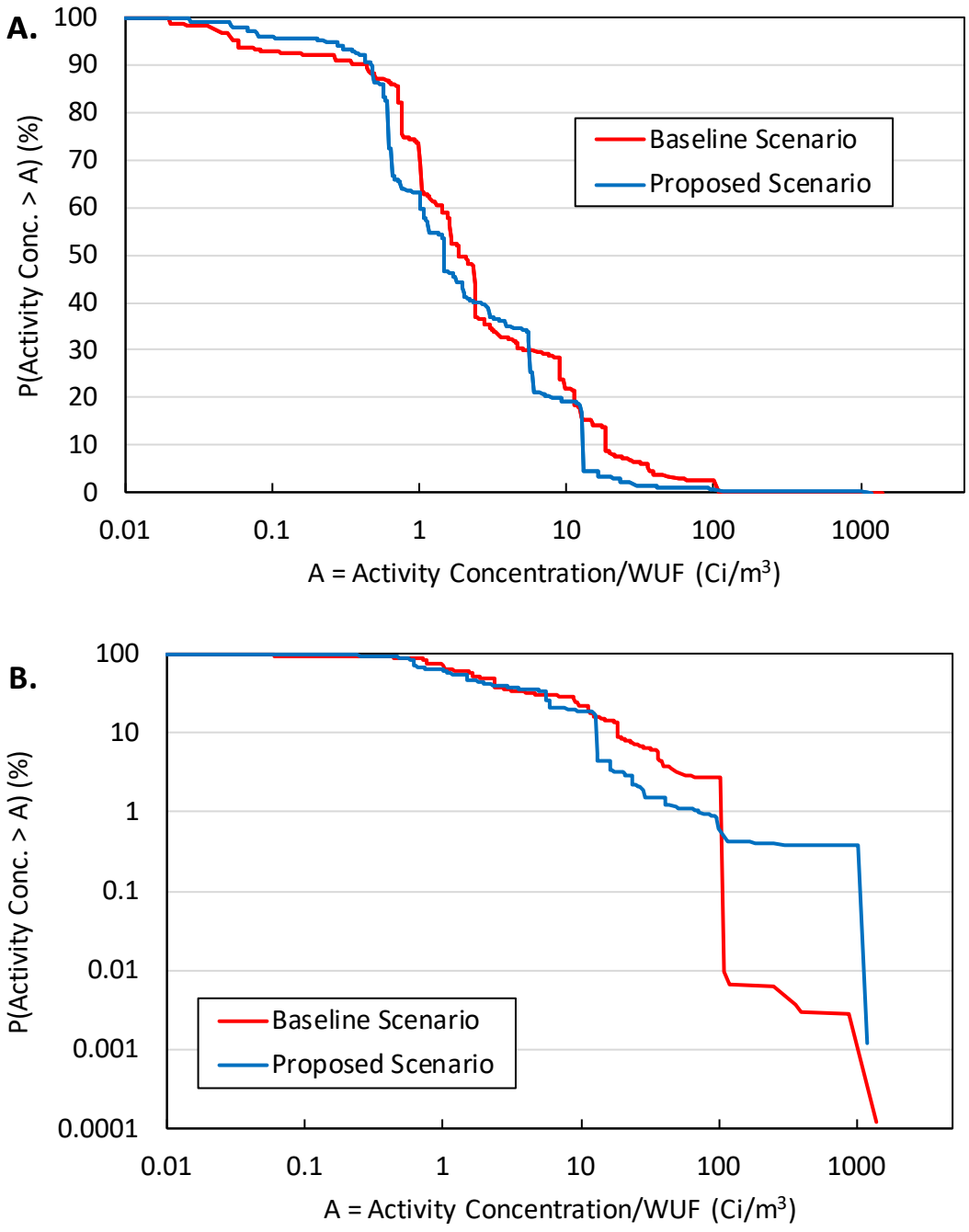

Figure 1. Cumulative distribution function for activity concentration based on waste stream volume (part B shows the same data as part A on a logarithmic scale).

The radionuclide activity associated with spallings releases is based on the volume-averaged activity of all CH waste. Although the overall activity concentration would increase under the change in waste volume calculation methodology, because of the normalization by the WUF, spallings concentrations, and thus spallings releases, are not expected to be substantially different.

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The radionuclide activity associated with DBRs and releases from the Culebra is based on the mobilized portion of the total inventory; that is, the amount of radionuclides present in the liquid brine in the waste areas of the repository. The updated inventory would have an updated amount of organic ligands, which impact radionuclide solubilities (in general, an increased organic ligand concentration results in increased radionuclide presence in brine (Brush and Domski 2013)). Although radionuclide solubility parameters would be updated with a new organic ligand inventory, because of the normalization by the WUF, radionuclide concentrations in brine, and thus DBRs and releases from the Culebra, are not expected to be substantially different.

Nonradioactive inventory includes a waste component and packaging materials component. In general, the nonradioactive inventory is expected to increase due to increased number of containers assumed to fit into the repository volume. Increased nonradioactive inventory would lead to greater gas generation and thus higher repository pressures. Higher pressures may lead to increased DBRs and spallings releases, but also can serve to decrease brine saturations, which then lead to decreased DBRs (DOE 2014, Appendix PA)—the net impact is not known a priori.

3. Conclusions

A qualitative assessment has been undertaken to address the potential impacts of the proposed change on the predicted long-term performance of the WIPP based on the expected changes to initial radionuclide and nonradioactive inventories. The technical assessment included the following components: 1) how waste stream volumes are calculated prior to becoming input for PA calculations; 2) how waste stream volumes are used in PA calculations; 3) how release limits are related to the assumed inventory at closure; 4) an example of potential changes to waste stream volumes; and 5) potential impacts to PA calculations.

The proposed change would impact the waste stream volumes and radionuclide activities that are used as PA inputs. Using the standard waste stream volume scaling methodology, in which total inventory volume is made equal to the legislated limit, an overall greater number of containers and radionuclide activity (in curies) would be assumed at the time of closure. While the overall activity would have increased, the legislated method for calculating releases to the accessible environment considers a normalization of releases by the total inventory. Thus, the potential release of radionuclides with respect to legislated limits is not expected to be substantially different under the proposed change to the volume of record.

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Appendix A:
Table A1 below lists radionuclide activities at closure (2033) for those radionuclides that contribute to the WUF (i.e., alpha-emitting radionuclides with half-lives greater than 20 years). Based on the baseline scenario provided in the VORPAIR-2017 (Van Soest 2018), the overall quantity of TRU waste radionuclides that apply to the waste unit factor (WUF) at 2033 is 3.30E+06 curies, thus:

WUF = 3.30 (baseline scenario).

Based on the proposed scenario provided in the VORPAIR-2017 (Van Soest 2018), the overall quantity of TRU waste radionuclides that apply to the WUF at 2033 is 5.31E+06 curies, thus:

WUF = 5.31 (proposed scenario).

Table A1. Radionuclide inventory activities at 2033 that contribute to WUF based on VORPAIR-2017

Radionuclide	**Baseline Scenario**		**Proposed Scenario**	
	Activity (Ci)	**Frequency**	**Activity (Ci)**	**Frequency**
Am-241	1.08E+06	32.580%	1.75E+06	32.935%
Am-242m	6.58E+00	0.000%	1.04E+01	0.000%
Am-243	2.70E+02	0.008%	2.88E+02	0.005%
Cf-249	2.09E+01	0.001%	2.56E+01	0.000%
Cf-251	1.86E+00	0.000%	1.87E+00	0.000%
Cm-243	2.21E+01	0.001%	2.24E+01	0.000%
Cm-245	9.91E+03	0.300%	1.09E+04	0.205%
Cm-246	4.87E+02	0.015%	5.30E+02	0.010%
Cm-247	1.21E+00	0.000%	2.01E+00	0.000%
Cm-248	1.59E+00	0.000%	2.28E+00	0.000%
Cm-250	2.45E-06	0.000%	2.47E-06	0.000%
Np-237	4.56E+01	0.001%	5.72E+01	0.001%
Pu-238	1.11E+06	33.676%	1.77E+06	33.329%
Pu-239	8.16E+05	24.696%	1.28E+06	24.199%
Pu-240	2.87E+05	8.702%	4.94E+05	9.301%
Pu-242	6.70E+02	0.020%	7.83E+02	0.015%
Pu-244	2.45E-03	0.000%	2.61E-03	0.000%
Total	3.30E+06	100.000%	5.31E+06	100.000%
WUF	**3.30**		**5.31**	

