U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

Project Plans for Fiscal Year 2002-2003: Performance Assessment

Presented to:
Nuclear Waste Technical Review Board

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Performance Assessment Project FY02-03 Planning Overview

- **Performance Assessment Project includes postclosure science and Total System Performance Assessment (TSPA)**
  - **Natural systems**
  - **Engineered systems**
  - **Testing**
  - **Performance assessment strategy and scope, including TSPA**
- **FY02-FY03 planning based on risk-informed prioritization**
- **Emphasis on a defensible and sound basis for a License Application (LA) in December 2004**

Selecting Work for FY02-FY03

- **Prioritization Process**
  - **Evaluate and prioritize work in performance assessment and science activities**
  - **Focus on necessary LA work scope**
  - **Identify and select an overall scope of work that balances project management risks**
  - **Document the basis for the selected scope of work**
- **Inform management decisions with input from**
  - **Technical staff and technical line management**
  - **TSPA analyses**
  - **Project management**
  - **Project planning (cost and schedule)**

Evaluating Proposed Work

- **Department managers redefined work scope**
  - **Work (model validation, analyses and testing) grouped by TSPA model component**
  - **Three alternative work scopes defined for each model component**
    - **Level 1 Scope: Quality Assurance and Model Validation (required)**
    - **Level 2 Scope: Risk Informed (desirable)**
    - **Level 3 Scope: Additional Technical Basis (desirable)**
- **Staff and managers provide input evaluating each proposed work scope for the defined set of attributes**
  - **Questionnaire distributed to facilitate collection of input**
- **Multi-attribute utility analysis used to aid in evaluation of work and decision making**

TSPA Model Components used in the Development of Work Scope Descriptions

- Unsaturated Zone (UZ) Flow
- UZ Seepage
- UZ Coupled Effects
- Engineered Barrier System (EBS) Thermal and Moisture Model
- EBS Chemical Model
- Rockfall
- Waste Package (WP) Drip Shield Performance
- Waste Package Performance
- Waste form (WF) In--Package Chemistry
- WF Cladding
- WF Dissolution
- WF Radionuclide Inventory
- WF Dissolved Concentration
- EBS Radionuclide Flow and Transport
- UZ Radionuclide Transport
- Saturated Zone (SZ) Flow
- SZ Radionuclide Transport
- Biosphere
- Natural Analogues
- Igneous Activity
- Seismic Activity
- Criticality

Sixteen Specific Attributes Defined for Three Principal Attributes

- **Quantitative Performance**
  - Change in 10,000 year mean annual dose
  - Change in estimated groundwater concentration
  - Change in dose associated with the human intrusion scenario
- **Regulatory Defensibility and Acceptability**
  - Ensure inclusion of credible FEPs/exclusion of unnecessary FEPs
  - Impact on ability to identify and describe multiple barriers
  - Impact on ability to meet specific KTI agreements
- **Qualitative Acceptability and Internal/External Defensibility**
  - Impact on confidence of internal reviewers in the technical basis
  - Impact on confidence of external reviewers in the technical basis
  - Additional quantitative metrics
    - Change in time to 15 mrem
    - Change in uncertainty in system performance
    - Change in 10,000 year mean dose conditioned on early WP failure
    - Change in peak dose
    - Change in consequences associated with igneous intrusion
  - Impact on representation of uncertainty at the parameter level
  - Impact on ability to defend conceptual model representation

Input Information for each Attribute

- **How likely is it that this scope of work will result in a change with respect to the attribute**
  - **Response provided by technical staff and managers**
- **What is the impact (magnitude) of the change likely to be**
  - **Response provided by TSPA staff and managers**
- **What value does the project assign to possible impacts**
  - **Elicited from project management independent of technical input**
- **What weight does the project assign to the attribute itself**
  - **Elicited from project management independent of technical input**

