YMP/90-109

U.S. DEPARTMENT OF ENERGY

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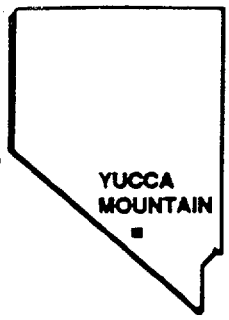

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

RESPONSES TO STATE OF NEVADA LETTER ON THE SITE CHARACTERIZATION PLAN/ EXPLORATORY SHAFT FACILITY

DECEMBER 1990

UNITED STATES DEPARTMENT OF ENERGY

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PDR WASTE
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U.S DEPARTMENT OF ENERGY'S COMMENT RESPONSES FOR THE PRELIMINARY COMMENTS RECEIVED FROM THE STATE OF NEVADA

The State of Nevada submitted preliminary comments on the Site Characterization Plan in a letter dated May 30, 1989. The U.S. Department of Energy first renumbered the pages contained in the letter received from the State of Nevada and identified individual comments within the letter. The comments were then enumerated from the submitted package; fifty-eight comments were submitted. A copy of the enumerated comment package is provided under separate enclosure for cross reference. Each comment number is marked in the margin of the page and the page number is marked in the upper right hand corner of the page. Where multiple comments occur on one page, each is bracketed by horizontal lines.

For each comment, the DOE response package provides a description of the comment, followed by the response to the comment. Each comment was given an individual response, or cross-referenced to a response addressing comments pertaining to the same overall theme.

U.S. DEPARTMENT OF ENERGY RESPONSES TO THE PRELIMINARY COMMENTS RECEIVED FROM THE STATE OF NEVADA ON THE SITE CHARACTERIZATION PLAN

COMMENT 1

The attached Preliminary Comments on the ESF describe Nevada's critical concerns over both the selected location of the ESF at Yucca Mountain and some aspects of the ESF Design at its current level of development. The summary conclusion that arises from the attached comments and concerns is that the DOE should not proceed with the initiation of site characterization and ESF construction until certain fundamental ESF site location and design issues are resolved. Without such advance reconsideration and resolution, the potential consequences are twofold; first, that DOE's activities associated with ESF construction will preclude the future collection of data critical to a determination of Yucca Mountain sit suitability, and second, that DOE's ESF construction activities will compromise the capability of the site to safely isolate waste, should it be developed as a repository.

RESPONSE:

The Yucca Mountain Site Characterization Project Office is currently conducting a study to evaluate and identify a defensible basis for the design and construction of the Exploratory Shaft Facility (ESF) at the Yucca Mountain site. This study, the ESF Alternatives Study, would

1) Identify all applicable regulatory and nonregulatory requirements relating to repository and ESF design and construction.

2) Identify comments and concerns raised by the U.S. Nuclear Regulatory Agency (NRC), the Nuclear Waste Technical Review Board (NWTRB), State of Nevada, and the DOE during review of the Site Characterization Plan.

3) Identify all repository access configurations and ESF configurations and construction methods considered in the past.

4) Develop new repository access configurations and ESF configuration and construction methods to address comments and concerns raised by the NRC, NWTRB, State of Nevada, and U.S. Department of Energy.

5) Develop evaluation methodology.

6) Evaluate all historic and new repository and ESF options.

7) Select the preferred ESF configuration and construction method.

8) Revise the applicable design requirements documents before re-commencement of design.

This study is intended to resolve all NRC performance-assessment-related objections and concerns, address NWTRB recommendations, and resolve appropriate concerns of the State of Nevada and local agencies before ESF construction is started.

COMMENT 2

The ESF location at Coyote Wash was initially selected by DOE in mid-1982, with the selection process documented in a Sandia Report (SAND84-1003). The selection of this location was recently reviewed by the DOE, in December 1988, with that analysis, the Exploratory Shaft Location Documentation report, confirming the earlier location decision. Nevada's review has revealed that neither the original Sandia Report nor the recent review by DOE acknowledges a 1982 United States Geological Survey report (USGS Open File Report 82-182) which contains strong evidence of a fault intersecting the selected ESF site, possibly between the two proposed exploratory shafts. The Location Documentation Report claims to have reviewed certain cited post-1982 reports of geophysical data relevant to the selected ESF site, with the conclusion that no adverse subsurface structures appear to be present at the selected Coyote Wash ESF site. However, the resistivity survey data document in the 1982 U.S.G.S. report, and later summarized in a 1984 U.S.G.S. report were not included in the DOE's recent review even though the work was performed for the Yucca Mountain Project.

The known existence of a fault at the Coyote Wash ESF site would result in the disqualification of this proposed ESF site according to the criteria established in the 1982 Sandia ESF site screening report for setback from adverse subsurface geologic structures. Furthermore, placing the ESF in a fault-disturbed area casts into great question the representativeness of any site characterization data collected from the ESF. It also renders the ESF vulnerable to potential severe flooding from surface water infiltration along a preferred pathway, or from intersection of a perched groundwater zone during shaft or drift construction.

RESPONSE:

The U.S. Department of Energy (DOE) response to this comment is documented in the Technical Assessment Review (TAR), "Geologic and Geophysical Evidence Pertaining to the Structural Geology in the Vicinity of the Proposed Exploratory Shaft" (DOE, 1990).

In 1978, a slingram survey of the Yucca Mountain area indicated a conductive zone underlying Drill Hole Wash (Flanigan, 1981). This zone was inferred to be a possible zone of significant faulting and fracturing based on comparison of the survey results over known faults (Smith and Ross, 1982). Because of the possibility of a significant fault in the repository block, additional studies were performed to evaluate the structure under Drill Hole Wash in 1979. The resistivity and induced polarization study of Smith and Ross (1982) was one of these studies. The Smith and Ross report inferred from resistivity contrasts that faulting may have dropped the area of Drill Hole Wash with respect to the ridges on either side (Spengler and Rosenbaum, 1980). In order to test this interpretation, a series of drillholes (UE25a-4, -5, -6, -7) was completed in 1979 and 1980 in the area of Drill Hole Wash (Spengler and Rosenbaum, 1980). The results from these drillholes showed no evidence of vertical offsets, but Spengler and Rosenbaum (1980) inferred possible strike-slip movement on the basis of paleomagnetic and foliation trends. Other studies, such as the mapping by Scott and Bonk

(1984), were completed during the 1979-1982 period and were also used to evaluate the Drill Hole Wash area (Scott et al. 1984) and concluded that Drill Hole Wash and other washes to the northeast were probably underlain by right-lateral strike-slip faults.

In addition to the fault/fracture zone inferred in Drill Hole Wash, Smith and Ross (1982) inferred the presence of a minor normal fault in Coyote Wash (Figure 1). This inferred fault was located about 400 meters (1,300 feet) east of Ghost Dance fault and was inferred to be downthrown to the east.

In March, 1982, a working group was organized by the Yucca Mountain Site Characterization Project Office to evaluate exploratory shaft (ES) construction methods and to conduct a screening of potential ES sites. Procedures were developed by the working group and approved on April 28, 1982 (Bertram, 1984). At this time, the working group became the Ad Hoc Technical Overview Contractor (TOC) Committee at the request of the NNWSI Project Technical Integration Group (TIG). A draft report on the ES selection was completed by the committee on June 7, 1982.

Because of the uncertainty at that time about structures in Drill Hole Wash, the Ad Hoc TOC Committee generated a selection criterion that established a set-back distance of 308 meters (1,000 feet) from Drill Hole Wash. The set-back was established to account for the possibility of bedrock fractures extending westward from Drill Hole Wash. In selecting the shaft location, it was desired that the shaft be far enough away from Drill Hole Wash (<308 meters (1,000 feet)) that the shaft and drifts would have a low likelihood of encountering fractures associated with the repository block bounding structure. At the same time, it was considered desirable to be within a distance (<616 meters (2,000 feet)) that would permit horizontal drilling from the ES to intersect the Drill Hole Wash structures. A similar criterion was generated for other "potentially adverse structures" where it was considered desirable to be within 308 to 616 meters of these structures. Sites having subsurface facilities closer than 30.8 meters (100 feet) to a potentially adverse structure were to be excluded (Stephenson, 1982).

USGS Open File Report 84-792 (USGS, 1984) is a compilation and interpretation of geologic data on the Yucca Mountain region acquired before January 1, 1983. The report was used as a source in the preparation of the geologic descriptions of Yucca Mountain for the Environmental Assessment (EA) (DOE, 1986) and the Site Characterization Plan (SCP). Figure 32 of the Open File Report shows a map of "Faults and (or) fractures at Yucca Mountain interpreted from electrical resistivity data." The text of the Open File Report does not give any additional information on the source of this interpretation. The same figure was also duplicated in the SCP as Figure 1-40. This figure shows a fault in Coyote Wash at the location where a fault was inferred by Smith and Ross (1982), but also shows the fault extending much farther to the south than Smith and Ross indicated.

The Open File Report figure is apparently based on an unpublished interpretive map of published and unpublished electrical resistivity data compiled by D.B. Hoover. This unpublished map indicates that the location of the northern end of this longer fault cutting Coyote Wash is based on the interpretation of Smith and Ross (1982). Hoover used a dashed line to connect the inferred fault in Coyote Wash with another fault inferred to cross unpublished resistivity line YM10 at a point about 7,500 ft south of

Coyote Wash (Figure 2). The location of the inferred fault cutting line YM10 coincides with a fault mapped by Lipman and McKay (1965), which trends to the northeast of the hypothesized connection between the inferred resistivity faults and terminates near Whale Back Ridge (Figure 2). However, in the figure that appears in the Open File Report (USGS 1984) and the SCP, the dashed line connecting the two inferred fault segments has been replaced by a solid line (Figure 3). This appears to represent a drafting error in the preparation of the published figure since other dashed lines shown on the unpublished version of the map were generally deleted from the published map.

Use of the term "potentially adverse" in Bertram (1984) and in the TAR is not the same as the use of the term in 10 CFR Part 60. In 10 CFR Part 60, the term "potentially adverse" is used solely in the context of those things or conditions that "may compromise the ability of the geologic repository to meet the performance objectives relating to isolation of the waste" (10 CFR 60.122(a)(2)). Use of this term in Bertram (1984) is more generic, because it refers to any condition which may affect the design or construction of the Exploratory Shaft Facility (ESF), including but not necessarily restricted to those aspects that would affect "waste isolation" in the repository. Thus, the use of the term "potentially adverse" in Bertram (1984) and in this report does not automatically infer that waste isolation may be compromised.

A map identifying potentially adverse structures was prepared using a preliminary version of the Scott and Bonk (1984) map as a source (Spengler, oral communication). The only potentially adverse structure identified on this map in the Coyote Wash area was the Ghost Dance fault (Figure 4). One Ad Hoc TOC committee member was aware of the report by Smith and Ross, but was of the opinion that the Scott and Bonk mapping was more reliable because topographic effects may have affected the resistivity/IP survey and the interpretation of Smith and Ross was not confirmed by the drilling program in Drill Hole Wash. Also, the main concern at the time was to identify significant throughgoing structures; apparently minor features, such as the fault inferred by Smith and Ross (1982) in Coyote Wash, were not considered in shaft selection because they had no mapped extent. Therefore, the faults shown in the Smith and Ross (1982) report in Coyote Wash were not considered to be potentially adverse structures.

Five preferred site areas for the exploratory shaft location were identified by the Ad Hoc TOC Committee largely on the basis of the location of potentially adverse structures and topography (Bertram, 1984). The area in Coyote Wash was evaluated as having the highest ranking of the five site areas; thus it was the unanimous recommendation of the committee that the shaft be located on the western side of the Coyote Wash area at 766000N and 563300E (Bertram, 1984). The committee recognized the potential need for minor relocation resulting from architectural/engineering design considerations, but advised caution in making such changes because of the small size of the preferred area (Bertram, 1984). The recommendation of Coyote Wash as the preferred site was approved by the TIG, the Yucca Mountain Site Characterization Project Office, and DOE Headquarters (DOE/HQ) between June 14 and August 11, 1982. A reanalysis of the ESF siting process up to the present is contained in the TAR cited at the beginning of this response (DOE, 1990).

The assertion that placing the ESF in a "fault disturbed area" renders it vulnerable to "potential flooding from surface water infiltration along a preferred pathway or from intersection of a perched groundwater zone during shaft or drift construction" is hypothetical at the present time. Studies to be carried out during site characterization that bear upon the concerns expressed are part of Study Plan 8.3.1.2.2.4 "Characterization of Yucca Mountain percolation in the unsaturated zone -- exploratory shaft facility study."

REFERENCES

Bertram, S.G., 1984. NNWSI Exploratory Shaft Site and Construction Method Recommendation Report, SAND84-1003, Sandia National Laboratories, Albuquerque, NM.

DOE (U.S. Department of Energy), 1986. Environmental Assessment, Yucca Mountain Site, Nevada Research and Development Area, Nevada, DOE/RW-0073, 3 vols., U.S. Department of Energy, Washington, D.C.

DOE (U.S. Department of Energy), 1990. Geologic and Geophysical Evidence Pertaining to the Structural Geology in the Vicinity of the Proposed Exploratory Shaft, Technical Assessment Review, YMP/90-2, U.S. Department of Energy, Las Vegas, NV.

Flanigan, V.J., 1981. A Slingram Survey at Yucca Mountain on the Nevada Test Site, Open File Report USGS-OFR-81-980, U.S. Geological Survey, 38 p.

Lipman, P.W., and E.J. McKay, 1964. Geology of the Topopah Spring SW Quadrangle, Nye County, Nevada, Technical Letter NTS-72 (February 25, 1964), U.S. Geological Survey, 8 p.

Scott, R.B., G.D. Bath, V.J. Flanigan, D.B. Hoover, J.G. Rosenbaum, and R.W. Spengler, 1984. Geological and Geophysical Evidence of Structures in the Northwest-Trending Washes, Yucca Mountain, Southern Nevada, and Their Possible Significance to a Nuclear Waste Repository in the Unsaturated Zone, Open File Report USGS-OFR-84-567, U.S. Geological Survey.

Scott, R.B., and J. Bonk, 1984. Preliminary Geologic Map of Yucca Mountain Nye County, Nevada with Geologic Section, Open File Report USGS-OFR-84-494, U.S. Geological Survey. [HQS.880517.1443]

Smith, C., and H.P. Ross, 1982. Interpretation of Resistivity and Induced Polarization Profiles with Severe Topographic Effects, Yucca Mountain Area, Nevada Test Site, Nevada, Open File Report USGS-OFR-82-182 with introduction by D.B. Hoover, U.S. Geological Survey.

Spengler, R.W., and J.G. Rosenbaum, 1980. Preliminary Interpretations of Geologic Results Obtained from Boreholes UE25a-4, -5, -6, -7, Yucca Mountain, Nevada Test Site, Open File Report USGS-OFR-80-929, U.S. Geological Survey, 33 p.

REFERENCES

S.P. 8.3.1.2.2.4, Characterization of Yucca Mountain Percolation in the Unsaturated Zone -- Exploratory Shaft Facility Study, Site Characterization Plan, 1988.

USGS (U.S. Geological Survey), 1984. A Summary of Geological Studies through January 1, 1983, of a Potential High-Level Radioactive Waste Repository Site at Yucca Mountain, Southern Nye County, Nevada, Open File Report USGS-OFR-84-792, U.S. Geological Survey.