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Appendix B:

Table B1 below summarizes volume and activity for the 506 CH waste streams considered in VORPAIR-2017. Activity is the sum of activities at the time of closure (2033) for the following radionuclides: Am-241, Am-243, Cm-244, Cs-137, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Pu-244, Sr-90, Th-229, Th-230, Th-232, U-233, U-234, U-235, U-236, and U-238. The highest and lowest volume changes and highest activity ratio are highlighted. The lowest (i.e., most negative) volume change from VOR_BL to VOR_PR is for waste stream IN-BN650, which decreased in volume by 4,068.01 m^3. The largest increase in volume was 10,531.31 m^3 for waste stream LA-MHD01.001—that waste stream also showed the highest proportional increase in activity, with a factor of 2.45. The maximum possible ratio is 2.46, the CH scaling factor; the lowest possible ratio is 1.00, which is shared by many waste streams with no projected waste volume component.

Table B1. Summary waste stream information for baseline and proposed inventories in VORPAIR-2017

Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
AE-T001	117.84	1.51E+02	228.81	2.92E+02	110.96	1.94
AE-T003	16.77	1.79E+01	22.51	2.41E+01	5.73	1.34
WP-AECHDM	102.33	2.86E+02	78.33	2.86E+02	-24.00	1.00
WP-AECHHM	13.95	7.54E+01	11.55	7.54E+01	-2.40	1.00
WP-MU-W002	4.50	6.75E+00	1.47	6.75E+00	-3.03	1.00
AW-5649N	0.21	9.19E-03	0.21	9.19E-03	0.00	1.00
AW-N027.531	8.06	7.40E+01	17.81	1.63E+02	9.75	2.21
AW-T033.1325	48.59	2.41E+02	107.09	5.32E+02	58.49	2.20
IN-AE-102	59.90	1.64E+02	59.90	1.64E+02	0.00	1.00
IN-AE-105	2.91	8.71E+00	2.91	8.71E+00	0.00	1.00
IN-BC-203	7.58	2.32E+01	7.58	2.32E+01	0.00	1.00
IN-BN004	58.59	3.60E+02	25.79	3.60E+02	-32.80	1.00
IN-BN222	85.05	1.20E+03	37.44	1.20E+03	-47.61	1.00
IN-BN-501	2.50	6.48E-02	2.50	6.48E-02	0.00	1.00
IN-BN510	0.76	1.03E+00	0.76	1.03E+00	0.00	1.00
IN-BN510.1	17.81	2.76E+02	17.81	2.76E+02	0.00	1.00
IN-BN510.2	12.51	1.31E+03	12.51	1.31E+03	0.00	1.00
IN-BN510.3	382.41	1.49E+04	382.41	1.49E+04	0.00	1.00
IN-BN510.4	2671.13	7.81E+04	2671.13	7.81E+04	0.00	1.00
IN-BN-522	61.15	1.66E+01	61.15	1.66E+01	0.00	1.00
IN-BN-523	1.14	5.37E-01	1.14	5.37E-01	0.00	1.00
IN-BN-525	0.38	5.34E-01	0.38	5.34E-01	0.00	1.00
IN-BN-527	1.14	6.74E-01	1.14	6.74E-01	0.00	1.00
IN-BN-529	0.21	4.47E-03	0.21	4.47E-03	0.00	1.00

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Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
IN-BN600	121.66	6.67E+01	121.66	6.67E+01	0.00	1.00
IN-BN650	7267.05	1.82E+04	3199.04	1.82E+04	-4068.01	1.00
IN-BN835	22.68	1.49E+02	9.98	1.49E+02	-12.70	1.00
IN-BN836	75.60	6.90E+00	33.28	6.90E+00	-42.32	1.00
IN-BNINW216	608.58	6.99E+03	267.90	6.99E+03	-340.68	1.00
IN-BNINW218	88.83	1.60E+01	39.10	1.60E+01	-49.73	1.00
IN-BW-515	1.90	1.02E+01	1.90	1.02E+01	0.00	1.00
IN-BW-516	0.38	5.20E-01	0.38	5.20E-01	0.00	1.00
IN-BW-517	0.38	1.31E-01	0.38	1.31E-01	0.00	1.00
IN-IC-605	0.21	1.24E-01	0.21	1.24E-01	0.00	1.00
IN-ID-RF-S3114	2350.35	1.54E+02	1083.68	1.54E+02	-1266.67	1.00
IN-ID-RF-S3150-A	3.78	1.04E+00	1.66	1.04E+00	-2.12	1.00
IN-ID-RF-S5100-A	0.21	9.58E+02	0.21	9.58E+02	0.00	1.00
IN-ID-RF-S5126	4.50	1.86E+02	2.08	1.86E+02	-2.42	1.00
IN-ID-RF-S5300-A	4.50	1.32E+04	2.08	1.32E+04	-2.42	1.00
IN-ID-SDA-Debris	716.56	2.55E+03	716.56	2.55E+03	0.00	1.00
IN-ID-SDA-Sludge	2737.28	6.87E+03	2737.28	6.87E+03	0.00	1.00
IN-ID-SDA-Soil	507.31	1.04E+03	507.31	1.04E+03	0.00	1.00
IN-ID-SRP-S3000	2602.53	3.12E+02	1145.66	3.12E+02	-1456.87	1.00
IN-JH-826	1.14	9.78E+00	1.14	9.78E+00	0.00	1.00
IN-JH-827	1.14	9.78E+00	1.14	9.78E+00	0.00	1.00
IN-MD-842	60.74	3.28E+00	60.74	3.28E+00	0.00	1.00
IN-MO-530	0.38	4.95E+02	0.38	4.95E+02	0.00	1.00
IN-MO-535	1.14	1.34E+03	1.14	1.34E+03	0.00	1.00
IN-MO-540	3.79	3.07E+01	3.79	3.07E+01	0.00	1.00
IN-MO-545	0.38	7.24E+01	0.38	7.24E+01	0.00	1.00
IN-MX-142	6.06	1.08E+01	6.06	1.08E+01	0.00	1.00
IN-RF-090	55.74	6.34E+00	55.74	6.34E+00	0.00	1.00
IN-RF-311	2.91	1.52E+02	2.91	1.52E+02	0.00	1.00
IN-RF-361	0.42	3.87E+01	0.42	3.87E+01	0.00	1.00
IN-RF-393	20.38	5.52E+02	20.38	5.52E+02	0.00	1.00
IN-RF-409	13.31	1.37E+03	13.31	1.37E+03	0.00	1.00
IN-RF-410	8.32	1.37E+02	8.32	1.37E+02	0.00	1.00
IN-RF-411	8.74	3.02E+02	8.74	3.02E+02	0.00	1.00
IN-RF-412	0.42	7.31E+00	0.42	7.31E+00	0.00	1.00
IN-RF-414	2.08	1.04E+02	2.08	1.04E+02	0.00	1.00
IN-RF-420	5.41	1.19E+02	5.41	1.19E+02	0.00	1.00

