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TECHNICAL SUPPORT DOCUMENT FOR SECTIONS 194.25, 194.32 AND 194.33

COMPLIANCE RECERTIFICATION APPLICATION REVIEW OF FEATURES, EVENTS AND PROCESSES

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ACRONYM LIST

CARD	Compliance Application Review Documents
CCA	Compliance Certification Application
CCDFs	Complementary cumulative distribution functions
CFR	Code of Federal Regulations
CH	Contact handled
CRA	Compliance Recertification Application
DOE	U.S. Department of Energy
DP	Disturbed performance
DRZ	Disturbed rock zone
EPA	U.S. Environmental Protection Agency
FEP	Features, events, and processes
HCN	Historic, current, and near-future human activities
HI	Human-initiated
LWA	Land Withdrawal Act
PA	Performance Assessment
PAVT	Performance Assessment Verification Testing
RH	Remote handled
SO-C	Screened out, consequence
SO-P	Screened out, probability
SO-R	Screened out, regulatory
TRU	Transuranic waste
TSD	Technical Support Document
UP	Undisturbed performance
USDW	Underground sources of drinking water
WIPP	Waste Isolation Pilot Plant

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) evaluated features, events, and processes (FEPs) associated with the WIPP and surrounding areas in the original 1996 Compliance Certification Application (CCA) and included screened FEPs in its Performance Assessment (or PA) of the WIPP's ability to contain radioactive waste over a 10,000 year period. DOE is required to submit an application for recertification of the WIPP site to the U.S. Environmental Protection Agency (EPA or the Agency) every five years. The first Compliance Recertification Application (CRA) was submitted in March 2004 (US DOE 2004 also called CRA). DOE carried out a re-assessment of the FEPs which are documented in CRA Appendix PA Attachment SCR. DOE also documents details of the CRA FEP reevaluation in Wagner et al. 2003.

The Agency reviewed DOE's FEPs reevaluation for the CRA (US DOE 2004). EPA reviewed information provided with the CRA, and compared this information with similar information in the CCA to evaluate any changes in FEPs or DOE's FEPs review process. The results of this review confirmed the results of DOE's FEPs analysis that:

- Of 237 FEPs, 106 FEPs have not changed since the CCA.
- Of the 131 FEPs that have changed, 118 of the changes are updates to text descriptions, as well as additional information supporting the original CCA screening arguments.
- Only 13 FEPs have changed since the CCA (See Table I below):
  - Two new FEPs addressing solution mining (H58, *Solution mining for potash* and H59, *Solution mining for other resources*) that had been considered as part of an existing FEP, were added to the FEPs list.
  - Four FEPs (N17, Lateral Dissolution; N19, Solution Chimneys; H33, Flow Through Undetected Boreholes; and W38, Investigation Boreholes) were combined logically with other related FEPs.
  - Seven FEPs (W50, Galvanic coupling; W68, Organic complexation; W69, Organic ligands; H27, Liquid waste disposal; H28 Enhanced oil and gas production; H29, Hydrocarbon storage; and H41, Surface disruptions) had their Screening Decisions changed. However, these FEPs were all screened out in the CCA assessment, and for the CRA, only the basis for screening them out was changed.

The Agency's analysis identified no significant changes in drilling, fluid injection, or mining activities that have occurred in the WIPP area since the CCA that would warrant reconsideration or modification of FEPs. Additionally, no significant changes have occurred that require modifications to human-initiated PA input parameters other than those identified by DOE in the

CRA (e.g., DOE has tracked deep drilling rates and has modified the drilling rate accordingly). Also, DOE elected to modify human-intrusion related parameters, such as angular drilling velocity, to be consistent with the Agency's Performance Assessment Verification Test (PAVT) values; these types of modifications are appropriate (US EPA 1998a).

Table I – FEPs Changed Since the CCA

EPA FEP I.D.	FEP Name	Summary of Change
		FEPs Combined with other FEPs
N17	**Lateral Dissolution**	Combined with N16, **Shallow Dissolution**. N17 removed from baseline.
N19	**Solution Chimneys**	Combined with N20, **Breccia Pipes**, N19 removed from baseline.
H33	**Flow Through Undetected Boreholes**	Combined with H31, **Natural Borehole Fluid Flow**. H33 removed from baseline.
W38	**Investigation Boreholes**	Addressed in H31, **Natural Borehole Fluid Flow**, and H33, **Flow Through Undetected Boreholes**. W38 removed from baseline.
		FEPs With changed Screening Decisions
W50	**Galvanic Coupling**	SO-P to SO-C
W68	**Organic Complexation**	SO-C to UP
W69	**Organic Ligands**	SO-C to UP
H27	**Liquid Waste Disposal**	SO-R to SO-C
H28	**Enhanced Oil and Gas Production**	SO-R to SO-C
H29	**Hydrocarbon Storage**	SO-R to SO-C
H41	**Surface Disruptions**	SO-C to UP (HCN)
		New FEPs for CRA
H58	**Solution Mining for Potash**	Separated from H13, **Potash Mining**
H59	**Solution Mining for Other Resources**	Separated from H13, **Potash Mining**

From CRA Appendix PA, Attachment SCR, Table SCR-1

1.0 INTRODUCTION

1.1 Background and Regulatory Framework

The Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico, is an underground facility designed for the permanent disposal of transuranic (TRU) defense-related waste. The U.S. Department of Energy (DOE) operates the WIPP repository under the oversight of the U.S. Environmental Protection Agency (EPA or the Agency). DOE submitted the Compliance Certification Application (CCA) to the Agency in 1996 (US DOE 1996). After review of the CCA and supporting information, the Agency certified that DOE met regulatory requirements and the WIPP site began receiving waste in 1999. The WIPP Land Withdrawal Act (LWA; U.S. Congress 1992) requires that DOE submit an application for recertification of the WIPP site to the Agency every five years after initial receipt of waste. As part of the certification and recertification process, the DOE must demonstrate compliance of the WIPP site with the relevant radioactive waste disposal regulations. These regulations are contained in 40 CFR Part 191 and include requirements for:

- The containment of radionuclides in a disposal system, expressed in terms of release limits set forth in Appendix A, Table 1 of 40 CFR §191.13; and
- Individual protection requirements set forth in 40 CFR §191.15; and
- Groundwater protection as noted in 40 CFR §191, Subpart C.

Assessment of the likelihood that the WIPP will meet the requirements of §191.13, §191.15, and Subpart C is conducted through the performance assessment (PA) and compliance assessment processes. PAs carried out by the DOE must include both natural and man-made processes and events over the 10,000-year regulatory time frame (40 CFR §194.32). Thus, in the CCA, the DOE was required to determine and assess features, events, and processes (FEPs) associated with the WIPP and surrounding areas and to include, as applicable, these FEPs in its assessment of the WIPP's ability to contain radioactive waste over a 10,000-year period. Compliance assessments use methods similar to performance assessment, but do not incorporate human intrusion process.

Future States (§194.25) analysis as well as initial FEPs examination and assessment were important parts of the original certification process. FEP analysis was used to identify and assess credible natural, repository-induced, waste-induced, and human-initiated (HI) FEPs. Future States requirements allowed the exclusion of certain activities from consideration in the original performance assessment (See Section 4.0). For example, air drilling was excluded from the PA because it was not current practice at the time of the Agency's CCA review.

In addition, §194.33 sets forth specific requirements for incorporation of human-initiated drilling events in the PA.

1.2 Scope of Review

As part of its CCA review, the Agency performed a detailed analysis of DOE's FEPs, with particular emphasis on those FEPs related to human intrusion (HI) and future states. EPA issued a series of Technical Support Documents (TSDs) on HI FEPs (US EPA 1998a, 1998b, 1998c) and also Compliance Application Review Documents (CARDs) for relevant technical areas and each of the regulatory sections of 40 CFR 194 (US EPA 1997a, 1997b, 1997c, 1997d, 1997e).

The Agency, during the CCA review, examined DOE's categorization of HI activities and concluded that the activities analyzed by DOE capture the spectrum of activities that would occur during the 10,000-year regulatory time period. With regard to Future State Assumptions, the Agency found "*no potentially significant omissions in the lists of FEPs, and no major inadequacies in the CCA's descriptions of FEPs and related future state assumptions"* (1998d). EPA concluded that DOE adequately described all the future state assumptions that were applicable under 194.25(a) (US EPA 1998d).

For the Compliance Recertification Application (CRA) mandated by the LWA, the DOE carried out a re-assessment of FEPs, focused on evaluating any new information that could impact or result in inconsistencies regarding the screening arguments and decisions presented in the CCA. This re-assessment was described in CRA Appendix PA, Attachment SCR, and a separate report describing the process and its findings (Wagner et al. 2003). As part of the CRA review process, EPA carried out a detailed re-evaluation of the series of FEPs related to HI activities (US EPA 2004).

Given this background, the focus of this TSD is twofold:

- Review of the FEPs contained in the CRA (Appendix PA, Attachment SCR) in order to identify: (a) those FEPs that have not changed from the CCA; and (b) those FEPs that have changed since the CCA. In the latter case, the specific changes of interest are:

  - Existence of new FEPs;
  - FEPs for which the Screening Decision has changed, and the basis for the change;
  - FEPs that have been deleted and the reason for their removal.

  The objective of this review has been to establish whether EPA agrees with these changes and, if not, whether further examination of specific FEPs is warranted. The Agency review did not include in-depth technical analysis of FEP incorporation in the CRA, e.g., with respect to parameters.

- Re-examination of the FEPs that were originally screened out due to regulatory considerations under Future States (194.25(a)) (See Section 4.0). The goal of this review was to examine what has changed since the original certification and identify any changes in future states assumptions, in order to determine whether any new FEPs must be considered, or whether any FEPs originally screened out from the PA must be revisited. The analysis of 194.25(a) continued compliance was accomplished by:

  - Listing the places where future state assumptions were applied during the original certification (See Table 4);
  - Evaluating any changes that may impact future states or activities that were excluded and if those decisions have changed since the original certification; and
  - Identifying if there are any new future-states assumptions that should be considered and whether they should be excluded or included in the CRA PA.

Note that CFR 194.25(b) deals with potential changes to hydrologic and geologic conditions, which DOE was required to project into the future for use in the PA as part of the future states analysis. These 194.25(b) Future State requirements are not covered in the review described in this document.

2.0 DISCUSSION

2.1 Review Tables

The main results of DOE's FEPs review are shown in Table 1, Natural FEPs, Table 2, Waste- and Repository-Induced FEPs, and Table 3, Human-Initiated FEPs. Within each of these tables, information is presented as follows:

- The first column identifies the FEP number used by DOE in CRA Appendix PA, Attachment SCR.
- The second column list the name of each FEP as well as the feature, event, or process issue addressed by each FEP.
- Columns 3 and 4 contain the CCA Screening Decision and the CRA Screening Decision.
- Columns 5 and 6 identify the key parameters associated with each FEP and where these parameters are discussed in the CCA and CRA, respectively.
- The last column summarizes EPA's analysis of the FEP in the CCA and indicates whether DOE has provided any new information in the CRA.

The majority of FEPs that did not change since the CCA are not addressed in this TSD to avoid redundancy. Therefore, the optimal approach for understanding the Agency's review and conclusions regarding a particular FEP would be to consult the appropriate entry in the tables. For FEPs where an additional comment is merited beyond what is provided in Tables 1, 2 and 3, the relevant discussion section is identified in the last column of the tables.

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment[1]**
N1	*Stratigraphy* Disposition and properties of geological formations control system performance	UP	No change	Accounted for through model geometries (discussed in Section 6.4.2) Appendix PAR, Table PAR-57, *Reference Thicknesses for Hydrostratigraphic Units in BRAGFLO*	Same Appendix PA, Attachment PAR, Table PAR-49	CCA: Screening arguments for N1 and N2 appeared reasonable to the Agency CRA: No new information was identified for this FEP
N2	*Brine reservoirs* Pressurized brine reservoirs may be present in the Castile beneath controlled area	DP	No change Appendix PA, Attachment SCR (p. 26) discusses N2 under Stratigraphy but with Screening Decision UP. However, Table SCR-2 contains the correct screening decision.	Accounted for in the treatment of inadvertent drilling (Sections 6.4.12.6, Probability of Intersecting a Brine Reservoir; and 6.4.8, Castile Formation and Brine Reservoir) Appendix PAR, Parameters 27, *Brine far-field pore pressure*; 28, *Log intrinsic permeability*, X-, Y-, Z-, Castile Brine Reservoir; 29 *Bulk compressibility*; and 31, *Index for selecting brine pocket* Table PAR-30, *Culebra Member of the Rustler Formation Parameters*	Same Appendix PA Attachment PAR, Parameters 27 (same), 28 (same), 29 (same) and 31, not used in CRA Table PAR-26	

[1] Unless otherwise noted, new information is discussed under the appropriate FEP in Appendix PA, Attachment SCR.