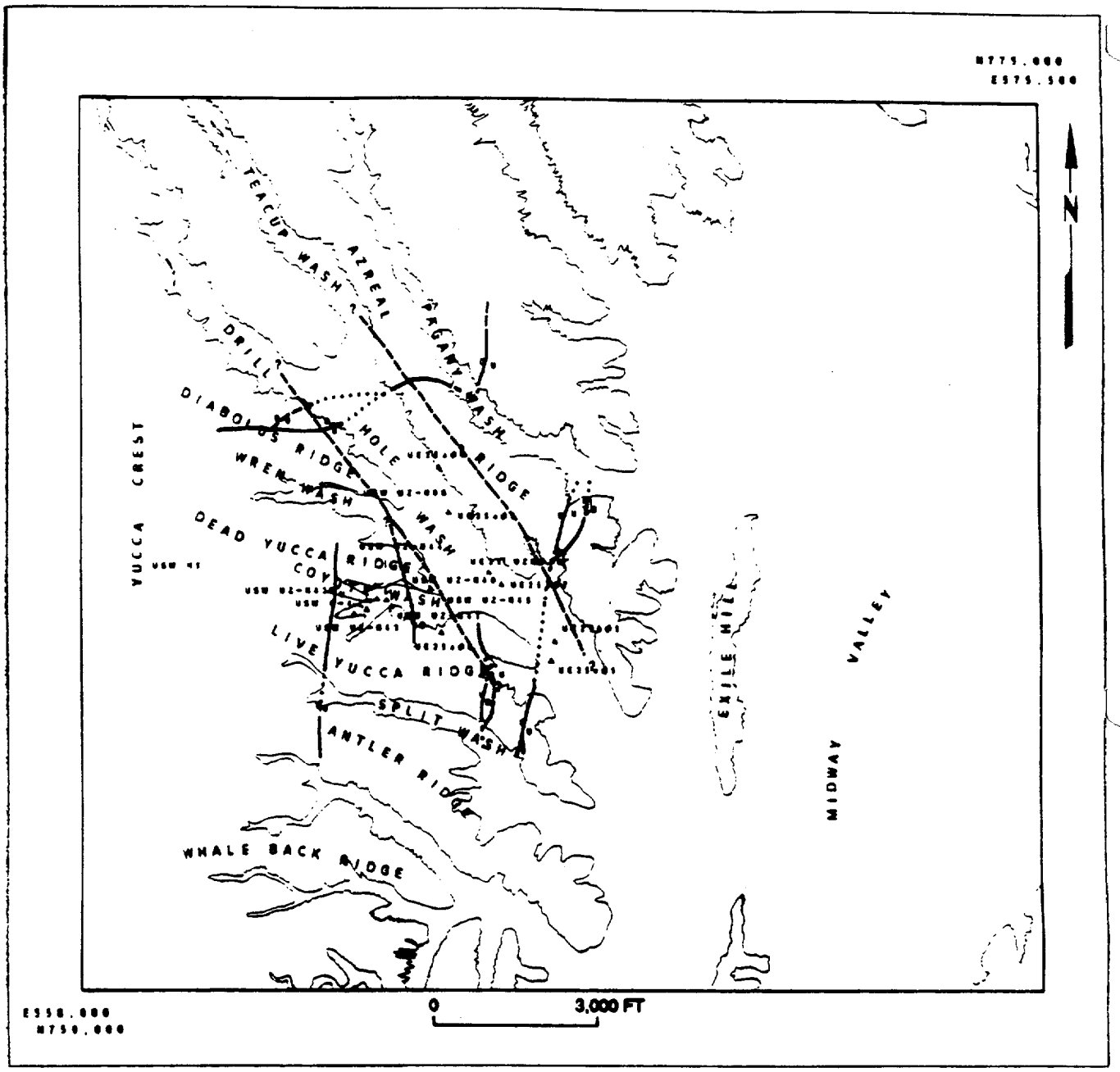
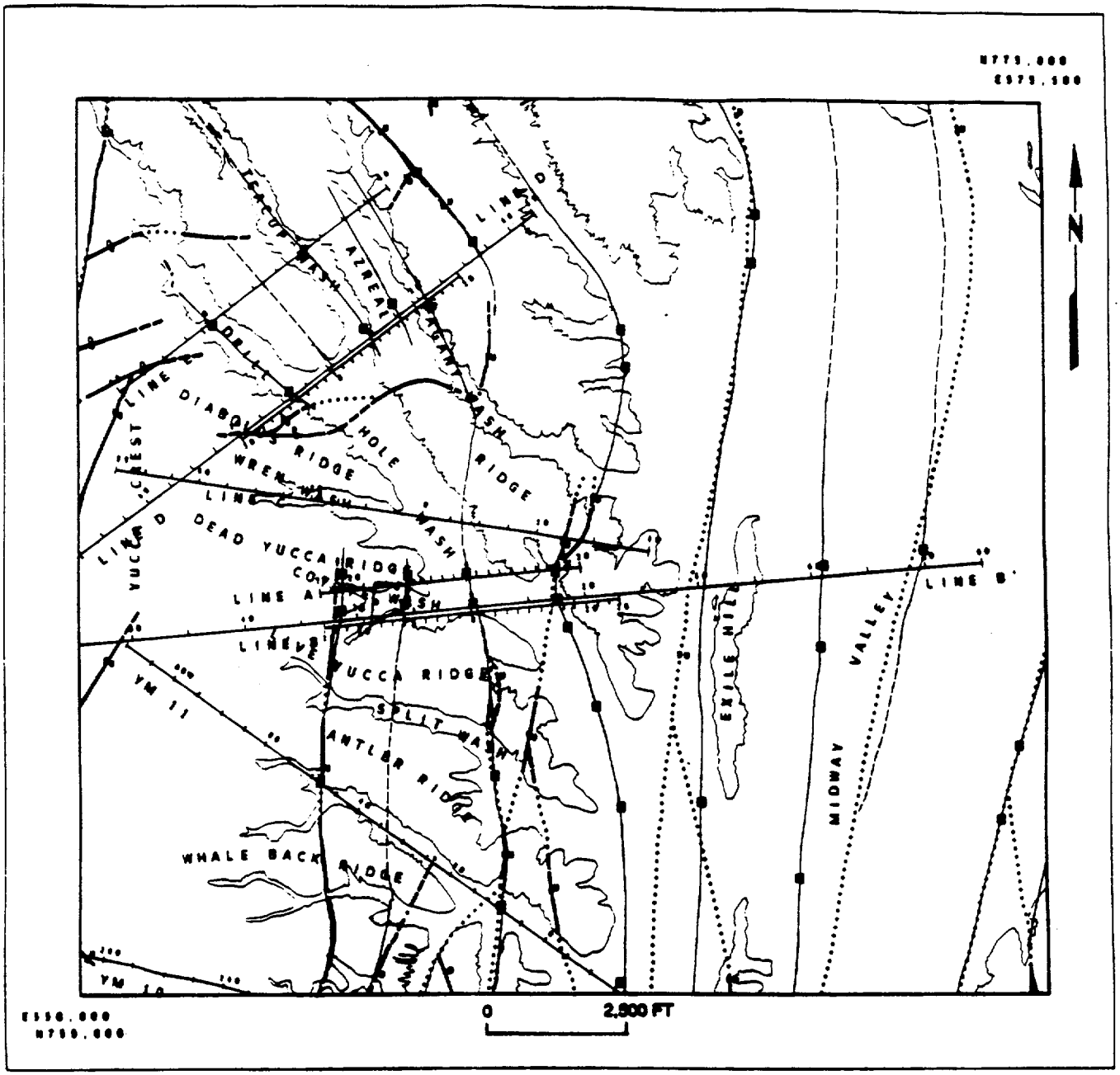


Figure 1. Inferred faults in the Coyote Wash area as interpreted by Smith and Ross (1982).



EXPLANATION

FAULT MAPPED BY LIPMAN AND McKAY (1965)

FAULT INFERRED FROM RESISTIVITY DATA BY HOOVER

LOCATION OF RESISTIVITY LINE

YM 11

AREA RECOMMENDED BY BERTRAM (1984) WITH ORIGINAL SHAFT LOCATIONS (OPEN CIRCLES) AND REVISED SHAFT LOCATIONS (SOLID CIRCLES)

Figure 2. Faults interpreted from resistivity data by Hoover, mapped faults shown by Lipman and McKay (1965), locations of resistivity lines.

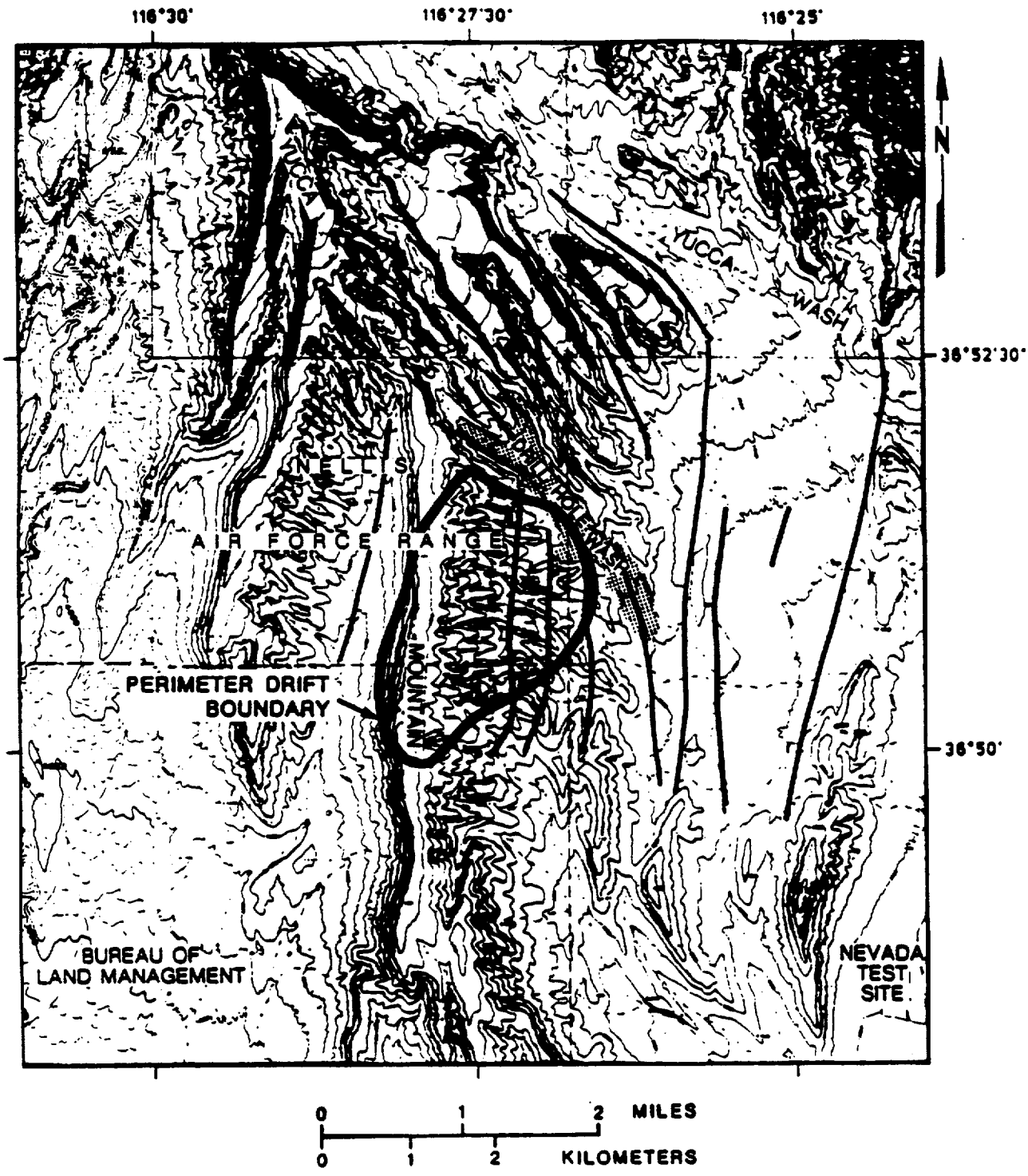


Figure 3. Faults interpreted from electrical resistivity data as shown on Figure 32 of U. S. Geological Survey Open File Report 84-792 and in SCP Figure 1-40.

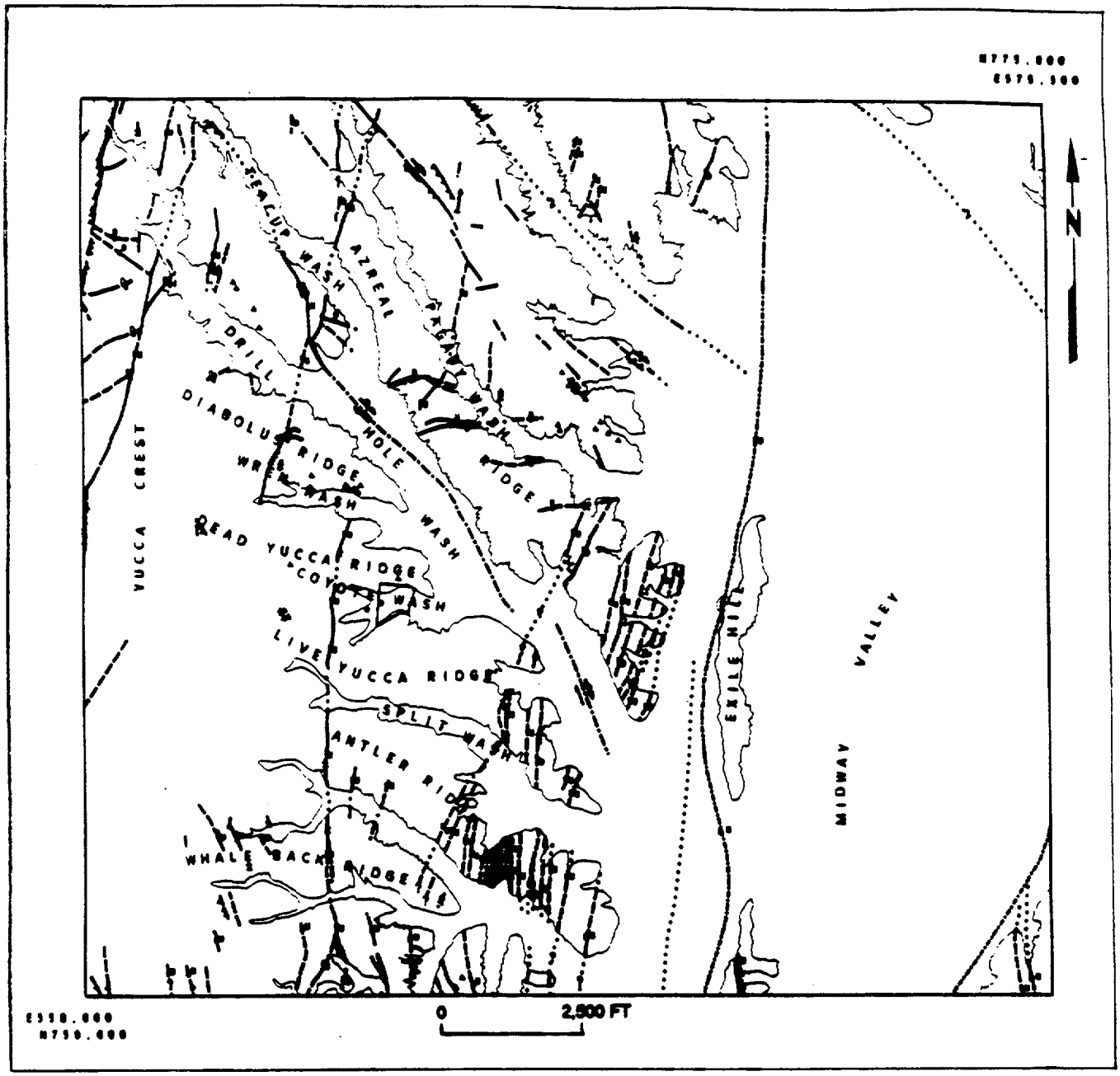


Figure 4. Location of faults shown by Scott and Bonk (1984) and siting area and shaft locations recommended by Bertram (1984).

COMMENT 3

Aside from concerns about flooding of the ESF related to the probable fault as described above, the location of the two shaft openings at the proposed ESF in Coyote Wash is such that there is significant concern over potential surface water flooding of the ESF surface facility, the shafts, and underground drifts. The SCP acknowledges in numerous disclaimers that flood level predictions regarding washes in and around the Yucca Mountain area are speculative at best, and that there is essentially no site specific flood data for Coyote Wash. In addition, as Nevada has commented to DOE previously, the effect of proposed ESF surface modifications and structures on flood heights and velocities has not been adequately analyzed, primarily due to a lack of site specific information. The consequences of flooding the ESF as a result of the lack of adequate shaft collar elevation and adequate surface flood protection structures, aside from the obvious risks to personnel, are such that the ESF may be rendered useless for collection of necessary in situ site characterization data, and the abandoned damaged ESF itself may adversely impact the site's waste isolation capabilities.

RESPONSE:

Regarding shaft location with respect to flood-associated in-filling, this issue was previously raised by the NRC to DOE in 1985. The specific concern was the possibility that run-off along Coyote Wash could occur over the ESF location, eventually resulting in erosion of alluvium around the shaft collar. It was stated that this situation could lead to eventual higher influx of run-off into the sealed shaft.

Comments were made at the Title I 50% Design Review and changes in the ESF surface layout were resolved to provide additional assurance that surface flooding would not enter the shafts.

In response to these NRC concerns, DOE made recommendations in 1986 for new shaft locations that took into account two important considerations. The shaft should be located out of any main natural drainage and the shaft should be collared in solid competent material. The shaft locations in the SCP, allow the shaft collar to be set in rock rather than alluvium, and effectively mitigate any flood in-flow threat to the ESF caused by eroding alluvium. Until additional surface data on rate of in-fill in the Wash can be collected or modeled, this move, agreed upon by the NRC and the Sate of Nevada in 1987, appears to be adequate. In addition, an analysis with respect to the potential for flooding and the ESF location was conducted by Fernandez et al. (1988).

The ESF Alternatives study, discussed in the response to Comment 1, will identify all repository access configurations and ESF configurations and construction methods considered in the past. The purpose of the study is to perform a documented, detailed analysis of ESF/repository access configurations and construction methods in response to comments raised by the NRC, the NWTRB, the State of Nevada, and DOE. The data, and uncertainties in that data, that pertain to the potential for flooding and probable maximum flood is part of this study.

REFERENCES

Fernandez, J.A., T.E. Hinkebein, and J.B. Case, 1988. Selected Analyses to Evaluate the Effect of the Exploratory Shafts on Repository Performance at Yucca Mountain, SAND85-0598, Sandia National Laboratories, Albuquerque, NM.

COMMENT 4

From the design standpoint, the SCP and associated documents do not provide plans for sealing, or otherwise isolating from the remainder of the repository block, a failed shaft in the ESF, whether resulting from flooding or other causes, in order to assure that it will not adversely impact the waste isolation performance of a repository. This matter stands as one of the many unresolved design problems, which also include inadequate evaluation of environmental impacts of construction of the ESF.