Example: EBS Flow and Transport Inputs

TSPA Model Component (select from drop-down) EBS Radionuclide Flow and Transport Enter Cost for Each Scope Considered-->	Level 1 Scope $3,000,000	Level 2 Scope ☑ Check if this scope is used $3,600,000	Level 3 Scope ☑ Check if this scope is used $4,400,000
1. IMPACTS ON COMPLIANCE WITH QUANTITATIVE PERFORMANCE OBJECTIVES			
1a) How likely are the activities in the proposed scope to change the results of the model component significantly enough that they could impact the 10,000-year mean annual dose?	Very unlikely (e.g., <10% chance)	Very unlikely (e.g., <10% chance)	Very unlikely (e.g., <10% chance)
1b) If the activities change the model component results significantly, what is the likely change to the 10,000-year mean annual dose?	Change by a factor <10	Change by a factor <10	Change by a factor <10
1c) How likely are the activities in the proposed scope to change model component performance in a way that could impact estimated groundwater concentrations?	Neither likely nor unlikely (e.g., 40-60	Likely (e.g., 60-90% chance)	Likely (e.g., 60-90% chance)
1d) If the activities change the estimated groundwater concentrations, what is the likely change?	Change by a factor <10	Change by a factor <10	Change by a factor <10
1e) How likely are the activities in the proposed scope to change the model component performance in a way that may impact the 10,000-year mean annual dose associated with the human intrusion scenario?	Very unlikely (e.g., <10% chance)	Very unlikely (e.g., <10% chance)	Very unlikely (e.g., <10% chance)
1f) If the activities change the model component results associated with the human intrusion scenario results, what is the likely change to estimated mean annual dose?	Change by a factor <10	Change by a factor <10	Change by a factor <10
2. IMPACTS ON REGULATORY			
2a) How likely are the activities in the proposed scope to result in a new FEP being screening in?	Neither likely nor unlikely (e.g., 40-60	Likely (e.g., 60-90% chance)	Likely (e.g., 60-90% chance)
2b) How likely are the activities in the proposed scope to result in a currently included FEP being screened out?	Very unlikely (e.g., <10% chance)	Very unlikely (e.g., <10% chance)	Very unlikely (e.g., <10% chance)
3. IMPACTS ON COMPLIANCE WITH REQUIREMENTS FOR MULTIPLE BARRIERS			
3a) How likely are the activities in the proposed scope to enhance the ability to identify the barriers important to waste isolation? NO LONGER USED	Very unlikely (e.g., <10% chance)	Very unlikely (e.g., <10% chance)	Very unlikely (e.g., <10% chance)
3b) How likely are the activities in the proposed scope to enhance the description of the ability of a barrier important to waste isolation to limit movement of water or radionuclides?	Likely (e.g., 60-90% chance)	Very likely (e.g., >90% chance)	Very likely (e.g., >90% chance)

Illustration of Utility Calculations as Implemented in a Spreadsheet Model

$$\text{Utility} = \sum p_i \times v_i \times w_i$$

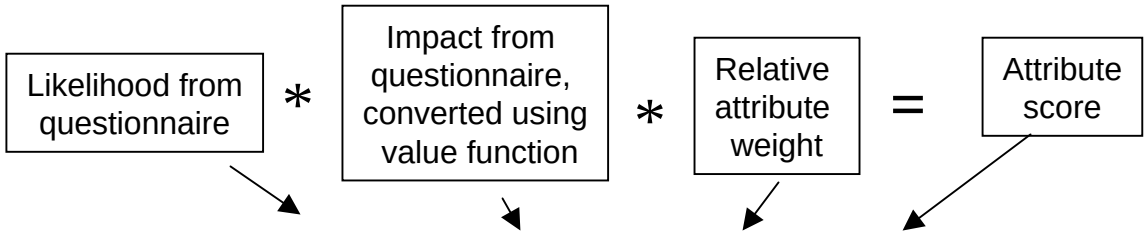
For each attribute:

	likelihood (p)	impact (v)	weight (w)
Technical staff define likelihood and impact	Likely (e.g., 60-90% chance)	Increase by factor of >10	
Project Management defines value functions and attribute weights		1.00	.128
Calculate utility for that attribute	75% ×	1.00 ×	.128 = .096

Repeat for each attribute and sum to get the total utility → .443

Illustration of Utility Calculations as Implemented in a Spreadsheet Model

(Continued)

