

**OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
ANALYSIS/MODEL COVER SHEET**

1. OA: QA 52

Page: 1 of: 2

Complete Only Applicable Items

2/22/01

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4. Title: Evaluation of the Applicability of Biosphere-Related Features, Events, and Processes (FEP)

5. Document Identifier (including Rev. No. and Change No., if applicable): ANL-MGR-MD-000011, REV 01

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Enclosure 3

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OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
ANALYSIS/MODEL REVISION RECORD

1. Page: 2

of: ⁵² 7/25
2/22/01

Complete Only Applicable Items

2. Analysis or Model Title:
Evaluation of the Applicability of Biosphere-Related Features, Events, and Processes (FEP)

3. Document Identifier (including Rev. No. and Change No., if applicable):

ANL-MGR-MD-000011, REV 01

4. Revision/Change No.

5. Description of Revision/Change

Rev 00

Initial Issue

Rev 01

Completely revised to address the guidance provided in proposed 10 CFR Part 63 and to remove discussion and consideration of model validation. This revision supercedes Rev.00 completely.

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ACRONYMS AND ABBREVIATIONS

AMR	Analysis and Model Report
CFR	Code of Federal Regulations
CRWMS	Civilian Radioactive Waste Management System
DOE	U.S. Department of Energy
FEPs	Features, Events, and Processes
IA	Igneous Activity
IRSR	Issue Resolution Status Report
M&O	Management and Operating Contractor
NRC	U.S. Nuclear Regulatory Commission
PMR	Process Model Report
QA	Quality Assurance
QARD	Quality Assurance Requirement and Description
RIG	Revised Interim Guidance
RT	Radionuclide Transport
TSPA	Total System Performance Assessment
USFIC	Unsaturated and Saturated Flow under Isothermal Conditions
YMP	Yucca Mountain Site Characterization Project

1. PURPOSE

The purpose of this revision of the Analysis and Model Report (AMR), *Evaluation of the Applicability of Biosphere-Related Features, Events, and Processes (FEPs)* is to perform and document the screening analysis of FEPs that are potentially biosphere-related and to remove the model validation analysis from this AMR. This screening analysis includes the screen decision, screening argument, and recommended Total System Performance Assessment (TSPA) disposition for biosphere-related primary FEPs.

1.1 SCOPE

The *Technical Work Plan for Biosphere Modeling and Expert Support* (CRWMS M&O 2000a) identifies the general overall scope of work and objectives for this AMR including evaluation of the applicability of the biosphere-related primary FEPs. The scope of this AMR is limited to the "Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada" (Revised Interim Guidance [RIG]) (Dyer 1999) and the new regulations proposed by the U.S. Nuclear Regulatory Commission (NRC), 10 CFR Part 63 (see Federal Register for February 22, 1999, 64 FR 8640), and is not intended to address other regulatory areas such as the National Environmental Policy Act.

Evaluation of the applicability of the biosphere-related primary FEPs assigned to the *Biosphere Process Model Report* (PMR) (CRWMS M&O 2000b) was originally identified in terms of the guidance provided in RIG (Dyer 1999). The proposed regulations in 10 CFR Part 63, when finalized will provide licensing criteria for the disposal of spent nuclear fuel and high-level waste. Until such time as these regulations are finalized, these proposed regulations will be used as guidance for the evaluation of FEP applicability in conjunction with that provided in the RIG. In those cases where the RIG guidance is not consistent with the proposed regulations the NRC guidance will be used. This helps ensure consistency between the evaluation of applicability and proposed regulatory requirements.

The results of this analysis will be used to support the revision of *The Development of Information Catalogued in REV00 of the YMP FEP Database* (YMP FEP Database) (CRWMS M&O 2000c) and to support the *Total System Performance Assessment - Site Recommendation* (TSPA-SR) (CRWMS M&O 2000d).

1.1.1 Development of Features, Events, and Processes

The YMP FEP Database (CRWMS M&O 2000c) provides a list of FEPs potentially applicable to the Yucca Mountain Site Characterization Project (YMP). A detailed summary of the development of that list of FEPs and its structure is presented in the YMP FEP Database (CRWMS M&O 2000c). Those primary FEPs determined to be applicable to the biosphere are identified in Table 1. Secondary FEP associated with each of these primary FEP are identified in Attachment I of this AMR.

Table 1. Biosphere Features, Events, and Processes

FEP NAME	FEP NUMBER
Erosion/denudation	1.2.07.01.00
Deposition	1.2.07.02.00
Climate change, global	1.3.01.00.00
Periglacial effects	1.3.04.00.00
Glacial and ice sheet effects, local	1.3.05.00.00
Human influences on climate	1.4.01.00.00
Greenhouse gas effects	1.4.01.02.00
Acid rain	1.4.01.03.00
Ozone layer failure	1.4.01.04.00
Altered soil or surface water chemistry	1.4.06.01.00
Water management activities	1.4.07.01.00
Wells	1.4.07.02.00
Social and institutional developments	1.4.08.00.00
Technological developments	1.4.09.00.00
Species evolution	1.5.02.00.00
Capillary rise	2.2.07.03.00
Soil type	2.3.02.01.00
Radionuclide accumulation in soils	2.3.02.02.00
Soil and sediment transport	2.3.02.03.00
Surface water transport and mixing	2.3.04.01.00
Marine features	2.3.06.00.00
Animal burrowing/intrusion	2.3.09.01.00
Precipitation	2.3.11.01.00
Surface runoff and flooding	2.3.11.02.00
Biosphere characteristics	2.3.13.01.00
Biosphere transport	2.3.13.02.00
Human characteristics (physiology, metabolism)	2.4.01.00.00
Diet and fluid intake	2.4.03.00.00
Human lifestyle	2.4.04.01.00
Dwellings	2.4.07.00.00
Wild and natural land and water use	2.4.08.00.00
Agricultural land use and irrigation	2.4.09.01.00
Animal farms and fisheries	2.4.09.02.00
Urban and industrial land and water use	2.4.10.00.00
Drinking water, foodstuffs and drugs, contaminant concentrations in	3.3.01.00.00
Plant uptake	3.3.02.01.00
Animal uptake	3.3.02.02.00
Bioaccumulation	3.3.02.03.00
Contaminated non-food products and exposure	3.3.03.01.00
Ingestion	3.3.04.01.00
Inhalation	3.3.04.02.00
External exposure	3.3.04.03.00
Radiation doses	3.3.05.01.00
Radiological toxicity/effects	3.3.06.00.00
Sensitization to radiation	3.3.06.02.00
Non-radiological toxicity/effects	3.3.07.00.00
Radon and radon daughter exposure	3.3.08.00.00

2. QUALITY ASSURANCE

This analysis has been determined to be quality affecting in accordance with AP-2.21Q, *Quality Determination and Planning for Scientific, Engineering, and Regulatory Compliance Activities*, because the information will be used to support performance assessment and other quality-affecting activities. This analysis is subject to the requirements of the *Quality Assurance Requirements and Description* (QARD) (DOE 2000). This analysis is covered by the *Technical Work Plan for Biosphere Modeling and Expert Support* (CRWMS M&O 2000a). The primary implementing procedure for this work is Office of Civilian Radioactive Waste Management procedure AP-3.10Q, *Analyses and Models*. Several other procedures were used to support development of this AMR. These include the following:

- AP-2.1Q, Indoctrination and Training of Personnel
- AP-2.2Q, Establishment and Verification of Required Education and Experience of Personnel
- AP-2.14Q, Review of Technical Products
- AP-3.4Q, Level 3 Change Control
- AP-3.15Q, Managing Technical Product Inputs AP-6.1Q, Controlled Documents
- AP-17.1Q, Record Source Responsibilities for Inclusionary Records
- AP-SI.1Q, Software Management
- AP-SV.1Q, Control of the Electronic Management of Data

Personnel performing work on this analysis were trained and qualified according to AP-2.1Q, *Indoctrination and Training of Personnel*, and AP-2.2Q, *Establishment and Verification of Required Education and Experience of Personnel*. Preparation of this analysis does not require the classification of items in accordance with QAP-2-3, *Classification of Permanent Items*. This analysis is not a field activity. Therefore, a Determination of Importance Evaluation in accordance with NLP-2-0 is not required.

Methods used to control the electronic management of data were done in accordance with AP-SV.1Q as specified in the *Technical Work Plan for Biosphere Modeling and Expert Support* (CRWMS M&O 2000a).

3. COMPUTER SOFTWARE AND MODEL USAGE

This AMR uses no computational software. As a result, these analyses are not subject to software controls. The analyses, arguments and evaluations presented in this AMR are based on DOE guidance and proposed NRC regulations, results of analyses presented in other AMRs, or technical literature.

This AMR was developed using only Microsoft Word software for word processing. This software is exempt from qualification requirements in accordance with AP-SI.1Q, *Software Management*. No additional applications, routines or macros, were developed using this software.

4. INPUTS

4.1 DATA AND PARAMETERS

No data or parameters were used in the preparation of this AMR.

4.2 CRITERIA

At the present time there are no regulations in effect that provide criteria for evaluating the applicability of FEPs to be used to assess the performance of the potential repository. New regulations being developed by the NRC (64 FR 8640) will provide such criteria. As a result, guidance for evaluating the applicability of a FEP is provided by the DOE in the RIG (Dyer 1999). This guidance is referred to as RIG throughout this document. The RIG provides specific guidance on the performance objectives for the repository after permanent closure (Section 113) and the associated performance requirements (Section 114). Guidance on the characteristics and limits of the reference biosphere and receptor of interest to be considered are provided in Section 115. For the purpose of this analysis, the guidance in Section 115 is referred to as qualitative criteria. The technical justifications for exclusion of a FEP from consideration on the basis of low probability and/or low consequence are provided in Section 114. For the purpose of this analysis, these technical justifications are referred to as technical criteria. Section 114 guidance, although specific to the geologic setting, was used in this analysis for the purpose of consistency with other Analysis and Model Reports. The RIG was used in lieu of specific criteria based on regulatory requirements. However, in the event that the guidance in the RIG is not consistent with that in the proposed regulations, the proposed regulations were used as guidance.