RESPONSE:

The U.S. Department of Energy (DOE) did not include any plans for the sealing of "failed" exploratory shafts in the Site Characterization Plan (SCP) for the following reasons:

1. The current Exploratory Shaft Facility (ESF) design requirements documents require that certain permanent structures, systems, and components of the ESF be designed and constructed using the same criteria, standards, and quality assurance levels as required for the repository. The permanent items are shaft liners, ground support, underground openings, and operational seals.

2. In the unlikely event of a shaft "failure," either by flooding or by a permanent component not performing its intended function, the shaft would not be sealed and isolated from the remainder of the repository block without performing a full recovery of the affected area(s).

3. These recovery efforts are standard industry practice and are conducted in such a way that the affected areas or components in question are restored to their original condition. However, if DOE decides it would not be prudent to continue to use these affected areas, they would be backfilled and sealed in accordance with the decommissioning and closure strategies identified in the current design requirements documents and Section 8.7 of the SCP.

COMMENT 5

An additional design issue involves the placement of planned boreholes associated with the ESF. Because of the known lack of quality borehole data at the proposed ESF site for use in shaft design, DOE has planned to drill at least two multipurpose boreholes on the ESF pad at Coyote Wash. The data from these boreholes will be necessary for further shaft design, yet if these holes are drilled as planned, and the DOE's criteria for distance to be maintained between boreholes and shafts at the ESF are honored, there is insufficient space to complete both activities. If some degree of borehole deviation during drilling is assumed (a realistic assumption), not only will the spacing criteria be violated, but there is a possibility that the shafts will intersect the previously drilled boreholes. With reference to the possibility of a proposed third multipurpose borehole, implementing the plan would result in the borehole intersecting a planned ESF drift at the underground test horizon. Further, the surface location of this hole would coincide with the planned location of the hoist house for the No. 2 exploratory shaft. In sum, the design and layout of the ESF cannot accommodate all the planned excavations and proposed construction while continuing to comply with the spacing criteria established by DOE for the ESF underground facility. The spacing criteria have their bases in assuring safety and preserving the ability to collect needed site characterization data that is representative of the site's undisturbed geohydrologic conditions.

The above comments constitute a set of fundamental concerns regarding the DOE's plans for developing and constructing an exploratory shaft facility at Yucca Mountain. Accompanying the attached State of Nevada Preliminary Comments are three letters in which we have previously detailed for DOE a number of the same concerns which are discussed in this letter and attached comments. It is Nevada's position that,without substantial resolution of these matters, it is both unsafe and imprudent to initiate site characterization and ESF activities at the Yucca Mountain site.

RESPONSE:

These boreholes would be drilled using state-of-the-art drilling and logging techniques and the deviations would be controlled such that the stated tolerances are not exceeded. Following results of the ESF Alternatives Study, new layouts for the ESF may be necessary which may or may not leave the multipurpose borehole activity unaltered from the plan identified in the SCP. These criteria are discussed in the SCP Section 8.4.2, page 8.4.2-14. This discussion noted that a 28' radius curve should be maintained around the shaft and the MPBHs to ensure isolation of these elements from each other. The SCP also noted that the descriptions of the tasks are current concepts which would be reviewed and revised as necessary in the future.

COMMENT 6

The State of Nevada has strongly warned the Department of Energy to reevaluate its plan to sink two exploratory shafts at Yucca Mountain because an earthquake fault intersecting the shaft site could render it useless for further studies and unsafe for storing nuclear waste.

In preliminary comments released today, the State Nuclear Waste Project Office revealed that the DOE ignored one of its own reports solicited from the United States Geological Survey which indicates a fault intersects the selected exploratory shaft (ESF) location.

As part of its scheme to determine whether Yucca Mountain can safely isolate deadly, high-level nuclear waste for 10,000 years, the DOE plans to sink two 12-foot wide, 1,050-foot deep shafts about 90 miles northwest of Las Vegas.

Besides possibly compromising Yucca Mountain's ability to safely store nuclear waste, the State said that unless fundamental design and location problems for the ESF are resolved, drilling could discredit vital information that must be collected to determine Yucca Mountain's suitability.

The State's preliminary comments came in response to the DOE's site characterization plan, an unwieldy, 6,300-page document which outlines the DOE's study of Yucca Mountain as the nation's first nuclear waste dump. Final comments are scheduled for release in late summer.

RESPONSE:

The author of the comment is not explicit about which U.S. Department of Energy (DOE) report was solicited from the USGS, but claims that the report shows a fault in the vicinity of the proposed ESF location. In February of this year, the DOE completed a thorough investigation of the fault inferred in Coyote Wash by Smith and Ross (1982). This investigation came as a result of an NRC inquiry on geophysically inferred faults reported in the SCP, in particular, the Smith and Ross (1982) analysis. The Technical Assessment Review (TAR) Review Record Memorandum (RRM) titled "Geologic and Geophysical Evidence Pertaining to Structural Geology in the Vicinity of the Proposed Exploratory Shaft", Rev. 0, was issued by the DOE on 1/10/90. That report directly considers the issue of faulting in the vicinity of the proposed ESF, and more specifically the mining and waste management implications of faults that may intersect the ESF. It also summarizes the findings of the TAR Team (DOE, 1990).

In short, the TAR Team found that the available data did not support a finding for a significant fault in the proximity of the ESF, but because of the inherent limitations of the geophysical methods used by Smith and Ross, the Team found that there was a possibility that a relatively small fault could be present at depth in the vicinity of the proposed repository. In addition to planned work such as drilling and logging the multipurpose boreholes and mapping the ESF surface excavations, the TAR Team recommended conducting several activities to increase knowledge of subsurface conditions at the shaft locations. These activities include: new seismic reflection

and geoelectrical soundings; new dipole-dipole and Slingram surveys, clearing talus from the slopes to map the area between ES-1 and ES-2 with greater certainty prior to any excavation, and drilling and logging, to ESF depth, two centerline boreholes at the shaft locations (DOE, 1990-, Section 7.2).

For further information on this matter, see the response to Comment 2.

REFERENCES

DOE (U.S. Department of Energy), 1990. Geologic and Geophysical Evidence Pertaining to the Structural Geology in the Vicinity of the Proposed Exploratory Shaft, Technical Assessment Review, YMP/90-2, U.S. Department of Energy, Las Vegas, NV.

Smith, C., and H.P. Ross, 1982. Interpretation of Resistivity and Induced Polarization Profiles with Severe Topographic Effects, Yucca Mountain Area, Nevada Test Site, Nevada, Open File Report USGS-OFR-82-182 with introduction by D.B. Hoover, U.S. Geological Survey.

COMMENT 7

Bob Loux, executive director of the State Nuclear Waste Project Office, said in a letter to the DOE that if drilling on a known earthquake fault proceeds, it will likely encounter perched water that could severely flood the shafts, taint the ESF and cast great doubts on the entire project.

RESPONSE:

See the response to Comments 2 and 3.

COMMENT 8

He further asserted that based on DOE's own criteria for safety and data preservation, the ESF site cannot accommodate the numerous additional boreholes the DOE plans to drill near the shafts.

Loux said that "without substantial resolution of these matters, it is both unsafe and imprudent to proceed" with site characterization and the ESF."

RESPONSE:

See the response to Comment 5.

COMMENT 9

"I am very disappointed by the fact that the DOE has once again ignored its own scientists in the critical stages of the decision-making process," said Governor Miller.

"The Secretary assured us at our May 22nd meeting that this would be a scientific and technical process. I have asked that Secretary Watkins personally review and reconsider this decision.

"This would be the third instance in the past two years of the DOE ignoring its own scientists and contractors to satisfy a timetable at the expense of scientific data.

"If Secretary Watkins lets this decision stand,. it would seriously undermine the credibility of his stated desire to change a repository program so it is based on scientific facts, not politics."

The two other instances the Governor referred to were the DOE disregarding a study of one of its own scientists, Jerry Szymanski, who suggested the site might easily be disqualified on scientific grounds, and a "disaster" warning issued by 16 USGS hydrologists. In Aug. 5, 1987, and Aug. 17, 1988, memo, they expressed great concern about the scientific merits of DOE's study, and in the latter memo said that "in subjugating the technical program to satisfy DOE political objectives, we may succeed in making the program comply with regulations, while being scientifically indefensible."

RESPONSE:

The U.S. Department of Energy (DOE) has reviewed Mr. Szymanski's ideas, which were presented in a November 1987 draft manuscript by J.S. Szymanski, "Conceptual Considerations of the Death Valley Groundwater System with Special Emphasis on the Adequacy of this System to Accomodate a High-level Nuclear Waste Repository". A report that compiled the comments of 24 project scientists was released on July 26, 1989, entitled, "Review of a Conceptual Model and Evidence for Tectonic Control of the Ground-water System in the Vicinity of Yucca Mountain, Nevada".

Briefly, Szymanski's hypothesis is that the water table under Yucca Mountain could undergo large variations in elevation over time periods of thousands of years or less in response to changes in stress in the rocks caused by earthquake activity. The principal evidence cited for this hypothesis is the presence of calcite-silica veins in fracture zones at Yucca Mountain, which Szymanski believes were deposited by rising hot groundwater from deep in the earth. To date, no studies conducted by other scientists have supported this theory; on the other hand, existing studies do not positively disprove the Szymanski hypothesis.

Both the manuscript and the review report referenced above focus on work relevant to several studies and activities presented in the Site Characterization Plan (SCP) Investigation on postclosure tectonics found in Section 8.3.1.8 of the SCP. The reviewers concluded, though not unanimously, that (1) the tectonic processes and geomechanical models that Mr. Szymanski proposed dominantly influence the hydrologic system are described with insufficient rigor for testing or further analysis; (2) although the stress

and geothermal heterogeneities in the Earth's shallow crust probably influence the hydrologic system, the magnitude and duration of the effects proposed in the manuscript are highly unlikely; (3) the geologic and hydrologic field data claimed to support Szymanski's hypothesis are more readily and consistently explained by traditionally accepted geologic and hydrologic processes, particularly when supplemented by other available evidence; (4) Szymanski's recommendations for testing his hypothesis lack valid diagnostic criteria. In other words, if the recommended testing was carried out, the results would not demonstrate the validity of the Szymanski hypothesis. The review also recommends some additions and modifications to existing plans that have not yet been fully evaluated for possible incorporation into the DOE's program of study for the site.

DOE conducted a workshop in April 1988; with DOE scientists, scientists independent of the project, including university professors who are experts in the origin of calcite-silica deposits, and technical staff from the Nuclear Regulatory Commission, determined that the vein deposits at Yucca Mountain have the characteristics of "pedogenic calcrete," commonly known as caliche.

In July 1989, the Yucca Mountain Site Characterization Project Office released a final report by Szymanski entitled, "Conceptual Considerations of the Yucca Mountain Groundwater System with Special Emphasis on the Adequacy of this System to Accomodate a High-level Nuclear Waste Repository." Concepts and processes described in the final report will be reviewed by the National Academy of Sciences (NAS), and another review panel. The DOE anticipates that the results of the NAS review will provide significant additional evidence bearing upon the feasibility and likelihood of the mechanism proposed by Szymanski.

REFERENCES

Szymanski, J. S., 1989. "Conceptual Considerations of the Yucca Mountain Groundwater System with Special Emphasis on the Adequacy of this System to Accomodate a High-level Nuclear Waste Repository." Internal report, Yucca Mountain Project Office, U.S. Department of Energy, Las Vegas NV.

COMMENT 10

The proposed ESF site is located in Coyote Wash in the northeastern corner of the repository block. Coyote Wash is a narrow wash lying on U.S. Air Force land just west of the NTS boundary. Nearby Drill hole USW G-4 was drilled in Coyote Wash after the site was selected.

According to Sandia Report SAND84-1003 by Bertram, the site was selected in April and May of 1982. In a matter of only a few weeks the selection procedure was developed, screening done, and Coyote Wash selected. Drill hole USW G-4 was not started until August of 1982, so the nearest available drill hole data at the time of ESF site selection was from USW H-1, 3300 feet to the east. See letter of 09/22/1988, Loux to Gertz.

> **Concern: The ESF site was hastily selected based on drill hole data of questionable applicability.**

RESPONSE:

The Sandia Report is a description of a process that used the best available data at the time the shafts were first sited in Coyote Wash. Those decisions have been reviewed and the locations were adjusted in 1987 to satisfy more recent interpretations of geologic data. The ESF Alternatives study is now underway to perform a documented, detailed analysis of ESF/repository access configurations and construction methods in response to comments raised by the NRC, the NWTRB, the State of Nevada, and DOE. This study is being carried out using a QA program that fulfills the requirements of 10CFR60 Subpart G, and the results will be available for review by the State of Nevada.

COMMENT 11

Of the criteria used for screening of the five preferred sites considered, heavy emphasis was placed on setback from the repository block boundary and avoidance of adverse geologic conditions. As is pointed out below, the Coyote Wash site may well exhibit adverse geologic conditions.

The proposed repository block contains roughly 1520 acres. During the selection of the ESF site the following areas were summarily eliminated from consideration:

1. a) 500-ft wide buffer area east of Solitario Canyon Fault.
   b) 1000-ft wide buffer area south of Drill Hole Wash.
   c) 2000-ft wide buffer area along east side of block.
   d) All land south of a line 4000 ft north of USW H-3.

This eliminated 633 acres, or 42 percent of the repository block

2. All lands less than 1000 ft, but not more than 2000 ft from adverse geologic structure as identified by the USGS. This eliminated another 812 acres of another 53 percent of the original block.

3. Areas identified as being "steep slopes." This eliminated another 52 acres of the block.

The remaining 23 acres, or 1.5 percent of the original repository block fell into five potentially suitable ESF sites from which the Coyote Wash was selected. However, in the published site rankings, Coyote Wash either tied or was out-ranked by other potential ESF sites in 8 of the 12 subcriteria applied to compare the five sites.

The recent DAA review of the Bertram Report evaluated only the five candidate sites identified by Bertram. It would seem prudent in any review of the site selection to reevaluate the entire repository block for alternate sites.

Concern: Unrealistic and arbitrary criteria were used in screening, and

98 percent of the proposed repository block was eliminated without objective consideration.

RESPONSE:

See the response to Comment 10.

COMMENT 12

The Site Characterization Plan, U.S.G.S. Water Investigations report 83-4001 by Squires and Young, and other reports referenced in the SCP all contain numerous disclaimers that flooding predictions regarding the washes in and around Yucca Mountain are speculative at best. Historical records on streamflow, rainfall, runoff, recharge, flash floods, storms, infiltration, and debris movement range from sparse to nonexistent. Essentially no such data exist for Coyote Wash. The probable maximum flood configurations shown on project maps are based on generalized, regional data (Bullard, 1986) and do not appear to reflect how the proposed structures in Coyote Wash may impact future flood characteristics.

Separately, a visual inspection of the configuration of the lower drainage channel of Coyote Wash suggests that a change in slope which corresponds approximately with the proposed shaft collar elevation may be the erosional remnant of the highest flood runoff. That level is many feet above the maximum flood calculated by Bullard for Coyote Wash. See attached letters of 09/19/88, Loux to Gertz and letter of 03/31/89 Loux to Valentine in which these matters are discussed in greater detail.

It must be recognized that even partial flooding of the ESF during the construction and testing period could have serious consequences. In addition to the risk of personnel injury or loss of life, flood waters would infiltrate the shaft and drift walls. This would render highly questionable the results of tests conducted to characterize hydrologic features of the rock mass such as groundwater travel times. The current ESF plans call for drifts to slope downward to pump installations. In the event of an exploratory drift intersecting a sizeable perched water reservoir or being flooded from the surface via the shafts, the pumping system may be engulfed or otherwise become inoperative. Such an event would likely render the ESF useless for further testing, and could affect the waste isolation capability of the proposed repository horizon.

The DAA (page 3-7) states that, "... significant concentrations of infiltration are more likely to occur in drainage channels, along ridge crests, and in localized depressions." This raises the question of why the ESF is proposed to be located at the mouth of a wash.

Based on the preliminary information provided, the 10-foot wide drainage channel around the north side of the main ESF pad appears to be inadequate for containing or diverting the slope and main pad runoff during a maximum flood. Although the shaft collars are elevated one foot above grade to avoid direct flow of surface water into the shafts, the blast fractured nature of the collar rock and the possibility of deterioration of collar construction materials during the 100-year life, require that surface water diversion be ample to avoid infiltration into the shaft.

> Concern: The ESF site was selected without adequate flood potential data in the shaft collar areas, and ESF design has proceeded without sufficient evaluation of possible impacts to site characterization objectives resulting from ESF flooding.

RESPONSE:

The ESF is being designed to protect against flooding and a Floodplain/Wetlands Assessment is being prepared to evaluate impacts from constructing in a floodplain. The ESF Alternatives study, discussed in the response to Comment 1, will identify all repository access configurations and ESF configurations and construction methods considered in the past. The purpose of the study is to perform a documented, detailed analysis of ESF/repository access configurations and construction methods in response to comments raised by the NRC, the NWTRB, the State of Nevada, and DOE. The data, and uncertainties in that data, that pertain to the potential for flooding and probable maximum flood is part of this study.

COMMENT 13

The underground test area of the ESF will cover about 15 acres, and the drifting to the projected fault locations will expose about 3 more acres, providing a total of 18 acres of underground excavations. Thus, of the 1520 acre repository block, a little over 1 percent of the underground area will be available to be characterized at the ESF. While the proposed location and configuration should give some insight into the faults in the area, hydrologic characteristics and in situ rock properties of the remaining 99 percent of the block will remain unknown.