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Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
IN-RF-421	41.60	2.06E+03	41.60	2.06E+03	0.00	1.00
IN-RF-422	8.74	8.78E+01	8.74	8.78E+01	0.00	1.00
IN-RF-697	9.15	4.62E-02	9.15	4.62E-02	0.00	1.00
IN-RF-753	10.82	2.68E+00	10.82	2.68E+00	0.00	1.00
IN-RF-817	11.23	2.65E+01	11.23	2.65E+01	0.00	1.00
IN-RF-823	7.49	1.35E+00	7.49	1.35E+00	0.00	1.00
IN-RF-990	38.69	3.13E+00	38.69	3.13E+00	0.00	1.00
WA-BNINW216	29.67	7.73E+01	29.67	7.73E+01	0.00	1.00
WA-ID-RF-S3114	45.00	3.88E+00	21.00	3.88E+00	-24.00	1.00
WC-BN510.3	13.30	7.64E+01	13.30	7.64E+01	0.00	1.00
WP-BN004	414.06	3.17E+03	189.55	3.17E+03	-224.51	1.00
WP-BN161	58.39	4.60E+02	27.30	4.60E+02	-31.09	1.00
WP-BN211	522.34	4.10E+03	243.18	4.10E+03	-279.16	1.00
WP-BN222	113.75	8.15E+02	50.82	8.15E+02	-62.93	1.00
WP-BN243	149.96	2.49E+02	71.40	2.49E+02	-78.56	1.00
WP-BN252	178.58	2.30E+03	88.20	2.30E+03	-90.38	1.00
WP-BN296	474.54	3.76E+03	237.09	3.76E+03	-237.45	1.00
WP-BN304	304.51	1.28E+04	143.01	1.28E+04	-161.50	1.00
WP-BN510	9632.16	3.23E+04	9631.04	3.23E+04	-1.12	1.00
WP-BN510.1	3412.52	2.07E+04	3412.52	2.07E+04	0.00	1.00
WP-BN510.2	75.90	8.85E+02	75.90	8.85E+02	0.00	1.00
WP-BN510.3	9.12	1.89E+02	9.12	1.89E+02	0.00	1.00
WP-BN600	2.31	1.05E-01	2.31	1.05E-01	0.00	1.00
WP-BN835	1089.70	1.59E+03	516.81	1.59E+03	-572.89	1.00
WP-BN836	1782.69	1.55E+03	821.73	1.55E+03	-960.96	1.00
WP-BNINW216	6179.06	4.79E+04	3054.71	4.79E+04	-3124.35	1.00
WP-BNINW218	607.74	1.64E+02	253.03	1.64E+02	-354.71	1.00
WP-ID-AECHDM	18.05	5.80E+01	16.38	5.80E+01	-1.67	1.00
WP-ID-AECHHM	8.38	1.78E+01	6.30	1.78E+01	-2.08	1.00
WP-ID-GEVNC-02	1.26	7.97E-02	1.26	7.97E-02	0.00	1.00
WP-ID-LBNL-S5400	0.21	1.05E-01	0.21	1.05E-01	0.00	1.00
WP-ID-LL-M001-S5400	43.24	6.26E+02	40.32	6.26E+02	-2.92	1.00
WP-ID-LL-T004-S3141	3.76	3.82E+01	1.05	3.82E+01	-2.71	1.00
WP-ID-LL-W019-S3900	5.97	3.33E+01	3.57	3.33E+01	-2.40	1.00
WP-ID-NRD.1	18.27	5.84E+02	18.27	5.84E+02	0.00	1.00

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Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
WP-ID-NTLBL-S3900	1.88	1.56E+00	0.21	1.56E+00	-1.67	1.00
WP-ID-NTLBL-S5400	2.09	6.38E+00	2.09	6.38E+00	0.00	1.00
WP-ID-NTLLLBL-S5400	1.88	6.00E-01	1.88	6.00E-01	0.00	1.00
WP-ID-NTLLNL-S3900	18.02	3.38E+01	12.60	3.38E+01	-5.42	1.00
WP-ID-NTLLNL-S5400	139.55	3.23E+02	136.42	3.23E+02	-3.13	1.00
WP-ID-NTLRC-S5400	0.21	2.82E+00	0.21	2.82E+00	0.00	1.00
WP-ID-NT-RF-DECON	0.42	9.82E-01	0.42	9.82E-01	0.00	1.00
WP-ID-NTS-EGG-HET	0.21	2.27E+00	0.21	2.27E+00	0.00	1.00
WP-ID-NTS-ITRI-S5310	0.21	8.74E-02	0.21	8.74E-02	0.00	1.00
WP-ID-NTS-TTR-HET	0.21	9.98E-02	0.21	9.98E-02	0.00	1.00
WP-ID-NTVERB-S5400	3.76	4.93E+01	3.76	4.93E+01	0.00	1.00
WP-ID-RF-BNL-ASH	0.21	1.38E+00	0.21	1.38E+00	0.00	1.00
WP-ID-RF-S3114	2665.50	4.37E+02	1225.23	4.37E+02	-1440.27	1.00
WP-ID-RF-S3150-A	247.56	3.98E+02	159.39	3.98E+02	-88.17	1.00
WP-ID-RF-S5100-A	641.62	1.21E+03	386.61	1.21E+03	-255.01	1.00
WP-ID-RF-S5126	250.79	1.75E+03	159.81	1.75E+03	-90.98	1.00
WP-ID-RF-S5300-A	2792.80	5.48E+02	1299.06	5.48E+02	-1493.74	1.00
WP-ID-SA-T001	5.88	2.12E+01	5.88	2.12E+01	0.00	1.00
WP-ID-SDA-DEBRIS	542.17	1.89E+03	452.33	1.89E+03	-89.84	1.00
WP-ID-SDA-SLUDGE	5758.48	1.36E+04	4495.68	1.36E+04	-1262.80	1.00
WP-ID-SDA-SOIL	1073.36	1.61E+03	719.04	1.61E+03	-354.32	1.00
WP-ID-SNL-HCF-S5400	2.72	1.55E+00	1.68	1.55E+00	-1.04	1.00
WP-ID-SNL-SOURCES-S5400	0.63	1.44E-01	0.63	1.44E-01	0.00	1.00
WP-INW161.001	19.32	3.17E+02	19.32	3.17E+02	0.00	1.00
WP-INW169.001	19.32	4.24E+01	19.32	4.24E+01	0.00	1.00
WP-INW198.001	49.56	7.63E+01	49.56	7.63E+01	0.00	1.00
WP-INW211.001	306.79	8.13E+03	304.08	8.13E+03	-2.71	1.00
WP-INW216.001	1256.77	6.13E+04	1252.17	6.13E+04	-4.60	1.00
WP-INW218.001	1117.41	1.80E+03	1115.95	1.80E+03	-1.46	1.00
WP-INW222.001	65.73	5.99E+02	65.73	5.99E+02	0.00	1.00

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Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
WP-INW243.001	75.60	5.46E+02	75.60	5.46E+02	0.00	1.00
WP-INW247.001R1	118.02	9.34E+02	118.02	9.34E+02	0.00	1.00
WP-INW252.001	61.53	7.42E+02	61.53	7.42E+02	0.00	1.00
WP-INW276.001	10.29	7.10E+01	10.29	7.10E+01	0.00	1.00
WP-INW276.002	16.17	1.07E+02	16.17	1.07E+02	0.00	1.00
WP-INW276.003	188.37	4.18E+03	188.37	4.18E+03	0.00	1.00
WP-INW276.004	47.25	8.93E+02	47.25	8.93E+02	0.00	1.00
WP-INW296.001	98.70	1.20E+03	98.70	1.20E+03	0.00	1.00
KN-B234TRU	747.41	1.68E+03	1585.81	3.56E+03	838.40	2.12
LA-CIN01.001	665.90	7.94E+04	1157.27	1.43E+05	491.37	1.80
LA-CIN02.001	121.40	7.48E+02	121.40	7.48E+02	0.00	1.00
LA-CIN03.001	2.91	8.61E-01	2.91	8.61E-01	0.00	1.00
LA-LA225D	4.78	2.58E+00	4.78	2.58E+00	0.00	1.00
LA-LA238HONR	1.89	1.40E+02	1.89	1.40E+02	0.00	1.00
LA-LA238HOR	0.21	8.52E+01	0.21	8.52E+01	0.00	1.00
LA-LAMHD02238	1.66	1.30E+01	0.41	1.30E+01	-1.26	1.00
LA-LAMIN04S	0.83	1.97E+02	0.20	1.97E+02	-0.63	1.00
LA-LANHD01	15.12	3.93E+01	15.12	3.93E+01	0.00	1.00
LA-LANHD02238	6.92	5.83E+02	5.98	5.83E+02	-0.94	1.00
LA-LANIN03NC	0.42	1.63E+02	0.10	1.63E+02	-0.31	1.00
LA-MHD01.001	8627.73	5.26E+05	19159.04	1.29E+06	10531.31	2.45
LA-MHD03.001	1555.33	3.95E+03	3422.57	8.72E+03	1867.24	2.21
LA-MHD04.001	99.14	4.79E+02	99.14	4.79E+02	0.00	1.00
LA-MHD05-ITRI.001	2.91	2.23E+01	2.91	2.23E+01	0.00	1.00
LA-MHD08.001	1.25	1.15E+00	0.78	1.15E+00	-0.47	1.00
LA-MHD09.001	23.16	1.25E+01	23.16	1.25E+01	0.00	1.00
LA-MIN02-V.001	17.72	7.43E+02	16.46	7.43E+02	-1.26	1.00
LA-MIN03-NC.001	59.73	6.06E+01	57.62	6.06E+01	-2.12	1.00
LA-MIN04-S.001	3.97	1.93E+02	2.28	1.93E+02	-1.69	1.00
LA-MIN05-V.001	2.72	9.70E+00	2.72	9.70E+00	0.00	1.00
LA-MSG04.001	62.71	1.27E+01	62.71	1.27E+01	0.00	1.00
LA-OS-00-01.001	294.41	1.67E+04	41.61	1.95E+04	-252.80	1.17
LA-OS-00-04	0.21	2.05E-01	0.01	2.05E-01	-0.20	1.00
LA-TA-00-01	82.24	3.52E+00	82.24	3.52E+00	0.00	1.00
LA-TA-03-10	64.88	1.31E+00	64.88	1.31E+00	0.00	1.00
LA-TA-03-14	9.45	2.35E+00	9.45	2.35E+00	0.00	1.00