4.2.1 Technical Criteria

This analysis applies the RIG guidance for exclusion of a FEP from consideration on the basis of either low probability or low consequence. Specifically, the guidance allows a FEP to be excluded from consideration if it is of low-probability (i.e., less than one chance in 10,000 of occurring in 10,000 years) or if occurrence of the FEPs can be shown to have no significant effect on expected annual dose. The low probability guidance is provided in Section 114 (d) of the RIG. This section explicitly states, "Consider only events that have at least one chance in 10,000 of occurring over 10,000 years."

The guidance for low consequence screening arguments for FEPs is provided by the DOE in Section 114(e and f) of the RIG. This guidance is as follows:

- (e) Provide the technical basis for either inclusion or exclusion of specific features, events, and processes of the geologic setting in the performance assessment. Specific features, events, and processes of the geologic setting must be evaluated in detail if the magnitude and time of the resulting expected annual dose would be significantly changed by their omission.
- (f) Provide the technical basis for either exclusion or inclusion of degradation, deterioration or alteration processes of engineered barriers in the performance

assessment, including those processes that would adversely affect the performance of natural barriers. Degradation, deterioration, or alternative processes of engineered barriers must be evaluated in detail if the magnitude and time of the result in expected annual dose would be significantly changed by their omission.”

4.2.2 Qualitative Criteria

The qualitative criteria that define the nature of the environment in which the receptor resides and the characteristics of the receptors of interest are provided in Section 115 (a and b) of the RIG as the reference biosphere and the critical group.

4.2.2.1 Reference Biosphere

The guidance pertaining to the characteristics of the reference biosphere are presented in Section 115 (a)(1-2) of the RIG. This guidance is as follows:

“Reference Biosphere.

- (1) Features, events, and processes that describe the reference biosphere shall be consistent with present knowledge of the conditions in the region surrounding the Yucca Mountain site
- (2) Biosphere pathways shall be consistent with arid or semi-arid conditions.”

The NRC guidance in proposed 10 CFR Part 63 (64 FR 8640) that addresses the reference biosphere differs from that of the RIG. It requires consideration of the effects of both climatic and geologic evolution. Specifically, proposed 10 CFR Part 63.115(a) (64 FR 8640) requires that:

- (3) Climate evolution shall be consistent with the geologic record of natural climate change in the region surrounding the Yucca Mountain site.
- (4) Evolution of the geologic setting shall be consistent with present knowledge of natural processes.”

This additional guidance is considered in this screening analysis of FEP applicability.

4.2.2.2 Critical Group

The DOE establishes the characteristics of the critical group to be considered in the dose assessment calculations in Section 115 (b)(1-5) of the RIG. This guidance is as follows:

“Critical group.

- (1) The critical group shall reside within a farming community located approximately 20 km south from the underground facility (in the general location of the junction of U.S. Route 95 and Nevada Route 373).

- (2) The behaviors and characteristics of the farming community shall be consistent with current conditions of the region surrounding the Yucca Mountain site. Changes over time in the behaviors and characteristics of the critical group including, but not necessarily limited to, land use, lifestyle, diet, human physiology, or metabolics, shall not be considered.
- (3) The critical group resides within a farming community consisting of approximately 100 individuals, and exhibits behaviors or characteristics that will result in the highest expected annual doses.
- (4) The behaviors and characteristics of the average member of the critical group shall be based on the mean value of the critical group's variability range. The mean value shall not be unduly biased based on the extreme habits of a few individuals.
- (5) The average member of the critical group shall be an adult. Metabolic and physiological consideration shall be consistent with present knowledge of adults."

4.3 CODES AND STANDARDS

There are no Codes or Standards directly applicable to this analysis.

5. ASSUMPTIONS

No assumptions were used in the analysis of FEPs applicability.

6. ANALYSIS/MODEL

This section documents the screening analysis of FEPs that are identified as biosphere-related.

6.1 SCREENING AND ANALYSIS OF THE BIOSPHERE-RELATED PRIMARY FEATURES, EVENTS, AND PROCESSES

The primary method used in this analysis was a screening of the biosphere-related primary FEPs and the associated secondary FEPs through use of the screening criteria identified in Section 4.2. These criteria are applicable to both primary and secondary FEP. The FEP descriptions and associated database field titles, such as Screening Decision and Regulatory Basis, Related Primary FEPs, IRSR Issues, Screening Argument, TSPA Disposition, Supplemental Discussion, as presented in Section 6.2 are taken directly from the YMP FEP Database (CRWMS M&O 2000c). All of the fields except the FEP description and number may be updated as a result of this analysis process.

For FEPs that were excluded based on specific guidance the screening argument includes a reference to the appropriate section of the RIG or proposed 10 CFR Part 63 (64 FR 8640) as necessary. A short discussion of the reason for exclusion is included to support the screening argument. For those that were excluded based on probability or consequence criteria, the screening argument includes a summary of the basis that indicates either low probability or low consequence. For FEPs that were included, a reference to the biosphere AMR(s) that includes that FEP is provided. These FEPs are ultimately used to support the *Total System Performance Assessment - Site Recommendation* (TSPA-SR) (CRWMS M&O 2000d).

Included in the screening of each of the primary FEP is an identification of the related subissue(s) in the U.S. Nuclear Regulatory Commission Key Technical Issues as identified in Appendix B of *Issue Resolution Status Report Key Technical Issue: Total System Performance Assessment and Integration* (IRSR KTI:TSPAI) (NRC 2000). These subissues include: Unsaturated and Saturated Flow under Isothermal Conditions - Climate change (USFIC1), Radionuclide Transport – through alluvium (RT2), and, Igneous Activity– Consequences of igneous activity within the repository setting (IA2).

The 47 primary FEPs, and the associated secondary FEPs, identified in Attachment I of this AMR were screened for inclusion or exclusion based on criteria provided in Section 4.2 of this AMR. A review of the secondary FEPs relationship to the primary FEP was conducted to determine if the primary FEP description captured the intent of the secondary FEPs. The results of this review indicated that for the 47 biosphere-related primary FEPs, the primary FEP description did capture the intent of the secondary FEPs. However, it was also determined that not all secondary FEPs were applicable to Yucca Mountain biosphere. Secondary FEPs, which are excluded from TSPA, are identified in Attachment I of this AMR.

6.2 BIOSPHERE FEPs EVALUATION AND ANALYSIS

6.2.1 Erosion/denudation (FEP 1.2.07.01.00)

FEP Description: Erosion and denudation are processes, which cause significant changes in the present-day topography and thus affect local and regional hydrology and the biosphere. Erosion of surficial materials can occur by a variety of means, including physical weathering (including glacial and fluvial erosion), chemical weathering, erosion by wind (aeolian erosion), and mass wasting (e.g., landslide) processes. The extent of erosion depends to a large extent on climate and uplift.

Screening Decision and Regulatory Basis:

Included—(processes that may result in significant change such as physical weathering, chemical weathering and mass wasting)

Excluded—low probability (Not Credible)(glacial erosion)

Related Primary FEPs:

1.3.01.00.00

2.3.02.02.00

2.3.02.03.00

2.3.13.01.00

IRSR Issues:

USFIC1, RT2, IA2

Screening Argument:

Future climate projections (USGS 2000) indicate that, although the climate is expected to evolve to a cooler, wetter climate, conditions will be that of a glacial transition climate. A full glacial climatic state is not expected within the next 10,000 years. As a result glacial erosion is not considered a credible event. Therefore, glacial erosion is excluded on the basis of low probability.

Erosional processes are included in the TSPA as described under the TSPA Disposition.

TSPA Disposition:

The effects of erosional processes are considered in AMR entitled *Evaluate Soil/Radionuclide Removal by Erosion and Leaching* (CRWMS M&O 2000e) and are considered in TSPA-SR (CRWMS M&O 2000d) Sections 3.9 and 3.10.

Supplemental Discussion: N/A

6.2.2 Deposition (FEP 1.2.07.02.00)

FEP Description: Deposition and erosion are processes, which cause significant changes in the present-day topography and thus affect local and

regional hydrology and the biosphere. Deposition of surficial materials can occur by a variety of means, including fluvial, aeolian, and lacustrine deposition and redistribution of soil through weathering and mass wasting processes.

**Screening Decision
and Regulatory Basis:**

Included.

Related Primary FEPs:

1.2.07.01.00
1.3.01.00.00
2.3.02.02.00
2.3.02.03.00
2.3.13.01.00

IRSR Issues:

USFIC1, RT2, IA2

Screening Argument:

The effects of depositional processes are included in the TSPA as described under the TSPA Disposition.

TSPA Disposition:

Depositional processes are considered in AMR entitled *Evaluate Soil/Radionuclide Removal by Erosion and Leaching* (CRWMS M&O 2000e). The effects of these processes are used in TSPA-SR Section 3.9 and 3.10 (CRWMS M&O 2000d). Section 3.10 considers ash redistribution, resuspension and related soil processes.

Supplemental Discussion:

N/A

6.2.3 Climate Change, Global (FEP 1.3.01.00.00)

FEP Description:

Climate change may affect the long-term performance of the repository. This includes the effects of long-term change in global climate (e.g., glacial/interglacial cycles) and shorter-term change in regional and local climate. Climate is typically characterized by temporal variations in precipitation and temperature.

**Screening Decision
and Regulatory Basis:**

Included.

Related Primary FEPs:

2.3.02.02.00
2.3.11.01.00
2.3.11.02.00
2.3.13.01.00

IRSR Issues:

USFIC1, RT2, IA2

Screening Argument:

Climate change is included in TSPA as described in the TSPA Disposition.

TSPA Disposition: The effect of temporal variations in precipitation and temperature on movement of radionuclides through the reference biosphere is presented in AMR entitled *Nominal Performance Biosphere Dose Conversion Factors* (CRWMS M&O 2000f). These factors are considered in Section 3.9 of TSPA-SR (CRWMS M&O 2000d).

Supplemental Discussion: N/A

6.2.4 Periglacial Effects (FEP 1.3.04.00.00)

FEP Description: This category contains FEPs related to the physical processes and associated landforms in cold but ice-sheet-free environments. Permafrost and seasonal freeze/thaw cycles are characteristic of periglacial environments.

Screening Decision and Regulatory Basis: Excluded—low probability (Not Credible).

Related Primary FEPs: 1.3.01.00.00
1.3.05.00.00

IRSR Issues: N/A

Screening Argument: Future climate projections estimate that the climate around Yucca Mountain will evolve to a cooler, wetter glacial transition state within the next 10,000 years (USGS 2000). The lower bound of the mean average temperature range for the glacial transition state (USGS 2000, Section 6.6.2) is above the temperature needed to support periglacial effects. As a result periglacial effects are not credible. Therefore, this FEP is excluded on the basis of low probability.