Multiple intersections of adverse geologic structures (i.e. faults) should be planned to assure representativeness. The SCP is silent on plans to evaluate unknown adverse geologic features which may be present within the repository block.

> **Concern: The location and extent of the planned underground ESF severely limit the extent to which the collected data are representative of the entire repository block.**

RESPONSE:

An ongoing activity (ESF Alternatives Study) to consider alternate designs and locations for an exploratory shaft facility includes recognition of concerns about representativeness of data from ESF openings. Data for the three dimensional characterization of the repository block are not limited to those available from the ESF shafts and drifts. Additional data will be provided by surface studies, drill cores, and geophysical investigations. The objective is to combine data sources so that the characterization of the repository block will be representative enough while preserving the waste isolation capabilities of the site.

COMMENT 14

Major faults at Yucca Mountain have been mapped, described and discussed for several years; indeed, they form the boundaries of the proposed repository block, with the Solitario fault on the west, the suspected Drill Hole Wash fracture zone on the north, the Imbricate faults on the east, and the Abandoned Wash fault on the southeast.

DOE documents to date have described the repository block as relatively free of faults with the exception of the Ghost Dance Fault which trends north-south just west of the proposed ESF site. The SCP on page 1-128 acknowledges that the Ghost Dance Fault has as much as 38m of vertical offset and an accompanying breccia zone as wide as 20m. Characterization may give further insight into the significance of this fault to waste isolation.

Of particular importance to the ESF is another possible fault lying parallel to and east of the Ghost Dance Fault. The unnamed fault identified by resistivity geophysical methods is discussed in USGS OFR 82-182 by Smith and Ross. Plate V of that report maps this fault 400m east of the Ghost Dance. Plotting the ES-1 and ES-2 shaft locations on plate V we find that the proposed fault lies between the proposed shafts. Smith and Ross (page 11) describe the block between the unnamed fault and the Ghost Dance Fault as a horst, and suggest (on page 16) that this horst may be a spur of the main fracture zone that underlies Drill Hole Wash.

Verification of the presence of this unnamed fault is supported by the geophysical identification by Smith and Ross of another fault subsequently mapped by Scott and Bonk as the Ghost Dance Fault.

This fault is also shown on Fig 1-40 on page 1-121 of the SCP and in USGS OFR 84-792 on Fig 3 and discussed on page 50. This fault is not discussed in the SCP, but is described in the USGS report as a fault with at least 5m of displacement.

Reviewing the Bertram siting criteria (page 56) regarding setbacks we find two requirements: (1) "ES sites that would have subsurface facilities closer than 100 feet to a potentially adverse structure would be excluded." Either ES-1, ES-2, or the test drifts may well fall within 100 feet of (or intercept) the unnamed fault; (2) "The shaft should be located far enough from potentially adverse structures within the block so that there would be a low likelihood that the shaft itself and the drifts would encounter fractures associated with those structures." "...A 1000-foot setback distance was judged to be sufficient to place the shaft outside the zones of fracturing associated with the structures." The Smith and Ross report (OFR 82-182) identifying the fault is dated "October, 1979" and therefore was available for the Bertram team in 1982.

> Concern: Using the two setback requirements for potentially adverse structures developed by Bertram, the Coyote Wash site should have been excluded on both counts. The presence and extent of the fault identified at Coyote Wash must be confirmed and its potential impact on the ESF evaluated before the Coyote Wash ESF site can be considered acceptable.

RESPONSE:

The U.S. Department of Energy response to Comment 2, and the support documentation cited in it, addresses this concern.

COMMENT 15

The DAA adopted the potential ESF sites of the Bertram Siting report and only reviewed faults at the Coyote Wash site interpreted from the geophysical data based on magnetic and gravity surveys. The resistivity surveys used by Smith and Ross to delineate the unnamed fault were not referenced and apparently ignored by the DAA analysis.

> **Concern: Confirmation of the ESF site selection by the DAA has ignored existing information regarding adverse structures at the Coyote Wash ESF site and makes questionable the objectivity of the DAA analysis.**

RESPONSE:

The Design Acceptability Analysis (DAA) did not evaluate the currently proposed location for the ESF in relation to a postulated "resistivity fault" (Smith and Ross, 1982), since (1) the anomaly is not unambiguously recognizable as a fault due to lack of surface expression, (2) there exists the possibility of alternative explanations for the origin of the resistivity anomaly, and (3) even if the DAA did assume a fault, it is not a through-going structure of significant mappable extent that could be considered a "potentially adverse condition". See also the response to Comment 2, and the Technical Assessment Review, "Geologic and Geophysical Evidence Pertaining to Structural Geology in the Vicinity of the Proposed Exploratory Shaft" (DOE, 1990).

DOE (U.S. Department of Energy), (1990). Geologic and Geophysical Evidence Pertaining to Structural Geology in the Vicinity of the Proposed Exploratory Shaft, Technical Assessment Review, YMP/90-2, Las Vegas, Nevada.

Smith,C., and H.P. Ross, 1982. Interpretation of Resistivity and Induced Polarization Profiles with Severe Topographic Effects, Yucca Mountain Area, Nevada Test Site, Nevada, Open File Report USGS-OFR-82-182 with introduction by D.B. Hoover, U.S. Geological Survey.

COMMENT 16

The Design Acceptability Analysis (DAA) of the Technical Acceptability Review (TAR) (page 3) contains, without basis, an underlying assumption that any ESF location in the northeast part of the repository block will provide groundwater travel times from the repository horizon to the water table in excess of 10,000 years. This concept is presently speculative and may prove erroneous given the suspected highly fractured nature of the host rock in the Coyote Wash ESF area.

It is likely that the unnamed fault delineated by Smith and Ross resistivity surveys is accompanied by a water-bearing fracture zone or even a perched water reservoir on one side of the fault. This could place any excavations near or through the fault area at risk from flooding due to perched water or rapid infiltration through the fracture zone.

Resistivity surveys identify structural anomalies by measuring differences in resistance within the rock mass. Usually a change in resistance indicates a change in water characteristics, either in water volume or in dissolved solids. The data from core holes on Yucca Mountain indicate a reasonably constant value for dissolved solids; therefore, anomalies identified by resistivity surveys would support a change in water content in the zone.

> **Concern: The selected ESF subsurface test area appears to lie in a highly fractured zone that could lead to water inflow and stability problems and may not provide data representative of the repository block.**

RESPONSE:

The comment appears to misunderstand a statement made on page 3-1 of Chapter 3 and also on page 4-6 of Appendix J of the DAA (DOE, 1990). The comment states that the DAA contains, "an underlying assumption that any ESF location in the northeast part of the repository block will provide groundwater travel times (GWTTs) from the repository horizon to the water table in excess of 10,000 years". The DAA states, "Significant differences [in the waste isolation potential of alternative ESF locations relative to GWTT] might also exist if current or future local concentrations of large flux are caused by subsurface lateral diversion of spatially variable pulses of surface infiltration. In either of these cases, locations toward the northeast [of the repository block] would be more likely to have groundwater flow times to the water table less than the period of regulatory concern (10,000 yr) in the local zones of flux concentration."

Regarding the perched water, the potential for perched water bodies in the vicinity of the ESF location cannot be ruled out on the basis of currently available information. It is unlikely that large perched water bodies exist, because they have not been encountered in drilling at the site performed to date. Some of these holes have been drilled close to the proposed ESF locations, for example USW G-4. Some minor apparently perched water zones have been penetrated in past site drilling, for example USW H-1. The

categories of site characterization data to be collected to address the possibility of perched water at the site are listed in Site Characterization Plan (SCP) Table 8.3.5.17-15, which also references the SCP studies and activities that discuss the collection of the data.

SCP Activity 8.3.1.2.2.4.7, Perched Water Test in the Exploratory Shaft Facility, is designed to detect and estimate properties of any perched water zones in the part of the unsaturated zone penetrated by the Exploratory Shaft. This evaluation is needed to understand the geohydrologic conditions causing accumulation of perched water, the implication of such a zone on flux, flow paths, travel time, and on whether perched water is a transient or permanent feature.

Before shaft sinking, any significant amount of perched water near the ESF will have been detected by the multipurpose boreholes (MPBH) (SCP Activity 8.3.1.2.2.4.9, Multipurpose-borehole Testing Near the Exploratory Shaft Facility). If perched water is detected, the activity allows for full preparation for sample collection and testing in the shaft. If perched water is not detected with the MPBH activity, the shaft walls will still require visual inspection for indications of infiltration possibly due to perched water.

One explanation for a resistivity anomaly could indeed be the presence of zones of greater water saturation in the unsaturated zone.

See also the DOE response to Comment 18 regarding surface infiltration pulses and lateral diversion in the unsaturated zone.

REFERENCES

DOE (U.S. Department of Energy), 1990. Geologic and Geophysical Evidence Pertaining to Structural Geology in the Vicinity of the Proposed Exploratory Shaft, Technical Assessment Review, YMP/90-2, Las Vegas, NV.

COMMENT 17

Concern: Movement in the near-term along the unnamed fault between the exploratory shafts could damage or disable the common hoist house and/or hoist foundations; damage or rupture buried service utilities (water, sewer, electrical, compressed air, and communications) lines in the main ESF pad; misalign conveyance guides in the shaft; damage or rupture the shaft liners and utilities in the shafts.

RESPONSE:

The seismic design of the exploratory shafts (ES), as currently configured, has been analyzed in relation to potential earthquakes and underground nuclear explosions (UNEs) in Subramanian et al. (1989). Although directly intended for design of ES shaft liners, this design basis analysis is also appropriate for seismic design of other surface structures, shafts, and other underground structures that do not affect public radiological health and safety. The report is an evaluation to determine the functions the shafts must perform during the preclosure period of the repository facilities.

Recommendations in the report include design basis parameters for both natural earthquakes that may possibly occur at or near the ES and repository site and for UNEs. The evaluation of faulting potential at the ES site and vicinity indicates that the annual probability of faulting in excess of 5 cm is less than 1 in 10,000. This analysis would be unaffected by a postulated "resistivity" fault in the location shown by Smith and Ross (1982), if it is indeed a fault. Based on this evaluation together with the results of studies to support the ES conceptual design, the report recommended that faulting effects need not be considered in the design of the ES. A failure of the ES would not affect public radiological health and safety, and the ES need only be designed to adequately provide for worker safety.

See also the response to Comment 2.

REFERENCES

Smith, C., and H. P. Ross, 1982. Interpretation of Resistivity and Induced Polarization Profiles with Severe Topographic Effects, Yucca Mountain Area, Nevada Test Site, Nevada, Open File Report USGS-OFR-82-182 with introduction by D.B. Hoover, U.S. Geological Survey.

Subramanian, C. V., J. L. King, D. M. Perkins, R. W. Mudd, A. M. Richardson, J. C. Calovini, E. Van Eckout, and D. O. Emerson, 1989. Exploratory Shaft Seismic Design Basis Working Group Report, SAND88-1203, Sandia National Laboratory, NM.

COMMENT 18

Concern: The unnamed fault bisecting Coyote Wash, the main ESF pad and the underground test drifts will provide a pathway for surface water in Coyote Wash to enter the underground facility.

RESPONSE:

Free water flowing into or out of a shaft must necessarily result from conditions that cause local saturation of the rock. Appendix J, pp. 2-8, of the Design Acceptability Analysis (DAA) (DOE, 1990) describes two possible methods by which water may be concentrated locally to cause water to flow into the shaft: (1) concentrations by infiltration pulses and (2) concentration by lateral diversion. Although a number of numerical models have been proposed to address the flow of water, these models are based on assumptions and data requiring field verification. Further, the hydraulic properties are unknown for any fault near the exploratory shafts, so that predictions of performance, based on calculations using these models, would contain many uncertainties that will not be resolved until appropriate hydrologic data is collected during site characterization.

Surface water from precipitation events and surface hydrologic channeling has been modeled using simulated faulted/fractured rock with a wide range of rock hydrologic properties. In all cases studied, the faulted/fractured region does not conduct water for the large distances that might be considered to cause deteriorated performance. Rather, the unsaturated matrix absorbs excess water from fractures so that the zone of saturation is limited to tens of feet from the ground surface. Consequently, the small quantity of water that might enter one of the shafts as a result of intersections with faults or fractures is several orders of magnitude less than the drainage capacity of the exploratory shaft facility (ESF).

Lateral diversion of water in the dipping bedded units of Yucca Mountain has been projected to occur when the flux rate exceeds some minimum value. This minimum value depends strongly on the hydrologic properties of the bedded units as well as those of the faulted zone. However, at the low flux rates projected for Yucca Mountain (approximately 0.1 mm/year based on comparisons with ambient saturation data), modeling efforts to date indicate that either (1) no flow will occur in faulted regions, or (2) flow that does occur will have very negative potentials that will not cross the seepage face at the shaft wall. At higher flux rates (0.5 mm/yr), a small amount of water could enter the shaft; however, the volume of water is much less than the drainage capacity of the ESF so that no performance impacts are expected.

Further detailed information regarding surface channeling and lateral diversion can be found in the Technical Assessment Review (DOE, 1989).

See also the response to Comment 2.

REFERENCES

DOE (U.S. Department of Energy), 1990. Geologic and Geophysical Evidence Pertaining to Structural Geology in the Vicinity of the Proposed Exploratory Shaft, Technical Assessment Review, YMP/90-2, Las Vegas, NV.

COMMENT 19

The SCP (page 1-209) discusses the effect on the repository block of underground nuclear weapons testing (UNEs) at the Nevada Test Site. Surface rupture and minor movements on faults have been observed locally at Yucca Flat and Pahute Mesa, current test shot areas. Mid Valley and buckboard Mesa, both of which are closer to Yucca Mountain than current test areas, are potential sites for future weapons tests.

Concern: That future UNEs located at Mid Valley or Buckboard Mesa could trigger fault slippage movement at the ESF site.

RESPONSE:

Potential impacts of ground motion induced by underground nuclear explosions (UNEs) are the focus of planned work described in the Site Characterization Plan (SCP). SCP Study 8.3.1.17.3.2 (Underground Nuclear Explosion Sources), considers ground motion from UNE sources and, using data from this and other SCP studies, Study 8.3.1.17.2.1 (Faulting Potential at the Repository), assesses the potential for fault offsets at the surface facilities site and within the repository block.

The U.S. Department of Energy response to Comment 17 further discusses the seismic design of the exploratory shafts in relation to potential earthquakes and UNEs.

COMMENT 20

On page 3-68, Fig 3-26, the Integrated Data System (IDS) Block Diagram shows input from "Calico Hills Experiments." In the text on the following pages there is no mention of this experiment. The Title I design does not show the shafts sunk to the Calico Hills horizon. However, the SCP (page 6-179) states that, "Four shafts and two ramps are proposed to penetrate the underground horizon at Yucca Mountain. Only the exploratory shaft is planned to extend below the repository horizon into the zeolitized tuff of the Calico Hills." This is inconsistent with our understanding of the current ESF project, but if the Calico Hills formation is to be penetrated, major revisions in the design must be made to accommodate the additional shaft depth, hoisting system, etc.

If characterization of the Calico Hills from the exploratory shaft is not presently contemplated, then what studies does DOE plan to adequately characterize this unit that will not compromise site integrity, since the Calico Hills tuff is considered to be the primary natural barrier to radionuclide transport.

> Concern: That a future decision to deepen the exploratory shafts will compromise the safety and structural integrity of the planned test area.

RESPONSE:

As a result of U.S. Nuclear Regulatory Commissions (NRC) Objection 2 on the Site Characterization Plan/Consultation Draft, U.S. Department of Energy (DOE) agreed to conduct a study of the risks and benefits of alternatiave methods of characterizing the Calico Hills unit. DOE is currently conducting a study of alternative exploratory shaft and ramp configurations and construction methods. The results of this study are being integrated with an analysis of the risk/benefit of excavating into the Calico Hills unit to conduct in situ tests. It is possible, as a result of these studies, that the exploratory shafts would be relocated.

In addition, DOE presented a revised process for controlling the ESF design at a meeting with the NRC and the State of Nevada in July 1989. The NRC indicated that the revised process appeared to be adequate and it has been incorporated into DOE administrative procedures.

COMMENT 21

We find no contingency plans for sealing the underground ESF if one of the exploratory drifts encounters a structural hydrologic feature that condemns the ESF and renders it unfit to be part of a possible repository.

Concern: There are no plans to isolate a failed ESF to assure the integrity and performance of the remainder of the repository block.

RESPONSE:

Concepts for sealing exploratory drifts against major underground flows are given in Chapter 6 of the Site Characterization Plan. The specific section is 6.2.8.6 on pages 6-185 and 6-186. Drawings for the concepts are given in Figure 6-83 on page 6-189. The repository is located in an unsaturated zone, and these flows would most likely be discrete. Drifts with large inflows would be isolated by grouting and drifts with small inflows would be controlled by small dams and drains.

Any Exploratory Shaft Facility failure due to structural features such as faults, fractures, or excessive stressed or broken ground should be accommodated and controlled through standard mining practices for ground control. See also the response to Comment 4.

COMMENT 22

The Title I Design Summary Report and the TAR Review Record Memorandum list comments generated by reviewers of Title I design. Of the 1172 comments presented, 478 (41 percent) were deferred to Title II, assuming that any problems in Title I would be solved during title II Design. NWPO understands that DOE proposes a phased approach to construction of the ESF.