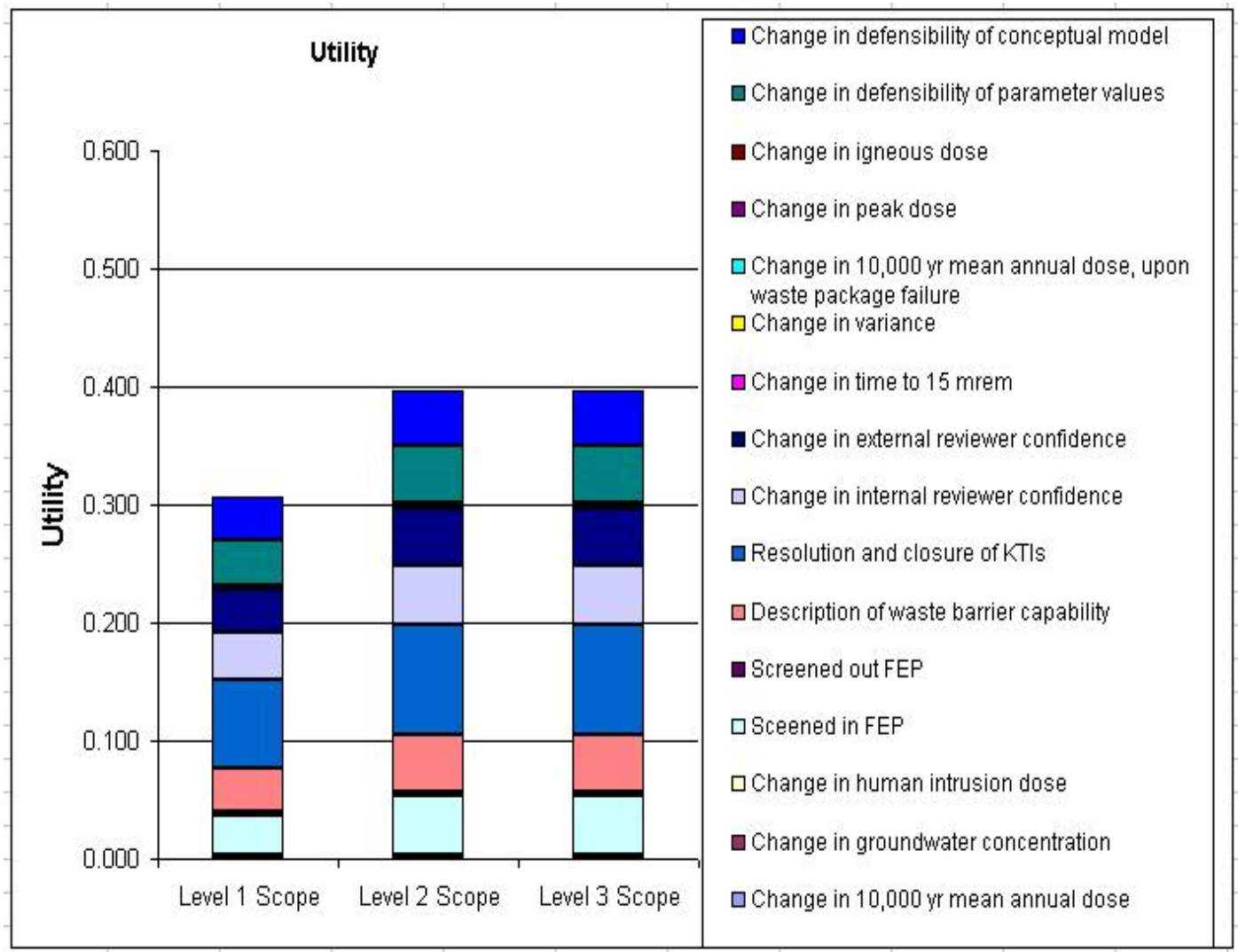


Attribute	P	Value	Weight	Total
Change in 10,000 yr mean annual dose	75%	1.00	0.128	0.096
Change in groundwater concentration	50%	1.00	0.115	0.058
Change in human intrusion dose	50%	0.15	0.115	0.009
▪	▪	▪	▪	▪
▪	▪	▪	▪	▪
▪	▪	▪	▪	▪
				0.443