TSPA Disposition: N/A

Supplemental Discussion: N/A

6.2.5 Glacial and Ice Sheet Effects, Local (FEP 1.3.05.00.00)

FEP Description: This category contains FEPs related to the effects of glaciers and ice sheets occurring within the region of the repository, including direct geomorphologic effects and hydrologic effects. These effects include changes in topography (due to glaciation and melt water), changes in flow fields, and isostatic depression and rebound.

Screening Decision and Regulatory Basis: Excluded—low probability (Not Credible).

Related Primary FEPs: 1.3.01.00.00
1.3.04.00.00.

IRSR Issues: N/A

Screening Argument: Future climate projections (USGS 2000) indicate that the climate is expected to evolve to a cooler and wetter climate over the next 10,000 years. The lower bound of the mean average temperature range for this cooler and wetter glacial transition state (USGS 2000, Section 6.6.2) is projected to be above the temperature needed to support glaciers or ice sheets. As a result presence of glaciers and/or ice sheets is not credible. Therefore, this FEP is excluded on the basis of low probability.

TSPA Disposition: N/A

Supplemental Discussion: N/A

6.2.6 Human Influences on Climate (FEP 1.4.01.00.00)

FEP Description: This category contains FEPs related to future human actions that could influence global, regional, or local climate. Human actions may be intentional or accidental. This FEP aggregates all human influences on climate into a single category. Technical discussions are presented separately for increased recharge (1.4.01.01.00), greenhouse gas effects (1.4.01.02.00), acid rain (1.4.01.03.00), and ozone layer failure (1.4.01.04.00).

Screening Decision and Regulatory Basis: Excluded—regulatory.

Related Primary FEPs: 1.4.01.01.00 _ 1.4.01.02.00
1.4.01.03.00
1.4.01.04.00

IRSR Issues: N/A

Screening Argument: Section 63.115(a)(3) of the proposed 10 CFR Part 63 (64 FR 8640, p. 8677) specifically limits consideration of climate evolution to that which is consistent with the geologic record of natural climate change. Therefore, this FEP, which considers the consequences of future human activity on climate, is excluded on the basis of the regulation.

TSPA Disposition: N/A

Supplemental Discussion: N/A

6.2.7 Greenhouse Gas Effects (FEP 1.4.01.02.00)

FEP Description: The greenhouse effect refers to the presence of carbon dioxide and other gases in the atmosphere that tend to allow solar radiation through to the earth's surface and reflect heat back to it. Thus, these gases act much as the glass of a greenhouse, with the earth as the greenhouse. Human activities such as burning of fossil fuels, forest clearance, and industrial processes produce these greenhouse gases. The greenhouse effect could increase concentrations of carbon dioxide and other gases in the atmosphere, and lead to changes in climate such as global warming.

Screening Decision and Regulatory Basis: Excluded–regulatory.

Related Primary FEPs: 1.04.01.00.00

IRSR Issues: N/A

Screening Argument: Section 63.115(a)(3) of the proposed 10 CFR Part 63 (64 FR 8640, p. 8677) specifically limits consideration of climate evolution to that which is consistent with the geologic record of natural climate change. Therefore, this FEP, which considers the consequences of human activity on the concentration of greenhouse gases in the atmosphere, is excluded on the basis of the regulation.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.8 Acid Rain (FEP 1.4.01.03.00)

FEP Description: Human actions may result in acid rain on a local to regional scale. Acid rain can detrimentally affect aquatic and terrestrial life by interfering with the growth, reproduction and survival of organisms. It can influence the behavior and transport of contaminants in the biosphere, particularly by affecting surface water and soil chemistry.

Screening Decision and Regulatory Basis: Excluded–regulatory.

Related Primary FEPs: 1.4.01.00.00

IRSR Issues: N/A

Screening Argument: Section 63.115(a)(4) of the proposed 10 CFR Part 63 (64 FR 8640, p. 8677) specifically focuses consideration of FEPs that describe the reference biosphere to those which are consistent with present knowledge of the conditions in the region of Yucca Mountain site. This FEP, which considers the consequences of human actions that result in air pollution and therefore acid rain, is excluded on the basis of the regulation.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.9 Ozone Layer Failure (FEP 1.4.01.04.00)

FEP Description: Human actions (i.e., the use of certain industrial chemicals) may lead to destruction or damage to the earth's ozone layer. This may lead to significant changes to the climate, affecting properties of the geosphere such as groundwater flow patterns.

Screening Decision and Regulatory Basis: Excluded—regulatory.

Related Primary FEPs: 1.4.01.00.00

IRSR Issues: N/A

Screening Argument: Section 63.115(a)(4) of the proposed 10 CFR Part 63 (64 FR 8640, p. 8677) specifically limits consideration of climate evolution to that which is consistent with the geologic record of natural climate change. Therefore, this FEP, which considers the consequences of human activity on the ozone layer and thereafter climate change, is excluded on the basis of the regulation.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.10 Altered Soil or Surface Water Chemistry (FEP 1.4.06.01.00)

FEP Description: Human activities (e.g., industrial pollution, agricultural chemicals) may produce local changes to the soil chemistry or to the chemistry of water infiltrating Yucca Mountain and could provide a plume of unspecified nature to interact with the repository and possibly with containers.

Screening Decision and Regulatory Basis: Excluded—regulatory.

Related Primary FEPs: N/A

IRSR Issues: N/A

Screening Argument: Section 113(d) of the RIG stipulates that human intrusion into the repository shall be considered only in the form of a specified stylized drilling scenario. This FEP, which deals with human intrusion by other scenarios, is therefore excluded on the basis of the regulation.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.11 Water Management Activities (FEP 1.4.07.01.00)

FEP Description: Water management is accomplished through a combination of dams, reservoirs, canals, pipelines, collection and storage facilities. Water management activities could have a major influence on the behavior and transport of contaminants in the biosphere.

Screening Decision and Regulatory Basis: Excluded—regulatory.

Related Primary FEPs: N/A

IRSR Issues: N/A

Screening Argument: Section 115(b) of the RIG specifies that the behavior and characteristics of the farming community be consistent with current conditions. Figure 2–2 of LaPlante and Poor (1997) and Section 7.1 of the Yucca Mountain Site Description (CRWMS M&O 2000g) show that there are no major dams, reservoirs, canals, pipelines, collection and storage facilities within 20 km of the location of the critical group specified in Section 115(b). Man-made impoundments are those in the area of Ash Meadows, approximately 20 km south of the proposed location of the critical group. As a result, this FEP is excluded on the basis of regulation.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.12 Wells (FEP 1.4.07.02.00)

FEP Description: One or more wells drilled for human use (e.g., drinking water, bathing) or agricultural use (e.g., irrigation, animal watering) may intersect the contaminant plume.

Screening Decision and Regulatory Basis: Included—(use of well water for domestic and agricultural purposes consistent with current human behavior and characteristics.)

Excluded—regulatory (effects of wells located in Crater Flats, Jackass Flats, and Midway Valley).

Related Primary FEPs: 2.3.02.02.00
2.4.03.00.00
2.4.09.01.00
3.3.01.00.00
3.3.04.01.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Section 115(b) of the RIG specifies the location of the critical group as approximately 20 km south of the underground facility. Therefore, those FEPs that address the effects of wells at other locations are excluded by the regulation.

Use of a well for human or agricultural use is included in the TSPA as described under the TSPA Disposition.

TSPA Disposition: A well is considered as the source of radionuclides entering the biosphere under the nominal performance scenario. (See AMR entitled *Groundwater Usage by the Proposed Farming Community* (CRWMS M&O 2000i), and *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f).) Biosphere dose conversion factors are directly considered in Section 3.9 of TSPA-SR (CRWMS M&O 2000d) in the evaluation of expected annual dose. To the extent that existing wells throughout the region affect saturated zone flow, they have been included in the development of the saturated zone flow model for TSPA.

Supplemental Screening: N/A

6.2.13 Social and Institutional Developments (FEP 1.4.08.00.00)

FEP Description: This category contains FEPs related to social and institutional developments that could affect the long-term performance of the repository. The most likely is social and institutional development resulting in new activities, communities or cities in the vicinity of Yucca Mountain.

Screening Decision and Regulatory Basis: Excluded—regulatory.

Related Primary FEPs: 1.4.09.00.00

IRSR Issues: N/A

Screening Argument: Section 115(b)(2) the RIG specifies that the behavior and characteristics of the farming community be consistent with current conditions and that the critical group resides within that farming community. Changes over time in the behaviors and characteristics of the critical group including but not limited to land use, lifestyle, diet, human physiology, or metabolics shall not be considered. Therefore, change in the social and institutional attributes of society is excluded on the basis of the regulation.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.14 Technological Developments (FEP 1.4.09.00.00)

FEP Description: Technological developments may affect the long-term performance of the repository. These include changes in the ability of man to intrude the site, and changes that might affect contaminant exposure and its health implications.

*Screening Decision
and Regulatory Basis:* Excluded—regulatory.

Related Primary FEPs: 1.4.08.00.00

IRSR Issues: N/A

Screening Argument: Section 115(b)(2) of the RIG specifies that the behavior and characteristics of the farming community be consistent with current conditions and that the critical group resides within that farming community. Changes over time in the behaviors and characteristics of the critical group including but not limited to land use, lifestyle, diet, human physiology, or metabolics shall not be considered. Therefore, this technological development is excluded on the basis of regulation.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.15 Species Evolution (FEP 1.5.02.00.00)

FEP Description: Species living at or near the repository, including humans, may evolve in the future and new behavior and characteristics of living

organisms may affect their contaminant exposure and its health implications.

Screening Decision and Regulatory Basis: Excluded–regulatory.

Related Primary FEPs: N/A

IRSR Issues: N/A

Screening Argument: Section 115(b)(2) of the RIG specifies that the behavior and characteristics of the farming community be consistent with current conditions. Changes over time in the behaviors and characteristics of the critical group including, but not limited to, land use, lifestyle, diet, human physiology, or metabolics shall not be considered. Therefore, consideration of human evolution is specifically excluded. Consideration of non-human receptors is precluded by the performance objective specified in Section 113 (b) of the RIG which deals with dose to man. Therefore, species evolution is excluded on the basis of the regulation.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.16 Capillary Rise (FEP 2.2.07.03.00)

FEP Description: Capillary rise involves the drawing up of water, above the water table or above locally saturated zones, in continuous pores of the unsaturated zone until the suction gradient is balanced by the gravitational pull downward. Capillary rise may provide a mechanism for radionuclides to reach the surface environment in locations where the water table is shallow.