> **Concern: Unresolved conceptual problems from ESF Title I design remain unaddressed as Title II Design continues.**

RESPONSE:

The changes resulting from recommendations in the Exploratory Shaft Facility Alternative Study will address or circumvent many of the open items noted in the Title I Design Reviews. Since major changes to the configuration of the ESF could result, resolution of many of those problems may not be necessary. Those that are still outstanding will be resolved during Title II Design Reviews. Title II Design has not begun, contrary to the assertion in the comment.

COMMENT 23

Title I Design gave little consideration to environmental issues and possible ESF impacts upon the environment. This deficiency may be partly due to there being inadequate environmental baseline data prior to commencing design work. Items such as sewage, chemical and industrial wastes, air emissions, mine wastewater and concrete batch plant emission shave not been fully quantified to accommodate mitigation in the design. No consideration has been given in Title I Design for reclamation of the ESF, if the site proves unsuitable.

In a similar manner, during the site selection process, the environmental criteria, "surface disturbance," "reclamation," "archaeological," and "effluents and emissions" received the lowest weightings. As a group, these four items constituted only 15 percent of the total consideration. (Bertram Report, pg 78)

> **Concern: In addition to inadequate consideration being given to environmental issues in the site selection, design of the ESF continues without appropriate regard for possible environmental impacts related to the facility.**

RESPONSE:

The U.S. Department of Energy believes environmental impacts of the Exploratory Shaft Facility (ESF) are being given adequate consideration. The Site Characterization Plan only describes the activities to be conducted to determine the suitability of the Yucca Mountain site for a repository (geologic conditions and parameters) and thus does not address the environmental impacts of the ESF or the repository. Environmental impacts are addressed in other programs and documents. An environmental assessment was prepared (DOE, 1986), an environmental monitoring and mitigation program has been established (DOE, 1988), and a Floodplain/Wetlands Assessment is being conducted.

REFERENCES

DOE (U.S. Department of Energy), 1986. Final Environmental Assessment: Yucca Mountain Site, Nevada Research and Development Area, Nevada, DOE/RW-0073, Washington, D.C.

DOE (U.S. Department of Energy), 1988. Environmental Monitoring and Mitigation Plan for Site Characterization, DOE/RW-0208, Oak Ridge, TN.

COMMENT 24

The SCP states (page 8.3.1.2-310) that, "The two multi-purpose boreholes will be located such that they do not penetrate within a distance of two shaft or drift diameters, as appropriate, of any underground opening." Using the drift widths shown on F&S drawing FS-GA-0162 Rev B from title I Design drawings, the boreholes MP-1 and MP-2 as located on SCP page 8.3.1.2-311 cannot meet the setback requirements. In fact, there appears no location in either of the designated pillars that can meet the standoff criteria.

The SCP (page 8.3.1.2-312) states that a third multipurpose borehole may be drilled midway between ES-1 and ES-2. Again applying the "Two drift diameter standoff" rule, there is no ground between the shafts that can qualify. Further if this third hole was drilled plumb, it would intersect the north-south drift south of the demonstration breakout drift. This same hole would collar in the drum pit of ES-2 hoist in the surface hoist house.

It is also likely that these boreholes will deviate horizontally as they are drilled. USW G-4 deviated 26 feet to the southwest at 1000 feet of depth and 48 feet at 1250 feet of depth. (See Fig 3 of USGS OFR 84-789). This anticipated deviation must also be considered in locating boreholes and setting standoff requirements.

> Concern: Consideration must be given to deviation and standoff requirements and possible borehole deviation in locating future boreholes around the ESF and failure to do so may compromise drift and shaft integrity.

RESPONSE:

The U.S. Department of Energy is reconsidering the role and location of multi-purpose boreholes in connection with the ESF Alternatives Study. Integral to the reconsiderations are the questions of appropriate standoff distances, reasonable target areas for boreholes at depth, and the potential for horizontal deviation of vertical boreholes. See also the response to Comment 5.

COMMENT 25

Some TAR Committee members that reviewed the DAA as well as many of the DAA reviewers are members of the various organizations contracted and funded by DOE. This group determined that all of the NRC concerns were "judged to be adequately addressed in the Title I design." At least five reviewers or committee members participated in either ESF site screenings or Title I design, thus their independence is questioned. The intent of the TAR would have been better suited to have an independent, unbiased team perform the TAR.

Concern: Title II Design is proceeding because of the endorsement of Title I Design by a group not entirely independent.

RESPONSE:

The overall ESF design is currently being reviewed through efforts on the ESF Alternatives Study. This study is being performed at the YMPO and will comply with 10 CFR 60 Subpart G QA requirements. The study will consider all relevant NRC requirements and concerns raised by NRC and others in arriving at an optimum layout for the ESF which could be integrated with the future repository. Based on the results of this study and depending on how significant the changes proposed, the decision on whether to continue with ESF Title II design or start all over again with Title I design (especially for those items impacting future repository design) would be made. It is expected that all necessary design control measures would be satisfied. See also the response to Comment 1.

The U.S. Department of Energy believes that the standard of independence for Technical Assessment Review (TAR) team members that was established for the review of ESF Title I design was appropriate and that the standard was met.

The procedure that governs the TAR process, QMP-02-08, specifies that it is the responsibility of the TAR chairperson to establish minimum qualifications for review team members, including independence, to accomplish the scope and purpose of the review. In this case, the standard for sufficient independence that was established by the chairperson was that review team members must not have been principal contributors to the ESF Title I design or the Exploratory Shaft Design Requirements document that was used as the basis for the ESF Title I design.

The intent of the TAR chairperson in establishing this standard was to exclude from the review any persons whose contribution to the Title I design was substantial enough to create a sense of ownership of the design and, hence, a temptation to defend it, while not excluding from the review persons who were knowledgeable of the Title-I-design history, assumptions, and requirements, simply because they had some peripheral or minor involvement with the design effort. In the judgment of the TAR chairperson, none of the review team members had sufficient prior involvement with the Title I design to feel that they were reviewing their own work. Furthermore, the Department believes that the quality of the review would have suffered had the team comprised only people who had no prior connection with, and knowledge of, the ESF Title I design.

COMMENT 26

Page 2-60 of the DAA discusses several of the known potential problems with repository performance as related to structural failure within the ESF. With this acknowledgment that ESF failure could jeopardize repository performance, retrieval, etc., prudence would demand that ample, reliable data pertaining to rock strength and other characteristics be available before proceeding with detail design.

> **Concern: The ESF design is based on unsubstantiated rock properties which may lead to failure in the ESF and have future impacts on the repository.**

RESPONSE:

The comment expresses concern that the ESF design is based on insubstantial rock properties and that this would ultimately lead to ESF failure and ultimate future performance impacts. This is unwarranted and the comment considered failure modes in section 2.6.1.1 of the DAA that are not specifically addressed and is taken out of context.

Section 2.6.1.1 discusses the 10 CFR 60 requirements not specifically addressed in the DAA but would be addressed along with other requirements in Title II ESF Design. The DAA position is that the Title I ESF Design, construction, and testing activities are unlikely to impact repository operations or affect compliance with 10 CFR 60.

In short, the possible scenarios considered in 2.6.1.1 were to address the influence of ESF on the repository requirements outlined in 60.111, not to estimate the likelihood of occurrence of these events nor suggest that uncertain rock properties or possible tectonic events would necessarily lead to these scenario outcomes. It is one purpose of the ESF to carefully measure rock properties that are pertinent to waste isolation. To the extent that the design of the ESF is dependent on a priori detailed knowledge of rock properties, rock properties are based on the best available information.

COMMENT 27

On page 8.5-48 of the SCP there is a listing of Site Characterization Study Plans. Fourteen programs are listed which incorporate 106 study plans. While SCP Chapter 8 contains brief descriptions of the study plans, the detail here is not sufficient to evaluate procedures and equipment involved. More important, it is difficult, if not impossible, to determine the interface impacts of each study on concurrent studies or on the simultaneous development of the ESF.

Concern: Detailed study plans will be developed too late to be used in the design process to insure test-to-test and test-to-ESF construction compatibility.

DOE (U.S. Department of Energy) 1986. PMF Study, Memorandum: Bullard to Head, Flood Section.

DOE (U.S. Department of Energy) 1988. Yucca Mountain Project Exploratory Shaft Facility title I 100 Percent Technical Assessment Review, YMP/88-19A.

DOE (U.S. Department of Energy) 1989. Exploratory Shaft Facility (ESF) Title I Design Acceptability Analysis and Comparative Evaluation of Alternative ESF Locations, YMP/89-3.

DOE (U.S. Department of Energy) 1988. Site Characterization Plan, DOE/RW-0199.

Loux, R.R., 1988. Letter from Robert Loux (NWPO) to Carl Gertz (DOE) regarding flooding at the ESF site.

Loux, R.R., 1988. Letter from Robert Loux (NWPO) to Carl Gertz (DOE) regarding ESF site selection.

Loux, R.R., 1989. Letter from Robert Loux (NWPO) to Deborah Valentine (DOE) regarding determination of floodplain for Site Characterization.

Smith, C., and H.P. Ross, 1982. Interpretation of Resistivity and Induced Polarization Profiles with Severe topographic Effects, Yucca Mountain Area, Nevada Test Site, Nevada, USGS-OFR-82-182, Open-File Report, U.S. Geological Survey.

Squires, R.R., and R.L. Young, 1984. Flood Potential of Fortymile Wash and Its Principal Southwestern Tributaries, Nevada Test Site, Southern Nevada, USGS-WRI-83-4001, WAter Resources Investigations Report, U.S. Geological Survey.

USGS (U.S. Geological Survey) (Comp.), 1984. A Summary of Geological Studies Through January 1, 1983 of a Potential High-Level Radioactive Waste Repository Site at Yucca Mountain, Southern Nye County, Nevada, USGS-OFR-84-792, Open-File Report, U.S. Geological Survey.

RESPONSE:

Interface impacts between studies and Exploratory Shaft Facility (ESF) design are the subject of ongoing and continuing review. Although the descriptions of studies are relatively brief in the Site Characterization Plan, the level of thought behind those studies and their interrelations was generally more mature in detail than space permitted. These details are presented in study plans. More than half of the 106 study plans have been written and are in review at the U.S. Department of Energy (DOE), and thus available for the design process, if required. Study Plans for experiments in the ES have been approved and are in review at the U.S. Nuclear Regulatory Commission. DOE recognizes, however, that studies must and will change as site characterization proceeds. The use of the best available knowledge followed by continuing review is the only appropriate way to ensure maximum compatibility between conduct of studies and ESF design and construction.

COMMENT 28

During the past 5 years this office has observed with keen interest as the conceptual and preliminary designs for the Exploratory Shaft Facility evolved. While a few of our concerns regarding the planning, as expressed in my letter of 5/31/88, have been alleviated, most are still in limbo awaiting resolution in subsequent design processes or at some future discussion or review. This letter will discuss our continuing concern involving the location of the exploratory shafts and their related surface facilities.

In the early conceptual plans, the exploratory shaft collars were located close to midstream in Coyote Wash. At a DOE/NRC/State meeting held April 14 and 15, 1987, to discuss proposed changes to the ESF, DOE announced that the conceptual plans were being revised to relocate the shaft collars 440 feet to the northeast. The stated motivation for the relocation was NRC Staff concerns that the original locations were sited in the alluvial fill of Coyote Wash. The new location was said to minimize the likelihood of collar erosion because the shafts would now be collared in hard rock outside the flow channel of Coyote Wash.

At the ESF Title I 50 Percent Design Review meeting held in May of this year, the NRC Staff continued to express concerns related to collar erosion and possible shaft flooding resulting from flood flows in the adjacent Coyote Wash. It appeared that the shift to hardrock and retreat from the center of the wash did not entirely allay the NRC concerns.

The ESF Title One Design Review is currently nearing completion. Reviewing the latest release of Title I plans relating to the surface facilities in the subject area, we note minor revision in the drainage plans for the Coyote Wash channels that are culverted under the road connecting the ESF pad and drill hole G-4 pad. This situation is in the State's view a bottleneck and will be addressed in future correspondence.

Of major concern with the ESF Design is the analyses and references used to develop the Probable Maximum Flood (PMF) levels. We note that the prime reference for the PMF predictions is a USGS Water-Resources Investigations report, #83-4001, Flood Potential of Fortymile Wash and Its Principal Southwestern Tributaries, Nevada Test Site, Southern Nevada. This report was prepared by Squires and Young. However, in reviewing the Consultation Draft of the Site Characterization Plan, Chapter 3, we get the impression that the DOE has little confidence in the flood prediction studies done to date.

Note the following excerpts from your Draft SCP:

Page 3-8. Regarding runoff: "--scanty data available for the region---". Later: "Quantitative data on rainfall, runoff, and evaporation for the area are not yet adequate to determine rainfall-runoff-recharge relations for individual storms, seasons, or years. Therefore, only general knowledge of runoff parameters is available.---- models can't be calibrated until more field data become available."

Page 3-12. Regarding streamflow at Yucca Mountain: "---almost no streamflow data have been collected."

Regarding floods: "Flood analyses at Yucca Mountain are needed to provide flood data for design and performance considerations."

Page 3-13. Regarding future flooding: "Confidence in predictions of future flooding is lessened because of the sparse historical data, quantitative or qualitative, on streamflow or flooding throughout the region surrounding Yucca Mountain."

Page 3-14. Regarding long term flood predictions: "Predictions are especially difficult for drainages with minimal stream-flow records, such as those in the hydrologic study area."

Page 3-16. Regarding calculating probably maximum flood: "The sparse streamflow records, the availability of only minimal precipitation and storm data, and the absence of data on infiltration-runoff characteristics for the drainage basins in the Yucca Mountain area requires that many speculations and assumptions would be needed to calculate the magnitude of probable maximum floods in complex drainages the size of Forty mile and Topopah washes. Also, the lack of storm and runoff data throughout the hydrologic study area prevents checking the validity of the various assumptions used."

Page 3-17. Regarding the drainage basins of Busted butte Wash and Drill Hole Wash: "The regional maximum flood would inundate all central flat-fan areas in these two watersheds."

Page 3-19. Regarding erosion: "The extent of erosion and sediment movement caused by flood flow in Fortymile Wash and its tributaries that drain Yucca Mountain is not known quantitatively."

Regarding flood and debris hazard: "The sparseness of the historic data base on surface water hydrology, including the movement of both water and debris inhibits accurate prediction of flood and debris hazards for the immediate future. Likewise, a deficient understanding of the paleoclimates and the past geomorphic processes limits the ability to predict climatic changes and their probable effects on flood-and-debris-hazards potential over the next several thousands of years."

Page 3-20. Regarding hazard potential: "The minimal data on stream flow and insufficient knowledge of geomorphic parameters make predictions of flood and debris hazards very speculative."

In looking at the overall Yucca Mountain Project, we view the determination of the PMF or other major hydrologic event as major design uncertainties. Without substantiated hydrologic data on a given site, it is impossible to obtain a PMF at that particular site. Since it is clearly acknowledge in

both the CD-SCP and the CDR that no site specific data exist for the Coyote Wash area, it becomes a question of conservatism as to the determination of the PMF.

The problem is that the design depends on the PMF determination and the PMF determination is likewise dependent upon the design. PMF is determined by considering hydrologic data, which is sparse, and the planned structures in the wash that will cause backwater effects, damming, etc. In a relatively narrow wash, such as Coyote Wash, the peak level of the PMF is highly dependent on the existence of such obstructions.

In order to insure that the ESF shafts will be safe and free from the damage due to major hydrologic events, it is critical to place the shafts in a position and at an elevation that the engineering and scientific community as a whole agree as safe from the PMF. At their current locations, the shafts certainly do not meet this standard.

We certainly concur with the discussion contained in the Draft SCP: flood prediction at Yucca Mountain is indeed very speculative. Our obvious question is, therefore, how can you confidently site the ESF shafts that will technically be an integral part of the licensed repository in Coyote Wash considering the unfounded, admittedly deficient condition of the potential flood data? We might further point out that the other proposed shafts, the ramps and the surface facilities described in the CDR all may have a similar problem.

RESPONSE:

U.S. Department of Energy (DOE) first responded to these concerns in a letter from Carl Gertz to Robert Loux dated November 27, 1989. The ESF Alternatives study, discussed in the response to Comment 1, will identify all repository access configurations and ESF configurations and construction methods considered in the past. The purpose of the study is to perform a documented, detailed analysis of ESF/repository access configurations and construction methods in response to comments raised by the NRC, the NWTRB, the State of Nevada and DOE. The data, and uncertainties in that data, that pertain to the potential for flooding and probable maximum flood is part of this study.

REFERENCES

DOE (U.S. Department of Energy), 1989. Consultation Draft of the Site Characterization Plan, DOE/RW-160, Washington, D.C.

COMMENT 29

At the July, 1988 DOE/NRC/State meeting in Rockville, MD, regarding NRC concerns about the Exploratory Shaft Facility (ESF), Joe Tillerson of Sandia gave a presentation that responded to NRC Objection No. 4, "Shaft Locations." Part of this presentation was a bit of history that attempted to defend the reasoning behind the selection of the present ESF shaft locations. Mr. Tillerson cited two references: (1) "detailed discussion with NRC in 8/85 meeting" and (2) "Selection process documented in SAND84-1003." The purpose of this letter is to discuss the latter.