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Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
LA-TA-03-28	1.04	2.23E+00	1.04	2.23E+00	0.00	1.00
LA-TA-03-30	0.21	4.30E-02	0.21	4.30E-02	0.00	1.00
LA-TA-03-CVD	2.08	1.40E+02	0.51	1.40E+02	-1.57	1.00
LA-TA-03-CVD-C&NC	4.58	3.82E+03	3.79	3.82E+03	-0.79	1.00
LA-TA-21-05	0.42	1.81E+00	0.42	1.81E+00	0.00	1.00
LA-TA-21-06	326.35	1.22E+04	326.35	1.22E+04	0.00	1.00
LA-TA-21-07	635.56	9.33E+03	635.56	9.33E+03	0.00	1.00
LA-TA-21-08	4.16	8.08E+01	4.16	8.08E+01	0.00	1.00
LA-TA-21-09	14.14	1.22E+03	14.14	1.22E+03	0.00	1.00
LA-TA-21-12	343.06	3.78E+04	343.06	3.78E+04	0.00	1.00
LA-TA-21-13	459.33	1.02E+04	459.33	1.02E+04	0.00	1.00
LA-TA-21-15	3.33	7.18E+00	3.33	7.18E+00	0.00	1.00
LA-TA-21-16	55.12	1.65E+03	55.12	1.65E+03	0.00	1.00
LA-TA-21-17	0.62	4.36E-02	0.62	4.36E-02	0.00	1.00
LA-TA-50-18	0.42	2.93E-01	0.42	2.93E-01	0.00	1.00
LA-TA-50-19	62.40	2.35E+01	62.40	2.35E+01	0.00	1.00
LA-TA-55-19	41.60	2.53E+03	41.44	2.53E+03	-0.16	1.00
LA-TA-55-21	2.29	2.22E+01	2.29	2.22E+01	0.00	1.00
LA-TA-55-30	79.37	2.57E+03	79.37	2.57E+03	0.00	1.00
LA-TA-55-38	0.83	1.93E+01	0.83	1.93E+01	0.00	1.00
LA-TRU-Empty-55	13.23	1.82E+01	13.23	1.82E+01	0.00	1.00
LA-TRU-Empty-85	79.38	1.46E+02	79.38	1.46E+02	0.00	1.00
WA-LA-MHD01.001	16.92	2.66E+02	6.70	2.66E+02	-10.22	1.00
WA-LA-MHD04.001	3.76	4.66E+01	3.76	4.66E+01	0.00	1.00
WC-LA-CIN01.001	86.95	4.00E+03	35.91	4.00E+03	-51.04	1.00
WC-LA-CIN02.001	0.94	7.64E-01	0.42	7.64E-01	-0.52	1.00
WC-LA-CIN03.001	1.10	8.87E-02	0.42	8.87E-02	-0.68	1.00
WC-LA-MHD01.001	76.77	1.74E+03	40.45	1.74E+03	-36.32	1.00
WC-LA-MHD03.001	5.95	6.34E+01	3.56	6.34E+01	-2.39	1.00
WC-LA-MHD04.001	83.26	3.83E+02	82.74	3.83E+02	-0.52	1.00
WC-LA-MHD05-ITRI.001	2.51	1.36E+01	1.05	1.36E+01	-1.46	1.00
WC-LA-MHD08.001	2.35	1.14E+01	0.63	1.14E+01	-1.72	1.00
WC-LA-MHD09.001	21.93	1.54E+01	20.06	1.54E+01	-1.87	1.00

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Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
WC-LA-MIN02-V.001	65.80	2.02E+03	26.45	2.02E+03	-39.35	1.00
WC-LA-MIN03-NC.001	19.90	5.99E+00	8.40	5.99E+00	-11.50	1.00
WC-LA-MIN04-S.001	1.88	5.09E+01	0.84	5.09E+01	-1.04	1.00
WC-LA-MIN05-V.001	2.04	1.40E+00	0.84	1.40E+00	-1.20	1.00
WC-LA-MSG04.001	0.47	2.33E-02	0.21	2.33E-02	-0.26	1.00
WP-LA-CIN01.001	526.19	2.96E+04	275.61	2.96E+04	-250.57	1.00
WP-LA-CIN02.001	121.97	1.26E+03	107.18	1.26E+03	-14.79	1.00
WP-LA-MHD01.001	5328.18	1.98E+05	3063.64	1.98E+05	-2264.54	1.00
WP-LA-MHD02.001	13.65	1.45E+03	13.65	1.45E+03	0.00	1.00
WP-LA-MHD02-PTX.001	0.63	2.78E-01	0.63	2.78E-01	0.00	1.00
WP-LA-MHD03.001	727.69	5.05E+03	662.79	5.05E+03	-64.90	1.00
WP-LA-MHD04.001	448.90	1.73E+03	443.95	1.73E+03	-4.95	1.00
WP-LA-MHD05-ITRI.001	12.78	4.22E+01	10.38	4.22E+01	-2.40	1.00
WP-LA-MHD08.001	9.24	6.63E+00	8.92	6.63E+00	-0.32	1.00
WP-LA-MHD09.001	87.59	7.20E+02	83.91	7.20E+02	-3.68	1.00
WP-LA-MHD10.001	65.80	2.98E+01	65.80	2.98E+01	0.00	1.00
WP-LA-MIN02-V.001	90.41	5.48E+03	65.97	5.48E+03	-24.44	1.00
WP-LA-MIN03-NC.001	797.75	9.05E+02	781.62	9.05E+02	-16.13	1.00
WP-LA-MIN04-S.001	67.68	2.34E+03	17.01	2.34E+03	-50.67	1.00
WP-LA-MSG04.001	4.18	8.24E-01	1.89	8.24E-01	-2.29	1.00
WP-LA-OS-00-01	0.42	1.54E+01	0.10	1.54E+01	-0.32	1.00
WP-LA-OS-00-01.001	259.98	2.75E+04	20.47	2.75E+04	-239.51	1.00
WP-LA-OS-00-03	14.70	2.34E+01	14.70	2.34E+01	0.00	1.00
WP-LA-OS-00-04	0.21	2.74E+00	0.00	2.74E+00	-0.21	1.00
WP-LA-TA-55-19.01	81.08	5.77E+02	81.08	5.77E+02	0.00	1.00
WP-LA-TA-55-19.02	230.57	2.55E+03	213.29	2.55E+03	-17.28	1.00
WP-LA-TA-55-30	96.15	7.29E+02	91.98	7.29E+02	-4.17	1.00
WP-LA-TA-55-43.01	189.88	4.39E+02	189.88	4.39E+02	0.00	1.00
LB-T001	0.43	2.06E-02	0.72	3.43E-02	0.29	1.66