Screening Decision and Regulatory Basis: Excluded–low probability (Not Credible).

Related Primary FEPs: N/A

IRSR Issues: N/A

Screening Argument: Section 115 (b)(1) of the RIG specifies the location of the critical group as approximately 20 km south of the underground facility. Since depth to groundwater in that area is in excess of 90 meters (Kilroy 1991) and capillary rise is a process that occurs close to an area of saturation, capillary rise is not a credible mechanism by which radionuclides may reach the surface environment.

Therefore, capillary rise is excluded on the basis of low probability.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.17 Soil Type (FEP 2.3.02.01.00)

FEP Description: Soil type is determined by many different factors (e.g., formative process, geology, climate, vegetation, land-use). The physical and chemical attributes of the surficial soils (such as organic matter content, pH), may influence the mobility of contaminants.

Screening Decision and Regulatory Basis: Included.

Related Primary FEPs: 2.3.02.02.00
2.3.02.03.00
2.3.13.02.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Soil-type is included in the TSPA as described under the TSPA Disposition.

TSPA Disposition: Soil-type is addressed in AMR entitled *Evaluate Soil/Radionuclide Removal by Erosion and Leaching* (CRWMS M&O 2000e). These analyses are considered in Section 3.9 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.18 Radionuclide Accumulation in Soil (FEP 2.3.02.02.00)

FEP Description: Radionuclide accumulation in soils may occur as a result of upwelling of contaminated groundwater (leaching, evaporation at discharge location) or deposition of contaminated water or particulates (irrigation water, runoff, atmospheric deposition).

Screening Decision and Regulatory Basis: Include—(accumulation of radionuclides in soil as a result of irrigation).

Excluded—regulatory (accumulation of radionuclides in soil at locations other than that of the critical group).

Related Primary FEPs: 2.3.02.01.00
2.3.02.03.00
2.3.13.02.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Section 115 of the RIG specifies the location of the farming community, in which the critical group resides, as approximately 20 km south of the location of the potential repository. As a result of this specification, consideration of the accumulation of radionuclides at another location is excluded by regulation.

Accumulation of radionuclides in soil is included in the TSPA as described under the TSPA Disposition.

TSPA Disposition: Accumulation of radionuclides in soil is considered in the AMR entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and is considered in the TSPA-SR (CRWMS M&O 2000d) in Section 3.9. Ashfall and subsequent movement are considered within the identified related Primary FEP.

Supplemental Screening: N/A

6.2.19 Soil and Sediment Transport (FEP 2.3.02.03.00)

FEP Description: Contaminated sediments can be transported by fluvial, glacial and, to a lesser extent, aeolian processes. In addition, sediment transport may occur through the actions of living organisms (i.e., bioturbation). Sediment transport and redistribution may cause concentration or dilution of radionuclides.

Screening Decision and Regulatory Basis: Included- (soil and sediment transport)
Excluded-low probability (Not Credible) (glacial transport of sediments)

Related Primary FEPs: 1.2.07.01.00
1.2.07.02.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Future climate projections indicate that the climate will evolve to a cooler and wetter climatic state within the next 10,000 years (USGS 2000). This glacial transition climate is not cold enough to support glaciers. Therefore, glacial transport of soil and sediments

is not considered credible and this FEP is excluded on the basis of low probability.

Soil and sediment transport is included in the TSPA as described under the TSPA Disposition.

TSPA Disposition: Transport of soil and sediments are discussed in the AMR entitled *Evaluate Soil/Radionuclide Removal by Leaching and Erosion* (CRWMS M&O 2000e) and in AMR entitled *Nominal Performance Biosphere Dose Conversion Factors* (CRWMS M&O 2000f). The results of these analyses are used in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d). Aeolian and fluvial transport of contaminated volcanic ash has been indirectly included in the TSPA-SR igneous disruption scenario through the use of a wind direction is fixed toward the critical group for all hypothetical eruptions. As described in Section 3.10 of TSPA-SR (CRWMS M&O 2000d), use of a fixed wind direction compensates for the lack of an explicit model for sediment transport following ash deposition by ensuring that all eruptions result in the deposition of contaminated ash at the location of the critical group, regardless of the wind direction at the time of the event.

Supplemental Screening: N/A

6.2.20 Surface Water Transport and Mixing (FEP 2.3.04.01.00)

FEP Description: Contaminants released from an underground repository might enter the biosphere through discharge of deep groundwater into a lake or river. Transport and mixing within the surface water bodies affects the subsequent behavior and transport of contaminants in the biosphere. Transport and mixing includes dilution, sedimentation, aeration, streamflow, and river meander.

Screening Decision and Regulatory Basis: Excluded—low probability.

Related Primary FEPs: N/A

IRSR Issues: N/A

Screening Argument: The region around Yucca Mountain lacks permanent surface water bodies. Section 7.1 of the *Yucca Mountain Site Description* (CRWMS M&O 2000g) and Figure 2–2 of LaPlante and Poor (1997) indicate there are no perennial lakes and rivers within approximately 40 km of the location of Yucca Mountain. As a result, this FEP is excluded on the basis of low probability.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.21 Marine Features (FEP 2.3.06.00.00)

FEP Description: This category contains FEPs related to marine and coastal features and processes. Processes include erosion, sedimentation, deposition, sea-level change, and storms.

Screening Decision and Regulatory Basis: Excluded—low probability (Not Credible).

Related Primary FEPs: N/A

IRSR Issues: N/A

Screening Argument: Figure 1.1–1 of the *Yucca Mountain Site Description* (CRWMS M&O 2000g, P. F1.1–1) shows the location of the Yucca Mountain region relative to the continental boundaries of the United States. Given the location of Yucca Mountain, the potential for impact of coastal and/or marine features and processes on the area around Yucca Mountain is not considered as credible. As a result, this FEP is excluded on the basis of low probability.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.22 Animal Burrowing/Intrusion (FEP 2.3.09.01.00)

FEP Description: Burrowing animals may intrude into the repository, promoting release and spread of contamination. Burrowing animals may also contact or ingest contaminated soil.

Screening Decision and Regulatory Basis: Excluded—low probability (Not Credible) (non-human intrusion into the repository).

Excluded-regulation (non-human contact with or ingestion of contaminated soil)

Related Primary FEPs: N/A

IRSR Issues: N/A

Screening Argument: The current construction plans for the repository, as presented in *Site Recommendation Subsurface Layout* (CRWMS M&O 2000j), indicate that the subsurface emplacement level of the repository will be constructed at a depth of not less than 200 meters below the

surface. At these depths, intrusion by an animal (non-human) is not considered to be credible. Therefore, this FEP is excluded on the basis of low probability.

Section 113(b) of the RIG specifically limits the performance objective to a dose to man. Therefore, consideration of a non-human as part of the performance is excluded on the basis of the regulation.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.23 Precipitation (FEP 2.3.11.01.00)

FEP Description: Precipitation is an important control on the amount of recharge. It transports solutes with it as it flows downward through the subsurface or escapes as runoff. The amount of precipitation depends on climate.

Screening Decision and Regulatory Basis: Included.

Related Primary FEPs: 1.3.01.00.00
2.3.02.02.00
2.3.13.01.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Precipitation is included in the TSPA as described under the TSPA Disposition.

TSPA Disposition: Precipitation and the associated effects on processes such as irrigation, radionuclide leaching, and contaminant transport are considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h).

These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.24 Surface Runoff and Flooding (FEP 2.3.11.02.00)

FEP Description: Surface runoff and evapotranspiration are components in the water balance, together with precipitation and infiltration. They can also

be important vehicles for the dispersion of contaminants. Surface runoff produces erosion, and can feed washes, arroyos, and impoundments, where flooding may lead to increased recharge.

<i>Screening Decision and Regulatory Basis:</i>	Included.
<i>Related Primary FEPs:</i>	2.3.11.01.00 2.3.11.01.00
<i>IRSR Issues:</i>	USFIC1, RT2, IA2
<i>Screening Argument:</i>	Surface runoff and flooding are included in the TSPA as described under the TSPA Disposition.
<i>TSPA Disposition:</i>	Surface run-off and flooding are considered in the AMR entitled <i>Evaluate Soil/Radionuclide Removal by Erosion and Leaching</i> (CRWMS M&O 2000e). The effects of flooding and the movement of contaminated materials on contaminant dispersion are considered in the AMR entitled <i>Features, Events, and Processes in SZ Flow and Transport</i> (CRWMS M&O 2000k). These effects are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).
<i>Supplemental Screening:</i>	N/A

6.2.25 Biosphere Characteristics (FEP 2.3.13.01.00)

FEP Description: The conditions that exist in the biosphere are likely to vary over time in a largely unpredictable manner, due to both natural and anthropogenic events and/or processes. These biosphere conditions or characteristics can influence contaminant transport and can affect the long-term performance of the disposal system. Biosphere characteristics include climate, vegetation, plant and animal populations, and microbes.

Screening Decision and Regulatory Basis:

Included—(biosphere characteristics including plants and animal populations, microbes, current climatic conditions and climatic conditions as a result natural climate evolution).

Excluded—regulatory (climate change resulting from anthropogenic events).

Excluded—Low probability (Not Credible) (forests, grasses, wetlands).-

Related Primary FEPs: 1.3.01.00.00
2.3.02.02.00
2.3.09.01.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Section 63.115(a)(3) of the proposed 10 CFR Part 63(64 FR 8640, p. 8677) specifically limits consideration of climate evolution to that which is consistent with the geologic record of natural climate change. Therefore, those portions of this FEP that relate to anthropogenic events are excluded on the basis of the regulation.

The area around Yucca Mountain, which includes the location of the farming community, is characterized as an arid to semiarid climate with high evapotranspiration and low annual precipitation (CRWMS M&O 2000g). Although isolated areas of forest and wetlands do occur in the region, these do not occur in arid to semi-arid environments. Given the arid/semiarid nature of the area around Yucca Mountain, the presence of forests and grasslands is not considered credible. Therefore those aspects of this FEP that relate to forests and grasslands are excluded on the basis of low probability.