SAND84-1003, NNWSI EXPLORATORY SHAFT SITE AND CONSTRUCTION METHOD RECOMMENDATION REPORT, was authored by Sharla G. Bertram on Sandia's Seabed Programs Division, and published in August of 1984. The abstract claims that the report documents the evaluation of alternate construction methods and the screening of potential exploratory shaft sites. The report concludes by recommending a vertical shaft, conventionally mined, in a dry canyon known as Coyote Wash.

What we find incredible is the brief, just three month, duration of this effort and the lack of documented data upon which to compare alternatives as a basis for the selections. In fairness, we are aware that much has changed since these recommendations were made in the spring of 1982; however, unfortunately the results of this hasty, unreferenced evaluation survive and continue to be perpetuated by DOE.

According to the report, on March 29, 1982, a few months prior to passage of "The Nuclear Waste Policy Act," a working group was formed to develop procedures for evaluating ESF construction methods and screening sites. Thirty days later, on April 28th, the procedures were completed, approved by the senior project officers of all participating contractors in the NNWSI, and the working group became the Ad Hoc TOC Committee. Their task was to refine criteria and implement the methodology. They were further charged with recommending the preferred construction method by May 10 and recommending the preferred site by June 1. This schedule allowed 11 calendar days (6 working days) to select a construction method and generously allowed 33 calendar days (22 working days) to select a site. The method recommendation was presented and unanimously approved on May 12, two days late. No exact date is mentioned for the presentation of the site recommendation, but the report implies the work was completed in June.

On August 22, 1982 Drill Hole USW G-4 was started in Coyote Wash. Note that the shaft site was selected before G-4 was even started and therefore the evaluation criteria that addressed underground fractures, vertical thickness of units, and underground adverse conditions had to be based on the existing drill hole data from G-1, H-1, H-4, and UE25a-1, the latter being the closest to the selected site, being 3300 feet to the east. The Committee stated that it used the most current information available; most data, including that from USGS, was preliminary and unpublished; and that the information was incorporated into the report without reference. Perhaps the rushed schedule was prompted by the stated assumption that shaft construction would begin March 31, 1983.

Before recommending a construction method, the committee considered 12 alternatives. Five of these were evaluated using merit analysis. Two of the five called for shafts extending through the Calico Hills Unit into the Bullfrog and Tram Units. Though somewhat unsophisticated and general in nature, the process seems to have resulted in the Committee somehow stumbling onto perhaps the best construction method.

The Committee next selected four categories of screening criteria for site selection: 1) Scientific, 2) Engineering, 3) Environmental, and 4) Nontechnical.

From this point the Committee proceeded to screen alternate repository block areas using boundary setbacks, and distance to potentially adverse geologic structures to develop acceptable areas for siting. In addition, all areas of steep slopes or adverse topography were eliminated. From this screening emerged five preferred areas: two on Yucca Ridge and three located in washes on the eastern flank of Yucca Mountain.

It should be noted here that perhaps the greatest flaw in the selection process was in the logic applied to this screening that selected the five preferred sites. Heavy emphasis was placed on two factors: setback from the repository boundaries and avoidance of adverse geologic structures.

In an effort to center the ESF on the block and insure typical representation, the following buffer criteria were applied and the border areas of the block were eliminated:

1. A 500 foot wide strip along the west side of the block, thus avoiding Solitario Canyon Fault zone.

2. A 1000 foot wide strip along the north side of the block, thus avoiding possible drill Hole Wash faulting.

3. A 2000 foot wide strip along the eastern side of the block, thus avoiding the imbricate faults.

4. All land lying south of a line 4000 feet north of H3, thus avoiding the numerous faults suspected in Abandoned Wash.

This exercise eliminated 633 acres (42 percent) of the 1520 acre block and left 887 acres as acceptable. If roughly 40 percent of the block is unsatisfactory for the ESF, the question arises: should the block even be considered for a repository?

Next, to avoid adverse geologic structures as identified by USGS, all lands less than 1000 feet and more than 2000 feet from an adverse structure were eliminated. The intent here seemed to be to maintain a 1000 foot buffer for safety but stay within a maximum of 2000 feet distance so that underground horizontal drilling to the structure could be accomplished. These criteria eliminated another 812 acres leaving 75 acceptable acres.

Finally, of the remaining 75 acres, 52 acres of steep slopes (term undefined)

were eliminated. This left 23 acres of 1.5 percent of the original 1520 acre block that the committee considered acceptable for an ESF site. These 23 acres were divided among 5 sites, three in washes and two on the ridge top.

Perhaps it made sense to avoid the perimeter boundary of the block and seek a central location. However, a program mandated to characterize the repository block, including its structures, should not have eliminated so much area in an effort to avoid the very geologic structures that were to be investigated. Sinking a shaft near a fault zone is not uncommon, using existing technology. further, there is no assurance that the two ESF shafts or the Men & Materials and Exhaust shafts won't intercept currently unknown faults during sinking, however it seems assured that the proposed ramps will intersect several fault zones as they are driven. In addition, structures that were so carefully shunned in the screening were not all proven, many being only suspected by USGS, based on surface work.

In reviewing the maps that define the various areas discussed above, it is apparent that the nebulous "steep slope" factor was employed in to eliminate a 30 acre tract lying in the center of the block in the area of Antler Ridge. Construction of a road and the required utilities would have been comparatively more difficult here, but by no means restrictive.

The "Nontechnical Category" was discarded because all five sites were considered equal in this category. The remaining parameters were each assigned a weight, with flash flooding, reclamation and surface disturbance at the bottom of the list each with a maximum of 3.0 percent of the total score. Heading the list as most important to the site selection was "subsurface facilities located in good rock" at 16.5 percent of 5.5 times more important than flash flooding.

There then followed in the report a brief discussion of the pros and cons of each of the five sites. The two ridge top sites were suspect because building a mud pit for drilling effluents would be difficult; the muck piles would have to be at the heads of washes making reclamation difficult; a large area would have to be disturbed to gather enough material for the pads and berms; the long access road would require more control over off-road driving of heavy equipment; more road paving would be required; lack of topsoil would require hauling in topsoil for reclamation which would be dissimilar soil to that originally removed; and finally, vegetation recovery would be impeded by wind and water erosion. Needless to say, the ridge-top sites finished a distant 4th and 5th in the ranking.

The first of the wash-bottom sites was said to require some paving of the existing road. All other factors paralleled, but were rated slightly inferior to Coyote Wash. This site was ranked a close second.

The other runner-up wash-bottom site apparently was a throw-away early on. It was located in a "narrow, constricted, and steep wash." The report stated that flash flooding threatened to destroy mud pits, and wash away contained effluents and the muck pile. (We feel similar characteristics exist in Coyote Wash). Overhanging rock cliffs would have be be removed for safety during site preparation, and would be impossible to replace at reclamation. This site was ranked third.

The unanimous winner was, of course, the Coyote Wash site described as, "in a

broad, open wash" providing "suitable areas for mud pit or muck pile construction without flash flood problems." The clincher was that road construction would be required for only a short distance. It is interesting to note that even with the skewed ratings, Coyote Wash was tied or outranked in 8 of the 12 subcriteria applied to compare the 5 sites.

It is also noteworthy that the question of adequate available pad area was never addressed. In the recent Title I ESF Design Reviews, crowding of the facilities on the pad has been a recurring issue.

In the intervening years, as repository requirements and configurations were changed, as the NRC and State of Nevada repeatedly were critical of the Coyote Wash ESF location, and as the planned ESF was enlarged from one shaft to two and shaft depths changed, we saw no attempt to revisit the 1982 ESF selection decision. We therefore strongly recommend that the ESF Site selection decision be reviewed now, in the context of the existing information and consistent with the status of site characterization planning. We further recommend that, unlike the 1982 process, appropriate quality assurance procedures be applied to the evaluation and any resultant decisions and conclusions.

RESPONSE:

U.S Department of Energy (DOE) first responded to these concerns in a letter from Carl Gertz to Robert Loux dated November 27, 1989. The Exploratory Shaft Facility (ESF) Alternatives study, discussed in the response to Comment 1, will identify all repository access configurations and ESF configurations and construction methods considered in the past. The purpose of the study is to perform a documented, detailed analysis of ESF/repository access configurations and construction methods in response to comments raised by the U.S. Nuclear Regulatory Commission, the Nuclear Waste Technical Review Board, the State of Nevada and DOE. This study is being carried out using a QA program that fulfills the requirements of 10 CFR 60 Subpart G, and the results will be available for the State's review.

COMMENT 30

It has come to the attention of the Nevada Agency for Nuclear Projects, Nuclear Waste Project Office, and the subject Federal Register of DOE's Determination of Floodplains/Wetlands Involvement was published on February 9, 1989. We discovered this notice in March 1989, and in fact, have never received direct notification of its publication from the U.S. Department of Energy despite the fact that Yucca Mountain, Nevada, is named in the Nuclear Waste Policy Amendments Act of 1987, as the location of DOE's high-level nuclear waste candidate repository site characterization activities. Federal regulations for Compliance with Floodplains/Wetlands Environmental Review Requirements state, at 10 CFR Part 1022.14(b), that "DOE shall take appropriate steps to inform Federal, State, and local agencies and persons or groups known to be interested in or affected by the proposed floodplains/wetlands action." In view of the DOE's apparent oversight in providing direct notification of the subject determination of the State of Nevada, please provide this office with a description of the "appropriate steps" taken by DOE for notification of this determination, and a list of those agencies, persons, or groups (if any) that were individually informed of the DOE's February 9, 1989, determination.

RESPONSE:

Publication of a notice in the Federal Register served as notification to the State of Nevada and other interested parties. No agencies, persons or groups were individually notified.

COMMENT 31

In reviewing the subject FR Notice, its cited references, and additional information that is available from the DOE, it is apparent that these documents do not provide adequate and complete descriptions of the proposed specific actions and their locations for comprehensive analysis, nor do they provide adequate information on the delineations of the floodplains/wetlands and their natural environmental and ecological characteristics that are likely to be affected.

RESPONSE:

The intent of a Federal Register Notice is not to provide detailed information on the assessment, but to provide a notice of proposed activities in a floodplain. The specifics of the proposed action will be addressed in a Floodplains/Wetlands Assessment. When the Assessment is available, DOE will issue an announcement in the Federal Register and also notify the State of Nevada.

COMMENT 32

Although the subject FR Notice makes specific reference to Site Characterization activities as the proposed actions, it is unclear, based upon cited references, whether the Determination is also intended to refer to repository surface facilities, should such facilities be constructed. This matter should be clarified.

RESPONSE:

The determination applies only to site characterization activities and does not include repository surface facilities because the Yucca Mountain site has not, as yet, been recommended for development as a repository. Should such facilities be constructed, a separate flood plain/wetlands review will be conducted.

COMMENT 33

Specific comparisons of alternative sites considered for proposed actions in floodplains/wetlands have not been discovered in the referenced materials, or other available information.

RESPONSE:

Alternative sites will be presented in the Floodplains/Wetlands Assessment. Initially, five sites were identified as suitable for the Exploratory Shaft Facility (ESF). The final site was selected on the basis of four site selection criteria: scientific (e.g., favorable rock conditions), engineering (e.g., flooding), nontechnical (e.g., land use constraints), and environmental (Bertram, 1984).

The ESF Alternatives study, discussed in the response to Comment 1, will identify all repository access configurations and ESF configurations and construction methods considered in the past. The purpose of the study is to perform a documented, detailed analysis of ESF/repository access configurations and construction methods in response to comments raised by the U.S. Nuclear Regulatory Commission, the Nuclear Waste Technical Review Board, the State of Nevada, and U.S. Department of Energy. This study is being carried out using a QA program that fulfills the requirements of 10 CFR 60 Subpart G, and the results will be available for review by the State.

REFERENCES

Bertram, S.G., 1984. NNWSI Exploratory Shaft Site and Construction Method Recommendation Report, SAND84-1003, Sandia National Laboratories, Albuquerque, NM.

COMMENT 34

There is no specific discussion regarding the applicability and compliance requirements of Section 404 of the Clean Water Act relative to the proposed actions. Additional information should be provided regarding this matter.

RESPONSE:

The Floodplains/Wetlands Assessment will discuss the applicability of the Clean Water Act Section 404 Permit. The U.S. Department of Energy (DOE) has asked the Army Corps of Engineers for a determination concerning the applicability of the 404 Permit. The Army Corps of Engineers has granted DOE a Section 404 Permit, as required by the Clean Water Act, under its Nationwide Permit (33 CFR Part 330.5).

COMMENT 35

The referenced materials and other available information are insufficient to permit calculations of the affects of structures proposed to be located in floodplains/wetlands on resultant flood heights and velocities.

RESPONSE:

The Floodplains/Wetlands Assessment will provide information on construction activities in the floodplain. Most of the facilities will be located outside of the 100-year floodplain. Proposed structures such as roads, culverts, borrow areas, screening plant, and channels have been designed for protection from erosion, scouring, and debris loading and transportation. Due to the extreme volume of flow from a probable maximum precipitation event, culverts and roadways will be designed so that they do not back water to more than a 2-meter (6-foot) depth to prevent flash flooding produced by retention dams.

COMMENT 36

Given the general lack of sufficient, and traditionally available, information to evaluate the proposed floodplains/wetlands actions relative to the requirements of 10 CFR Part 1022 and the relevant executive orders, I am requesting that the Floodplains/Wetlands Assessment, required to be prepared by DOE (10 CFR Part 1022.12), be issued in draft form for review and comment, prior to DOE's issuance of its statement of findings as required by 10 CFR Part 1022.15. This will enable Nevada to undertake a comprehensive evaluation of the proposed actions with respect to the requirements of 10 CFR Part 1022 and provide substantive comment to DOE in a timely and constructive manner. This request is in accord with the intent of the regulation, as well as that of the Nevada's assigned review and oversight role pursuant to the Nuclear Waste Policy Act.

RESPONSE:

The U.S. Department of Energy is preparing the Floodplain/Wetlands Assessment (FWA) in accordance with 10 CFR Part 1022. A draft FWA will be provided to the State of Nevada. The opportunity for review and comment on the FWA is set forth in 10 CFR Part 1022.

COMMENT 37

Referring to the ESF Title I design, engineering drawings and design narrative do not describe the relationship between hydrologic events expected for the site and the region and the design of the facilities. Other literature presents several storm hydrographs for the Yucca Mountain area which relate to expected precipitation at the site in a general way. How these areal data affect the flood boundaries illustrated within the design drawings is not clear. Such data, if site-specific, also relate to expected flood elevations, volumes, and velocities.

Originally, the Squires and Young Report (USGS Water Resources Investigations Report 83-4001, 1984) was to be the major tool by which the ESF location was justified and other ESF improvements were designed. The current site plans for the ESF conflict with the drawings within the Squires and Young Report in terms of flood boundaries. These differences may prove to be justified, but without specific data and calculations any alteration of the originally established flood boundaries cannot be accepted.

RESPONSE:

The Exploratory Shaft Facility (ESF) design, as required by the design constraints in the exploratory shaft facility Subsystem Design Requirements Document (SDRD) for Title II (DOE, 1990), incorporates design features to protect the facility against credible hydrologic events, such as flooding.

The ESF Alternatives study, discussed in the response to Comment 1, will identify all repository access configurations and ESF configurations and construction methods considered in the past. The purpose of the study is to perform a documented, detailed analysis of ESF/repository access configurations and construction methods in response to comments raised by the U.S, Nuclear Regulatory Commission, the Nuclear Waste Tecnical Review Board, the State of Nevada, and U.S. Department Of Energy. The data, and uncertainties in that data, that pertain to the potential for flooding and probable maximum flood is part of this study.

REFERENCES

DOE (U.S. Department of Energy), 1990. Exploratory Shaft Facility (ESF) Subsystem Design and Requirements Document (SDRD) for Title II, YMP/CM-0006, Las Vegas NV.

COMMENT 38

Throughout the ESF Title I drawings, channels, roads, culverts, and even buildings are depicted that may prove to have an adverse impact on the hydraulic characteristics of the washes in the area. For example, on Sheet C39, three 36-inch culverts are to be placed underneath H Road. Further up the wash, H Road enters the 100-year floodplain (see Sheet C45 B). This illustrates that the wash does carry some significant flows as would be expected, but the impacts of placing the three culverts downstream have not been addressed, as is evident by the information presented. it is one thing to simply ensure that all pad and roadway elevations are above the 100-year Floodplain; but of concern is the impact that improvements downstream, which may not be in the floodplain, may have on the upstream improvements as a result of backwater effects.

RESPONSE:

The effects of a 100-year flood were considered in the design of the proposed structures (i.e., roads, culverts, channels, etc.). Minimum side slopes of 2:1 are used on all ditches and channels. Culvert design incorporates corrugated metal pipes with concrete headwall and tailwall. Rip rap protection, added to both the side slopes and bottoms of channels is placed a minimum distance of 9.8 meters (30 feet) upstream and 16.4 (50 feet) downstream of the culvert.

The possible impact of heavy water flows being backed up by blockages in the culverts under a road was discussed at the 50% Design Review and was resolved by lowering the elevation of the road so that water would not build up above the shaft collars.