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N3	*Changes in regional stress* Tectonic activity on a regional scale may change level of stress	SO-C	No change In Appendix PA, Attachment SCR, Section SCR-4.1.2, p. 26), the numbers for this FEP and the following one have been exchanged. However, these FEPs are considered together and all have the same Screening Decision	None	None	CCA: Screening arguments for N3-N5 appeared reasonable to the Agency CRA: Seismic monitoring since the CCA continues to record small events but distant from WIPP. Recent nearby events linked to rockfalls rather than tectonics
N4	*Regional tectonics* Tectonic setting of the region governs current level of stress	SO-C	No change In Appendix PA, Attachment SCR, Section SCR-4.1.2, p. 26), the numbers for this FEP and the previous one have been exchanged. However, these FEPs are considered together and all have the same Screening Decision	None	None	
N5	*Regional uplift and subsidence* Tectonic activity on a regional scale could cause uplift and subsidence	SO-C	No change	None	None	

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N6	*Salt deformation* Salt formations may deform under gravity or other forces	SO-P	No change; UP near repository	None	None	CCA: Screening arguments for N6, N7 appeared reasonable to the Agency CRA: Recent study supports DOE's screening decision in CCA
N7	*Diapirism* Buoyancy forces may cause salt to rise through denser rocks	SO-P	No change	None	None	
N8	*Formation of fractures* Changes in stress may cause new fracture sets to form	SO-P	No change; UP near repository	None	None	CCA: Screening arguments for N8 and N9 appeared reasonable to the Agency CRA: Additional text added to screening argument to reflect recent studies and to emphasize that the formation of fractures, or changes in fracture properties near the repository is addressed in the PA via treatment of the disturbed rock zone (DRZ)
N9	*Changes in fracture properties* Changes in the local stress field may change fracture properties such as aperture and asperity	SO-C	No change; UP near repository	None	None	
N10	*Formation of new fault(s)* Tectonic activity on a regional scale could cause new faults to form	**SO-C** (CCA, Appendix SCR, Table SCR-1)	**SO-P**	None	None	CCA: Screening arguments for N10 and N11 appeared reasonable to the Agency CRA: Additional text added to screening argument to reflect seismic monitoring since CCA **CRA: Appendix PA, Attachment SCR, Section SCR-4.1.3.2.3.2 states that no changes have been made to the FEP Screening Decision for these FEPs. Text in CCA (Appendix SCR, Section SCR.1.1.3.3) indicates that Screening Decision should be SO-P.** These FEPs are discussed further in Section 2.2.1
N11	*Fault movement* Movement along faults in the Rustler or in units below the Salado could affect the hydrogeology	**SO-C** (CCA, Appendix SCR, Table SCR-1)	**SO-P**	None	None	

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N12	*Seismic activity* Ground shaking may give rise to cracking at free surfaces such as the roof of the repository	UP	No change	Potential effects accounted for by the DRZ, zone of permanently high permeability (see Section 6.4.5.3, DRZ) Appendix PAR, Table PAR-37, *Disturbed Rock Zone Parameters*	Same Also Table 6-19, DRZ Parameter Values Appendix PAR, Attachment PAR, Table PAR-33	CCA: Screening argument appeared reasonable to the Agency The Agency required DOE to treat DRZ permeability as uncertain during the PAVT; also anhydrite fracture model was applied to DRZ for PAVT (US EPA 1998e) CRA: No new information identified. Same treatment of DRZ as in PAVT
N13	*Volcanic activity* Igneous material feeding volcanoes or surface flows could affect disposal system performance	SO-P	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
N14	*Magmatic activity* Subsurface intrusion of igneous rocks could affect disposal system performance	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
N15	*Metamorphic activity* High pressures and/or temperatures could cause solid state recrystallization changes	SO-P	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N16	***Shallow dissolution*** Percolation of groundwater and dissolution in the Rustler may increase transmissivity	**UP**		Effects included in PA calculations through use of multiple transmissivity fields (no cross-reference in Appendix SCR) – Section 6.4.6.2, The Culebra Appendix PAR, Parameters 35, *Index for selecting realizations of the transmissivity field*; 50, *Culebra advective porosity*; and 51, *Diffusive porosity for Culebra dolomite*	Same Appendix PA, Attachment PAR, sampled Parameters 47, 50 and 51	CCA: Screening argument appeared reasonable to the Agency CRA: Text modified substantially to account for deletion of N17. Results from recent studies (more extensive borehole geological database) presented. No justification for changing how the transmissivity field for the Culebra is treated within PA calculations This FEP is discussed further in Section 2.2.1
N17	***Lateral dissolution*** Dissolution at the Rustler – Salado contact may create pathways and/or increase transmissivity	**SO-C**	**Removed from baseline - no longer separate FEP; combined with N16, *Shallow dissolution*. Note that CCA Screening Decisions were different for these two FEPs**	---	---	CCA: Screening argument appeared reasonable to the Agency CRA: Features and processes are considered very similar to Shallow dissolution This FEP is discussed further in Section 2.2.1

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N18	*Deep dissolution* Dissolution in the Castile or at the base of the Salado may create pathways	SO-P	No change	As above	As above	CCA: Screening arguments for N18-N21 appeared reasonable to the Agency Additional information on *Deep dissolution* and the formation of *Breccia pipes* was provided by DOE and adequately addresses this issue (US EPA 1997a). The Agency concluded that the rate or magnitude of deep dissolution is not high enough to threaten integrity of WIPP over next 10,000 years CRA: Solution chimneys and Breccia pipes are equivalent as used in CCA, so N19 has been removed from CRA FEPs. These FEPs are discussed further in Section 2.2.1
N19	***Solution chimneys*** Dissolution cavities in the Castile or at the base of the Salado may propagate towards the surface	**SO-P**	**Removed from baseline - no longer separate FEP; combined with N20 *Breccia pipes***	---	---	
N20	***Breccia pipes*** Formations above deep dissolution cavities may fracture	**SO-P**	No change **FEP now combined with N19, *Solution chimneys* which has been removed**	See H1	See H1	
N21	*Collapse breccia* Dissolution may result in collapse of overlying units	SO-P	No change	None	None	
N22	*Fracture infills* Precipitation of minerals as fracture infills can reduce hydraulic conductivities	SO-C - Beneficial	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N23	*Saturated groundwater flow* Groundwater flow beneath the water table is important to disposal system performance	UP	No change	Accounted for (see Sections 6.4.5, The Salado; and 6.4.6, Units Above the Salado) Appendix HYDRO, Geohydrology of Proposed WIPP; Appendix BRAGFLO, Sections 4.1 to 4.4, 4.8, 4.9, under Section 4, Description of Models and Methods	Same MODFLOW-2000 code replaces SECOFL2D, incorporating spatially varying transmissivity (see Appendix PA, Attachment TFIELD)	CCA: Screening arguments for N23-N25 appeared reasonable to the Agency. The Agency initially questioned how DOE treated *Infiltration* and *Fracture flow* in PA. After examining data, the Agency concluded that DOE has included transmissivity and flow velocity variations in the Culebra CRA: No new information identified
N24	*Unsaturated groundwater flow* The presence of air or other gas phases may influence groundwater flow	UP SO-C for Culebra	No change			
N25	*Fracture flow* Groundwater may flow along fractures as well as through interconnected pore space	UP	No change			
N26	*Density effects on groundwater flow* Spatial variability of groundwater density could affect flow directions	SO-C	No change	Excluding brine density variations within Culebra and their effect on groundwater flow is conservative	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
N27	*Effects of preferential pathways* Groundwater flow may not be uniform, and may occur along particular pathways	UP UP in Salado and Culebra	No change	Accounted for via estimates of transmissivity and aquifer thickness (no cross-reference provided in Attachment SCR) Appendix TFIELD, Culebra Transmissivity Fields, Sections 2.2, Culebra Hydrologic Data Appendix PAR, Parameters 35, *Index for selecting realizations of the transmissivity field*; 50, *Culebra advective porosity*; and 51, *Diffusive porosity for Culebra dolomite*	Same Appendix PA, Attachment PAR, sampled Parameters 47, 50 and 51	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N28	*Thermal effects on groundwater flow* Natural temperature variability could cause convection or otherwise affect groundwater flow	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
N29	*Changes in groundwater flow – Saline intrusion* The introduction of more saline water into the Rustler could affect groundwater flow	SO-P	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
N30	*Changes in groundwater flow - Freshwater intrusion* The introduction of freshwater water into the Rustler could affect groundwater flow	SO-P	No change	None	None	None
N31	*Hydrological response to earthquakes* Fault movement can affect groundwater flow directions and pressure changes can affect groundwater levels and movement	SO-C	No change	None	None	None
N32	*Changes in groundwater flow - Natural gas intrusion* The introduction of natural gas from formations beneath the repository could affect groundwater flow	SO-P	No change	None	None	None

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N33	*Groundwater geochemistry* Groundwater geochemistry influences actinide retardation and colloid stability	UP	No change	Salado and Castile brines: accounted for via actinide source term (see Section 6.4.3.4, Chemical Conditions in the Repository). Culebra brine: accounted for via retardation factors for actinide transport (see Section 6.4.6.2, The Culebra) Appendix PAR, Parameters 36 to 45, *Solubilities of actinides in different oxidation states, Salado and Castile Formations*; 52 to 57, *Matrix distribution coefficients for U+6, U+4, Pu+3, Pu+4, Th+4, Am+3*, all sampled parameters; Table PAR-39, *Waste Chemistry Parameters*	Same Appendix PA, Attachment PAR, sampled parameters 34 to 43 Appendix PA, Attachment PAR, sampled parameters 52 to 57; Table PAR-35	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. Key property is salinity (affects retardation and colloid stability)
N34	*Saline intrusion (geochemical effects)* The introduction of more saline water into the Rustler could affect actinide retardation and colloid stability	SO-C	No change	In any case, K_d values for actinides based on saline solutions.	None	CCA: Screening argument appeared reasonable to the Agency CRA: Considered with N38. No new information identified. Low probability *natural* event as well as low consequence. Injection of Castile-Formation or Salado brines into the Culebra as a result of human intrusion was included in PA calculations for the CCA and the Agency's PAVT and is included in the CRA

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N35	*Freshwater intrusion (geochemical effects)* The introduction of freshwater into the Rustler could affect actinide retardation and colloid stability	SO-C	No change	None	None	CCA: Screening arguments for N35-N37 appeared reasonable to the Agency CRA: Additional discussion on extent and timing of recharge of Culebra; screening arguments based on conclusion that "*consequences of such recharge are probably reflected in the ranges of geochemical conditions currently observed in the Culebra as a whole*"
N36	*Changes in groundwater Eh* Changes in oxidation potentials could affect radionuclide mobilization	SO-C	No change	None	None	
N37	*Changes in groundwater pH* Changes in pH could affect colloid stability and radionuclide mobility	SO-C	No change	None	None	
N38	*Effects of dissolution* [on groundwater chemistry] Dissolution could affect groundwater chemistry and hence radionuclide transport	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: See information on N34
N39	*Physiography* The physiography of the area is a control on the surface water hydrology	UP	No change	Accounted for in "setup" of PA calculations (see Section 6.4.2,The Culebra) Appendix PAR, Table PAR-57, *Reference Thicknesses for Hydrostratigraphic Units in BRAGFLO*	Same Appendix PA, Attachment PAR, Table PAR-49	The Agency considered the CCA screening evaluation to be technically reasonable CRA: No new information identified
N40	*Impact of large meteorite* A large meteorite could fracture the rocks above the repository	SO-P	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N41	*Mechanical weathering* Processes such as freeze-thaw affect the rate of erosion	SO-C	No change	None	None	CCA: Screening arguments for N41 and N42 appeared reasonable to the Agency CRA: No new information identified
N42	*Chemical weathering* Breakdown of minerals in the surface environment affects the rate of erosion	SO-C	No change	None	None	
N43	*Aeolian erosion* The wind can erode poorly consolidated surface deposits	SO-C	No change	None	None	CCA: Screening arguments for N43-N45 appeared reasonable to the Agency CRA: No new information identified
N44	*Fluvial erosion* Erosion by rivers and streams could affect surface drainage	SO-C	No change	None	None	
N45	*Erosion - Mass wasting* Gravitational processes can erode material on steep slopes	SO-C	No change	None	None	
N46	*Aeolian deposition* Sand dunes and sheet sands may be deposited by the wind and affect surface drainage	SO-C	No change	None	None	CCA: Screening arguments for N46-N49 appeared reasonable to the Agency CRA: No new information identified for these depositional processes
N47	*Fluvial deposition* Rivers and streams can deposit material and affect surface drainage	SO-C	No change	None	None	
N48	*Lacustrine deposition* Lakes may be infilled by sediment and change the drainage pattern	SO-C	No change	None	None	
N49	*Sedimentation - Mass wasting* Land slides could block valleys and change the drainage pattern	SO-C	No change	None	None	