The region around Yucca Mountain lacks permanent surface water bodies. Section 7.1 of the *Yucca Mountain Site Description* (CRWMS M&O 2000g) and Figure 2-2 of LaPlante and Poor (1997) indicates there are no natural perennial lakes and rivers within approximately 40 km of Yucca Mountain. Therefore, the presence of wetlands is not considered credible and is therefore excluded.

Biosphere characteristics, both present and future, are included in the TSPA as described under the TSPA Disposition.

TSPA Disposition: Biosphere characteristics such as climate, plants, animals, soils, and associated ecological processes are considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factors* (CRWMS M&O 2000h). Natural climate evolution is considered in *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f). The biosphere dose conversion factors generated in these AMRs are used in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.26 Biosphere Transport (FEP 2.3.13.02.00)

<i>FEP Description:</i>	Radionuclides contained in sediments and surface water bodies and in the gaseous phase may be transferred to the biosphere by a variety of processes. Once in the biosphere, radionuclides may be transported and transferred through and between different compartments of the biosphere. Time-dependent chemical environments in the biosphere may promote or retard the transport and transfer processes, and consequently control exposure to the human population.
<i>Screening Decision And Regulatory Basis:</i>	Included—(radionuclide transport and transfer through and between biosphere compartments). Excluded—low probability (Not Credible) (radionuclide transport in surface water bodies).
<i>Related Primary FEPs:</i>	1.3.01.00.00 2.4.09.01.00
<i>IRSR Issues:</i>	USFIC1, RT2, IA2
<i>Screening Argument:</i>	The Yucca Mountain region is characterized by a lack of perennial surface water bodies except for the man-made impoundments in the area of Ash Meadows (CRWMS M&O 2000g) which are approximately 20 km from the proposed location of the farming community in which the critical group resides. Therefore, radionuclide transport in surface water bodies is not credible and is excluded on the basis of low probability. Biosphere transport is included in the TSPA as described under the TSPA Disposition.
<i>TSPA Disposition:</i>	Biosphere transport is considered in the development of biosphere dose conversion factors as presented in the AMRs entitled <i>Nominal Performance Biosphere Dose Conversion Factor Analysis</i> (CRWMS M&O 2000f) and <i>Disruptive Event Biosphere Dose Conversion Factor Analysis</i> (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).
<i>Supplemental Screening:</i>	N/A

6.2.27 Human Characteristics (Physiology, Metabolism) (FEP 2.4.01.00.00)

FEP Description: This category contains FEPs related to human characteristics. These include physiology, metabolism, and variability among individual humans.

Screening Decision and Regulatory Basis: Included—(characteristics of the human adult).
Excluded—regulatory (characteristics of the human other than the adult, such as, infant, child, and adolescent).

Related Primary FEPs: N/A

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Sections 115(b)(5) of the RIG specifies that the average member of the critical group shall be an adult. As a result, consideration of any other age receptor is excluded by regulation.

TSPA Disposition: The adult human receptor as specified in the regulations is considered in the AMR entitled *Dose Conversion Factor Analysis: Evaluation of GENII-S Dose Assessment Methods* (CRWMS M&O 1999a). These methods are considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These biosphere dose conversion factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d). Human characteristics are included in the TSPA as described under the TSPA Disposition.

Supplemental Screening: N/A

6.2.28 Diet and Fluid Intake (FEP 2.4.03.00.00)

FEP Description: This category contains FEPs related to human diet and fluid intake. Consumption of food, water, soil, drugs, etc., will affect human exposure to radionuclides. Other influences include filtration of water, dilution of diet with uncontaminated food, and food preparation techniques.

Screening Decision and Regulatory Basis: Included.

Related Primary FEPs: 2.4.09.01.00
2.4.09.02.00
3.3.03.01.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Diet and fluid intake are included in the TSPA as described under the TSPA Disposition.

TSPA Disposition: Diet and fluid intake are considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.29 Human Lifestyle (FEP 2.4.04.01.00)

FEP Description: Human lifestyle, including leisure activities, will influence the critical exposure pathways to man.

Screening Decision and Regulatory Basis: Included—(aspects of human lifestyle including work, leisure activities).

Excluded—regulatory (hunter/gathering lifestyle).

Related Primary FEPs: 3.3.04.01.00
3.3.04.02.00
3.3.04.03.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Sections 115(b) of the RIG specify that the critical group is part of a farming community. Hunter gathering lifestyle is inconsistent with the behavior of a farming community and is therefore excluded by regulation. Human lifestyle is included in the TSPA as described under the TSPA Disposition.

TSPA Disposition: Human lifestyle is considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.30 Dwellings (FEP 2.4.07.00.00)

FEP Description: This category contains FEPs related to human dwellings, and the ways in which dwellings might affect human exposures. Exposure pathways might be influenced by building materials, location, and everyday household activities.

*Screening Decision
and Regulatory Basis:*

Included—(household activities).

Excluded—low probability (type of dwelling, use of local materials for construction and as a source of fuel).

Excluded—low consequence (household cooling).

Excluded—regulatory (variation in location).

Related Primary FEPs: 3.3.04.02.00
3.3.04.03.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: U.S. Census Bureau (1999) data indicate that dwellings in Amargosa Valley are predominately manufactured-housing which are prefabricated from non-local material and do not have basements. Therefore, those portions of this FEP which deal with build-up of radionuclides in basements or the use of local, contaminated building materials are excluded on the basis of low probability.

Given the arid/semi-arid nature of the climate around Yucca Mountain, the lack of perennial streams (Section 7.1. CRWMS M&O 2000g), and the depth to groundwater (90 meters) (Kilroy 1991) at the location of the farming community in which the critical group resides, the environment is too dry to support the mass of vegetation needed to be used as fuel. An investigation of the soils in the around the proposed location of the farming community (CRWMS M&O 1999b) did not indicate the presence of any organic deposits, such as peat. Therefore this FEP, which includes the use of local materials for heating, is not considered credible and is excluded on the basis of probability.

Household cooling, using an air conditioner or an evaporative (swamp) cooler, will tend to reduce the concentration of radionuclides in indoor air relative to the concentration of that in outdoor air. This reduction is a result of pulling outdoor air through either a filter or a wet straw mat. However, there is the possibility that radionuclides could enter the house as a result of

evaporation of the water used to cool and moisten the air. This could result in a potential increase in exposure via inhalation and/or external exposure. Since such units are used approximately half of the year and that inhalation and external exposure contribute a very small fraction of the expected annual dose relative to dose from ingestion (CRWMS M&O 2000f), these processes are not expected to have a significant impact on the expected annual dose. Therefore they can be excluded on the basis of low consequence.

Section 115(b)(1) of the RIG specifies the location of the critical group as approximately 20 km south of the underground facility. As a result, consideration of other locations is excluded on the basis of regulation. Household activities are included in the TSPA as described under the TSPA Disposition.

TSPA Disposition:

Household activities, although not individually identified, are inherently considered by estimating dose associated with time spent indoors in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.31 Wild and Natural Land and Water Use (FEP 2.4.08.00.00)

FEP Description:

This category contains FEPs related to human uses of wild and natural lands (forests, bush, coastlines) and water (lakes, rivers, oceans) that may affect the long-term performance of the repository. Wild and natural land use will be primarily controlled by natural factors (topography, climate, etc.).

Screening Decision and Regulatory Basis:

Excluded—low consequence

Related Primary FEPs:

2.4.04.01.00

IRSR Issues:

N/A

Screening Argument:

Section 115(b) of the RIG specifies that the critical group resides within a farming community. Use of wild and natural lands and waters would remove the members of the critical group from the area of potential contamination. Omission of these activities is not expected to significantly alter the expected annual dose. As a result, these activities are excluded on the basis of low consequence.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.32 Agricultural Land Use and Irrigation (FEP 2.4.09.01.00)

FEP Description: Agricultural land use depends on many interrelated factors including climate, geology, topography, human lifestyle and economics. Land use includes traditional crop farming, greenhouses, and hydroponics. Agricultural activities may influence the long-term performance of the repository through contamination of the foodchain or alternative exposure pathways. Agricultural activities of concern include irrigation, ploughing, fertilization, crop storage, application of soil conditioners and agricultural chemicals, and fires.

*Screening Decision
and Regulatory Basis:*

Included—(current agricultural land use practices including irrigation, ploughing, crop storage.)

Excluded— low consequence (ashes and sewerage sludge, use of contaminated agricultural chemicals.)

Excluded—regulatory (changes in agricultural practices, hydroponics gardening, use of peat.)

Related Primary FEPs: 3.3.04.01.00
3.3.01.00.00
3.3.02.01.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Several of the agricultural practices addressed in the FEP, such as hydroponic gardening, and the development and subsequent use of peat deposits, are not consistent with current conditions in the Yucca Mountain region, and are therefore excluded on the basis of the regulation.

Use of locally produced soil conditioners, such as manure, is expected to contribute significantly less radionuclides to the soil than that added by irrigation with contaminated water. The omission of this activity is not expected to significantly affect the expected annual dose. Therefore, this activity is excluded on the basis of low consequence.

Consideration of changes in agricultural practices as a result of climate change and/or socioeconomic changes is excluded on the basis of Section 115(b) (2) of the RIG. This section requires that

behaviors and characteristics of the farming community be consistent with current conditions. Therefore, this activity is excluded on the basis of regulations. Agricultural practices are included in the TSPA as described under the TSPA Disposition.

TSPA Disposition: Agricultural land use and irrigation are considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.33 Animal Farms and Fisheries (FEP 2.4.09.02.00)

FEP Description: Domestic livestock or fish could become contaminated through the intake of contaminated feed, water, or soil. Such contamination would then enter the foodchain.

Screening Decision and Regulatory Basis: Included.

Related Primary FEPs: 3.3.04.01.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: N/A

TSPA Disposition: Animal and fish farming are considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factors Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.34 Urban and Industrial Land and Water Use (FEP 2.4.10.00.00)

FEP Description: This category contains FEPs related to urban and industrial uses of land and water (industry, urban development, earthworks, energy production, etc.) that may affect the long-term performance of the repository. Urban and industrial land use will be controlled by both natural factors (topography, climate, etc.) and human factors (economics, population density, etc.).