COMMENT 39

Another concern that should be addressed is the affect of flood water velocities. Although the ESF site improvements proposed within the 100-year Floodplain may be safe as far as elevation is concerned, the scour potential of flood events in the Yucca Mountain area is enormous. The borrow pit proposed is to be constructed as a channel within the floodway and the muck storage pad is to be placed adjacent to the channel at a bend. Scour at the bend not only can realign the channel, but can undermine the access road and muck storage area.

RESPONSE:

Information on potential flood water velocities from Squires and Young (1984) will be used as a basis to prepare the Floodplains/Wetlands Assessment and was used as input to Title I Design to protect against scouring, erosion, and debris loading and transportation. In addition, protection and control of erosion would be provided by reduced channel gradient, structures at abrupt changes in gradient, and entrance of water course branches, drop spillways, energy dissipaters, and rip rap protection at key points. See also the response to Comment 3.

The ESF Alternatives study, discussed in the response to Comment 1, will identify all repository access configurations and ESF configurations and construction methods considered in the past. The purpose of the study is to perform a documented, detailed analysis of ESF/repository access configurations and construction methods in response to comments raised by the NRC, the NWTRB, the State of Nevada, and the U.S. Department Energy. The data, and uncertainties in that data, that pertain to the potential for flooding and probable maximum flood is part of this study.

REFERENCES

Squires, R.R., and R.L. Young, 1984. Flood Potential of Fortymile Wash and Its Principal Southwestern Tributaries, Nevada Test Site, Southern Nevada, USGS-WRI-83-4001, Water-Resources Investigations Report, U.S. Geological Survey.

COMMENT 40

The ESF site improvements to the floodplain should be designed based on the expected flood conditions, and then the flood elevations recomputed based on improvements with the floodways. From a review of the available literature, there is nothing to justify the 100-year and PMF (500-year) boundaries presented. It is likely the boundaries could be altered dramatically by the proposed improvements.

RESPONSE:

Section 3.2 in the Site Characterization Plan contains a detailed discussion of the flood history and potential for future flooding in the Yucca Mountain area and was modified from Squires and Young (1984). Squires and Young used a method that allows reliability evaluation based on nearby flood data. Title II Design will incorporate flood and erosion control procedures based on site-specific flood elevation analyses.

The Exploratory Shaft Facility (ESF) Alternatives study, discussed in the response to Comment 1, will identify all repository access configurations and ESF configurations and construction methods considered in the past. The purpose of the study is to perform a documented, detailed analysis of ESF/repository access configurations and construction methods in response to comments raised by the Nuclear Regulatory Commissions, the Nuclear Waste Technical Review Board, the State of Nevada, and U.S. Department of Energy. The data, and uncertainties in that data, that pertain to the potential for flooding and probable maximum flood is part of this study.

REFERENCES

Squires, R.R., and R.L. Young, 1984. Flood Potential of Fortymile Wash and Its Principal Southwestern Tributaries, Nevada Test Site, Southern Nevada, USGS-WRI-83-4001, Water-Resources Investigations Report, U.S. Geological Survey.

COMMENT 41

For the repository surface facilities site, no information is provided in the literature to evaluate the affects of sheet flooding on the proposed site or what floodplain modifications will be made to the site for site characterization activities and how such modifications might impact flood elevations.

RESPONSE:

Potential impacts due to sheet flooding on the repository surface facilities site will be evaluated as part of the site characterization program, for example Study Plan 8.3.1.2.1.2 (Characterization of Runoff and Streamflow), and results will be used as input to the engineering design for the repository. See also the response to Comment 44.

COMMENT 42

The probability of flood damage to the structures located in the floodplain should not be discounted. Thus, it is deemed critical that a study be initiated to evaluate the impact of such a hydrological event on the performance of the proposed repository. Specifically, the study should outline the damage assessment in the event of surface support facilities' inundation on the total operation and performance of the repository.

RESPONSE:

Refer to responses for Comments 41 and 44.

COMMENT 43

The proposed borrow pit channel and the smaller channel below the ESF equipment storage area, both appear to outfall into the natural drainage ways. These drainage ways appear to parallel and flow across the main haul road. As an alternative, the road could be built up above its natural grade, as appropriate, to keep it out of the 100-year Floodplain, and a culvert crossing constructed (station 366-50?) to control the flow across the roadway.

RESPONSE:

The proposed borrow pit is designed to become part of the natural drainage way. The main access road is designed to enter the floodplain only one time, at the lower end of the borrow area. No culverts are planned at this crossing. If flooding occurs, the water would be allowed to flow over the road. Culverts are planned where the access road crosses over the wash below the main exploratory shaft facility pad. The design of the proposed borrow area and access road incorporates protective measures against erosion, scouring, and debris loading and transportation. See also comment 40.

COMMENT 44

On a project of this magnitude, where the consequences of failure are catastrophic, the elemental design cannot be based on an inadequate data base. A thorough investigation of all design parameters must be carried out, and all pertinent information gathering tools should be utilized to construct and build a sound data base for project-specific aerial distribution of rainfall, rainfall ground infiltration, and magnitude of stream channel losses. There should be a concerted effort to initiate a program to systematically collect long-term flood data within the project perimeter, so that more relevant rainfall-runoff models for the ESF site and the repository surface facility site can be studied.

RESPONSE:

The importance of the need for long-term flood data was identified in the Site Characterization Plan (SCP). SCP Section 3.2.1.1, Ongoing and Future Studies of Flood and Debris Hazard Potentials, addresses the plans to improve the surface-hydrologic data base at Yucca Mountain and the surrounding areas. Also, future plans for investigations of, and data collection for, potential flood and debris hazards are described in SCP Section 8.3.1.5.2.

COMMENT 45

For the ESF site, it is not clear what provisions have been made to contain spills and contaminants from flowing or being carried by storm water runoff into the floodplain from the compressor, generator building, and substation area.

RESPONSE:

Field contractors are required to adopt specific waste minimization, handling, accumulation, manifesting, and disposal practices that comply with Federal law and the State hazardous waste program. Details of these practices will be presented in the Hazardous Materials Management and Handling Program, which is in preparation.

COMMENT 46

The proposed measures of rerouting segments of several dry washes around critical facilities and straightening banks along several wash segments to "avoid adverse effects related to the location of surface facilities in the floodplain" do not address the effects of observed extensive erosion and deposition patterns characteristics of neighboring floodplains noted during field surveys. Erosion of, or deposition in channels and floodplains would be significant in the Yucca Mountain area during a 100-year flood event and could be severe during the 500-year and regional maximum floods. Ephemeral-channel systems generally undergo significant changes in depth, width, alignment, and stability with time, particularly during floods of long recurrence interval.

RESPONSE:

On the basis of studies by Squires and Young (1984) and Bullard (1986) flood magnitudes and erosion effects were determined. The proposed control measures have considered the erosion and scouring potential of the various floods. The new channel, a deepening of the existing channel, makes the new proposed floodplain narrower. The major "rerouting" of the proposed channel is located at the north end of the borrow area. Rip rap would be used to further reduce the potential of erosion. This new channel is designed to control potential floodwaters flowing through the exploratory shaft facility area while still not significantly changing the floodplain below the planned activities. See also the response to Comments 38 and 40.

REFERENCES

Bullard, K.L., 1986. PMF (Probable Maximum Flood) Study for Nevada Nuclear Waste Storage Investigations Project, GR-87-8, U.S. Department of the Interior, Bureau of Reclamation, Washington, D.C.

Squires, R.R., and R.L. Young, 1984. Flood Potential of Fortymile Wash and Its Principal Southwestern Tributaries, Nevada Test Site, Southern Nevada, USGS-WRI-83-4001, Water-Resources Investigations Report, U.S. Geological Survey.

COMMENT 47

For the ESF site, considering the significant modifications proposed to be constructed in the floodway (not just the floodplain), it would seem appropriate to include the results of a backwater analysis (HEC-2) conducted on the site in the floodplain assessment. Such an analysis might assist determination of whether the improvements proposed have a positive or negative impact during flood occurrences.

RESPONSE:

Section 3.2.2, Flood Protection, in the Site Characterization Plan discusses proposed flood analyses. A preliminary analysis of the probable maximum flood (PMF) was done based on a study by Bullard (1986). The primary purpose was to evaluate the feasibility of locating the shaft and its supporting complex in such a rugged area. The Corps of Engineers' HEC-1 methodology for estimating PMF and HEC-2 methodology for conducting backwater analyses are being used to prepare the Floodplain/Wetlands Assessment. Title II surface facility design will be based on PMF flows and levels, determined in accordance with ANSI/ANS 2.8-1981, which incorporates HEC-1 and HEC-2 analyses.

REFERENCES

Bullard, K.L., 1986. PMF (Probable Maximum Flood) Study for Nevada Nuclear Waste Storage Investigations Project, GR-87-8, U.S. Department of the Interior, Bureau of Reclamation, Washington, D.C.

COMMENT 48

For the ESF Title I Design, data were not issued in the Title I Design Report to allow review of specifications on "fill" areas, such as allowable materials, compaction requirements, compaction techniques, and final acceptance criteria. These are necessary considerations when considering effects of storm water.

RESPONSE:

Fill specifications are discussed in the ESF Title I Summary Report, Chapter 6, Design Aspects. In the design, all pads are constructed in a similar manner. Excavation is below grade approximately 21 ±7 centimeters (9 ±3 inches). Type II material is placed in two lifts, which are not greater in depth than 14 ±2 centimeters (6 ±1 inch) and are compacted to 95 percent at optimum moisture.

In fill subgrade, after removal of topsoil, the surface is compacted to 95 percent and select material from the borrow pit is brought in and mixed by alternate loading and blading with blasted rock if available.

The depth of base coarse is determined by California Bearing Ratio (CBR) and is a type II material in 14 ±2 centimeters (6 inch ±1 inch) lifts compacted to 95 percent at optimum moisture.

Several methods have been considered and are used to protect side slopes from erosion, depending on the fill characteristics. Ditches adjacent to berms and built on fill are concrete lined if velocities are greater than 1.3 meters (4 feet) per second. Runoff is collected in catch basins and piped down slopes where concrete grouted rip-rap is used for erosion control. Side slopes are sprayed with soil stabilizer and compacted and trimmed with side rolling during their construction.

COMMENT 49

ESF Title I Design drawings (DWR C-37) locate a buried fuel tank in a floodway and possibly the floodplain. The buried fuel tank for emergency generators must comply with Section 601 of the 1984 RCRA Amendments (Public Law 48-616), which provides requirements on buried fuel tanks for the protection of the environment, which were not addressed in the drawings issued.

RESPONSE:

The proposed buried fuel tank for the emergency generators is located outside of the 100-year floodplain. RCRA requirements for underground storage tanks (USTs) are addressed in the Title I Summary Report in Chapter 4, Environmental Aspects, under Section 4.5 Hazardous and Solid Wastes. All USTs will be designed, operated, and monitored as required under RCRA Subtitle I and the State of Nevada UST program.

REFERENCES

U.S. Department of Energy (DOE), 1988. Yucca Mountain Project Exploratory Shaft Facility Title I Design Summary Report, YMP/88-02, U.S. Department of Energy, Nevada Operations Office, Yucca Mountain Project Office, Las Vegas, NV.

COMMENT 50

According to ESF Title I Design drawing C-41, the leach field and sediment lagoon appear to be within the maximum regional floodplain boundary. If so, alternative locations should be considered, or precautions taken to minimize impacts.

RESPONSE:

Both the sewage system and leach field lagoon are outside of the 100-year floodplain. Final design of both systems will be in compliance with applicable Federal, State, and local regulations.

COMMENT 51

A borrow pit is proposed (for a reason that is unclear although it is assumed to be for site pad volumetrics) to be constructed in the form of a channel. This channel within the 100-Year Floodplain may prove to have high impacts on the ESF activities. High velocities within the channel can erode the southwestern face of the channel, causing destruction of the access roads and other facilities within Drill Hole Wash.

RESPONSE:

The borrow area is being designed to provide a channel to control potential runoff and protect against flooding, as well as to provide fill materials for the Exploratory Shaft Facility (ESF). The channel is designed to control a 100-year flood. Minimum side slopes will be 2:1. Rip rap will be used to reduce floodwater damage to the channel.

Very few facilities will be located in the wash. Most of the ESF is outside of the 100-year floodplain. The access road through the lower end of the wash is designed to allow water to flow over it. Because of its simple design and construction, the screening plant should not be significantly affected by floodwaters.

COMMENT 52

How will DOE meet the requirement in 10 CFR 1022.12(a)(3) to address "alternative sites, actions, and no action" with respect to the Exploratory Shaft Facility. This is a crucial point of concern regarding the proposed location of the two shafts in the critical action (500-year) floodplain where, in accord with 10 CFR 1022 "even a slight chance of flooding would be too great." The Agency for Nuclear Projects as well as the Nuclear Regulatory Commission have discussed flooding hazards relative to the current shaft location with DOE in the past. In September 1988, the Agency issued a letter report to the DOE (R. Loux to C. Gertz, September 22, 1988) which documented the State's concerns with the process of exploratory shaft site selection used by the DOE. The report also discussed the concerns with respect to the flood hazard at the "preferred site location." From a review of the DOE selection process (Title I Exploratory Shaft Site and Construction Method Recommendation Report, SAND 84-1003), the criteria used to compare sites and the alternative locations considered did not address impacts to flood plains as contemplated by 10 CFR 1022.

RESPONSE:

In February 1989, U.S. Department of Energy (DOE) published notification in the Federal Register of their intention to prepare a Floodplain/Wetlands Assessment to address the impacts of Yucca Mountain Site Characterization Project Office activities in the floodplain, pursuant to 10 CFR Part 1022. This assessment will address alternative sites, actions and no action relative to the floodplain. It is important to note that the shafts are currently located out of the Probable Maximum Flood (PMF) event.

In addition, an engineering activity has been initiated to undertake an evaluation of the ESF Title I design and construction concepts and the ESF/repository interfaces, addressing comments by the U.S. Nuclear Regulatory Commission (NRC) staff, the State of Nevada, and suggestions from the NWTRB. This activity was identified as the ESF Alternative Configuration Study (ESF ACS).

An evaluation to satisfy the 10 CFR 60.21 (c) (1) (ii) (D) requirement to perform a comparative evaluation of several possible alternatives to the major design features during the design process will be undertaken as part of the ESF ACS. DOE has committed to provide the flexibility to allow the ESF to become part of the repository design and subsequent license application. All other 10 CFR Part 60 requirements have been reviewed, and those requirements considered to be major discriminators between the 34 options were identified, and are included in the evaluation process.

The scope of the ESF ACS includes the identification and evaluation of potential alternative locations and construction methods for the ESF and repository accesses, the identification and evaluation of the potential locations of underground facilities, and the selection of a preferred ESF configuration and construction method(s), which will accommodate the identified site characterization testing needs. This is to be accomplished by examining a number of ESF design options wherein the alternative features and attributes of the ESF design are varied and evaluated against the appropriate design requirements to identify those options that best meet the

design requirements. This preferred option will be used as a basis for subsequent Title II design efforts. As part of the selection process for the preferred option, a comparative evaluation of these design features will be conducted, taking into account test requirements, performance and impact assessments, preclosure health and safety, environmental protection, and cost and schedule aspects.

COMMENT 53

Will a single floodplain assessment conducted in accord with 10 CFR 1022 address all affected floodplains at Yucca Mountain or will there be more than one such assessment that addresses different locations, proposed actions, and floodplains anticipated to be involved throughout the course of site characterization?

RESPONSE:

More than one floodplain and wetland assessment may be necessary to address all site characterization activities. The majority of the work taking place on the floodplain will involve exploratory shaft facility activities. Some of the surface-based investigations will be conducted in other drainages.

COMMENT 54

It is noted that the DOE Environmental Regulatory Compliance Plan (DOE/RW-0177, January 1988) for the Yucca Mountain Project states with respect to compliance with floodplain regulations that, "It is likely, however, that because no maps exist showing areas of flooding along those small washes, compliance with (10 CFR 1022) for these remote activities will not be required." The Agency would appreciate receiving from DOE an inventory of and maps for all the proposed floodplain actions at Yucca Mountain with an indication as to DOE's determination on an individual basis regarding the applicability of the regulations..

RESPONSE:

It should be noted that the Environmental Compliance Plan (DOE, 1989), Revision 1 for the Yucca Mountain Site Characterization Project Office no longer includes this statement. The Floodplain/Wetlands Assessment will include maps showing the applicable floodplains and planned Project facilities for the site characterization program.

REFERENCES

DOE (U.S. Department of Energy), 1989. (Revision 2) Environmental Regulatory Compliance Plan, DOE/RW-0209, Oak Ridge, TN.

COMMENT 55

It would be appreciated if DOE could provide the Agency with a study plan for the floodplain assessment that describes the field studies to be undertaken, the analyses to be conducted, the alternative sites to be evaluated to avoid harm to floodplains, and the steps to be considered for minimizing floodplain damage, and for following-up of the action to verify that implementation of the selected alternative and any adopted mitigation measures proceed as described in the assessment.

RESPONSE:

The U.S. Department of Energy does not plan on preparing a study plan for preparing the Floodplain/Wetlands Assessment because it is not required by 10 CFR 1022. Flooding potential studies are part of site characterization. Study Plan 8.3.1.16.1.1 (Characterization of Flood Potential and Debris Hazard at the Yucca Mountain Site), is a part of this study program.