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N50	*Soil development* Vegetation and surface water movement is affected by the types of soil present	SO-C	No change	None	None	The Agency considered the CCA screening argument to be technically valid CRA: No new information identified
N51	*Stream and river flow* The amount of flow in streams and rivers affects erosion and deposition	SO-C	No change	None	None	CCA: Screening argument appeared technically reasonable to the Agency CRA: No new information identified
N52	*Surface water bodies* The disposition of lakes is a control on the surface hydrology	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
N53	*Groundwater discharge* The amount of water leaving the groundwater system to rivers, springs and seeps affects the groundwater hydrology	UP	No change	Accounted for via groundwater flow modeling (see Section 6.4.10.2, Culebra Flow and Transport Modeling) Parameters include Height of water table, Vertical hydraulic conductivity, and Partitioning of precipitation among evapotranspiration, runoff, and infiltration Appendix PAR, Parameter 35, *Index for selecting realizations of transmissivity field*; Table PAR-30, *Culebra Member of the Rustler Formation Parameters*	Same Appendix PA, Attachment PA, Parameter 47 Table PAR-26	CCA: Screening arguments for N53-N55 appeared reasonable to the Agency CRA: No new information identified
N54	*Groundwater recharge* The amount of water passing into the saturated zone affects the groundwater hydrology	UP	No change			
N55	*Infiltration* The amount of water entering the unsaturated zone controls groundwater recharge	UP	No change			

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N56	*Changes in groundwater recharge and discharge (as a result of climate change)* Changes in climate and drainage pattern may affect the amount of water entering and leaving the groundwater system	UP	No change	Changes in groundwater recharge and discharge are accounted for through definition of boundary conditions for flow and transport in the Culebra (see Section 6.4.9, Climate Change) Appendix MASS, Section 14.2; Appendix PAR, Parameter 48, *Climate index*	Same Same	CCA: Screening argument appeared reasonable to the Agency CRA: No new information found that would justify change in screening decision
N57	*Lake formation* Formation of new lakes will affect the surface hydrology	SO-C	No change	None	None	The Agency considered CCA screening arguments for N57 and N58 to be technically valid, although a screening argument based on probability appeared more appropriate CRA: No new information identified
N58	*River flooding* Flooding will affect the area over which infiltration takes place	SO-C	No change	None	None	
N59	*Precipitation (e.g., rainfall)* Rainfall is the source of water for infiltration and stream flow	UP	No change	Accounted for via sampled parameter for scaling groundwater flow velocity in Culebra (see Section 6.4.9, Climate Change) Appendix PAR, Parameter 48, *Climate index*	Same Same	CCA: Screening arguments for N59 and N60 appeared reasonable to the Agency CRA: No new information identified
N60	*Temperature* The temperature influences how much precipitation evaporates before it reaches streams or enters the ground	UP	No change	Same as above (N59)	Same as above (N59)	

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N61	*Climate change* Temperature and precipitation will vary as natural changes in the climate take place	UP	No change	Same as N59	Same as N59	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
N62	*Glaciation* Natural climate change could lead to the growth of glaciers and ice sheets	SO-P	No change	None	None	CCA: Screening arguments for N62 and N63 appeared reasonable to the Agency CRA: No new information identified
N63	*Permafrost* The regions in front of advancing ice sheets will be subject to frozen ground preventing infiltration	SO-P	No change	None	None	
N64	*Seas and oceans* The volume and circulation patterns in seas and oceans would affect the distribution of radionuclides	SO-C	No change	None	None	CCA: Screening arguments for N64 and N65 appeared reasonable to the Agency CRA: No new information identified
N65	*Estuaries* Water movement in estuaries would affect the distribution of radionuclides	SO-C	No change	None	None	
N66	*Coastal erosion* Coastal erosion could affect the local groundwater system	SO-C	No change	None	None	CCA: Screening arguments for N66 and N67 appeared reasonable to the Agency CRA: No new information identified
N67	*Marine sediment transport and deposition* Transport and deposition could affect the distribution of radionuclides	SO-C	No change	None	None	

Table 1. NATURAL FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
N68	*Sea level changes* Sea level changes would affect coastal aquifers	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
N69	*Plants* Plants may play a role in the hydrological cycle by taking up water	SO-C	No change	None	None	CCA: Screening arguments for N69 and N70 appeared reasonable to the Agency CRA: No new information identified
N70	*Animals* Burrowing animals can affect the structure of surface sediments	SO-C	No change	None	None	
N71	*Microbes* Microbes can be important in soil development. Microbes in groundwater may sorb radionuclides	SO-C UP for colloidal effects [W78] and gas generation [W44]	No change	None Appendix MASS, Section 15.3, Colloidal Actinide Transport in the Culebra	None Same	CCA: Screening argument appeared reasonable to the Agency CRA: Additional information provided in screening argument to support screening decision. Size effect (large sizes) will result in rapid filtering
N72	*Changes in flora & fauna - natural ecological development* Changes in climate may cause changes in the types of vegetation and animals present	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Key

UP: FEPs included in the PA as *undisturbed* performance. Note that UP FEPs and DP FEPs must be considered to evaluate compliance with 40 CFR §191.13.

SO-C: FEPs screened out based on consequence. **SO-P**: FEPs screened out based on low probability.

SO-R: FEPs screened out based on regulations.

Table 2. WASTE- and REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment[2]**
W1	*Disposal geometry* WIPP repository disposal geometry will influence flow and transport patterns	UP	No change	Accounted for in setup of PA calculations (see Section 6.4.3, The Repository)	Same (see Section 6.4.2.1, Model Geometries, Disposal System)	CCA: Screening argument appeared technically reasonable to the Agency CRA: Repository layout changed since CCA but no effect on screening decision
W2	*Waste inventory* The quantity and type of radionuclides emplaced in the repository will dictate performance requirements	UP	No change	Accounted for in deriving dissolved actinide source term and gas generation rates (see Sections 6.4.3.5, Dissolved Actinide Source Term; and 6.4.3.3, Gas Generation) Appendix BIR, Baseline Inventory Report Appendix WCA, Waste Characterization Analysis, Sections 3.2, 8.2 and 8.3 Appendix PAR, Table PAR-41, *Isotope Inventory*	Same Appendix PA, Attachment PAR, Table PAR-37	CCA: Screening arguments for W2 and W3 appeared technically reasonable to the Agency CRA: No new information identified
W3	*Heterogeneity of waste forms* The distribution of radionuclides within the different waste types could affect release patterns	DP	No change	Distribution of CH and RH TRU waste accounted for when considering potential activity of waste material encountered during inadvertent borehole intrusion (see Section 6.4.7. The Intrusion Borehole) Appendix WCA, Waste, Section 3.2.1, Radionuclides Included in Direct Releases by Cuttings, Cavings and Spallings	Same Appendix PA, Sections PA-4.5 and PA-4.6	

[2] Unless otherwise noted, new information is discussed under the appropriate FEP in Appendix PA, Attachment SCR.

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W4	*Container form* The type and shape of waste container will affect heat dissipation and container strength	SO-C - Beneficial	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Additional information reflecting the updated waste inventory is provided in the screening argument
W5	*Container material inventory* Steel and other materials will corrode and affect the amount of gas generated	UP	No change	Accounted for through estimation of gas generation rates (see Section 6.4.3.3, Gas Generation). Appendix PAR, Parameter 1, *Inundated corrosion rate for steel without CO_2 present*; Table PAR-43, *Stoichiometric Gas Generation Model Parameters*	Same Appendix PA, Attachment PAR, Parameter 1 and Table PAR-39	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W6	*Seal geometry* Size, location, and materials of shaft seals, ad panel and drift closures will affect flow-patterns and transport pathways	UP	No change	Accounted for through representation of seal system in BRAGFLO (see Section 6.4.4, Shafts and Shaft Seals) Appendix PAR, Figure PAR-2, *Shaft-Seal System Conceptual Framework*	Same Figure 6-14, Appendix PA, Attachment PAR, Figure PA-11	CCA: Screening arguments for W6 and W7 appeared reasonable to the Agency CRA: No new information identified. New shaft model underwent peer review as required; was incorporated in BRAGFLO (Appendix PA, Attachment PA, Section PA.4.2.7)
W7	*Seal physical characteristics* Porosity and permeability of seals will control flow rates	UP	No change	As above (W7) Appendix PAR, Parameters 9 to 11, *Log intrinsic permeability* X-, Y-, Z-directions, various seals (clays, concrete and asphalt columns); Tables PAR-16 to PAR-24, *Shaft Material Parameters*	As above (W7); simplified seal system model Appendix PA, Attachment PAR, Parameters 64, Log intrinsic permeability – upper portion of simplified shaft; 65, Log intrinsic permeability – lower portion of simplified shaft (0-200 yrs); 66, Log intrinsic permeability – lower portion of shaft (200-10,000 yrs); Table PAR-19, Shaft Material Parameters	

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W8	*Seal chemical composition* The chemistry of seal materials could affect actinide speciation and mobility	SO-C - Beneficial	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Additional evidence provided in support of beneficial consequence to repository performance
W9	*Backfill physical properties* The amount and distribution of backfill could affect porosity and permeability of disposal rooms	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W10	*Backfill chemical composition* The chemical behavior of the backfill will affect actinide speciation and mobility	UP	No change	Accounted for in deriving dissolved and colloidal actinide source terms (see Section 6.4.3, The Repository) Appendix PAR, Parameters 36 to 47, *Log of distribution of solubilities of actinides in different oxidation states, in Castile and Salado brines* Table PAR-39, *Waste Chemistry Parameters*	Same Appendix PA, Attachment PAR, Parameters 34-45; Table PA-35	CCA: Screening argument appeared reasonable to the Agency. The Agency had questioned the *"effectiveness of MgO as a sequestering agent and lack of experimental data backing up the assessment."* DOE submitted additional experimental data as requested. The Agency also questioned the magnesium carbonate mineral species used to calculate actinide solubilities and required new solubility values to be used in PAVT (US EPA 1997e) CRA: No new information identified, magnesium carbonate phase specified in the PAVT used for the CRA PA
W11	*Postclosure monitoring* Inappropriate monitoring after closure could affect performance	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. Screening argument modified to reference 40 CFR 194.42(d)

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W12	*Radionuclide decay and ingrowth* Radioactive decay of waste radionuclides will change and decrease the inventory with time	UP	No change	Accounted for (see Section 6.4.12.4, Activity of Intersected Waste) Appendix BIR, Section 3.2, Supplemental Disposal Information	Same	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W13	*Heat from radioactive decay* Radioactive decay of waste will generate heat in the repository	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Additional information addresses WIPP transportation restrictions (thermal load). Updated information and studies indicate a lower radionuclide inventory and reduced heat load relative to CCA and therefore CRA screening arguments are bounded by CCA arguments
W14	*Nuclear criticality: heat* A sustained fission reaction would generate heat	SO-P	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Updated inventory on fissile material and additional arguments mean that CRA criticality screening arguments are bounded by previous CCA screening arguments
W15	*Radiological effects on waste* Radiation can change the physical properties of many materials	SO-C	No change	None	None	CCA: Screening arguments for W15 and W16 appeared valid to the Agency CRA: New radiological waste data referenced reflect reduction in radionuclide inventory
W16	*Radiological effects on containers* Radiation can change the physical properties of many materials	SO-C	No change	None	None	

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Reference / Corresponding Cross-References**	**Agency Disposition / Comment**
W17	*Radiological effects on seals* Radiation can change the physical properties of many materials	SO-C	No change	None	None	See above (W15 and W16)
W18	*Disturbed rock zone* Repository construction has led to fracturing of rock around the repository	UP	No change	Accounted for via excavation-induced host rock fracturing with increased permeability and effective porosity (see Section 6.4.5.3, DRZ) Appendix MASS, Section 13.4, Flow in the DRZ Appendix PAR, Parameter 12, *Log intrinsic permeability, Shaft DRZ*; Tables PAR-2 and PAR-3, *Extent of DRZ*; PAR-37. *Disturbed Rock Zone Parameters*	Same; same geometry as used in CCA and PAVT Appendix PA, Attachment PAR, Parameter 9, Log intrinsic permeability – DRZ directly above concrete portion of panel closure; and 31, Log intrinsic permeability, DRZ; Table PAR-33	CCA: Screening arguments for W18 and W19 appeared reasonable to the Agency CRA: No new information identified
W19	*Excavation-induced changes in stress* Repository construction has led to changes in stress around the repository opening	UP	No change	See above (W18) Appendix PAR, Table PAR-38, *Waste Area and Waste Material Parameters*	See above (W18) Appendix PA, Attachment PAR, Table PAR-34	