Screening Decision and Regulatory Basis: Excluded—regulatory.

Related Primary FEPs: 2.4.04.01.00

IRSR Issues: N/A

Screening Argument: Consideration of urban and industrial activities is inconsistent with Section 115(b)(1) of the RIG, which specifies that the critical group resides within a farming community. Therefore, this FEP is excluded on the basis of the regulation.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.35 Drinking Water, Foodstuffs and Drugs, Contaminant Concentrations in (FEP 3.3.01.00.00)

FEP Description: This category contains FEPs related to human exposure to contaminants as a result of ingesting foodstuffs, water, or drugs.

Screening Decision and Regulatory Basis: Included—(ingestion of locally grown foods and consumption of local groundwater).

Related Primary FEPs: 3.3.04.01.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: N/A

TSPA Disposition: Effect of radionuclide concentrations in foodstuff and water are considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.36 Plant Uptake (FEP 3.3.02.01.00)

FEP Description: Uptake of contaminants by plants could affect the long-term performance of the disposal system. Some contaminants escaping from the repository are expected to eventually be able to reach natural outfalls (e.g., Franklin Lake Playa), where plant uptake would be possible. Particulate deposition onto plant surfaces is

also possible. These plants may be used as feed for livestock and/or consumed directly by humans.

**Screening Decision
and Regulatory Basis:**

Included—(plant uptake of radionuclides, deposition of radionuclides on plant surfaces, and subsequent ingestion by livestock and humans).

Excluded—regulatory (natural outfalls).

Related Primary FEPs:

2.4.09.01.00
2.4.09.02.00
3.3.04.01.00

IRSR Issues:

USFIC1, RT2, IA2

Screening Argument:

Section 115 (b)(1) of the RIG specifies the location of the critical group as 20 km south of the location of the potential repository. Based on the depth to groundwater presented in Kilroy (1991), there are no natural outfalls in that area. Therefore, the occurrence of natural outfalls is not considered credible and is therefore excluded on the basis of low probability.

TSPA Disposition:

Plant uptake and transfer of radionuclides along the foodchain to man are considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening:

N/A

6.2.37 Animal Uptake (FEP 3.3.02.02.00)

FEP Description:

Livestock and fish may accumulate radionuclides as a result of ingestion of water, feed and soil/sediment and inhalation of aerosols and particulates. Depending on the livestock, they may be used for human consumption directly, or their produce (milk, eggs, etc.) may be consumed.

**Screening Decision
and Regulatory Basis:**

Included—(accumulation of radionuclides in livestock and fish and subsequent transfer to man via the ingestion pathway).

Excluded—regulatory (non-human [animal] receptor of interest).

Related Primary FEPs:

3.3.04.01.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: The receptor of interest in Section 113(b) of the RIG is man. As a result, assessment of dose to a non-human is excluded on the basis of regulation.

TSPA Disposition: Animal uptake and transfer of radionuclides along the foodchain to man are considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.38 Bioaccumulation (FEP 3.3.02.03.00)

FEP Description: Contaminants may accumulate in different organisms, including members of the critical group, affecting impacts. Bioconcentration and biomagnification are related processes.

Screening Decision and Regulatory Basis: Included.

Related Primary FEPs: 3.3.04.01.00
3.3.04.02.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: N/A

TSPA Disposition: Accumulation (build-up) of radionuclides along the foodchain to man are considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.39 Contaminated Non-Food Products and Exposure (FEP 3.3.03.01.00)

FEP Description: Contaminants may be concentrated in various products: clothing (e.g., hides, leather, linen, wool); furniture (e.g., wood, metal); building materials (e.g., stone, clay for bricks, wood, dung); fuel (e.g., peat), tobacco, pets.

Screening Decision and Regulatory Basis: Excluded–low probability.

Related Primary FEPs: N/A

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Section 115(b)(2) of RIG specifies that the behavior and characteristics of the farming community shall be consistent with current conditions of the region surrounding the Yucca Mountain site. The data (U.S. Census Bureau 1999) suggest that manufacturing of durable and non-durable goods, using local materials, for use by local residents is not a common occurrence. This FEP is excluded, therefore, on the basis of low probability.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.40 Ingestion (FEP 3.3.04.01.00)

FEP Description: Ingestion is human exposure to repository-derived radionuclides through eating contaminated foodstuffs or drinking contaminated water.

Screening Decision and Regulatory Basis: Included.

Related Primary FEPs: 3.3.01.00.00
3.3.02.01.00
3.3.02.01.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: N/A

TSPA Disposition: Consumption of contaminated food products and water is considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f). Consumption of contaminated food products is considered in *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.41 Inhalation (FEP 3.3.04.02.00)

FEP Description: Two inhalation pathways are likely. The first is inhalation of gases and vapors emanating directly from the ground after transport through the far-field. The second is inhalation of suspended, contaminated particulate matter (e.g., daughter products of radon, dust, smoke, pollen, and soil particles).

Screening Decision and Regulatory Basis: Included.

Related Primary FEPs: 2.3.13.02.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: N/A

TSPA Disposition: Inhalation of radionuclides of interest is considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.42 External Exposure (FEP 3.3.04.03.00)

FEP Description: External exposure is human exposure to repository-derived radionuclides by contact, use, or exposure to contaminated materials. The mode is typically through dermal sorption.

Screening Decision and Regulatory Basis: Included—(external exposure to radionuclides in the air (submersion) and on the ground (groundshine)).

Excluded—low consequence (dermal sorption of radionuclides).

Related Primary FEPs: 2.4.09.01.00
2.3.02.01.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: Dermal sorption and injection of radionuclides are usually associated with activities that are of short duration. They are considered to result in a dose that is significantly lower than that associated with ingestion and inhalation. Omission of dermal sorption and injection is not expected to significantly alter the

expected annual dose. Therefore, dermal sorption and injection are excluded on the basis of low consequence.

TSPA Disposition: External exposure radionuclides in air and on the ground is considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h). These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.43 Radiation Doses (FEP 3.3.05.01.00)

FEP Description: The radiation dose is calculated from exposure rates (external, inhalation, and ingestion) and dose conversion factors. The latter are based upon radiation type, human metabolism, metabolism of the element of concern in the human body, duration of exposure.

Screening Decision and Regulatory Basis: Included.

Related Primary FEPs: 3.3.04.01.00
3.3.04.02.00
3.3.04.03.00

IRSR Issues: USFIC1, RT2, IA2

Screening Argument: N/A

TSPA Disposition: Radiation dose from a unit concentration in water and in soil are considered in the AMRs entitled *Nominal Performance Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000f) and *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2000h) respectively. These factors are considered in Sections 3.9 and 3.10 of the TSPA-SR (CRWMS M&O 2000d).

Supplemental Screening: N/A

6.2.44 Radiological Toxicity/Effects (FEP 3.3.06.00.00)

FEP Description: This category contains FEPs related to the estimation of human health effects resulting from radiation doses.

Screening Decision and Regulatory Basis: Excluded—regulatory.

Related Primary FEPs: 3.3.05.01.00
IRSR Issues: N/A
Screening Argument: Section 113(b) of the RIG establishes a performance objective that is based on radiation dose. Therefore, this FEP is excluded on the basis of regulation.
TSPA Disposition: N/A
Supplemental Screening: N/A

6.2.45 Sensitization to Radiation (FEP 3.3.06.02.00)

FEP Description: Human and other organisms may become sensitized to radiation exposure so that its effects are more severe.
Screening Decision and Regulatory Basis: Excluded—regulatory (effects of radiation exposure increased due to biological sensitivity).
Related Primary FEPs: 3.3.06.00.00
IRSR Issues: N/A
Screening Argument: Section 115(b)(2) of the RIG establishes that changes over time in the characteristics of the critical group shall not be considered. Therefore, this FEP is excluded on the basis of regulation.
TSPA Disposition: N/A
Supplemental Screening: N/A

6.2.46 Non-Radiological Toxicity/Effects (FEP 3.3.07.00.00)

FEP Description: This category contains FEPs related to the estimation of human health effects resulting from the non-radiological toxicity of the waste.
Screening Decision and Regulatory Basis: Excluded—regulatory.
Related Primary FEPs: 3.3.06.00.00
IRSR Issues: N/A
Screening Argument: Section 113(b) of the RIG establishes a performance objective that is based on radiation dose and not on health effects. Therefore, this FEP is excluded on the basis of regulation.

TSPA Disposition: N/A

Supplemental Screening: N/A

6.2.47 Radon and Radon Daughter Exposure (FEP 3.3.08.00.00)

FEP Description: This category contains FEPs related to human exposure to radon and radon decay products. Ra-226 occurs in nuclear fuel waste and it gives rise to radon (Rn-222) gas, the radioactive daughters of which can be harmful to humans and animals upon inhalation.

Screening Decision and Regulatory Basis: Excluded—low probability (Not Credible).

Related Primary FEPs: 3.3.05.01.00

IRSR Issues: N/A

Screening Argument: Based on the radionuclide inventory data provided in *Inventory Abstraction* (CRWMS M&O 20001), the Ra-226 parent radionuclide, Th-230, is not expected to appear in the groundwater within the first 10,000 years. As a result, generation of Rn-222, the decay product of Ra-226, is not expected to occur. This FEP is considered not credible and is excluded on the basis of low probability.

TSPA Disposition: N/A

Supplemental Screening: N/A

7. CONCLUSIONS

Of the 47 primary FEPs identified in Table 1 of this report, it was concluded that 25 FEPs are applicable, in part or in total, to Yucca Mountain. For those FEPs for which the screening against the criteria revealed that one or more of the secondary FEPs associated with the primary FEPs were applicable, the FEP was screened as "Include." The FEPs that are currently considered to be applicable are identified in Table 2. Status of and/or changes to the referenced documents may affect this document. Any changes to this document that may occur as a result of changes to the referenced documents will be reflected in subsequent revisions.