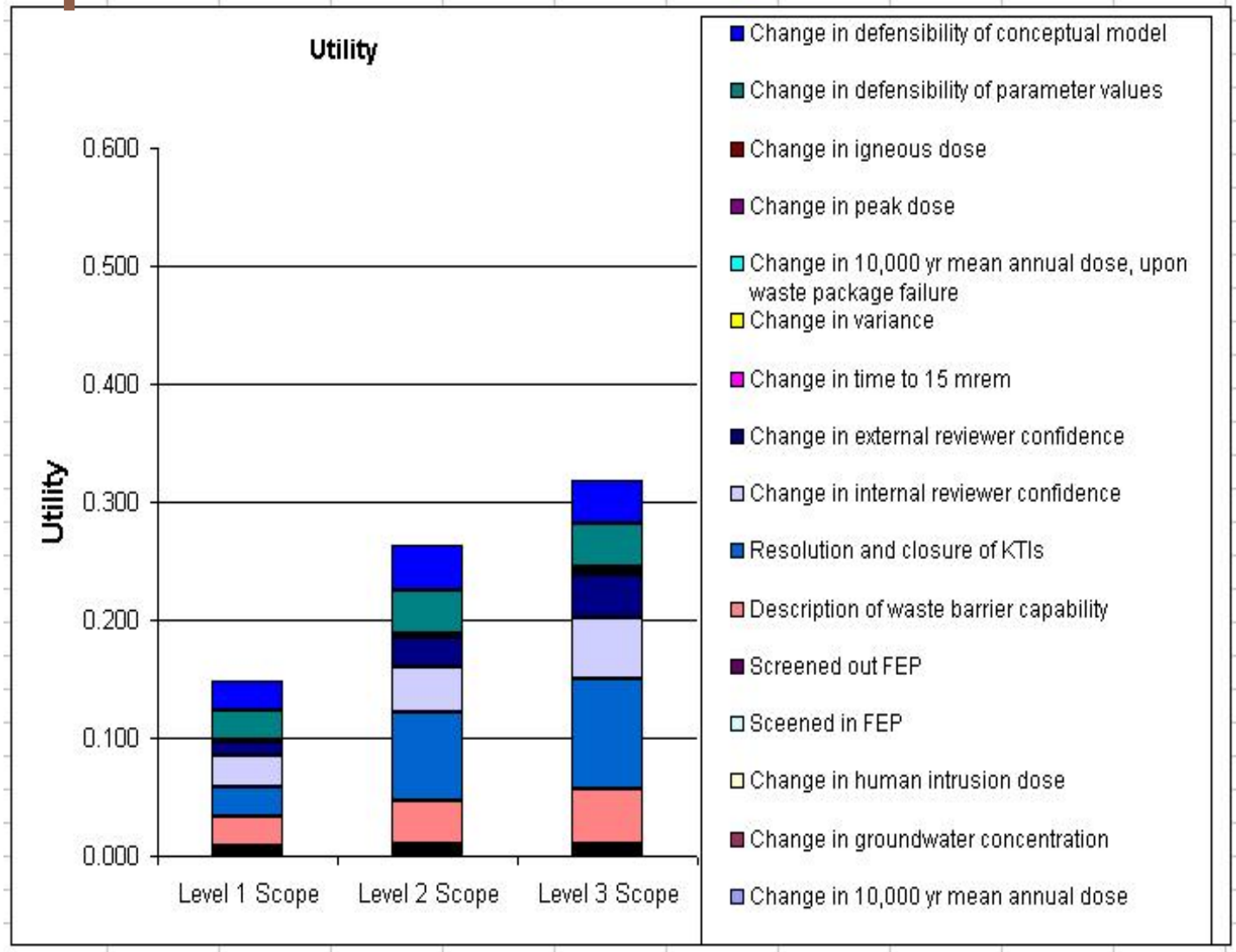
The contribution from each attribute to the total score