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Reference / Corresponding Cross-References**	**Agency Disposition / Comment**
W20	*Salt creep* Salt creep will consolidate seal components and close the disposal rooms, thereby compacting the waste	UP	No change	Accounted for in modeling of creep closure (see Section 6.4.3.1, Creep Closure) via reductions in porosity and permeability, increases in pore fluid pressure, reductions in fluid flow rates Appendix PAR, Table PAR-38, *Waste Area and Waste Material Parameters*, Appendix PORSURF, Attachment PORSURF-6, Final Porosity Surface Data	Same Appendix PA, Attachment PAR, Table PAR-34 Same	CCA: Screening arguments for W20 and W21 appeared valid to the Agency CRA: No new information identified
W21	*Changes in stress field* Salt creep will affect the stress field around the repository opening	UP	No change			
W22	*Roof falls* Instability of the DRZ could lead to roof falls	UP	No change	Accounted for via appropriate ranges of DRZ parameters (higher permeability zone) (see Section 6.4.5.3, DRZ) Appendix PAR, Table PAR-37, *Disturbed Rock Zone Parameters*	Same Appendix PA, Attachment PAR, Table PAR-33	CCA: Screening argument appeared valid to the Agency CRA: No new information identified
W23	*Subsidence*	SO-C	No change	None	None	CCA: Screening arguments for W22 and W23 appeared reasonable to the Agency CRA: Potential effects are already accounted for via ranges of DRZ parameters (higher permeability zone) (see Section 6.4.5.3)
W24	*Large scale rock fracturing* Salt creep and roof falls could lead to subsidence of horizons above the repository	SO-P	No change	None	None	

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Reference / Corresponding Cross-References**	**Agency Disposition / Comment**
W25	*Disruption due to gas effects* Increased gas pressures may lead to fracturing of Salado interbeds	UP	No change	Accounted for in modeling of creep closure (see Sections 6.4.5.2, Salado interbeds; and 6.4.3.1, Creep Closure) via slowing of creep closure; fracturing of Salado interbeds Appendix PAR, Table PAR-36, *Salado Formation Parameters – Anhydrite Beds a&b, Intact and fractured*	Same Appendix PA, Attachment PAR, Table PAR-32	CCA: Screening arguments for W25 and W26 appeared technically reasonable to the Agency CRA: No new information identified
W26	*Pressurization* Increased gas pressures may slow the rate of salt creep	UP	No change	See above (W25) Also, Appendix PORSURF	See above (W25) Same	
W27	*Gas explosions* Explosion of gas mixtures in the repository could affect the DRZ	UP	No change	Considered no worse than Roof falls (see W22); no special treatment Appendix PAR, Table PAR-37, *Disturbed Rock Zone Parameters*	Same Appendix PA, Attachment PAR, Table PAR-33	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W28	*Nuclear explosions* A critical mass of plutonium in the repository could explode if rapidly compressed	SO-P	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Additional information referenced

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Reference / Corresponding Cross-References**	**Agency Disposition / Comment**
W29	*Thermal effects on material properties* Temperature rises could lead to changes in porosity and permeability	SO-C	No change	None	None	CCA: Screening arguments for W29-W31 appeared reasonable to the Agency CRA: No new information identified other than re-evaluation of heat sources using updated inventory data. Arguments consolidated with those of W72 and W73 on cement hydration (see W72, W73)
W30	*Thermally induced stress changes* Elevated temperatures could change the local stress field and alter the rate of salt creep	SO-C	No change	None	None	
W31	*Differing thermal expansion of repository components* Stress distribution and strain changes can depend on differing rates of thermal expansion between adjacent materials	SO-C	No change	None	None	
W32	*Consolidation of waste* Salt creep and room closure will change waste permeability	UP	No change	Accounted for in modeling of creep closure of disposal room (see Section 6.4.3.1, Creep Closure) Appendix PAR, Table PAR-38, *Waste Area and Waste Materials Parameters*	Same Appendix PA, Attachment PAR, Table PAR-34	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-Reference**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W33	*Movement of containers* Density differences or temperature rises could lead to movement of containers within the salt	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Description updated to include actual waste inventory data (waste density). Some waste streams may be more highly compacted and denser than those in the CCA but previous calculations on this topic indicated little impact on performance
W34	*Container integrity* Long-lived containers could delay dissolution of waste	SO-C - Beneficial	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. Integrity required only for transportation; hence, beneficial effect is retarding radionuclide transport
W35	*Mechanical effects of backfill* Backfill in disposal rooms will act to resist creep closure	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Updated information reflects elimination of MgO mini-sacks; backfill: waste volume ratio decreases (US EPA 2001 cited)

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-Reference**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W36	*Consolidation of seals* Salt creep will consolidate long-term seal components, reducing porosity and permeability	UP	No change	Accounted for via permeability range assumed for seal system (see Section 6.4.4, Shafts and Shaft Seals) Appendix PAR, Parameters 9 to 11, *Log intrinsic permeability, X-, Y-, Z-directions, seal materials* (Lower and Upper Salado Clay, concrete column, asphalt column); and 13, *Cumulative probability of shaft salt column compaction*; Tables PAR-16 to PAR-24, *Material Parameters for different horizons* (natural and man-made)	Same, but simplified seal system model Appendix PA, Attachment PAR, Parameters 64, Log intrinsic permeability – upper portion of simplified shaft; 65, Log intrinsic permeability – lower portion of simplified shaft (0-200 yrs); 66, Log intrinsic permeability – lower portion of shaft (200-10,000 yrs); Table PAR-19, Shaft Material Parameters	CCA: Screening arguments for W36 and W37 appeared reasonable to the Agency CRA: No new information identified
W37	*Mechanical degradation of seals* Gas pressurization, clay swelling, and cracking of concrete could affect seal properties	UP	No change	See above (W36)	See above (W36)	
W38	***Investigation boreholes*** Improperly sealed investigation boreholes near the repository could act as release pathways	**SO-C**	**Removed from baseline - no longer separate FEP; covered in H31, *Natural borehole fluid flow* and H33, *Flow through undetected boreholes***	None	None	CCA: Not discussed explicitly in the Agency's analysis (US EPA 1998d) CRA: Screening arguments covered by those for *Natural borehole fluid flow* (H31) and *Flow through undetected boreholes* (H33). This FEP is discussed further in Section 2.2.2
W39	*Underground boreholes* Improperly sealed boreholes drilled from the repository could provide pathways to the interbeds	UP	No change	Accounted for via assumption of permanently enhanced permeability for DRZ, cf. unsealed boreholes (but no cross-reference in Appendix SCR) Appendix PAR, Table PAR-37, *Disturbed Rock Zone Parameters*	Same (also no cross-reference in Attachment SCR) Appendix PA, Attachment PAR, Table PAR-33	CCA: Not discussed explicitly in the Agency's analysis (US EPA 1998d) CRA: No new information identified

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-Reference**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W40	*Brine inflow* Brine will enter the disposal rooms through the interbeds, impure halite and clay layers	UP	No change	Accounted for via two-phase flow of brine and gas in the repository and in the Salado (Section 6.4.3.2, Repository Fluid Flow) Appendix BRAGFLO, Section 4.8, Two Phase Flow	Same Appendix PA, Section PA-4.2	CCA: Screening arguments for W40 and W41 appeared reasonable to the Agency CRA: No new information identified
W41	*Wicking* Capillary rise is a mechanism for brine flow in unsaturated zones in the repository	UP	No change	Accounted for via capillary rise in waste material (see Section 6.4.3.2, Repository Fluid Flow) Appendix PAR, Parameter 8, *Index for computing wicking*; Appendix BRAGFLO, Section 7.2.9, Chemical Reaction Parameters	Same Appendix PA, Attachment PAR, Table PAR-34 Appendix PA, Section PA-4.2.6	
W42	*Fluid flow due to gas production* Increases in gas pressure could affect the rate of brine inflow	UP	No change	Accounted for in modeling two-phase flow (see Section 6.4.3.2), Repository Fluid Flow Appendix BRAGFLO, Section 4.8, Two Phase Flow	Same Appendix PA, Section PA-4.2	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W43	*Convection* Temperature differentials in the repository could lead to convection cells	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W44	*Microbial gas generation - degradation of organic material* Microbial breakdown of cellulose material in the waste will generate gas	UP	No change	Accounted for in calculation of gas generation (see Section 6.4.3.3, Gas Generation). Appendix SOTERM, Section 2.2.2; Appendix BRAGFLO, Section 4.13, Gas Generation Model; Appendix MASS, Section 8	Same Same Appendix PA, Section PA-4.2.5 same	CCA: Screening arguments for W44 and W45 appeared reasonable to the Agency CRA: No new information identified

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-Reference**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W45	*Effects of temperature on microbial gas generation* Temperature rises could affect the rate of microbial gas generation	UP	No change	Accounted for in gas generation rates used, derived from available experimental data (see Section 6.4.3.3, Gas Generation) Appendix PAR, Parameters 3 to 5, *Microbial gas production rate* and *biodegradation rate*; Table PAR-43, *Stoichiometric Gas Generation Model Parameters*	Same Appendix PA, sampled Parameters 3 to 5; Attachment PAR, Table PAR-39	See above (W44)
W46	*Effects of pressure on microbial gas generation* Increases in gas pressure could affect microbial populations and gas generation rates	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Screening argument updated to include new experimental information on microbial gas generation. No effect on screening decision
W47	*Effects of radiation on microbial gas generation* Radiation could affect microbial populations and gas generation rates	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Updated screening argument reflects new radionuclide inventory
W48	*Effects of biofilms on microbial gas generation* Biofilms serve to maintain optimum conditions for microbial populations and affect gas generation rates	UP	No change	Accounted for in gas generation rates used (see Section 6.4.3.3, Gas Generation) Appendix PAR, Parameters 3 to 5,*Microbial gas production rate* and *biodegradation rate*; Table PAR-43, *Stoichiometric Gas Generation Model Parameters*	Same Appendix PA, Parameters 3 to 5; Attachment PAR, Table PAR-39	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	**FEP Name** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W49	*Gases from metal corrosion* Anoxic corrosion of steel will produce hydrogen	UP	No change	Accounted for via gas generation rates derived from experimental data (see Section 6.4.3.3, Gas Generation) Appendix SOTERM, Section 2.2.3, Corrosion of Steel and Other Metals; Appendix BRAGFLO, Section 4.13, Gas Generation Model; Appendix MASS, Section 8 and Attachments 8-2, Gas generation parameters	Same Same	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W50	***Corrosion - Galvanic coupling*** Potential gradients between metals could affect corrosion rates	**SO-P**	**SO-C**	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. Modified screening argument to distinguish between internal and external (W95) coupling. This FEP is discussed further in Section 2.2.2
W51	*Chemical effects of corrosion* Corrosion reactions will lower the oxidation state of brines and affect gas generation rates	UP	No change	Accounted for in gas generation rates used (see Section 6.4.3.3, Gas Generation) Appendix PAR, Parameter 1, *Inundated corrosion rate for steel without CO_2 present*; Table PAR-43, *Stoichiometric Gas Generation Model Parameters*	Same Appendix PA, Attachment PAR, Parameter 1; Table PAR-39	CCA: Screening argument appeared reasonable to the Agency
W52	*Radiolysis of brine* Alpha particles from decay of plutonium can split water molecules to form hydrogen and oxygen	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	**FEP Name** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W53	*Radiolysis of cellulose* Alpha particles from decay of plutonium can split cellulose molecules and affect gas generation rates	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Updated text to incorporate new inventory (cellulose content) data and gas generation information (limited by transportation requirements)
W54	*Helium gas production* Reduction of alpha particles emitter from the waste will form helium	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Owing to new inventory data (reduced radionuclide activity), CRA screening argument conservatively bound by CCA argument
W55	*Radioactive gases* Radon will form from decay of plutonium. Carbon dioxide and methane may contain radioactive C-14	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified that affects screening decision. Additional discussion in screening argument

W56	*Chemical speciation* Speciation is the form in which elements occur under particular conditions. This form controls mobility and the chemical reactions that are likely to occur	UP UP in disposal rooms and Culebra. SO-C elsewhere and beneficial SO-C in concrete seals	No change same	Accounted for in estimates of radionuclide solubility in the disposal rooms (see Section 6.4.3.5, Dissolved Actinide Source Term) and K_d values in Culebra (see Section 6.4.6.2.1, Transport of Dissolved Actinides in the Culebra). Effects of cementitious seals on speciation ignored because of beneficial effects Appendix PAR, Parameters 36 to 45, *Solubilities of actinides in different oxidation states*; 52 to 57, *Matrix distribution coefficients for U+6, U+4, Pu+3, Pu+4, Th+4, Am+3*; Table PAR-39, *Waste Chemistry Parameters*	Same Appendix PA, Attachment PAR, sampled Parameters 34 to 45 Appendix PA, Attachment PAR, sampled Parameters 52 to 57; Table PAR-35	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	**FEP Name** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W57	*Kinetics of speciation* Reaction kinetics control the rate at which particular reactions occur thereby dictating which reactions are prevalent in non-equilibrium systems	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W58	*Dissolution of waste* Dissolution of waste controls the concentrations of radionuclides in brines and groundwater	UP	No change	Accounted for in actinide source term model (see Section 6.4.3.5, Dissolved Actinide Source Term) Appendix PAR, Parameters 36 to 47, *Solubilities of actinides in different oxidation states*; Table PAR-39, *Waste Chemistry Parameters*	Same Appendix PA, Attachment PAR, sampled Parameters 34 to 45 Appendix PA, Attachment PAR, sampled Parameters 52 to 57; Table PAR-35	CCA: Screening arguments for W58 and W59 appeared reasonable to the Agency CRA: No new information identified
W59	*Precipitation of secondary minerals* Precipitation of secondary minerals could affect the concentrations of radionuclides in brines and groundwaters	SO-C - Beneficial	No change	None	None	
W60	*Kinetics of precipitation and dissolution* The rates of dissolution and precipitation reactions could affect radionuclide concentrations	SO-C	No change; kinetics of waste dissolution is a beneficial SO-C	None	None	CCA: Screening argument appeared reasonable to the Agency. The Agency had questioned original CCA screening argument but accepted DOE's argument based on new experimental results CRA: No new information identified since then