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Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
LB-T002	0.43	1.83E-04	0.72	3.04E-04	0.29	1.66
LL-M001	506.74	8.40E+03	938.44	1.73E+04	431.70	2.06
LL-T004	0.21	2.02E-01	0.21	2.02E-01	0.00	1.00
LL-W018-S5100	370.44	1.04E+02	664.62	1.86E+02	294.17	1.79
LL-W018-SS	7.76	1.63E+02	3.03	2.60E+02	-4.73	1.59
LL-W019	42.43	5.82E+02	70.53	9.67E+02	28.10	1.66
WP-BLCHDN.001	1.68	2.52E-01	1.68	2.52E-01	0.00	1.00
WP-LL-M001-S5400	144.46	1.98E+03	141.54	1.98E+03	-2.92	1.00
ND-T001	0.42	2.87E+01	0.42	2.87E+01	0.00	1.00
ND-T002	1.66	3.64E+00	1.66	3.64E+00	0.00	1.00
NT-JAS-01	121.80	2.26E+02	199.96	3.71E+02	78.16	1.64
NT-W021	5.41	9.46E+01	5.41	9.46E+01	0.00	1.00
WP-NTLBL-S5400	1.68	3.33E+00	1.68	3.33E+00	0.00	1.00
WP-NTLRC-S5400	3.15	2.52E+01	3.15	2.52E+01	0.00	1.00
WP-NT-RF-BERYLLIUM	29.61	4.74E+01	29.61	4.74E+01	0.00	1.00
WP-NT-RF-GRAPHITE	3.78	7.00E+01	3.78	7.00E+01	0.00	1.00
WP-NT-RF-METAL	6.09	1.40E+01	6.09	1.40E+01	0.00	1.00
WP-NTS54332R0	309.83	9.44E+02	296.31	9.44E+02	-13.52	1.00
WP-NTS54COMR0	50.81	1.62E+02	49.56	1.62E+02	-1.25	1.00
WP-NTS54MIX1R0	0.42	4.66E-02	0.42	4.66E-02	0.00	1.00
OR-CHEM-CH-HET	30.99	2.70E+02	30.60	2.70E+02	-0.39	1.00
OR-CRF-CH-HET	7.07	6.43E+00	7.07	6.43E+00	0.00	1.00
OR-GENR-CH-HET	30.37	3.24E+01	30.02	3.24E+01	-0.35	1.00
OR-IFEL-CH-HET	19.14	6.34E+00	19.14	6.34E+00	0.00	1.00
OR-ISTP-CH-HET	135.41	6.40E+03	134.39	6.40E+03	-1.02	1.00
OR-MRF-CH-HET	8.53	2.83E+00	8.53	2.83E+00	0.00	1.00
OR-NBL-CH-HET	12.27	3.50E+00	12.27	3.50E+00	0.00	1.00
OR-NFS-CH-HET	105.66	3.84E+02	105.66	3.84E+02	0.00	1.00
OR-NFS-CH-HOM	8.74	3.28E+02	8.42	3.28E+02	-0.31	1.00
OR-NFS-CH-SOIL	142.06	6.89E+01	142.06	6.89E+01	0.00	1.00
OR-OXIDE-CH-HET	6.66	1.87E+03	0.42	1.87E+03	-6.24	1.00
OR-PGDP-CH-HET	6.86	4.24E+00	6.86	4.24E+00	0.00	1.00
OR-RADP-CH-HET	36.19	7.59E+01	36.00	7.59E+01	-0.20	1.00

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	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
OR-REDC-CH-HET	1259.53	4.92E+03	2103.86	8.24E+03	844.33	1.67
OR-REDC-CH-HOM	80.98	2.33E+03	184.21	5.30E+03	103.22	2.27
OR-RF-CH-HET	78.21	3.93E+02	77.66	3.93E+02	-0.55	1.00
OR-RF-CH-HOM	1.25	8.49E-02	1.25	8.49E-02	0.00	1.00
OR-SWSA-CH-HET	0.83	3.68E-01	0.83	3.68E-01	0.00	1.00
OR-SWSA-CH-SOIL	2.70	1.38E+01	2.70	1.38E+01	0.00	1.00
OR-TBD-CH-HET	27.04	3.74E+02	27.04	3.74E+02	0.00	1.00
OR-WSTR-CH-HET	8.53	9.27E+00	8.53	9.27E+00	0.00	1.00
OR-Y12-CH-HET	0.62	3.88E-02	0.62	3.88E-02	0.00	1.00
WP-OR-CHEM-CH-HET	10.71	7.99E+00	10.71	7.99E+00	0.00	1.00
WP-OR-GENR-CH-HET	4.20	2.61E+00	4.20	2.61E+00	0.00	1.00
WP-OR-ISTP-CH-HET	23.73	2.69E+02	23.73	2.69E+02	0.00	1.00
WP-OR-NBL-CH-HET	2.73	6.37E-01	2.73	6.37E-01	0.00	1.00
WP-OR-NFS-CH-HET	23.52	1.22E+01	23.52	1.22E+01	0.00	1.00
WP-OR-NFS-CH-HET-A	46.62	7.20E+01	46.62	7.20E+01	0.00	1.00
WP-OR-NFS-CH-SOIL	108.55	7.61E+02	106.26	7.61E+02	-2.29	1.00
WP-OR-RADP-CH-HET	47.88	5.32E+01	47.88	5.32E+01	0.00	1.00
WP-OR-REDC-CH-HET	105.21	3.89E+02	105.21	3.89E+02	0.00	1.00
WP-OR-RF-CH-HET	41.37	2.27E+02	41.37	2.27E+02	0.00	1.00
WP-RF001.01	986.46	9.91E+03	951.82	9.91E+03	-34.64	1.00
WP-RF002.01	1459.51	1.34E+04	1426.82	1.34E+04	-32.69	1.00
WP-RF003.01	358.61	3.10E+04	133.17	3.10E+04	-225.44	1.00
WP-RF004.01	285.55	2.12E+03	278.36	2.12E+03	-7.19	1.00
WP-RF005.01	120.54	1.37E+04	28.01	1.37E+04	-92.53	1.00
WP-RF005.02	79.17	1.14E+04	18.40	1.14E+04	-60.77	1.00
WP-RF006.01	237.93	2.86E+04	57.39	2.86E+04	-180.54	1.00
WP-RF008.01	98.06	9.33E+03	26.11	9.33E+03	-71.95	1.00
WP-RF009.01	1339.57	1.70E+05	320.03	1.70E+05	-1019.54	1.00
WP-RF010.01	630.50	1.58E+04	562.87	1.58E+04	-67.63	1.00
WP-RF011.01	79.86	3.37E+03	54.81	3.37E+03	-25.05	1.00
WP-RF015.01	1.68	5.58E+01	1.68	5.58E+01	0.00	1.00