Table 2. Biosphere-related Features, Events, and Processes Considered Applicable to YMP

FEP NAME	YMP FEP DATABASE NUMBER
Erosion/denudation	1.2.07.01.00
Deposition	1.2.07.02.00
Climate change, global	1.3.01.00.00
Wells	1.4.07.02.00
Soil type	2.3.02.01.00
Radionuclide accumulation in soils	2.3.02.02.00
Soil and sediment transport	2.3.02.03.00
Precipitation	2.3.11.01.00
Surface runoff and flooding	2.3.11.02.00
Biosphere characteristics	2.3.13.01.00
Biosphere transport	2.3.13.02.00
Human characteristics (physiology, metabolism)	2.4.01.00.00
Diet and fluid intake	2.4.03.00.00
Human lifestyle	2.4.04.01.00
Dwellings	2.4.07.00.00
Agricultural land use and irrigation	2.4.09.01.00
Animal farms and fisheries	2.4.09.02.00
Drinking water, foodstuffs and drugs, contaminant concentrations in	3.3.01.00.00
Plant uptake	3.3.02.01.00
Animal uptake	3.3.02.02.00
Bioaccumulation	3.3.02.03.00
Ingestion	3.3.04.01.00
Inhalation	3.3.04.02.00
External exposure	3.3.04.03.00
Radiation doses	3.3.05.01.00

8. INPUTS AND REFERENCES

8.1 REFERENCES CITED

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8.2 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

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ATTACHMENT I
SUMMARY OF SCREENING DECISIONS FOR BIOSPHERE-RELATED PRIMARY
FEATURES, EVENTS, AND PROCESSES AND RELATED SECONDARY FEATURES,
EVENTS, AND PROCESSES

DISCUSSION

The following table identifies the Features Events and Processes (FEPs) considered as potentially applicable to the biosphere around Yucca Mountain. Those FEP identified in **bold** are the primary FEPs to which the secondary FEPs are mapped for the purpose of completeness.

FEP #	FEP Name	Screening Decision
1.2.07.01.00	Erosion/denudation	Include
1.2.07.01.01	Major incision	Exclude
1.2.07.01.02	Generalized denudation	Exclude
1.2.07.01.03	Localized denudation	Exclude
1.2.07.01.04	Solid discharge via erosional processes	Exclude
1.2.07.01.05	Basement alteration	Exclude
1.2.07.01.06	Hydraulic gradient changes (magnitude, direction) (in geosphere)	Exclude
1.2.07.01.07	Hydraulic gradient changes (magnitude, direction)	Exclude
1.2.07.01.08	Ephemeral stream erosion cuts Tiva Canyon units to underlying nonwelded units	Exclude
1.2.07.01.09	Land slide	Exclude
1.2.07.01.10	Stream erosion of Amargosa River lowers base levels and increases gradient in SZ	Exclude
1.2.07.01.11	Erosion	Include
1.2.07.01.12	Erosion - lateral transport	Include
1.2.07.01.13	Erosion (wind)	Include
1.2.07.01.14	Erosion on surface/sediments	Include
1.2.07.01.15	Denudation	Exclude
1.2.07.01.16	River, stream channel erosion	Exclude
1.2.07.01.17	Chemical denudation and weathering	Exclude
1.2.07.01.18	Erosion	Include
1.2.07.01.19	Erosion/deposition	Exclude
1.2.07.01.20	Fluvial erosion/sedimentation	Exclude
1.2.07.01.21	Surface denudation	Exclude
1.2.07.01.22	Chemical weathering	Exclude
1.2.07.01.23	Aeolian erosion	Include
1.2.07.01.24	Fluvial erosion	Exclude
1.2.07.01.25	Mass wasting	Exclude
1.2.07.01.26	Mass wasting	Exclude
1.2.07.01.27	Mechanical weathering	Exclude
1.2.07.02.00	Deposition	Include
1.2.07.02.01	Aeolian deposition	Include
1.2.07.02.02	Lacustrine deposition	Exclude
1.3.01.00.00	Climate change, global	Include
1.3.01.00.01	Climate change	Include
1.3.01.00.02	No ice age	Exclude
1.3.01.00.03	Solar insolation	Exclude
1.3.01.00.04	No ice age	Exclude
1.3.01.00.05	Climate change: Natural	Include
1.3.01.00.06	Exit from glacial/interglacial cycling	Exclude

FEP #	FEP Name	Screening Decision
1.3.01.00.00	1.3.01.00.07 Intensification of natural climate change	Exclude
(Continued)	1.3.01.00.08 Climatological (effects)	Include
	1.3.01.00.09 Climate change	Include
	1.3.01.00.10 Present-day climatic conditions	Include
	1.3.01.00.11 Seasonality of climate	Include
	1.3.01.00.12 Future climatic conditions	Include
	1.3.01.00.13 Warmer climate - arid	Include
	1.3.01.00.14 Warmer climate - seasonal humid	Exclude
	1.3.01.00.15 Warmer climate - equable humid	Exclude
	1.3.01.00.16 Climate change (effects on repository)	Exclude
	1.3.01.00.17 Global effects	Exclude
	1.3.01.00.18 Climate (meteorology)	Include
	1.3.01.00.19 Seasons (meteorology)	Include
	1.3.01.00.20 Temperature (meteorology)	Include
	1.3.01.00.21 Climate change (meteorology)	Include
1.3.04.00.00	Periglacial effects	Exclude
	1.3.04.00.01 Permafrost	Exclude
	1.3.04.00.02 Accumulation of gases under permafrost	Exclude
	1.3.04.00.03 Periglacial effects	Exclude
	1.3.04.00.04 Frost weathering	Exclude
	1.3.04.00.05 Solifluction	Exclude
	1.3.04.00.06 Tundra climate	Exclude
	1.3.04.00.07 Permafrost	Exclude
	1.3.04.00.08 Permafrost	Exclude
	1.3.04.00.09 Permafrost	Exclude
1.3.05.00.00	Glacial and Ice sheet effects, local	Exclude
	1.3.05.00.01 Glaciation	Exclude
	1.3.05.00.02 Glaciation	Exclude
	1.3.05.00.03 Glaciation	Exclude
	1.3.05.00.04 Glaciation	Exclude
	1.3.05.00.05 Glacial climate	Exclude
	1.3.05.00.06 Glacial erosion/sedimentation	Exclude
	1.3.05.00.07 Glacial-fluvial erosion/sedimentation	Exclude
	1.3.05.00.08 Ice sheet effects (loading, melt water recharge)	Exclude
	1.3.05.00.09 Glaciation	Exclude
	1.3.05.00.10 Glaciation	Exclude
	1.3.05.00.11 Glaciation	Exclude
	1.3.05.00.12 Isostatic rebound	Exclude

FEP #	FEP Name	Screening Decision
1.4.01.00.00	Human influences on climate	Exclude
1.4.01.00.01	Human-induced climate change	Exclude
1.4.01.00.02	Anthropogenic climate change	Exclude
1.4.01.00.03	Human-induced climate change	Exclude
1.4.01.00.04	Climate change: Human induced	Exclude
1.4.01.02.00	Greenhouse gas effects	Exclude
1.4.01.02.01	Greenhouse effect	Exclude
1.4.01.02.02	Greenhouse gas effects	Exclude
1.4.01.02.03	Greenhouse effect	Exclude
1.4.01.03.00	Acid rain	Exclude
1.4.01.03.01	Acid rain	Exclude
1.4.01.03.02	Surface water pH	Exclude
1.4.01.04.00	Ozone layer failure	Exclude
1.4.01.04.01	Damage to the ozone layer	Exclude
1.4.01.04.02	Ozone layer	Exclude
1.4.06.01.00	Altered soil or surface water chemistry	Exclude
1.4.06.01.01	Altered soil or surface water chemistry	Exclude
1.4.06.01.02	Groundwater pollution	Exclude
1.4.06.01.03	Surface pollution (soils, rivers)	Exclude
1.4.06.01.04	Altered soil or surface water chemistry by human activities	Exclude
1.4.06.01.05	Far field hydrochemistry - acids, oxidants, nitrate	Exclude
1.4.06.01.06	Arable farming	Exclude
1.4.07.01.00	Water management activities	Exclude
1.4.07.01.01	Water collection in cisterns over repository	Exclude
1.4.07.01.02	Water management of nearby ground water basins	Exclude
1.4.07.01.03	Water table drawdown by down gradient pumping increases hydraulic gradient	Exclude
1.4.07.01.04	Surface water impoundment is constructed near the site, increasing percolation	Exclude
1.4.07.01.05	Dams	Exclude
1.4.07.01.06	Human induced actions on groundwater recharge	Exclude
1.4.07.01.07	Human-induced changes in surface hydrology	Exclude
1.4.07.01.08	Dams and reservoirs, built and drained	Exclude
1.4.07.01.09	River rechannelled	Exclude
1.4.07.01.10	Damming of streams or rivers	Exclude
1.4.07.01.11	Reservoirs	Exclude
1.4.07.01.12	Lake usage	Exclude
1.4.07.01.13	Water management schemes	Exclude

FEP #	FEP Name	Screening Decision
1.4.07.02.00	Wells	Include
1.4.07.02.01	Irrigation wells in Midway Valley increase moisture flux through repository	Exclude
1.4.07.02.02	Irrigation wells in Midway Valley reduce distance to accessible environment	Exclude
1.4.07.02.03	Irrigation wells in Crater Flats or Jackass Flats increase hydraulic gradient under repository	Exclude
1.4.07.02.04	Wells (high demand)	Exclude
1.4.07.02.05	Groundwater abstraction	Include
1.4.07.02.06	Water resource exploitation	Include
1.4.07.02.07	Deep groundwater abstraction	Exclude
1.4.07.02.08	Water producing well	Include
1.4.07.02.09	Groundwater extraction	Include
1.4.08.00.00	Social and Institutional developments	Exclude
1.4.08.00.01	Demographic change and urban development	Exclude
1.4.08.00.02	City on the site	Exclude
1.4.08.00.03	Urbanization on the discharge site	Exclude
1.4.08.00.04	Demographic change, urban development	Exclude
1.4.09.00.00	Technological developments	Exclude
1.4.09.00.01	Cure for cancer	Exclude
1.4.09.00.02	Technological advances in food production	Exclude
1.5.02.00.00	Species evolution	Exclude
1.5.02.00.01	Biological evolution	Exclude
1.5.02.00.02	Critical group - evolution	Exclude
1.5.02.00.03	Plant and animal evolution	Exclude
2.2.07.03.00	Capillary rise	Exclude
2.2.07.03.01	Capillary rise (near surface hydrology)	Exclude
2.3.02.01.00	Soil type	Include
2.3.02.01.01	Pedogenesis	Include
2.3.02.01.02	Soil formation	Include
2.3.02.01.03	Soil development	Include
2.3.02.01.04	Soil	Include
2.3.02.02.00	Radionuclide accumulation in soils	Include
2.3.02.02.01	Soil moisture and evaporation (water transport)	Include
2.3.02.02.02	Radionuclide accumulation in sediments at Franklin Lake Playa (water transport)	Exclude
2.3.02.02.03	Accumulation in sediments (sorption/desorption processes)	Exclude
2.3.02.02.04	Accumulation in soils and organic debris (sorption/desorption processes)	Include
2.3.02.02.05	Soil	Include
2.3.02.02.06	Soil leaching	Include