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W61	*Actinide sorption* Actinides may accumulate at the interface between a solid and a solution. This affects the rate of transport of actinides in brines and groundwaters	UP in the Culebra and Dewey Lake SO-C – Beneficial elsewhere	No change Same	Accounted for via sorption isotherms. PA calculations assume that dissolution processes control radionuclide concentrations in disposal rooms. No credit given for sorption on seal materials. Sorption accounted for in Culebra (see Section 6.4.6.2, The Culebra). In other geological units (see Section 6.4.6.6, Dewey Lake) and on colloids, microbes and particulate material (see Section 6.4.3.6, Source Term for Colloidal Actinides) Appendix MASS Section 15.2, Dissolved Actinide Transport and Retardation in the Culebra	Same Same	CCA: Screening arguments for W61-W63 appeared reasonable to the Agency CRA: No new information identified
W62	*Kinetics of sorption* The rate at which actinides are sorbed can affect radionuclide concentrations	UP	UP in the Culebra and Dewey Lake. SO-C – Beneficial elsewhere	see above (W61) Appendix MASS Section 15.2, Dissolved Actinide Transport and Retardation in the Culebra Appendix PAR, Parameters 47, *Index for oxidation solubilities*; 52 to 57, *Matrix distribution coefficients for U+6, U+4, Pu+3, Pu+4, Th+4, Am+3*; Table PAR-39, *Waste Chemistry Parameters*	See above (W61) Same Appendix PA, Attachment PAR, Parameter 45 Appendix PA, Attachment PAR, sampled parameters 52 to 57; Table PAR-35	
W63	*Changes in sorptive surfaces* Changes in mineralogy along fracture walls could change the extent of sorption	UP	No change	see above (W61) Appendix PAR, Parameters 47, *Index for oxidation solubilities*; 52 to 57, *Matrix distribution coefficients for U+6, U+4, Pu+3, Pu+4, Th+4, Am+3*; Table PAR-39, *Waste Chemistry Parameters*	See above (W61) Appendix PA, Attachment PAR, Parameter 45 Appendix PA, Attachment PAR, sampled parameters 52 to 57; Table PAR-35	

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W64	*Effect of metal corrosion* Metal corrosion will have an effect on chemical conditions in the repository by absorbing oxygen	UP	No change	Accounted for in dissolved actinide source term (see Section 6.4.3.5, Dissolved Actinide Source Term) – estimates of probabilities that actinides are in specific oxidation states Appendix PAR, Parameters 36 to 47, *Solubilities of actinides in different oxidation states*; Table PAR-39, *Waste Chemistry Parameters*	Same Appendix PA, Attachment PAR, sampled Parameters 34 to 45; and 52 to 57 Table PAR-35	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W65	*Oxidation-reduction fronts* Redox fronts may affect the speciation and hence migration of radionuclides	SO-P	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W66	*Oxidation-reduction kinetics* Reduction-oxidation reactions may not be in thermodynamic equilibrium thereby affecting speciation	UP	No change	Uncertainty in kinetics accounted for in dissolved actinide source term – estimates of probabilities that actinides are in specific oxidation states (see Section 6.4.3.5, Dissolved Actinide Source Term) Appendix PAR, Parameters 36 to 47, *Solubilities of actinides in different oxidation states*; Table PAR-39, *Waste Chemistry Parameters*	Same Appendix PA, Attachment PAR, sampled Parameters 34 to 45; Table PAR-35	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W67	*Localized reducing zones* Localized reducing zones, bounded by reduction-oxidation fronts, may develop on metals undergoing corrosion	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. Screening argument discussed in greater detail

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W68	***Organic complexation*** Aqueous complexes between radionuclides and organic materials may enhance the total dissolved radionuclide load	**SO-C**	**UP**	None. Basis for eliminating anthropogenic organics described in Appendix SOTERM, Section 5 Appendix WCA, Section 4.1.3	Accounted for in calculations of actinide solubilities using FMT code (including organic complexation)	CCA: Screening argument for W68 appeared reasonable to the Agency. With regard to W69, the Agency requested additional information concerning ligand concentrations in the entire waste inventory and how this information was used to assess the effects of organic complexation. DOE provided supplemental information as required CRA: Updated calculations based on revised thermodynamic database and recent complexation studies. Reviewed in US EPA (2005). These FEPs are discussed further in Section 2.2.2
W69	***Organic ligands*** Increased concentrations of organic ligands favor the formation of complexes	**SO-C**	**UP**	See above (W68)	See above (W68)	
W70	*Humic and fulvic acids* High-molecular weight organic ligands, including humic and fulvic acids, may be present in soil waste	UP	No change	Accounted for in models of radionuclide transport by humic colloids (see Section 6.4.6.2.2, Transport of Colloidal Actinides in the Culebra) Appendix PAR, Parameter 46, *Proportionality constant of actinides in Castile brine with humic colloids, inorganic*; Table PAR-39, *Waste Chemistry Parameters*	Same Appendix PA, Attachment PAR, sampled Parameter 44; Table PAR-35	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W71	*Kinetics of organic complexation* The rates of complex dissociation may affect radionuclide uptake and other reactions	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Kinetics are fast and therefore of no consequence to repository performance

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W72	*Exothermic reactions* Exothermic reactions, including concrete and backfill hydration, and aluminum corrosion, may raise the temperature of the disposal system	SO-C	No change	None	None	CCA: Screening arguments for W72 and W73 appeared reasonable to the Agency CRA: See discussion for W29, W30 and W31. Description added of effects of water release during carbonation of backfill and effects of formation of metastable hydrated carbonates
W73	*Concrete hydration* Hydration of concrete in seals will enhance rates of salt creep and may induce thermal cracking	SO-C	No change	None	None	
W74	*Chemical degradation of seals* Reaction of cement with brine and groundwater may affect seal permeability	UP	No change	Accounted for through CCDFs used for seal material permeabilities (but no cross-reference in Appendix SCR) Appendix PAR, Parameter 10, *Log intrinsic permeability concrete column, X-, Y-, Z-directions*; Table PAR-19, *Concrete Shaft Material Parameters*	Same Appendix PA, Attachment PAR, Parameter 10; Table PAR-19	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W75	*Chemical degradation of backfill* Reaction of the MgO backfill with CO_2 and brine may affect disposal room permeabilities	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: More recent experimental MgO data show that MgO will "*…essentially behave as it was designed.*"

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W76	*Microbial growth on concrete* Acids produced by microbes could accelerate concrete seal degradation	UP	No change	Implicitly accounted for through CCDFs of seal material permeabilities (but no cross-reference in Appendix SCR) Appendix PAR, Parameter 10, *Log intrinsic permeability concrete column, X-, Y-, Z-directions*; Table PAR-19, *Concrete Shaft Material Parameters*	Same Appendix PA, Attachment PAR, Parameter 10; Table PAR-19	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W77	*Solute transport* Radionuclides may be transported as dissolved species or solutes	UP	No change	Accounted for by advection, dispersion and diffusion (see Sections 6.4.5.4, Actinide Transport in the Salado; and 6.4.6.2.1, Transport of Dissolved Actinides in the Culebra)	Same	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W78	*Colloid transport* Colloid transport, with associated radionuclides, may occur at a different rate from that of dissolved species	UP	No change	Accounted for (see Section 6.4.6.2.2, Transport of Colloidal Actinides in the Culebra)	Same	CCA: Screening arguments for W78-W81 appeared technically reasonable to the Agency CRA: No new information identified
W79	*Colloid formation and stability* The formation and stability of colloids is dependent upon chemical conditions such as salinity	UP	No change	Accounted for via estimates of colloid numbers in the disposal room based on prevailing chemical conditions (see Section 6.4.3.6, Source Term for Colloidal Actinides) Appendix PAR, Parameter 46, *Proportionality constant of actinides in Castile brine with humic colloids, inorganic*; Table PAR-39, *Waste Chemistry Parameters*	Same Appendix PA, Attachment PAR, sampled Parameter 44; Table PAR-35	

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W80	*Colloid filtration* Colloids with associated radionuclides may be too large to pass through pore throats in some media	UP	No change	Accounted for (see Section 6.4.6.2.2, Transport of Colloidal Actinides in the Culebra)	Same	See W78
W81	*Colloid sorption* Colloids with associated radionuclides may be physically or chemically sorbed to the host rock	UP	No change	As above (W80) Appendix PAR, Parameters 52-57, *Matrix distribution coefficients for U+6, U+4, Pu+3, Pu+4, Th+4, Am+3*	As above (W80)	
W82	*Suspensions of particles* Rapid brine flow could transport radioactive particles in suspension	DP SO-C for undisturbed conditions	DP	Section 6.4.7.1, Releases During Drilling Appendix CUTTINGS; Appendix A2, Release Processes	Same Appendix PA, Attachment PAR, Section PA-4.5 and PA-4.6	CCA: Screening arguments for W82-W86 appeared reasonable to the Agency. The Agency conducted its own analysis on spallings and reached similar conclusions to those of DOE (US EPA 1997b) CRA: No new information identified
W83	*Particulate transport – Rinse* Rapid brine flow could wash radioactive particulates from waste surface	SO-C	No change	None	None	
W84	*Particulate transport – Cuttings* Waste material intersected by a drill bit could be transported to the ground surface	DP Repository intrusion only	No change	Transport associated with inadvertent human intrusion accounted for (see Section 6.4.7.1, Releases During Drilling) Appendix CUTTINGS; Appendix A2, Release Processes	Same Appendix PA, Attachment PAR, Section PA-4.5 and PA-4.6	
W85	*Particulate transport – Cavings* Waste material eroded from a borehole wall by drilling fluid could be transported to the ground surface	DP Repository intrusion only	No change	As above (W84)	As above (W84)	

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**EPA Disposition / Comment**
W86	*Particulate transport – Spallings* Waste material entering a borehole through repository depressurization could be transported to the ground surface	DP Repository intrusion only	No change	As above (W84)	As above (W84)	See W82
W87	*Microbial transport* Radionuclides may be bound to or contained in microbes transported in groundwaters	UP	No change	Accounted for (see Section 6.4.6.2.2, Transport of Colloidal Actinides in the Culebra)	Same	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W88	*Microbial transport -Biofilms* Biofilms may retard microbes and affect transport radionuclide	SO-C - Beneficial	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Screening argument updated to include new experimental work since CCA
W89	*Transport of radioactive gases* Gas phase flow could transport radioactive gases	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Description updated to include recent inventory data
W90	*Advection* Dissolved and solid material can be transported by a flowing fluid	UP	No change	Accounted for (see Sections 6.4.5.4, Actinide Transport in the Salado; and 6.4.6.2, The Culebra)	Same	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W91	*Diffusion* Dissolved and solid material can be transported in response to Brownian forces	UP	No change	Accounted for (see Sections 6.4.5.4, Actinide Transport in the Salado 6.4.6.2, The Culebra)	Same	CCA: Screening arguments for W91 and W92 appeared reasonable to the Agency CRA: No new information identified
W92	*Matrix diffusion* Dissolved and solid material may be transported transverse to the direction of advection in a fracture and into the rock matrix	UP	No change	Accounted for (see Section 6.4.6.2, The Culebra)	Same	
W93	*Soret effect* There will be a solute flux proportional to any temperature gradient	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W94	*Electrochemical effects* Potential gradients may exist as a result of electrochemical reactions and groundwater flow and affect radionuclide transport	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W95	*Electrochemical transport phenomena - Galvanic coupling* Potential gradients may be established between metal components of the waste and containers and affect radionuclide transport	SO-P	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W96	*Electrophoresis* Charged particles and colloids can be transported along electrical potential gradients	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified; text modified

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W97	*Chemical gradients* Chemical gradients will exist at interfaces between different parts of the disposal system and may cause enhanced diffusion	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified; text modified
W98	*Osmotic processes* Osmosis may allow diffusion of solutes across a salinity gradient	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified; text modified
W99	*Alpha recoil* Recoil of the daughter nuclide upon emission of an alpha particle during radioactive decay at the surface of a solid may eject the daughter into groundwater	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified; text modified
W100	*Enhanced diffusion* Chemical gradients may locally enhance rates of diffusion	SO-C	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified
W101	*Plant uptake* Radionuclides released into the biosphere may be absorbed by plants	SO-C for 40 CFR §191.15 SO-R for 40 CFR §191.13	No change	None	None	CCA: Screening arguments for W101-W103 appeared reasonable to the Agency CRA: No new information identified
W102	*Animal uptake* Animals may eat or drink radionuclides released into the biosphere	SO-C for 40 CFR §191.15 SO-R for 40 CFR §191.13	No change	None	None	
W103	*Accumulation in soils* Radionuclides released into the biosphere may accumulate in soil	SO-C for 40 CFR §191.15 Beneficial SO-C	No change	None	None	