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Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
WP-RF029.01	4324.01	2.32E+04	4313.96	2.32E+04	-10.05	1.00
WP-RF031.01	20.79	1.41E+02	20.47	1.41E+02	-0.32	1.00
WP-RF032.01	211.26	1.95E+04	51.51	1.95E+04	-159.75	1.00
WP-RF033.01	25.83	2.06E+03	16.64	2.06E+03	-9.19	1.00
WP-RF036.01	44.52	8.21E+02	44.52	8.21E+02	0.00	1.00
WP-RF101.01	175.94	4.86E+03	156.95	4.86E+03	-18.99	1.00
WP-RF101.29	30.65	4.44E+02	30.65	4.44E+02	0.00	1.00
WP-RF101.30	118.06	2.50E+03	93.64	2.50E+03	-24.42	1.00
WP-RF101.31	62.93	6.53E+02	60.64	6.53E+02	-2.29	1.00
WP-RF101.35	80.16	1.95E+03	73.69	1.95E+03	-6.47	1.00
WP-RF102.01	223.13	1.87E+03	221.46	1.87E+03	-1.67	1.00
WP-RF102.31	123.79	9.06E+02	120.18	9.06E+02	-3.61	1.00
WP-RF104.01	54.76	1.07E+03	45.46	1.07E+03	-9.30	1.00
WP-RF107.01	64.05	3.07E+03	64.05	3.07E+03	0.00	1.00
WP-RF107.03	61.53	8.22E+01	61.53	8.22E+01	0.00	1.00
WP-RF107.04	111.26	3.05E+02	104.79	3.05E+02	-6.47	1.00
WP-RF107.05	4.41	6.40E+01	4.41	6.40E+01	0.00	1.00
WP-RF107.06	14.49	9.31E+00	14.49	9.31E+00	0.00	1.00
WP-RF107.07	59.42	2.45E+03	57.75	2.45E+03	-1.67	1.00
WP-RF110.01	9.24	3.99E+02	9.08	3.99E+02	-0.16	1.00
WP-RF110.05	31.64	1.07E+03	19.95	1.07E+03	-11.69	1.00
WP-RF113.01	0.42	1.11E+00	0.42	1.11E+00	0.00	1.00
WP-RF115.01	115.87	5.34E+03	40.30	5.34E+03	-75.57	1.00
WP-RF116.01	3.99	1.83E+02	0.93	1.83E+02	-3.06	1.00
WP-RF117.01	1.89	7.48E+01	1.89	7.48E+01	0.00	1.00
WP-RF118.01	1446.06	1.73E+05	336.84	1.73E+05	-1109.22	1.00
WP-RF119.01	24.36	4.54E+02	23.55	4.54E+02	-0.81	1.00
WP-RF121.01	46.41	3.73E+03	10.78	3.73E+03	-35.63	1.00
WP-RF122.01	35.91	2.91E+03	9.63	2.91E+03	-26.28	1.00
WP-RF122.03	4.41	7.32E+01	4.41	7.32E+01	0.00	1.00
WP-RF122.04	54.60	7.67E+02	54.60	7.67E+02	0.00	1.00
WP-RF122.05	16.38	1.88E+01	16.38	1.88E+01	0.00	1.00
WP-RF122.06	7.35	5.41E+02	2.03	5.41E+02	-5.32	1.00
WP-RF123.01	9.44	6.49E+02	1.97	6.49E+02	-7.47	1.00
WP-RF123.02	0.84	2.60E-01	0.84	2.60E-01	0.00	1.00
WP-RF123.03	12.18	8.88E+02	12.18	8.88E+02	0.00	1.00
WP-RF123.04	44.94	2.56E+03	44.94	2.56E+03	0.00	1.00

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Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
WP-RF124.01	95.12	7.35E+02	95.12	7.35E+02	0.00	1.00
WP-RF124.02	13.44	1.96E+02	13.44	1.96E+02	0.00	1.00
WP-RF125.01	14.47	1.04E+03	6.29	1.04E+03	-8.18	1.00
WP-RF126.01	1.05	7.90E+01	0.24	7.90E+01	-0.81	1.00
WP-RF126.04	2.10	1.44E+02	0.49	1.44E+02	-1.61	1.00
WP-RF128.01	200.13	1.78E+04	46.51	1.78E+04	-153.62	1.00
WP-RF129.01	465.47	2.79E+03	462.89	2.79E+03	-2.58	1.00
WP-RF129.05	445.99	2.62E+03	445.99	2.62E+03	0.00	1.00
WP-RF130.01	38.79	1.76E+03	28.77	1.76E+03	-10.02	1.00
WP-RF134.02	11.28	2.83E+00	11.28	2.83E+00	0.00	1.00
WP-RF135.01	2.31	1.44E+01	2.31	1.44E+01	0.00	1.00
WP-RF135.02	10.50	1.93E+01	10.50	1.93E+01	0.00	1.00
WP-RF137.01	0.42	2.17E+00	0.42	2.17E+00	0.00	1.00
WP-RF139.01	11.76	4.47E+02	11.76	4.47E+02	0.00	1.00
WP-RF140.01	171.31	8.03E+02	171.31	8.03E+02	0.00	1.00
WP-RF141.01	45.99	3.79E+03	10.69	3.79E+03	-35.30	1.00
WP-RF141.02	177.66	1.58E+04	41.28	1.58E+04	-136.38	1.00
RL105-01	105.90	3.65E+02	105.90	3.65E+02	0.00	1.00
RL105-03	68.43	6.55E+02	68.43	6.55E+02	0.00	1.00
RL200-01	149.30	8.16E+01	149.30	8.16E+01	0.00	1.00
RL200-02	7176.77	2.33E+04	16309.33	5.30E+04	9132.56	2.27
RL201-03	13.52	7.21E+01	13.52	7.21E+01	0.00	1.00
RL202S-01	1.04	2.04E-01	1.04	2.04E-01	0.00	1.00
RL209E-01	349.92	1.41E+04	349.92	1.41E+04	0.00	1.00
RL216Z-02	375.99	1.33E+04	375.99	1.33E+04	0.00	1.00
RL221U-03	0.21	1.67E-03	0.21	1.67E-03	0.00	1.00
RL222S-01	122.20	6.39E+01	122.20	6.39E+01	0.00	1.00
RL231Z-01	1219.50	1.78E+03	1219.50	1.78E+03	0.00	1.00
RL231Z-03	0.62	5.74E-01	0.62	5.74E-01	0.00	1.00
RL233S-01	44.21	9.02E+01	44.21	9.02E+01	0.00	1.00
RL233S-03	5.20	1.26E+00	5.20	1.26E+00	0.00	1.00
RL300-01	181.15	1.92E+03	181.15	1.92E+03	0.00	1.00
RL300-03	5.62	8.13E+01	5.62	8.13E+01	0.00	1.00
RL308-01	589.37	8.85E+04	589.37	8.85E+04	0.00	1.00
RL308-03	0.42	9.84E-01	0.42	9.84E-01	0.00	1.00
RL325-01	1300.48	1.03E+04	1512.80	1.19E+04	212.33	1.16
RL325-03	9.98	3.90E+02	9.98	3.90E+02	0.00	1.00

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	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
RL618-01	2.25	1.65E+01	5.12	3.76E+01	2.87	2.27
RLALE-02	0.62	5.68E-02	0.62	5.68E-02	0.00	1.00
RLARG-01	13.31	3.96E+02	13.31	3.96E+02	0.00	1.00
RLBAT-01	45.18	1.55E+02	45.18	1.55E+02	0.00	1.00
RLBW-01	202.87	2.02E+03	202.87	2.02E+03	0.00	1.00
RLBW-03	4.37	7.24E+01	4.37	7.24E+01	0.00	1.00
RLCFF-01	4.58	3.72E+01	4.58	3.72E+01	0.00	1.00
RLCFF-03	4.99	4.88E+01	4.99	4.88E+01	0.00	1.00
RLCH2-01	8.85	5.86E+00	17.45	1.16E+01	8.60	1.97
RLESG-01	35.75	1.27E+02	35.75	1.27E+02	0.00	1.00
RLESG-03	1.04	4.42E-01	1.04	4.42E-01	0.00	1.00
RLEXX-01	129.79	1.27E+03	129.79	1.27E+03	0.00	1.00
RLFFTF-01	1.04	8.24E-02	1.04	8.24E-02	0.00	1.00
RLGEV-01	224.26	7.14E+02	224.26	7.14E+02	0.00	1.00
RLGEV-03	1.87	7.31E+01	1.87	7.31E+01	0.00	1.00
RLHAN-01	605.71	1.52E+03	605.71	1.52E+03	0.00	1.00
RLHAN-03	0.21	1.76E-01	0.21	1.76E-01	0.00	1.00
RLIAEA-03	0.42	2.27E+00	0.42	2.27E+00	0.00	1.00
RLMLL-01	1.04	2.40E-01	1.04	2.40E-01	0.00	1.00
RLP11-01	64.26	2.52E+01	64.26	2.52E+01	0.00	1.00
RLPFP-01	9397.18	7.39E+04	10305.50	8.10E+04	908.33	1.10
RLPFP-03	21.22	7.72E+02	21.22	7.72E+02	0.00	1.00
RLPFP-04	24.96	6.07E+02	24.96	6.07E+02	0.00	1.00
RLPURX-01	712.60	4.56E+04	712.60	4.56E+04	0.00	1.00
RLRFET-01	253.14	9.24E+01	253.14	9.24E+01	0.00	1.00
RLSAN-01	4.16	1.77E+02	4.16	1.77E+02	0.00	1.00
RLSWO-01	406.06	1.14E+03	463.84	1.30E+03	57.78	1.14
RLWAR-01	417.09	1.57E+03	417.09	1.57E+03	0.00	1.00
RLWAR-03	7.28	2.56E+01	7.28	2.56E+01	0.00	1.00
WP-RLBWD.001	91.98	1.39E+03	91.98	1.39E+03	0.00	1.00
WP-RLCBWD.001	207.48	1.97E+03	158.97	1.97E+03	-48.51	1.00
WP-RLCCP300D1	17.01	1.89E+02	17.01	1.89E+02	0.00	1.00
WP-RLCCP308D1	37.60	6.81E+01	37.60	6.81E+01	0.00	1.00
WP-RLCFFD.001	286.43	2.92E+03	251.16	2.92E+03	-35.27	1.00
WP-RLETECD.001	35.10	7.41E+01	16.17	7.41E+01	-18.93	1.00
WP-RLEXXOD.001	12.14	2.13E+02	6.93	2.13E+02	-5.21	1.00
WP-RLHMOX.001	195.72	4.08E+04	45.48	4.08E+04	-150.24	1.00