FEP #	FEP Name	Screening Decision
2.3.02.02.00	2.3.02.02.07 Accumulation in peat	Exclude
(Continued)	2.3.02.02.08 Alkali flats (and other playa deposits)	Exclude
	2.3.02.02.09 Accumulation in soil (exposure factors)	Include
2.3.02.03.00	Soil and sediment transport	Include
	2.3.02.03.01 Soil and sediment bioturbation	Include
	2.3.02.03.02 Bioturbation	Include
	2.3.02.03.03 Sediment transport including bioturbation	Include
2.3.04.01.00	Surface water transport and mixing	Exclude
	2.3.04.01.01 Flushing of water bodies	Exclude
	2.3.04.01.02 Lake mixing (artificial)	Exclude
	2.3.04.01.03 Sediment resuspension in water bodies	Exclude
	2.3.04.01.04 Sedimentation in water bodies	Exclude
	2.3.04.01.05 River meandering	Exclude
	2.3.04.01.06 River meander	Exclude
	2.3.04.01.07 Freshwater sediment transport and deposition	Exclude
	2.3.04.01.08 River flow and lake level changes	Exclude
	2.3.04.01.09 Surface water flow (river Rhine)	Exclude
	2.3.04.01.10 Sedimentation	Exclude
	2.3.04.01.11 River course meander	Exclude
	2.3.04.01.12 Surface water bodies	Exclude
	2.3.04.01.13 Surface water mixing	Exclude
	2.3.04.01.14 Stream and river flow	Exclude
	2.3.04.01.15 Surface water bodies	Exclude
	2.3.04.01.16 Exfiltration to surface waters	Exclude
	2.3.04.01.17 Lake formation	Exclude
	2.3.04.01.18 Dilution of radionuclides in surface water (aquifer, river, lake, etc.)	Exclude
	2.3.04.01.19 Radionuclide accumulation in sediments (water transport)	Exclude
2.3.06.00.00	Marine Features	Exclude
	2.3.06.00.01 Marine sediment transport and deposition	Exclude
	2.3.06.00.02 Seas and oceans	Exclude
	2.3.06.00.03 Marine sediment transport and deposition	Exclude
	2.3.06.00.04 Coastal surge, storms and hurricanes	Exclude
	2.3.06.00.05 Coastal erosion and estuarine development	Exclude
	2.3.06.00.06 Estuaries	Exclude
	2.3.06.00.07 Coastal erosion	Exclude
	2.3.06.00.08 Sea level change	Exclude
	2.3.06.00.09 Change in sea level	Exclude
	2.3.06.00.10 Sea-level rise/fall	Exclude
	2.3.06.00.11 Sea level changes	Exclude

FEP #	FEP Name	Screening Decision
2.3.06.00.00	2.3.06.00.12 Sea level changes	Exclude
2.3.09.01.00	Animal burrowing/intrusion	Exclude
	2.3.09.01.01 Intrusion (animal)	Exclude
2.3.11.01.00	Precipitation	Include
	2.3.11.01.01 Precipitation, temperature and soil water balance	Include
	2.3.11.01.02 Flood (meteorology)	Include
	2.3.11.01.03 Extremes of precipitation, snow melt and associated flooding (meteorology)	Include
	2.3.11.01.04 Precipitation (meteorology)	Include
2.3.11.02.00	Surface runoff and flooding	Include
	2.3.11.02.01 Runoff (near surface hydrology)	Exclude
	2.3.11.02.02 Flooding (near surface hydrology)	Exclude
	2.3.11.02.03 Evapotranspiration (near surface hydrology)	Include
	2.3.11.02.04 Flooding occurs in Drill Hole Wash and increases percolation below the wash	Exclude
	2.3.11.02.05 Faulting at the surface produces a scarp causing an impoundment	Exclude
	2.3.11.02.06 River flooding	Exclude
2.3.13.01.00	Biosphere characteristics	Include
	2.3.13.01.01 Fires (forest and grass)	Exclude
	2.3.13.01.02 Wetlands	Exclude
	2.3.13.01.03 Ecological change	Include
	2.3.13.01.04 Microbes (ecological systems)	Include
	2.3.13.01.05 Ecological (processes)	Include
	2.3.13.01.06 Lake infilling	Exclude
	2.3.13.01.07 Plants	Include
	2.3.13.01.08 Future biosphere conditions	Include
	2.3.13.01.09 Ecological response to climate (e.g., desert formation)	Exclude
	2.3.13.01.10 Natural ecological development	Include
2.3.13.02.00	Biosphere transport	Include
	2.3.13.02.01 Sediment/water/gas interaction with the atmosphere	Include
	2.3.13.02.02 Biogeochemical processes	Include
2.4.01.00.00	Human characteristics (physiology, metabolism)	Include
	2.4.01.00.01 Critical group - individuality	Include
2.4.03.00.00	Diet and fluid intake	Include
	2.4.03.00.01 Intake of drugs	Include
	2.4.03.00.02 Human diet	Include
	2.4.03.00.03 Human soil ingestion	Include
	2.4.03.00.04 Consumption of uncontaminated products	Include
	2.4.03.00.05 Filtration (water processing)	Include
	2.4.03.00.06 Food preparation	Include

FEP #	FEP Name	Screening Decision
2.4.04.01.00	Human lifestyle	Include
2.4.04.01.01	Hunter/gathering lifestyle	Exclude
2.4.04.01.02	Critical group - leisure pursuits	Include
2.4.07.00.00	Dwellings	Include
2.4.07.00.01	Building materials	Exclude
2.4.07.00.02	Critical group - house location	Include
2.4.07.00.03	Gas leakage into basements	Exclude
2.4.07.00.04	Household dust and fumes	Include
2.4.07.00.05	Houseplants	Exclude
2.4.07.00.06	Showers and humidifiers	Include
2.4.07.00.07	Space heating	Include
2.4.07.00.08	Water leaking into basements	Exclude
2.4.07.00.09	Outdoor spraying of water	Exclude
2.4.08.00.00	Wild and natural land and water use	Exclude
2.4.08.00.01	Natural and semi-natural environments	Exclude
2.4.08.00.02	Land and surface water use: Terrestrial	Exclude
2.4.08.00.03	Coastal water use	Exclude
2.4.08.00.04	Sea water use	Exclude
2.4.08.00.05	Estuarine water use	Exclude
2.4.08.00.06	Land and surface water use: Estuarine	Exclude
2.4.08.00.07	Land and surface water use: Coastal waters	Exclude
2.4.08.00.08	Land and surface water use: Seas	Exclude
2.4.09.01.00	Agricultural land use and irrigation	Include
2.4.09.01.01	Crop fertilizers and soil conditioners	Exclude
2.4.09.01.02	Crop storage	Include
2.4.09.01.03	Fires (agricultural)	Exclude
2.4.09.01.04	Greenhouse food production	Exclude
2.4.09.01.05	Hydroponics	Exclude
2.4.09.01.06	Peat and leaf harvesting	Exclude
2.4.09.01.07	Irrigation	Include
2.4.09.01.08	Agricultural and fisheries practice changes	Exclude
2.4.09.01.09	Irrigation	Include
2.4.09.01.10	Ploughing	Include
2.4.09.01.11	Irrigation	Include
2.4.09.01.12	Critical group - agricultural labor	Include
2.4.09.01.13	Ashes and sewage sludge fertilizer	Exclude
2.4.09.01.14	Irrigation	Include
2.4.09.01.15	Herbicides, pesticides and fungicides	Exclude

FEP #	FEP Name	Screening Decision
2.4.09.02.00	Animal farms and fisheries	Include
2.4.09.02.01	Fish farming	Include
2.4.09.02.02	Ranching	Include
2.4.09.02.03	Fish farming	Include
2.4.10.00.00	Urban and Industrial land and water use	Exclude
2.4.10.00.01	Industrial water use	Exclude
2.4.10.00.02	Earthmoving	Exclude
2.4.10.00.03	Earthmoving projects	Exclude
2.4.10.00.04	Earthworks	Exclude
2.4.10.00.05	Land use changes	Exclude
2.4.10.00.06	Land use changes	Exclude
2.4.10.00.07	Post-closure surface activities	Exclude
2.4.10.00.08	Surface disruptions	Exclude
2.4.10.00.09	Biogas production	Exclude
3.3.01.00.00	Drinking water, foodstuffs and drugs, contaminant concentrations in	Include
3.3.01.00.01	Water source (exposure factors)	Include
3.3.02.01.00	Plant uptake	Include
3.3.02.01.01	Plant roots (foodchains)	Include
3.3.02.01.02	Uptake by crops (foodchains)	Include
3.3.02.01.03	Plant uptake	Include
3.3.02.01.04	Uptake by deep rooting species	Exclude
3.3.02.02.00	Animal uptake	Include
3.3.02.02.01	Carcasses	Exclude
3.3.02.02.02	Uptake by livestock (foodchains)	Include
3.3.02.02.03	Uptake in fish (foodchains)	Include
3.3.02.02.04	Animal diets	Include
3.3.02.02.05	Animal grooming and fighting	Exclude
3.3.02.02.06	Scavengers and predators	Exclude
3.3.02.02.07	Animal uptake	Include
3.3.02.02.08	Animals	Exclude
3.3.02.02.09	Animal soil ingestion	Exclude
3.3.02.03.00	Bioaccumulation	Include
3.3.02.03.01	Bioconcentration (foodchains)	Include
3.3.02.03.02	Foodchain equilibrium	Include
3.3.02.03.03	Biomagnification (foodchains)	Include
3.3.02.03.04	Recycling (exposure factors)	Exclude
3.3.02.03.05	Removal mechanisms (exposure factors)	Include
3.3.02.03.06	Bioaccumulation and translocation	Include