Table 2. WASTE- AND REPOSITORY-INDUCED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
W104	*Human uptake – Ingestion* Humans may receive a radiation dose from radionuclides in food or drink	SO-C for 40 CFR §191.15 SO-R for 40 CFR §191.13	No change	None	None	CCA: Screening arguments for W104-W108 appeared reasonable to the Agency CCA calculations were revised to include analysis of doses from potential exposure pathways such as stock consumption or irrigation. Conservative bounding-analysis approach was adopted for PAVT and CCA calculations. Results indicated that no changes to screening arguments or Screening Decisions are required CRA: No new information identified
W105	*Human uptake – Inhalation* Humans may receive a radiation dose from air taken into the lungs	SO-C for 40 CFR §191.15 SO-R for 40 CFR §191.13	No change	None	None	
W106	*Human uptake – Irradiation* Humans may receive a radiation dose from radionuclides external to the body	SO-C for 40 CFR §191.15 SO-R for 40 CFR §191.13	No change	None	None	
W107	*Human uptake – Dermal sorption* Humans may receive a radiation dose from radionuclides through the skin	SO-C for 40 CFR §191.15 SO-R for 40 CFR §191.13	No change	None	None	
W108	*Human uptake – Injection* Humans may receive a radiation dose from radionuclides injected beneath the skin	SO-C for 40 CFR §191.15 SO-R for 40 CFR §191.13	No change	None	None	

Key

UP: FEPs included in the PA under *undisturbed* performance.

DP: FEPs (and all UP FEPs) included in the PA as *disturbed* performance. Note that UP FEPs and DP FEPs must be considered to evaluate compliance with 40 CFR §191.13.

SO-C: FEPs screened out based on consequence.

SO-P: FEPs screened out based on low probability.

SO-R: FEPs screened out based on regulations.

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment[3]**
H1	*Oil and gas exploration* Oil and gas exploration is a reason for drilling in the Delaware Basin	SO-C (HCN) DP (future)	No change	Appendix DEL, Sections 4.2, Resources Within the Delaware Basin; and 7.4, Rate of Drilling in the Basin; Appendix PAR, Table PAR-53, *Intrusion Parameters*	Appendix PA, Attachment PAR, Tables Par-45 and PAR-46	CCA: Screening argument appeared reasonable to the Agency CRA: Drilling rates modified based on updated drilling information (provided in Appendix DEL, Appendix DATA, Attachment A – Delaware Basin Drilling Surveillance Data, and Section 6.3.2)
H2	*Potash exploration* Potash exploration is a reason for drilling in the Delaware Basin	SO-C (HCN) DP (future)	No change	See H1 Appendix DEL, Sections 4.2, Resources Within the Delaware Basin; and 7.4, Rate of Drilling in the Basin Appendix PAR, Table PAR-53, *Intrusion Parameters*	See H1 Same Appendix PA, Attachment PAR, Tables Par-45 and PAR-46	CCA: Screening argument appeared reasonable to the Agency CRA: See H1
H3	*Water resources exploration* Water resources exploration is a reason for drilling in the Delaware Basin	SO-C (HCN) SO-C (future)	No change	See H1	See H1	CCA: Screening argument appeared reasonable to the Agency CRA: Additional justification for screening decision provided
H4	*Oil and gas exploitation* Oil and gas exploitation is a reason for drilling in the Delaware Basin	SO-C (HCN) DP (future)	No change	See H1 Appendix DEL, Sections 4.2, Resources Within the Delaware Basin; and 7.4, Rate of Drilling in the Basin Appendix PAR, Table PAR-53, *Intrusion Parameters*	See H1 Same Appendix PA, Attachment PAR, Tables Par-45 and PAR-46	CCA: Screening argument appeared reasonable to the Agency CRA: See H1

[3] Unless otherwise noted, new information is discussed under the appropriate FEP in Appendix PA, Attachment SCR.

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H5	*Groundwater exploitation* Groundwater exploitation is a reason for drilling in the Delaware Basin	SO-C (HCN) SO-C (future)	No change	See H1 Appendix DEL, Sections 4.2, Resources Within the Delaware Basin; and 7.4, Rate of Drilling in the Basin; Appendix USDW, Section 3, Determination of USDWs in the Study Area	See H1 Same Appendix PA, Attachment PAR, Tables Par-45 and PAR-46	CCA: Screening argument appeared reasonable to the Agency CRA: See H3
H6	*Archeological investigations* Archeological investigations could be a reason for drilling	SO-R (HCN) SO-R (future)	No change	None	None	CCA: Screening arguments for H6 and H7 appeared reasonable to the Agency CRA: No new information identified
H7	*Geothermal* Geothermal energy could be a reason for drilling	SO-R (HCN) SO-R (future)	No change	None	None	
H8	*Drilling - Other resources* Exploration for other resources could be a reason for drilling	SO-C (HCN) DP (future)	No change	See H1 Appendix DEL, Sections 4.2, Resources Within the Delaware Basin; and 7.4, Rate of Drilling in the Basin Appendix PAR, Table PAR-53, *Intrusion Parameters*	See H1 Same Appendix PA, Attachment PAR, Tables Par-45 and PAR-46	CCA: Screening argument appeared reasonable to the Agency CRA: See H1
H9	*Enhanced oil and gas recovery* Enhanced oil and gas recovery is a reason for drilling in the Delaware Basin	SO-C (HCN) DP (future)	No change	See H1 Appendix DEL, Sections 4.2, Resources Within the Delaware Basin; and 7.4, Rate of Drilling in the Basin Appendix PAR, Table PAR-53, *Intrusion Parameters*	See H1 Same Appendix PA, Attachment PAR, Tables Par-45 and PAR-46	CCA: Screening argument appeared reasonable to the Agency CRA: See H1

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H10	*Liquid waste disposal* Liquid waste disposal could be a reason for drilling	SO-R (HCN) SO-R (future)	No change	None	None	CCA: Screening arguments for H10-appeared reasonable to the Agency CRA: No new information identified. FEPs H10 and H11 assessed by US EPA (2004)
H11	*Hydrocarbon storage* Hydrocarbon storage could be a reason for drilling	SO-R (HCN) SO-R (future)	No change	None	None	
H12	*Deliberate drilling intrusion* Deliberate investigation of the repository could be a reason for drilling	SO-R (HCN) SO-R (future)	No change	None	None	In the CCA, the Agency concluded that consideration of deliberate drilling into the repository need not be considered, exclusion being appropriate per §194.33(b)(1) requirements
H13	*Conventional underground potash mining* Potash mining is a reason for excavations in the region around WIPP	UP (HCN) DP (future) UP for mining outside the controlled area. DP for mining inside the controlled area.	No change	Appendix DEL, Sections 4.2, Resources Within the Delaware Basin; and 7.4, Rate of Drilling in the Basin Appendix PAR, Parameter 34, *Mining transmissivity multiplier, sampled parameter*	Footprint slightly modified but FEP re-analysis not required Same Appendix PA, Attachment TFIELD, Section TFIELD-9.2 Appendix PA, Attachment PAR, sampled Parameter 46	CCA: Screening argument appeared reasonable to the Agency (US EPA 1997c). This FEP was called *Potash mining* in the CCA (under Excavation activities) CRA: FEP title changed to identify more explicitly the mining process. New FEPs H58 and H59 now address solution mining. No new information. Supporting recent reference provided (Griswold and Griswold 1999)
H14	*Excavation - Other resources* Mining of other resources could be a reason for excavations	SO-C (HCN) SO-R (future)	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No changes have occurred in resources obtained via mining. FEP assessed by US EPA (2004)

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H15	*Tunneling* Tunneling could be a reason for excavations	SO-R (HCN) SO-R (future)	No change	None	None	CCA: Screening arguments for H15 and H16 appeared reasonable to the Agency CRA: No new information identified. FEPs H15 and H16 assessed by US EPA (2004)
H16	*Construction of underground facilities* Construction of underground facilities could be a reason for excavations	SO-R (HCN) SO-R (future)	No change	None	None	
H17	*Archeological excavations* Archeological excavations could be a reason for excavations	SO-C (HCN) SO-R (future)	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified.
H18	*Deliberate mining intrusion* Deliberate investigation of the repository could be a reason for excavations	SO-R (HCN) SO-R (future)	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. FEP assessed by US EPA (2004)
H19	*Explosions for resource recovery* Underground explosions could affect the geological characteristics of surrounding units	SO-C (HCN) SO-R (future)	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Additional text provided describing the past use of explosives for potash mining in Delaware Basin. FEP assessed by US EPA (2004)
H20	*Underground nuclear device testing* Underground nuclear device testing could affect the geological characteristics of surrounding units	SO-C (HCN) SO-R (future)	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. FEP assessed by US EPA (2004)

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H21	*Drilling fluid flow* Drilling within the controlled area could result in releases of radionuclides into the drilling fluid	SO-C (HCN) DP (future) for boreholes intersecting waste region and penetrating waste panel SO-C for other future drilling	No change	DP (future) E1 events - greater volume of brine flowing up borehole: accounted for (see Section 6.4.7, The Intrusion Borehole) Appendix DEL, Sections 5.1.3, Drilling Fluids; and 6.1.2.1, Well Drilling; and Attachment 1, Typical Oil and Gas Drilling Sequence in the Delaware Basin; Appendix CUTTINGS, Appendix A.2.2, Cavings	Same Appendix DATA, Attachment A Appendix PA, Sections PA-4.5 and PA-4.6	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified This FEP is discussed further in Section 2.2.3
H22	*Drilling fluid loss* Borehole circulation fluid could be lost to thief zones encountered during drilling	SO-C (HCN) DP (future) for boreholes intersecting waste region and penetrating waste panel SO-C for other future drilling	No change	DP (future): E1 events: SO-C (because drilling fluid loss small compared with potential brine flow E2 drilling events: Hydrological effects of drilling fluid loss implicitly accounted for via "*the potential for greater gas generation resulting from drilling fluid loss*". Accounted for "*within conceptual model of disposal room for drilling intrusions*" (see Section 6.3.2.2, Disturbed Performance Deep Drilling Scenario (E)) Appendix PAR, Parameters 1, *Inundated corrosion rate for steel without CO_2 present*; and 3, *Biodegradation rate, inundated conditions*; Table PAR-43, *Stoichiometric Gas Generation Model Parameters*	Same Appendix PA, Attachment PAR, Parameters 1 and 3; Table PAR-39	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified This FEP is discussed further in Section 2.2.3

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H23	*Blowouts* Fluid could flow from pressurized zones through the borehole to the land surface	SO-C (HCN) DP (future) for boreholes that penetrate the waste and Castile brine underlying the waste disposal region SO-C for other future drilling	No change	DP (future) accounted for but no cross-reference given in App. SCR Appendix DEL, Section 7.5, Pressurized Brine Encounters Within the Delaware Basin; Appendix CUTTINGS, Appendix A.2.4.1, Blowout (Solids Removal)	Same Appendix DATA, Attachment A Appendix PA, Sections PA-4.5 and PA-4.6	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. This FEP is discussed further in Section 2.2.3
H24	*Drilling-induced geochemical changes* Movement of brine from a pressurized zone, through a borehole, into potential thief zones such as the Salado interbeds or the Culebra, could result in geochemical changes	UP (HCN) DP (future)	No change	UP (HCN) accounted for via changes in sorption within Culebra (see Section 6.4.6.2, The Culebra). CDFs of Kd values based on suite of experimental studies including Culebra brines DP (future) for all boreholes: Movement of brine could alter water chemistry, thereby affecting sorption within Culebra – see UP (HCN) Appendix MASS, Section 15.2, Dissolved Actinide Transport and Retardation in the Culebra Appendix PAR, Parameters 47. *Index for oxidation solubilities*; and 52 to 57, *Matrix distribution coefficients for U+6, U+4, Pu+3, Pu+4, Th+4, Am+3*; Table PAR-39, *Waste Chemistry Parameters*	Same Same Appendix PA, Attachment PAR, sampled Parameter 45 and sampled Parameters 52 to 57; Table PAR-35	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H25	*Oil and gas extraction* Extraction of oil and gas could alter fluid-flow patterns in the target horizon, or in overlying units as a result of a failed borehole casing. Removal of confined fluids from oil- and gas-bearing units can cause compaction, potentially resulting in sub-vertical fracturing and surface subsidence	SO-C (HCN) SO-R (future)	No change	None	None	CCA: Screening arguments for H25 and H26 appeared reasonable to the Agency CRA: No new information identified. Delaware Basin monitoring does not indicate any changes. FEPs assessed by US EPA (2004)
H26	*Groundwater extraction* Groundwater extraction from formations above the Salado could affect groundwater flow	SO-C (HCN) SO-R (future)	No change	None	None	
H27	***Liquid waste disposal*** Injection of fluids could alter fluid-flow patterns in the target horizons or, if there is accidental leakage through a borehole casing, in any other intersected hydraulically conductive zone	SO-C (HCN) **SO-R (future)**	SO-C (HCN) **SO-C (future)**	None	None	CCA: Screening arguments for H27-H29 appeared reasonable to the Agency CRA: Results from fluid injection modeling since CCA support screening decision change for future timeframe. Screening arguments updated and basis changed. FEPs assessed by US EPA (2004). These FEPs are discussed further in Section 2.2.3