Sum the attribute scores to get the total utility

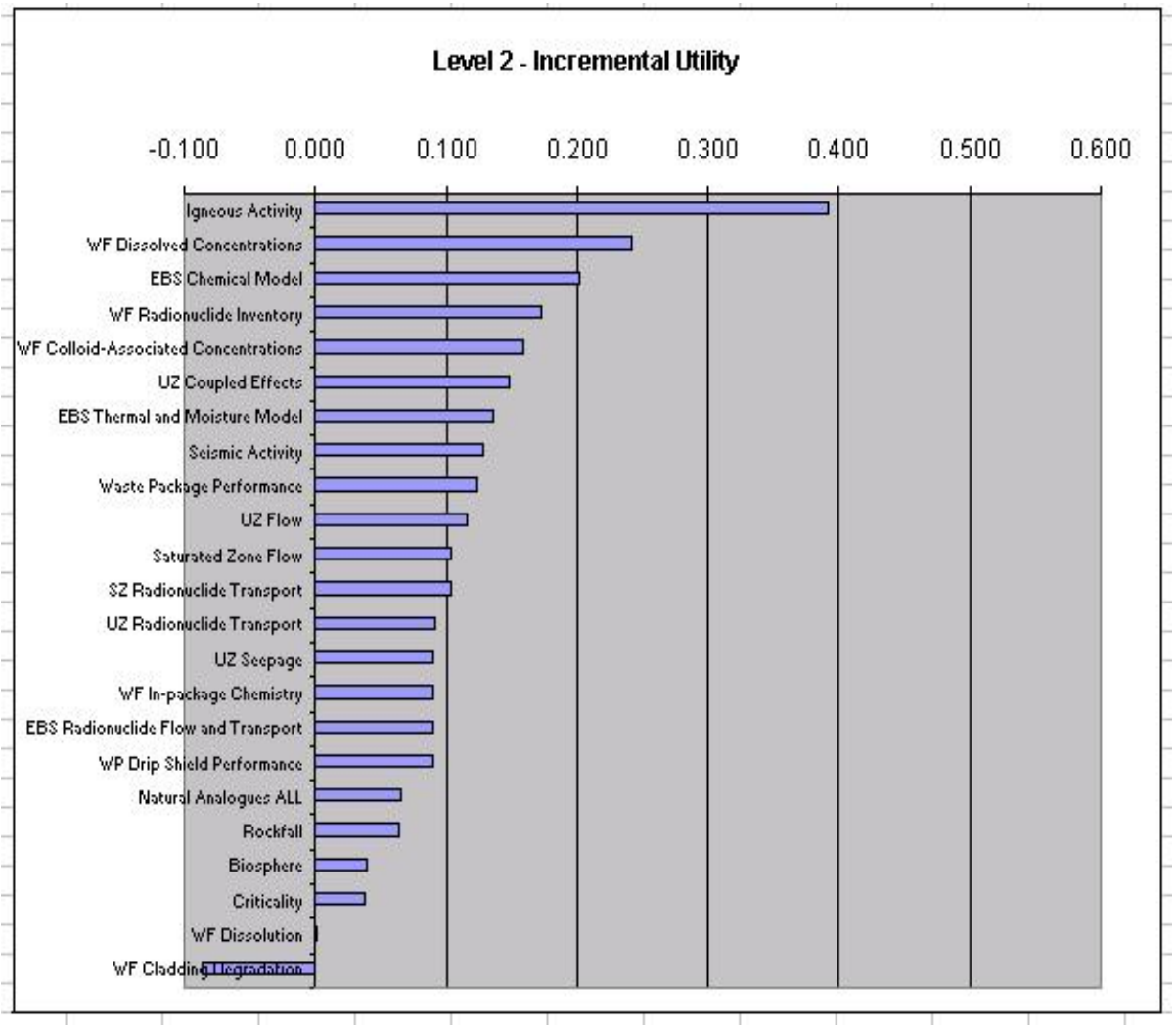
Example: EBS Flow and Transport Utility



Example: Unsaturated Zone Flow Utility



Level 2 Scopes Sorted by Incremental Utility[1]



- **Level 2 incremental utility is additional utility of work scope in going from Level 1 to Level 2**
- **High incremental utility implies a significant benefit in performing work**
- **Negative utility (for waste form cladding degradation) results from assumption that Level 2 scope implied taking no credit for cladding in the post-closure safety case**

[1]Incremental utility is the difference between absolute utility values

Use of Utility and Cost Results in Informing Management Review and Decisions

- **Absolute and incremental utility values were compared between different model components**
- **Sensitivity of absolute and incremental utility values to different weighting groups was analyzed and determined to not significantly change the rankings**
- **Cumulative utility, incremental utility, and incremental utility/cost ratios were used to guide initial prioritization provided for management review**