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Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
WP-RLM209ED.001	27.16	3.97E+02	11.34	3.97E+02	-15.82	1.00
WP-RLM231ZD.001	22.34	1.41E+02	18.27	1.41E+02	-4.07	1.00
WP-RLM233SD.001	50.96	1.35E+02	45.43	1.35E+02	-5.53	1.00
WP-RLM300D.001	31.34	1.94E+02	14.07	1.94E+02	-17.27	1.00
WP-RLM308D.001	82.51	8.30E+03	43.82	8.30E+03	-38.69	1.00
WP-RLM325D.001	231.51	2.51E+03	205.58	2.51E+03	-25.93	1.00
WP-RLMGEVALD.001	26.32	4.65E+01	11.34	4.65E+01	-14.98	1.00
WP-RLMHASH.001	62.79	4.96E+03	14.59	4.96E+03	-48.20	1.00
WP-RLMPDT.001	2130.11	3.30E+04	1658.62	3.30E+04	-471.49	1.00
WP-RLMPFPDD	451.49	4.71E+03	451.49	4.71E+03	0.00	1.00
WP-RLMPURX.001	149.84	7.38E+03	102.89	7.38E+03	-46.95	1.00
WP-RLMSSC.001	65.31	7.67E+03	15.18	7.67E+03	-50.13	1.00
WP-RLMWARD.001	106.65	4.74E+02	102.06	4.74E+02	-4.59	1.00
WP-RLNPDT.002	441.48	5.81E+03	383.88	5.81E+03	-57.60	1.00
WP-RLNPURX.001	39.15	2.97E+03	36.75	2.97E+03	-2.40	1.00
WP-RLRFETS.001	64.47	6.72E+03	14.98	6.72E+03	-49.49	1.00
WP-RLSWOCD.001	39.74	1.33E+02	32.13	1.33E+02	-7.61	1.00
WP-RLVIPAC.001	154.16	2.21E+03	154.16	2.21E+03	0.00	1.00
SA-W134	1.46	5.13E-01	1.46	5.13E-01	0.00	1.00
SA-W136	52.22	5.60E+02	104.33	1.12E+03	52.11	2.00
SA-W137	0.83	1.92E+00	0.83	1.92E+00	0.00	1.00
SA-W138M	0.21	1.38E-03	0.21	1.38E-03	0.00	1.00
SP-CHHD	6.29	2.54E+00	6.29	2.54E+00	0.00	1.00
SR-221H-EUOx	6.24	1.93E+01	1.53	1.93E+01	-4.71	1.00
SR-221H-PuOx	54.29	6.79E+03	13.31	6.79E+03	-40.98	1.00
SR-AGNS-HOM	2.31	8.39E+00	1.25	8.39E+00	-1.06	1.00
SR-BCLDP.003.001	0.21	2.37E-01	0.21	2.37E-01	0.00	1.00
SR-BCLDP.004.004	0.21	5.50E-02	0.21	5.50E-02	0.00	1.00
SR-BCLDP-HET	3.78	2.60E+01	3.78	2.60E+01	0.00	1.00
SR-DWPF-HET	0.21	1.97E-01	0.21	1.97E-01	0.00	1.00
SR-HBL-235F-HET	2.51	1.18E+00	2.51	1.18E+00	0.00	1.00
SR-KAC-HET	9.07	5.18E+01	18.25	1.04E+02	9.18	2.01
SR-KAC-PuOx	4499.06	1.51E+06	639.60	3.43E+06	-3859.46	2.27

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	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
SR-LA-PAD1	4.58	1.66E+03	4.58	1.66E+03	0.00	1.00
SR-MD-HET	14.69	7.87E+01	14.69	7.87E+01	0.00	1.00
SR-MD-PAD1	58.63	1.51E+04	58.63	1.51E+04	0.00	1.00
SR-MD-SOIL	2.08	9.96E-01	2.08	9.96E-01	0.00	1.00
SR-NIST-HET	0.21	2.70E+01	0.21	2.70E+01	0.00	1.00
SR-SDD-HET-A	5.65	3.47E+00	5.65	3.47E+00	0.00	1.00
SR-SDD-HOM-A	3.95	1.23E+01	3.95	1.23E+01	0.00	1.00
SR-SDD-HOM-B	10.63	5.01E+02	10.63	5.01E+02	0.00	1.00
SR-SWMF-HET-A	80.67	5.49E+02	94.44	6.43E+02	13.76	1.17
SR-SWMF-HET-B	1.04	2.23E+01	1.04	2.23E+01	0.00	1.00
SR-T001-WSB-1	4880.58	1.43E+05	11101.48	3.25E+05	6220.90	2.27
SR-W026-221F-HEPA	0.83	2.31E+00	0.83	2.31E+00	0.00	1.00
SR-W026-221F-HET	6.50	3.58E+01	6.50	3.58E+01	0.00	1.00
SR-W026-221F-HET-A	10.24	1.26E+01	10.24	1.26E+01	0.00	1.00
SR-W026-221F-HOM	1.46	7.11E+00	1.46	7.11E+00	0.00	1.00
SR-W026-772F-HET	78.12	7.17E+02	164.12	1.51E+03	86.01	2.10
SR-W026-MFFF-1	3212.56	1.00E+05	7307.35	2.29E+05	4094.79	2.27
SR-W026-WSB-2	597.25	4.17E+04	1358.52	9.49E+04	761.27	2.27
SR-W027-221F-HET-A	7.75	1.43E+01	7.75	1.43E+01	0.00	1.00
SR-W027-221H-HEPA	94.16	7.88E+02	114.38	9.58E+02	20.22	1.21
SR-W027-221H-HET	79.34	5.57E+03	79.34	5.57E+03	0.00	1.00
SR-W027-221H-HET-C	111.90	3.99E+02	207.39	7.39E+02	95.49	1.85
SR-W027-221H-HOM	0.83	2.60E+00	0.83	2.60E+00	0.00	1.00
SR-W027-235F-HEPA	9.87	8.75E+00	9.87	8.75E+00	0.00	1.00
SR-W027-235F-HET	7.11	7.81E+02	7.11	7.81E+02	0.00	1.00
SR-W027-235F-HOM	0.21	4.54E+01	0.21	4.54E+01	0.00	1.00
SR-W027-321-322M-HET	1.25	7.68E+01	1.25	7.68E+01	0.00	1.00
SR-W027-773A-HET	273.88	2.81E+03	492.35	5.05E+03	218.47	1.80
SR-W027-773A-HOM	1.04	6.01E+01	1.04	6.01E+01	0.00	1.00
SR-W027-FB-Pre86-C	67.32	5.83E+02	67.32	5.83E+02	0.00	1.00