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H28	***Enhanced oil and gas production*** Injection of fluids could alter fluid-flow patterns in the target horizons or, if there is accidental leakage through a borehole casing, in any other intersected hydraulically conductive zone	SO-C (HCN) **SO-R (future)**	SO-C (HCN) **SO-C (future)**	None	None	See H27
H29	***Hydrocarbon storage*** Injection of fluids could alter fluid-flow patterns in the target horizons or, if there is accidental leakage through a borehole casing, in any other intersected hydraulically conductive zone	SO-C (HCN) **SO-R (future)**	SO-C (HCN) **SO-C (future)**	None	None	
H30	*Fluid-injection induced geochemical changes* Injection of fluids through a leaking borehole could affect geochemical conditions in thief zones, such as the Culebra or the Salado interbeds	UP (HCN) SO-R (future)	No change	UP (HCN) accounted for via changes in sorption within Culebra. See H24 above	Same	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. FEP assessed by US EPA (2004)

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H31	***Natural borehole fluid flow*** Natural borehole flow through abandoned boreholes could alter fluid pressure distributions	**SO-C (HCN)** **DP (future**, for boreholes that penetrate Castile brine underlying waste disposal region) **SO-C (future**, for holes not penetrating waste panels)	**No change to Screening Decision. FEP now includes H33**	DP (future) accounted for – connection for brine flow from reservoir to waste panel, thereby increasing fluid pressure and brine volume (see Section 6.4.8, Castile Formation and Brine Reservoir) Appendix MASS, Section 16.3, Long-Term Properties of the Abandoned Intrusion Borehole; Appendix DEL, Sections 5.5, Well Plugging and Abandonment Practices and 6, Regulations	Same Same Appendix PA, Section PA-4.5 and PA-4; Appendix Data, Attachment A	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. This FEP is discussed further in Section 2.2.3
H32	*Waste-induced borehole flow* Abandoned boreholes that intersect a waste panel could provide a connection for transport away from the repository horizon	SO-R (HCN) DP (future, for boreholes that penetrate the waste) SO-C (future, for others)	No change	DP (future) accounted for – contaminant transport away from repository horizon (see Section 6.4.7.2, Long-Term Releases Following Drilling) Appendix MASS, Section 16.3, Long-Term Properties of the Abandoned Intrusion Borehole; Appendix DEL, Sections 5.5, Well Plugging and Abandonment Practices and 6, Regulations	Same Appendix PA, Section PA-4.5 and PA-4; Appendix A, Attachment A	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. FEP assessed by US EPA (2004)
H33	***Flow through undetected boreholes*** Undetected boreholes that are inadequately sealed could provide pathways for radionuclide transport	SO-P (HCN) N/A (future)	**Removed; combined with H31, *Natural borehole fluid flow***	N/A	N/A	CCA: Screening argument appeared reasonable to the Agency CRA: H33 combined with H31 "*because knowledge of a borehole's existence has no impact on its effects*" (Section SCR-5.2.1.8.2). This FEP is discussed further in Section 2.2.3

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H34	*Borehole-induced solution and subsidence* Boreholes could provide pathways for surface-derived water or groundwater to percolate into formations containing soluble minerals. Large-scale dissolution through this mechanism could lead to subsidence and to changes in groundwater flow patterns	SO-C (HCN) SO-C (future)	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No changes to description and screening arguments
H35	*Borehole-induced mineralization* Fluid flow through a borehole between hydraulically conductive horizons could cause mineral precipitation to change permeabilities	SO-C (HCN) SO-C (future)	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Text expanded to address effects of mineral precipitation on matrix diffusion
H36	*Borehole-induced geochemical changes* Movement of fluids through abandoned boreholes could change the geochemistry of units such as the Salado interbeds or the Culebra	UP (HCN) DP (future) SO-C for units other than Culebra	No change	UP (HCN) accounted for via changes in sorption within Culebra. See H24 and 30 above DP (future): Movement of fluids could alter water chemistry, thereby affecting sorption within Culebra – see UP (HCN) Appendix PAR, Parameters 47. *Index for oxidation solubilities*; and 52 to 57, *Matrix distribution coefficients for U+6, U+4, Pu+3, Pu+4, Th+4, Am+3*, all sampled Parameters; Table PAR-39, *Waste Chemistry Parameters*	Same Appendix PA, Attachment PAR, sampled Parameter 45; sampled Parameters 52 to 57; Table PAR-35	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H37	*Changes in groundwater flow due to mining* Fracturing and subsidence associated with excavations may affect groundwater flow patterns through increased hydraulic conductivity within and between units	UP (HCN) DP (future)	No change	UP (HCN) accounted for – effect on direction and magnitude of fluid flow (see Section 6.4.6.2.3, Subsidence Due to Potash Mining) DP (future) accounted for – effects on hydraulic conductivity of hydrogeologic units of disposal system (see Section 6.4.6.2.3, Subsidence Due to Potash Mining) Appendix DEL, Section 4.2.4; Appendix PAR, sampled Parameter 34, *Mining transmissivity multiplier*	Same Appendix DATA, Attachment A; Appendix PA, Attachment PAR, sampled Parameter 46	CCA: Screening argument appeared reasonable to the Agency, acknowledging that mining for potash is a relatively likely event, given past experience in the Delaware Basin CRA: No new information identified. Text modified
H38	*Changes in geochemistry due to mining* Fluid flow and dissolution associated with mining may change brine densities and geochemistry	SO-C (HCN) SO-R (future)	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information. FEP assessed by US EPA (2004)
H39	*Changes in groundwater flow due to explosions* Fracturing associated with explosions could affect groundwater flow patterns through increased hydraulic conductivity within and between units	SO-C (HCN) SO-R (future)	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information. FEP assessed by US EPA (2004)

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H40	*Land use changes* Land use changes could have an effect on the surface hydrology	SO-R (HCN) SO-R (future)	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: Recent report (US DOE 2002) did not identify any new land uses in WIPP vicinity. Text updated – additional information on industrial land uses in region
H41	***Surface disruptions*** Surface disruptions could have an effect on the surface hydrology	**SO-C (HCN)** SO-R (future)	**UP (HCN)** SO-R (future)	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: HCN screening argument changed from SO-C to UP. "….*effects of the activity capable of altering the disposal system (disposal of potash tailings) are included in our modeling*…" Such effects are discussed in Section 2.2.1.4.2.2 (water in the exhaust shaft). Activities predate water-level monitoring. Thus, hydrogeologic effects are implicitly included when defining boundary heads for Culebra flow models **Clarification is required from DOE on future Screening Decision**. Paragraph under Section SCR-5.3.1.2 should be deleted (misplaced). First paragraph under Section SCR-5.3.1.2.5 should be deleted (misplaced). Also, text in second paragraph states that future FEP is screened out on the basis of low consequence, yet Screening Decision is SO-R. This FEP is discussed further in Section 2.2.3
H42	*Damming of streams or rivers* Damming of streams or rivers could have an effect on the surface hydrology	SO-C (HCN) SO-R (future)	No change	None	None	CCA: Screening arguments for H42-H44 appeared reasonable to the Agency CRA: No new information
H43	*Reservoirs* Reservoirs could have an effect on the surface hydrology	SO-C (HCN) SO-R (future)	No change	None	None	
H44	*Irrigation* Irrigation could have an effect on the surface hydrology	SO-C (HCN) SO-R (future)	No change	None	None	

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H45	*Lake usage* Lake usage could have an effect on the surface hydrology	SO-R (HCN) SO-R (future)	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information
H46	*Altered soil or surface water chemistry by human activities* Surface activities associated with potash mining and oil fields could affect the movement of radionuclides in the surface environment	SO-C (HCN) SO-R (future)	No change	None	None	CCA: Screening argument appeared technically reasonable to the Agency CRA: No new information. This FEP is discussed further in Section 2.2.3
H47	*Greenhouse gas effects* Changes in climate resulting from increase in greenhouse gases could change the temperature and the amount of rainfall	SO-R (HCN) SO-R (future)	No change	None	None	CCA: Screening arguments for H47-H49 appeared reasonable to the Agency CRA: No new information
H48	*Acid rain* Acid rain could change the behavior of radionuclides in the surface environment	SO-R (HCN) SO-R (future)	No change	None	None	
H49	*Damage to ozone layer* Damage to the ozone layer could affect the flora and fauna and their response to radioactivity	SO-R (HCN) SO-R (future)	No change	None	None	

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H50	*Coastal water use* Coastal water usage could affect the uptake of radionuclides by animals and humans	SO-R (HCN) SO-R (future)	No change	None	None	CCA: Screening arguments for H50-H52 appeared technically reasonable to the Agency CRA: No new information
H51	*Sea water use* Sea water usage could affect the uptake of radionuclides by animals and humans	SO-R (HCN) SO-R (future)	No change	None	None	
H52	*Estuarine water use* Estuarine water usage could affect the uptake of radionuclides by animals and humans	SO-R (HCN) SO-R (future)	No change	None	None	
H53	*Arable farming* Arable farming could have an effect on the surface hydrology	SO-C (HCN) SO-R (future)	No change	None	None	CCA: Screening arguments for H53-H55 appeared reasonable to the Agency CRA: No new information
H54	*Ranching* Ranching could have an effect on the surface hydrology	SO-C (HCN) SO-R (future)	No change	None	None	
H55	*Fish farming* Fish farming could affect the uptake of radionuclides by animals and humans	SO-R (HCN) SO-R (future)	No change	None	None	
H56	*Demographic change and urban development* Demographic change and urban development could have an effect on the surface hydrology	SO-R (HCN) SO-R (future	No change	None	None	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified

Table 3. HUMAN-INITIATED FEPs: FEP Screening Decisions and Relevant Parameters, CCA and CRA (continued)						
FEP No.	***FEP Name*** **Issue**	**CCA Screening Decision**	**CRA Screening Decision**	**Parameters for CCA PA / Key Cross-References**	**Parameters for CRA PA / Corresponding Cross-References**	**Agency Disposition / Comment**
H57	*Loss of records* Loss of records could change the effectiveness of institutional controls	NA (HCN) DP (future)	No change	Accounted for in PA calculations (no cross-reference in Appendix SCR) Appendix PAR, Table PAR-53, *Intrusion Parameters*	Same Appendix PA, Attachment PAR, Tables PAR-45 and PAR-46	CCA: Screening argument appeared reasonable to the Agency CRA: No new information identified. DOE notes that credit is no longer taken for passive institutional controls in PA
H58	***Solution mining for potash***	N/A	**SO-R (HCN)** **SO-R (future)** **New FEP, FEP description, and screening argument. Solution mining for potash is not considered current practice in the area**	N/A	None	CCA: N/A CRA: the Agency noted the omission of brine mining (solution mining) from the CCA and requested additional information. DOE's response adequately supported relevant screening decisions in the CCA (US EPA 1998d). This FEP is discussed further in Section 2.2.3
H59	***Solution mining for other resources***	N/A	**SO-C (HCN)** **SO-C (future)** **New FEP, FEP description. Screening argument as for H58**	N/A	None	As above (H58). This FEP is discussed further in Section 2.2.3

Key

UP: FEPs included in the PA as *undisturbed* performance. **DP**: FEPs included in the PA as *disturbed* performance.

Note that DP FEPs and UP FEPs must be considered to evaluate compliance with 40 CFR §191.13

SO-C: FEPs screened out based on consequence. **SO-P**: FEPs screened out based on low probability.

SO-P: FEPs screened out based on regulations. **HCN**: historical, current, and near-future human activities.

N/A: not applicable.

2.2 Discussion of Specific FEPs

FEPs that have either changed in some way since the CCA or require additional comment are discussed in this section.

2.2.1 Natural FEPs

N10, *Formation of new fault(s),* and N11, *Fault movement*: Although these FEPs are screened out for both the CCA and CRA, the Screening Decision has changed, from SO-C in the CCA to SO-P in the CRA (CRA Appendix PA, Attachment SCR, Section SCR-4.1.3.2.3). In fact, the text in the CCA (US DOE 1996 Appendix SCR, Section SCR.1.1.3.3) indicates that the correct Screening Decision is based on low probability of occurrence over 10,000 years, i.e. SO-P. This conclusion appears reasonable based on the information reviewed.