Management Review and Decision Making

- **Process and results reviewed by BSC Project Oversight Board**
  - **Input from BSC licensing, laboratories, U.S. Geological Survey, and Project Management**
  - **Work scope descriptions reviewed in detail**
  - **Work scope adjusted by line management in response to Oversight Board Review**
- **Board Decisions based on**
  - **Utility, Cost, and Schedule**
  - **Informed management judgment, including recognition of utilities not identified in the analysis**
    - **e.g., high value placed on continuing ongoing testing**

Management Decisions

- **Generally the Level 1 work scope was appropriate to support a docketable LA**
  - **Emphasis on validating models that are already available**
- **Specific activities from Level 2 and Level 3 work scopes were brought into the planning portfolio on a case-by-case basis to add additional confidence for the LA**
  - **Continuing selected, ongoing testing and other validation studies**
  - **Accelerated activities for LA documentation**

Management Decisions
(Continued)

- **Detailed work package descriptions developed to support the integrated project schedule proposed to DOE March 1, 2002**
- **DOE endorsed the proposed work scopes and schedules**
- **This plan is currently being implemented**

Addressing Uncertainties within the Planned Scope of Work

- **DOE is committed to supporting a license application that meets NRC requirements regarding uncertainty, for example**
  - **DOE will "not exclude important parameters ... simply because they are difficult to precisely quantify..." (63.304)**
  - **DOE will focus "on the full range of defensible and reasonable parameter distributions..." (63.304)**
  - **DOE will "consider alternative conceptual models ... that are consistent with available data and current scientific understanding and evaluate the effects..." (63.114)**
- **Impact of uncertainty will be documented in the LA**

Addressing Uncertainties within the Planned Scope of Work

(Continued)

- **FY02-FY03 testing and research will focus on**
  - **Quantifying uncertainty**
  - **Evaluating the impact of uncertainty on system performance**
  - **Identifying those areas where impacts of existing uncertainty are large from a licensing perspective**
  - **Reducing uncertainty in those areas where impacts are significant**
- **Performance confirmation work and long-term research and development will further reduce uncertainty**

Specific Examples of FY02-FY03 Work to Address Uncertainties

- **Unsaturated Zone and Coupled Processes**
  - **Active fracture model**
    - **Testing in Alcove 8/Niche 3**
  - **Seepage model**
    - **Niche 5 testing**
    - **Cross Drift bulkhead passive monitoring test**
  - **Thermal seepage model**
    - **Drift scale test**
  - **Chlorine 36 validation investigations**
  - **Natural analog field studies at Peña Blanca**

Specific Examples of FY02-FY03 Work to Address Uncertainties

(Continued)

- **Engineered Barrier System**
  - **Rockfall and thermomechanical effects**
  - **Rock properties testing**
  - **Natural convection tests**
  - **Reactive transport tests**
  - **Thermal conductivity tests and analyses**

Specific Examples of FY02-FY03 Work to Address Uncertainties

(Continued)

- **Waste Form**
  - **Emphasis on inventory, thermodynamic databases, localized clad corrosion, in-package sorption, and fuel degradation (glass and spent fuel)**
- **Waste Package**
  - **Waste package environment testing**
  - **Stress corrosion cracking testing**
  - **Localized and general corrosion testing**
  - **Passive oxide film stability testing**

Specific Examples of FY02-FY03 Work to Address Uncertainties

(Continued)

- **Saturated Zone**
  - **Incorporate data from Nye County wells and single-well Alluvial Testing Complex (ATC)**
  - **Updated USGS model will be compared to site-scale model as part of validation process**
  - **Use of additional testing at ATC on hold due to permitting issues**

Specific Examples of FY02-FY03 Work to Address Uncertainties

(Continued)

- **Igneous Activity**
  - **Assessment of aeromagnetic anomalies impact on probability estimates**
  - **Modeling of dike-drift interactions**
  - **Independent peer review of work to support igneous consequence model**
- **Seismic Activity**
  - **Consequence models for lower probability ground motion**

Summary of FY02-03 Plans for Performance Assessment Project

- **Planning decisions informed by multi-attribute utility analysis**
  - **Utility (i.e., risk-informed importance)**
  - **Cost**
- **Emphasis on**
  - **Qualification and validation of current models**
  - **Treatment of uncertainty for license application**
  - **Continuation of ongoing testing**
- **Plan is currently being implemented**