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	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
SR-W027-HBL-Box	83.52	1.56E+02	83.52	1.56E+02	0.00	1.00
WA-SR-221H-PUOX	20.37	1.27E+03	4.73	1.27E+03	-15.64	1.00
WA-SR-MD-PAD1	22.18	4.80E+02	22.18	4.80E+02	0.00	1.00
WA-SR-W027-HBL-BOX	7.39	4.97E+02	7.39	4.97E+02	0.00	1.00
WP-SR2001.001.00	61.74	2.15E+01	61.74	2.15E+01	0.00	1.00
WP-SR2002.002.00	70.56	3.76E+01	70.56	3.76E+01	0.00	1.00
WP-SR-221H-PUOX	65.52	4.22E+03	15.23	4.22E+03	-50.29	1.00
WP-SR-AGNS-HET	59.17	3.44E+01	35.07	3.44E+01	-24.10	1.00
WP-SR-AGNS-HOM	4.81	1.42E+01	2.52	1.42E+01	-2.29	1.00
WP-SR-BCLDP.003.001	1.88	5.74E-01	0.42	5.74E-01	-1.46	1.00
WP-SR-BCLDP-HET	7.32	5.72E+00	7.32	5.72E+00	0.00	1.00
WP-SR-HBL-235F-HET	44.49	4.95E+01	44.49	4.95E+01	0.00	1.00
WP-SR-KAC-HET	0.21	2.02E-01	0.21	2.02E-01	0.00	1.00
WP-SR-LA-PAD1	149.25	3.06E+04	69.93	3.06E+04	-79.32	1.00
WP-SR-MD-HET	275.81	1.11E+03	269.87	1.11E+03	-5.94	1.00
WP-SR-MD-HOM-A	5.64	1.42E+02	2.31	1.42E+02	-3.33	1.00
WP-SR-MD-HOM-C	1.88	1.86E+00	0.63	1.86E+00	-1.25	1.00
WP-SR-MD-PAD1	594.09	9.58E+04	440.41	9.58E+04	-153.68	1.00
WP-SR-MD-SOIL	29.36	8.93E+00	21.03	8.93E+00	-8.33	1.00
WP-SR-SDD-HET-A	3.76	2.69E-01	3.76	2.69E-01	0.00	1.00
WP-SR-SDD-HOM-A	3.76	2.38E+00	1.47	2.38E+00	-2.29	1.00
WP-SR-SDD-HOM-B	16.32	1.56E+01	14.03	1.56E+01	-2.29	1.00
WP-SR-SWMF-HET-A	304.83	2.05E+03	270.22	2.05E+03	-34.61	1.00
WP-SR-W026-221F-HEPA	409.84	1.28E+03	409.84	1.28E+03	0.00	1.00
WP-SR-W026-221F-HET	1158.22	4.93E+03	836.48	4.93E+03	-321.74	1.00
WP-SR-W026-221F-HET-A	2.51	6.30E-01	1.05	6.30E-01	-1.46	1.00
WP-SR-W026-221F-HOM	13.21	6.20E+01	10.71	6.20E+01	-2.50	1.00
WP-SR-W026-772F-HET	1741.15	9.46E+03	884.02	9.46E+03	-857.13	1.00
WP-SR-W027-221F-HETA	2225.54	1.04E+04	1157.49	1.04E+04	-1068.05	1.00

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Waste Stream ID	Baseline Scenario (VOR_BL)		Proposed Scenario (VOR_PR)		Volume Change (VOR_PR - VOR_BL) (m^3)	Activity Ratio (VOR_PR/VOR_BL) (-)
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)		
WP-SR-W027-221F-HET-A	107.34	2.19E+02	104.22	2.19E+02	-3.12	1.00
WP-SR-W027-221H-HEPA	344.39	3.82E+03	344.39	3.82E+03	0.00	1.00
WP-SR-W027-221H-HET	3415.67	1.41E+05	1636.25	1.41E+05	-1779.42	1.00
WP-SR-W027-221H-HET-C	61.08	2.16E+02	56.70	2.16E+02	-4.38	1.00
WP-SR-W027-221H-HET-D	8.81	3.87E+00	7.56	3.87E+00	-1.25	1.00
WP-SR-W027-221H-HOM	4.60	2.11E+01	2.10	2.11E+01	-2.50	1.00
WP-SR-W027-235F-HEPA	80.84	1.90E+02	80.84	1.90E+02	0.00	1.00
WP-SR-W027-235F-HET	810.19	6.32E+04	447.39	6.32E+04	-362.80	1.00
WP-SR-W027-235F-HOM	5.24	6.19E+00	4.20	6.19E+00	-1.04	1.00
WP-SR-W027-321-322M-HET	3.15	4.91E-01	3.15	4.91E-01	0.00	1.00
WP-SR-W027-321M-HOM	1.88	3.90E-02	0.21	3.90E-02	-1.67	1.00
WP-SR-W027-773A-HET	887.32	6.20E+03	556.57	6.20E+03	-330.75	1.00
WP-SR-W027-773A-HOM	1.88	3.58E+01	0.63	3.58E+01	-1.25	1.00
WP-SR-W027-FB-PRE86-C	3171.54	1.67E+04	1592.89	1.67E+04	-1578.65	1.00
WP-SR-W027-HBL-BOX	1379.22	7.02E+03	1298.09	7.02E+03	-81.13	1.00
Grand Total	**1.68E+05**	**4.69E+06**	**1.68E+05**	**7.87E+06**	**0**	**1.68**

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Appendix C:

Tables C1, C2, and C3 below summarize nonradioactive inventory components for the baseline and proposed scenarios considered in VORPAIR-2017. Radionuclide solubilities are typically recalculated based on updated organic ligand inventory. Solubilities are used in calculating radionuclide concentrations that are used in DBR and release from the Culebra calculations (see Section 2.5). The modest increase in organic ligand inventory shown in Table C1 would result in increased solubilities, leading to increased released activity, the impact of which would be reduced ("normalized") by the increased WUF value in the proposed scenario.

Table C1. Organic ligands (kg) comparison for baseline and proposed scenarios

Organic Ligand	Baseline Scenario	Proposed Scenario	Net Change
Acetate	1.08E+04	1.28E+04	+1.98E+03
Acetic Acid	1.58E+04	1.67E+04	+9.69E+02
Citrate	2.64E+03	2.65E+03	+5.65E+00
Citric Acid	6.51E+03	6.56E+03	+4.90E+01
EDTA	1.70E+03	1.77E+03	+6.88E+01
Oxalate	1.95E+03	2.02E+03	+7.09E+01
Oxalic Acid	1.92E+04	1.92E+04	+4.63E+01
Grand Total	**5.85E+04**	**6.17E+04**	**+3.19E+03**

Table C2. Oxyanion (kg) comparison for baseline and proposed scenarios

Oxyanion	Baseline Scenario	Proposed Scenario	Net Change
Nitrate	1.81E+06	1.85E+06	+3.13E+04
Phosphate	2.26E+05	2.54E+05	+2.74E+04
Sulfate	4.69E+05	4.71E+05	+1.81E+03
Grand Total	**2.51E+06**	**2.57E+06**	**+6.05E+04**

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Table C3. CH Waste and packaging materials (kg) comparison for baseline and proposed scenarios

Waste Materials	Baseline Scenario	Proposed Scenario	Net Change
Iron-based Metal/Alloys	1.33E+07	1.51E+07	+1.80E+06
Aluminum-based Metal/Alloys	4.27E+05	7.78E+05	+3.51E+05
Other Metal/Alloys	7.81E+05	1.17E+06	+3.88E+05
Other Inorganic Materials	6.73E+06	1.21E+07	+5.39E+06
Cellulose	3.84E+06	4.37E+06	+5.32E+05
Rubber	1.01E+06	1.59E+06	+5.78E+05
Plastic	5.19E+06	7.19E+06	+2.00E+06
Cement*	1.76E+06	2.24E+06	+4.79E+05
Solidified Inorganic Material	1.17E+07	1.18E+07	+8.28E+04
Solidified Organic Material	5.56E+06	5.76E+06	+1.92E+05
Soil	5.87E+06	1.14E+07	+5.56E+06
Vitrified	--	--	--
Packaging Materials			
Cellulose	1.32E+06	2.04E+06	+7.20E+05
Plastic	2.92E+06	3.93E+06	+1.01E+06
Rubber	7.29E+04	9.61E+04	+2.33E+04
Steel	3.08E+07	3.84E+07	+7.57E+06
Lead	--	--	--
Grand Total	**9.14E+07**	**1.18E+08**	**+2.67E+07**

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