N16, *Shallow dissolution*, and N17, *Lateral dissolution*: Because these FEPs involve similar processes, N17 was deleted as an individual FEP in the CRA and combined with N16, now entitled *Shallow dissolution (including lateral dissolution)*. In the CCA, DOE described shallow dissolution as involving percolation of groundwater and mineral dissolution in the Rustler formation, whereas lateral dissolution occurred at the top of the Salado formation. DOE noted that shallow dissolution is included in PA calculations and "encompasses the nature and characteristics of lateral dissolution" (CRA Appendix PA, Attachment SCR, Sections SCR-4.1.5.1 and 4.1.5.2). This conclusion appears reasonable based on the information reviewed.

N19, *Solution chimneys*, and N20, *Breccia pipes*: Because there was no clear distinction made between these two FEPs in the discussions in the CCA, DOE combined the FEPs into a single FEP, N 20, *Breccia pipes* (CRA Appendix PA, Attachment SCR, Sections SCR-4.1.5.3 and 4.1.5.4). This decision appears reasonable based on the information reviewed.

2.2.2 Waste- and Repository-Induced FEPs

W38, *Investigation boreholes*: For the CRA, DOE considered this FEP to be redundant because potential effects of such boreholes are covered by H31, *Natural borehole fluid flow*, and H33, *Flow through undetected boreholes*, both of which address borehole penetration of the disposal horizon (CRA Appendix PA, Attachment SCR, Sections SCR-5.2.1.8 and 6.3.5.5). This decision appears reasonable based on the information reviewed.

W50, *Galvanic coupling (corrosion mechanism)*: This FEP was screened out of the CCA on the basis of low probability. However, DOE noted that the original CCA screening argument confused galvanic coupling between/among materials both inside and outside the repository. For the CRA, this FEP, W50, considers only galvanic coupling between materials in the repository as a corrosion mechanism and is screened out on the basis of low consequence. DOE considers this decision to be more appropriate than one based on probability. This treatment and the change in Screening Decision from SO-P to SO-C appear reasonable based on the information reviewed.

FEP, W95, *Galvanic coupling* with materials outside the repository, is treated as part of electrochemical transport phenomena and has not changed since the CCA (CRA Appendix PA, Attachment SCR, Section SCR-6.5.1.5).

W68, *Organic complexation*, and W69, *Organic ligands*: DOE changed the Screening Decision for these two FEPs from SO-C to UP, i.e., the possible effects of organic complexation and organic ligands are now accounted for in CRA PA calculations. Note that FEPs included in UP PA calculations are also considered in DP PA calculations to determine compliance with the Containment Requirements of 40 CFR §191.13. In the CCA, DOE argued that the presence of transition metals in the waste would dominate complexation with organic ligands so that organic complexation with actinides would not be significant. Experimental work carried out at Florida State University (Choppin et al. 2001) indicated significant complexation of actinides with carboxylate anions derived from acetic, citric, oxalic and ethylene diamine tetra-acetic (EDTA) acids. However, at that time, the thermodynamic database supporting these organic ligands was considered to be inadequate for PA calculations. After additional experimental work, the database was updated and complexation of actinides with these anions was included in CRA PA calculations (CRA, Appendix PA, Attachment SCR, Section SCR-6.5.6.1). This change in Screening Decision appears reasonable based on the information reviewed.

2.2.3 Human-Initiated FEPs

H21, *Drilling fluid flow*, and H22, *Drilling fluid loss*: There have been no changes to the Screening Decisions for these two FEPs, but the screening arguments have been updated. Some repetition was noted in the text for these FEPs. Because there are references to H23, *Blowout* in the discussion of H21 as well as references to H21, *Drilling fluid flow* in the discussion of H23, FEPs H21- H23 should be treated together for clarity (CRA, Appendix PA, Attachment SCR, Section SCR-5.2.1). The screening decision appears reasonable based on the information reviewed.

H22, *Drilling fluid loss*: There is a minor inconsistency concerning the discussion of how Drilling Fluid Loss is treated in PA calculations. In the CRA (CRA Appendix PA, Attachment SCR, page 84, line 10), DOE states that the "....effects of drilling fluid loss for E1 drilling events have been eliminated from PA calculations on the basis of low consequence….", and line 14 states that "....drilling fluid loss for E2 drilling events are accounted for in PA calculations." However, on lines 36/37 of page 84 in Attachment SCR, the text states that the ".....consequences of Drilling Fluid Loss into waste panels in the future is accounted for in PA calculations for E1 and E2 events." Based on the discussion provided on this page, drilling fluid loss should be eliminated for E1 drilling events and, therefore, should not be included in the last statement above, on line 37. This inconsistency/error further supports the discussion of FEPs H21-H23 together. The screening decision appears reasonable based on the information reviewed.

H27, *Liquid waste disposal*, H28, *Enhanced oil and gas production*, and H29, *Hydrocarbon storage*: The Screening Decision for these FEPs in the future time frame (up to 10,000 years) has

been changed from SO-R to SO-C. DOE cited a study (Stoelzel and Swift 1997) carried out after the CCA, on the potential effects on the disposal system from leakage due to pressurized brine injection. The results of this study indicated that if leaks do occur from brine injection in the vicinity of the WIPP, these leaks will not affect repository performance. This decision appears reasonable based on the information reviewed. The Screening Decision (SO-C) for the historical, current and near-future time frame has not changed (CRA, Appendix PA, Attachment SCR, Section SCR-5.2.1.6).

H31, *Natural borehole fluid flow*, and H33, *Flow through undetected boreholes*: FEP H33 has been removed from the FEPs baseline and the description covering H31 was modified to include undetected boreholes. DOE notes also that "*knowledge of a borehole's existence has no impact on its effects*." These modifications appear reasonable based on the information reviewed. No change has been made to the Screening Decision for FEP H31 (CRA Appendix PA, Attachment SCR, Section SCR-5.2.1.8)

H41, *Surface disruptions*: The Screening Decision in the CRA for this FEP for the historical, current and near-future time period is changed from SO-C to UP, i.e., the effects of surface disruptions on hydrologic conditions are taken into account in PA calculations. Recent indications of the possible effects of surface disruptions on hydrology include changes in hydraulic head of the Culebra. Potential seepage from a tailings (potash and salt) pond at a mine north of the WIPP site is believed to be a possible explanation for the observed changes in Culebra water levels. DOE notes that three tailings piles within approximately 10 km of the WIPP have been in operation for decades and that PA calculations account for the effects of brine disposal at the tailings piles. The revised Culebra groundwater flow model incorporates water levels measured in 2000. There is an inconsistency in the discussion of Screening Decision for the future time frame – Section SCR-5.3.1.2.5 provides an argument for screening out on the basis of low consequence, whereas Section SCR-5.3.1.2.1 indicates a Screening Decision of SO-R (CRA Appendix PA, Attachment SCR, Section SCR-5.3.1.2). The CCA states that the relevant regulatory basis is 40 CFR 194.32(a). However, this inconsistency has no bearing on the FEP's inclusion in the PA, as both Screening Decisions involve screening out. The Screening Decision of SO-R appears reasonable based on the information reviewed.

H46, *Altered soil or surface water chemistry by human activities*: In their review of the CCA, the Agency considered the DOE's screening evaluation for historical, current, near-future (SO-C) and future (SO-R) human-initiated effects to be technically reasonable. For the CRA, the DOE does not appear to have considered potential impacts from potash mining activities related to infiltration of mining-related waters, and the possible impact this might have on surface water chemistry. Potash mining has recently been shown to possibly impact water levels in the shallow groundwater zone differently than was assumed in the CCA. While hydrogeologic effects have been included in the CRA, geochemical effects do not appear to be. On the other hand, the arguments relating to hydrogeologic effects, i.e., that such effects are included in PA calculations in terms of the current variability in water heads, which implicitly takes into account ongoing surface disruptions, can also be applied to geochemical effects. In addition, the consequences of

soil or surface water chemistry altered in this way is likely to be low, especially when compared with H24, *Drilling-induced geochemical changes*, H30, *Fluid injection induced geochemical changes*, and H36, *Borehole-induced geochemical changes*, all of which may affect subsurface geochemistry, in particular in the Culebra, and all of which are included in PA calculations. Therefore, the Screening Decision in the CRA is acceptable.

H58, *Solution mining for potash*, and H59, *Solution mining for other resources*: These two FEPs are new to the CRA FEP baseline and were added to describe these activities explicitly rather than incorporate them within other FEPs. These additional FEPs were added as a result of the Agency's comments on the CCA FEPs and the fact that DOE had omitted solution (brine) mining as an activity in the Delaware Basin (US EPA 1997f). DOE's responses (Hicks 1997a, 1997b) to the Agency's 1997 letter addressed both solution mining for potash as well as solution mining for brine and were deemed adequate by the Agency (US EPA 1998d) to support the CCA Screening Decisions. In the CRA (CRA Appendix PA, Attachment SCR, Section SCR-5.2.2.3.3), DOE notes that solution mining for potash is not a current activity in the Delaware Basin and provides additional technical arguments why this technique is highly unlikely. For FEP H59, solution mining for brine is a current activity within the Delaware Basin but DOE argues that, because it occurs more than 30 km from the WIPP site, it will not affect the hydrogeology or geochemistry in the vicinity of the site. Thus, the Screening Decisions for these two FEPs appear justified based on the information reviewed.

3.0 Future States (40 CFR 194.25(a)) FEPs

DOE used future states (40 CFR 194.25(a)) to screen out 17 FEPs in the CRA (See Table 4 below). 40 CFR 194.25(a) states in part: "…shall assume that characteristics of the future remain what they are at the time the compliance application is prepared…". EPA reviewed DOE's application of the requirement and found it to be reasonable, that DOE's application of 40 CFR 194.25(a) is reasonable, and that DOE continues to comply with this requirement.

Table 4 - FEPs Future States (40 CFR 194.25(a)) Assumptions Applied

FEP No.	FEP Name	CRA Appendix PA Attachment SCR Reference
H6	Archeological Investigations	5.1.1.3, page 75
H7	Geothermal	5.1.1.3, page 75
H10	Liquid Waste Disposal	5.1.1.3, page 75
H11	Hydrocarbon Storage	5.1.1.3, page 75
H12	Deliberate Drilling Intrusion	5.1.1.3, page 75
H15	Tunneling	5.1.2.3, page 77
H16	Construction of Underground Facilities	5.1.2.3, page 77
H40	Land Use Changes	5.3.1.1, page 128
H41	Surface Disruptions	5.3.1.2, page 129
H47	Greenhouse Gas Effects	5.5.1.1, page 134
H48	Acid Rain	5.5.1.1, page 134
H49	Damage to Ozone Layer	5.5.1.1, page 134
H53	Arable Farming	5.7.1.1, page 135
H54	Ranching	5.7.1.1, page 135
H55	Fish Farming	5.7.1.1, page 135
H56	Demographic Change and Urban Development	5.7.2.1, page 135
H58	Solution Mining For Potash	5.2.2.3, page 119

4.0 SUMMARY

The Agency has reviewed the FEPs, as presented in the CRA (US DOE 2004). The Agency's analysis included review of information provided with and as part of the CRA, for comparison with similar information provided in the CCA. The results of this review confirmed the information provided by DOE that:

- Of the original 237 FEPs, 106 FEPs have not changed since the CCA.
- Of the 131 FEPs that have changed, most of the changes are updates to text descriptions, as well as additional information supporting the original (CCA) screening arguments.
- Significant changes noted include:
  - Two new FEPs addressing solution mining (H58, *Solution mining for potash* and H59, *Solution mining for other resources*) that had been considered as being part of an existing FEP, were added to the database. In its review of the CCA, the Agency had noted the omission of solution (brine) mining and had requested additional information.
  - Four FEPs (N17, Lateral Dissolution; N19, Solution Chimneys; H33, Flow Through Undetected Boreholes; and W38, Investigation Boreholes) were either deleted or combined logically with other related FEPs.

- Seven FEPs (W50, *Galvanic coupling*; W68, *Organic complexation*; W69, *Organic ligands*; H27, *Liquid waste disposal*; H28 *Enhanced oil and gas production*; H29, *Hydrocarbon storage*; and H41, *Surface disruptions*) had their Screening Decisions changed. However, these FEPs were all screened out in the CCA assessment, and for the CRA, only the basis for screening out was changed.

With regard to selected FEPs under the human-initiated series of FEPs, the Agency's analysis identified no significant changes in drilling, fluid injection, or mining activities that have occurred in the WIPP area since the CCA that would warrant reconsideration of FEPs (US EPA 2004). Additionally, no significant changes have occurred that require modifications to PA input parameters other than those identified by DOE (e.g., DOE has tracked deep drilling rates and has modified the drilling rate accordingly in CRA documentation). Also, DOE revises human-intrusion related parameters, such as angular drilling velocity, to be consistent with the Agency's Performance Assessment Verification Test (PAVT) values; these types of modifications appear appropriate (US EPA 2004).

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