REFERENCES

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.16.1.1, Characterization of Flood Potential and Debris, Yucca Mountain Project Office, Las Vegas, NV.

COMMENT 56

Will the DOE Environmental Field Activity Plans (EFAPs) be revised to include field studies needed for the 10 CFR 1022 Floodplain Assessment? For example, the current ecosystems EFAP (DOE/NV-10576-14, August 1988) does not address comprehensive surveys of biota in floodplains. This consideration is important in light of some of the earlier work performed at Yucca Mountain for the DOE statutory environmental assessment which noted that unique assemblages of plants occur in floodplains and nowhere else at the site. No details on the nature of this floodplain vegetation were provided. The assessment currently being planned by DOE should resolve that deficiency in information. The Agency's preliminary evaluation of this matter indicates that locations within the base (100-year) floodplains, e.g., the 50, 25, and 10-year floodplains frequently provide restricted favorable habitat for flora that is limited only to those specific floodplain areas by virtue of the unique soils and moisture conditions that occur there. Additionally, areas adjacent to floodplains often are underlain by shallow hardpans that have been eroded away in the floodplain itself. For this reason the desert tortoise and other important burrowing animals seek out floodplains for their burrows. The Agency's view is that field studies to be conducted by DOE in support of the floodplain assessment should address these and related issues.

RESPONSE:

The U.S. Department of Energy does not plan to revise the Environmental Field Activity Plans to address information needed for the Floodplains/Wetlands Assessment (FWA). However, the Department will revise the EFAPs to collect appropriate data for the EIS. Information needed to prepare a FWA has been collected. A biological assessment regarding the desert tortoise has been submitted to the U.S. Fish & Wildlife Service (USF&WS) (DOE, 1989), this document considered impacts to the desert tortoise and its habitat, both in and out of the floodplain. Prior to any surface disturbing activity, a pre-activity survey is conducted which reviews various environmental disciplines and is then used to provide guidance for environmental protection during the activity. As part of this process, recommendations are made to preserve areas of favorable habitat and unique assemblages of plants. The Yucca Mountain Site Characterization Project Office evaluated its responsibilities under the Endangered Species Act of 1973, as amended, through consultations with the USF&WS. On February 2, 1990, the USF&WS issued an opinion that the proposed site characterization activities would not joepardize the desert tortoise.

REFERENCES

U.S. Department of Energy (DOE), 1989. Biological Assessment of the Effects of Site Characterization Activities on the Endangered Desert Tortoise, U.S. Department of Energy, Yucca Mountain Project Office, Las Vegas, NV.

COMMENT 57

Will the DOE Environmental Monitoring and Mitigation Plan (DOE/RW-0208, December 1988) be revised to reflect the follow-up procedures required by 10 CFR 1022.17 that will be evaluated and selected in the course of conducting the flood assessment? If not, where in the various pieces of the DOE environmental program plan will such measures be described in detail? Does DOE perhaps intend to issue a separate piece of its environmental program plan specifically to address floodplain actions and compliance procedures in light of the fact that the presently existing 15-plus pieces do not mention environmental measures associated with 10 CFR 1022?

RESPONSE:

The Environmental Monitoring and Mitigation Plan (EMMP) will be revised as necessary during site characterization and subsequent phases of the program. The format for revising the EMMP is through the issuance of EMMP progress reports. Any follow-up procedure required by 10 CFR 1022.17 for proposed activities in the floodplain will be addressed in the EMMP progress reports.

U.S. Department of Energy's environmental program will continue to monitor and, if necessary, mitigate impacts to floodplains in the same manner it has with all environmental disciplines.

REFERENCES

DOE (U.S. Department of Energy), 1988. Environmental Monitoring and Mitigation Plan, DOE/RW-0208, Oak Ridge, TN.

COMMENT 58

Current DOE plans available to this Agency do not address the collection of soils information. 10 CFR 1022 requires that soil conditions in the floodplains be considered as part of the floodplain assessment. What soil studies are proposed for the floodplain assessment.

RESPONSE:

The U.S. Department of Energy regulation concerning Floodplains/Wetlands (10 CFR 1022.11(c)) applies to the determination of wetlands. As part of the determination of wetlands, the regulation recommends using, as appropriate, Soil Conservation Service Local Identification Maps. However, it has been determined through consultation with the U.S. Fish and Wildlife Service that wetlands do not exist in the Yucca Mountain site area.

The regulation does not require that soil conditions in the floodplain be considered as part of the assessment. However, in support of reclamation activities in and out of the floodplain, DOE is conducting a soil survey as part of the Environmental Field Activity Plan for Soils.

EVALUATION OF ALTERNATIVE LICENSING STRATEGIES FOR THE DEVELOPMENT OF A HIGH-LEVEL NUCLEAR WASTE REPOSITORY

YMP/90-47

October 2, 1990

EVALUATION OF ALTERNATIVE LICENSING STRATEGIES FOR THE DEVELOPMENT OF A HIGH-LEVEL NUCLEAR WASTE REPOSITORY

EXECUTIVE SUMMARY

The Secretary of Energy in his "60 day report" made a commitment to the U.S. Congress to identify ways to receive spent fuel at a licensed repository earlier than the year 2010 while still satisfying all technical, regulatory, and public health and safety requirements. The Yucca Mountain Project Office (Project Office) established a task force to evaluate Alternatives To the Current License Application Strategy (ATLAS). This report describes initiatives and overall strategies which the ATLAS Task Force recommends for further consideration by the Office of Civilian Radioactive Waste Management (OCRWM) and by the Yucca Mountain Project Office. This report documents the methodology used by the ATLAS Task Force for identification and preliminary screening of alternative strategies. Although these evaluations were completed prior to the National Research Council publication, "Rethinking High-Level Radioactive Waste Disposal" information is also provided that supports discussion of three issues raised in the report. These issues are (1) limitations of analysis; (2) modeling and its validity and; (3) strategic planning.

The scope of the ATLAS task force included the identification and screening of potential changes to the current OCRWM licensing strategy that could have a significant effect on the current OCRWM schedule. Alternatives were not limited to those meeting existing laws and regulations. Indeed, some of the identified alternatives suggest changes to existing laws and regulations to promote aspects of the site characterization and licensing processes. The task force focused on identifying alternative strategies with the potential to shorten the repository schedule by more than one year, while still fulfilling all regulatory requirements for public health and safety. The one year criterion was selected because it is both significant and within the accuracy of analytical resources that were available within the schedule of this deliverable. Strategies that would significantly reduce uncertainties in the current schedule were also identified. The sequence of ATLAS activities is illustrated in Figure 1.

A series of workshops was held to elicit potential licensing strategies. Workshop participants were drawn from diverse backgrounds, including senior Yucca Mountain Project staff, technical representatives from participating project organizations, U.S. Department of Energy (DOE) Headquarters staff, and outside consultants and advisors. Ideas suggested at the workshops were documented by the authors and modified by the ATLAS Task Force into 33 separate potential alternatives for further evaluation. Seven of these alternatives dealt with OCRWM management strategies; these seven management strategies were documented by the ATLAS Task Force, but were not subjected to further evaluation. The management issues have been retained in the report for information purposes. This is appropriate because the process of acquiring a license for a Mined Geologic Disposal System (MGDS) is not solely

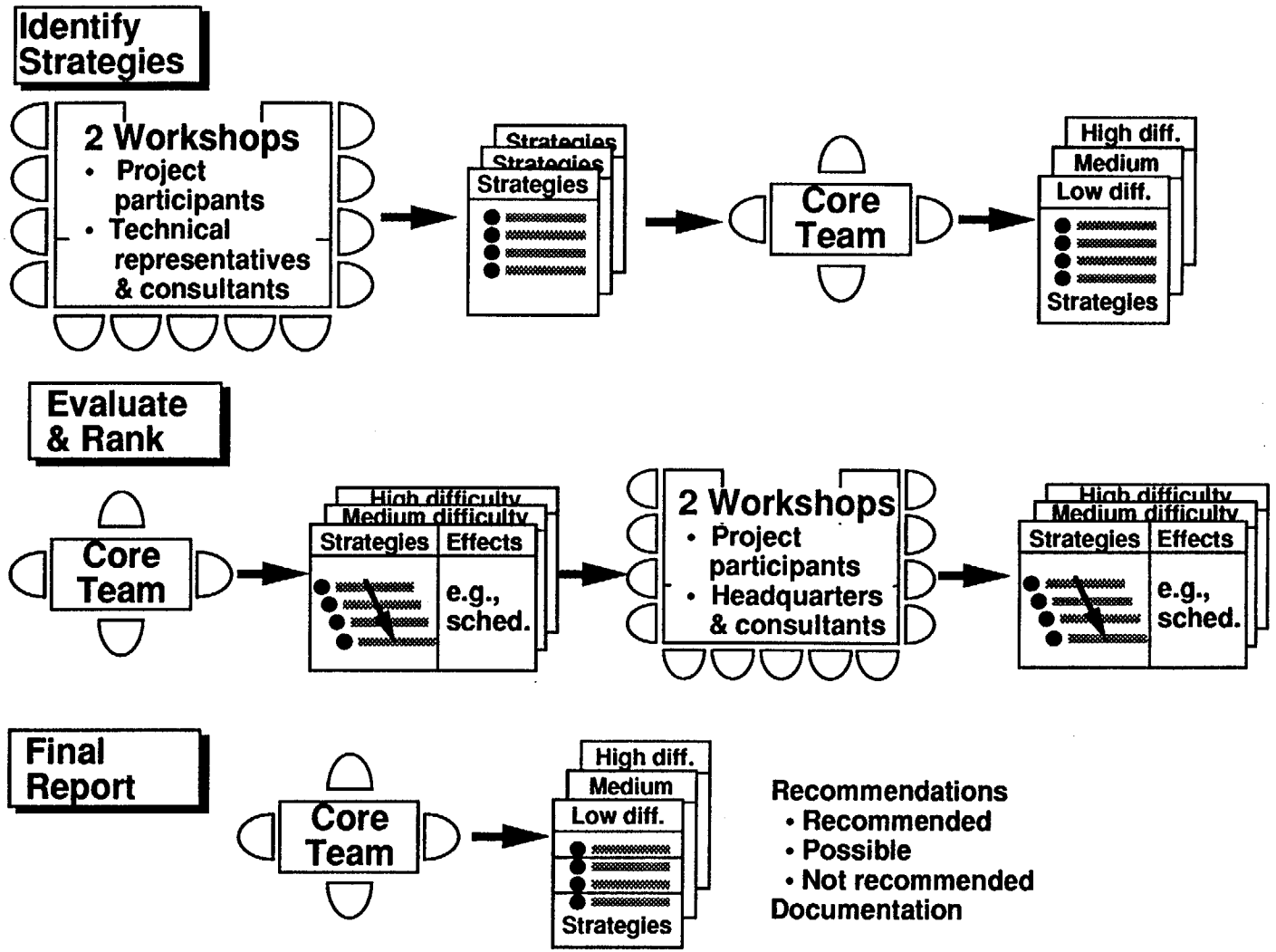


Figure 1. Overview of ATLAS Activities

equivalent to demonstrating regulatory compliance. Other factors, such as identifying the means to deal with potential litigation by intervenors, for example, were evaluated because of their potential to impact the probability and schedule of receiving a license.

The remaining 26 alternatives were evaluated using decision analysis techniques appropriate to this screening evaluation and the development of recommendations for further action. Preliminary decision analysis criteria included potential changes in project schedule, cost, licensability, and public hazards.

The ATLAS task force conducted its activities in coordination with other ongoing activities to evaluate changes in OCRWM technical planning and licensing strategy. These tasks are:

- Surface-Based Testing Prioritization Task
- Exploratory Shaft Facility (ESF) Alternatives Task
- Risk/Benefit Analysis of Alternative Strategies for Characterizing the Calico Hills Unit at Yucca Mountain
- Development of a new OCRWM Mission Plan
- Development of the "Strategic Planning Initiatives" document
- Alternative Licensing Strategies (ALS) work by Office of Systems and Compliance

RECOMMENDATIONS

Overall, the ATLAS Task Force participants are optimistic that some of the alternatives, if successfully implemented, would provide a significant improvement in program schedule. This conclusion is based on identification and preliminary evaluation of many alternatives that are superior to the base case strategy for one or more evaluation criteria and no worse for the remaining criteria. None of the recommended strategies were evaluated to have a significant adverse effect on public health and safety.

Two recommendations were identified. The first recommendation focuses on a group of alternative actions that could affect near-term licensing performance and make the program more responsive to future opportunities. The second recommendation supports enhancement of ongoing efforts to evaluate the technical basis of site characterization and suggests additional decision analysis of program options that could occur as a result of Recommendation 1. A summary of recommended alternatives is shown in Table 1 and described below.

Table 1. Summary of ATLAS recommendations

Recommendation 1 - Focus Near-Term Evaluations on Licensing Organization and Planning Strategies

1. Adopt New Licensing Posture:

   - o Refine the base case schedule
   - o Take initiative in licensing
   - o Link performance allocation and site testing
   - o Increase reliance on geochemical barriers
   - o Cooperate with outside organizations
   - o Place greater emphasis on EBS under Current Rules

2. Petition NRC for Rulemaking:

   - o Seek rulemaking to resolve licensing issues
   - o Emphasize total system performance
   - o Place greater emphasis on EBS with rulemaking

3. Seek Permit Relief:

   - o Reduce permitting delays

Recommendation 2 - Evaluate Contingencies in Site Characterization and Construction

1. Evaluate a Flexible Basis for DOE Site Characterization

   - o Test Calico Hills Unit Early and Re-evaluate Site Characterization program.
   - o Conduct Parallel Surface-Based Testing (SBT) and Exploratory Shaft Facility (ESF) program.
   - o Increase Reliance on Natural Barriers.

2. Request Phased Licensing:

   - o Seek phased licensing and performance confirmation
   - o Convince the NRC to accept repository components as completed
   - o Place greater reliance on EBS with Rulemaking and Defer Issue Resolution to closure

3. Contingent Strategies:

   If permits are granted early and phased approach is not approved:

   - o Seek a license for interim surface storage at the site.

Table 1. Summary of ATLAS recommendations (continued)

If interim surface storage at the site is not approved: - Submit license application based on early site characterization results - Use the ESF as a high-level waste (HLW) demonstration facility If permits are granted late (2-4 years) and phased approach is not approved: o Submit license application based on early site characterization results o Use the ESF as a high-level waste demonstration facility If permits are granted later (> 4 years) and phased approach is not approved: o Use Test and Evaluation Facility (TEF) with HLW

Not all of the evaluated alternatives could be recommended within the context of the ATLAS effort without further detailed study. Ideas not recommended include those with uncertain benefits (i.e., those requiring tradeoffs among criteria in the decision analysis, and apparently overlapping with ideas having clearer potential benefit). These ideas were documented and could be considered in the future as options to some of the recommended alternatives. A listing of the titles for alternatives not recommended is shown in Table 2. As previously mentioned, management alternatives were documented, but not evaluated. A list of titles for management alternatives is given in Table 3.

Recommendations in Table 1 were developed based on three characteristics: (1) timing of licensing strategy decisions, (2) level of implementation difficulty, and (3) preliminary evaluation of the alternatives against the study criteria. Timing was considered by first dividing the alternatives into groups according to the program stage for which the alternatives begin to influence program activities. Two time-related categories of strategies were created:

- o Licensing Organization and Planning Strategies (LO&P Strategies)
- o Site Characterization and Construction Strategies (SC&C Strategies)

Alternatives in the first category do not depend strongly on site information or access. Thus, the LO&P strategies can be the focus of near-term efforts to improve licensing strategy. These strategies also have the best chance of near-term payoff and are the focus of Recommendation 1.

Table 2. ATLAS Alternatives Identified and Not Included in Current Recommendations

Seek to Limit NRC Pre-Licensing Role and to Benefit by More Efficient Interaction with Oversight Groups
Alter Engineering Technical Basis of a Mined Geologic Disposal System (MGDS)
Change Procedural Aspects of Determining Site Suitability Prior to ESF
Place Increased Emphasis on Analog Field/Laboratory Studies
Seek Early Acceptance of Limited Quantities of HLW for Interim Storage (MRS in 1998)
Provide Off-Block Underground Research Laboratory

Table 3. Program management alternatives

Delegate Authority and Responsibility to OCRWM Components
Consolidate Participants and/or Hire Management and Integration Contractor
Control the Review and Approval Processes
Provide a Contingency Plan for Alternative Repository Sites
Establish an Independent Waste Disposal Corporation
Focus Current Resources Toward Licensing
Enhance QA Relative to Scientific Research and Development

The alternatives in the SC&C category are dependent on the outcomes of some of the LO&P strategies and, in some cases, on the availability of site data. For this reason, the benefits of SC&C strategies are likely to be realized later and in some instances only if there are unfavorable outcomes from the LO&P strategies. The use of "permit timing" illustrates how the relevance and viability of alternatives may change in response to external forces and flexible planning.

Licensing alternatives were also sorted by implementation difficulty. Low, medium, and high implementation difficulty categories were used, corresponding to whether the decision authority is primarily internal, requires outside approval, or Congressional action, respectively. Alternatives that provide potential improvement in the study criteria from each difficulty level were selected for inclusion in the packages of recommended strategies.

RECOMMENDATION 1: FOCUS NEAR-TERM EVALUATIONS ON LICENSING, ORGANIZATION, AND PLANNING STRATEGIES

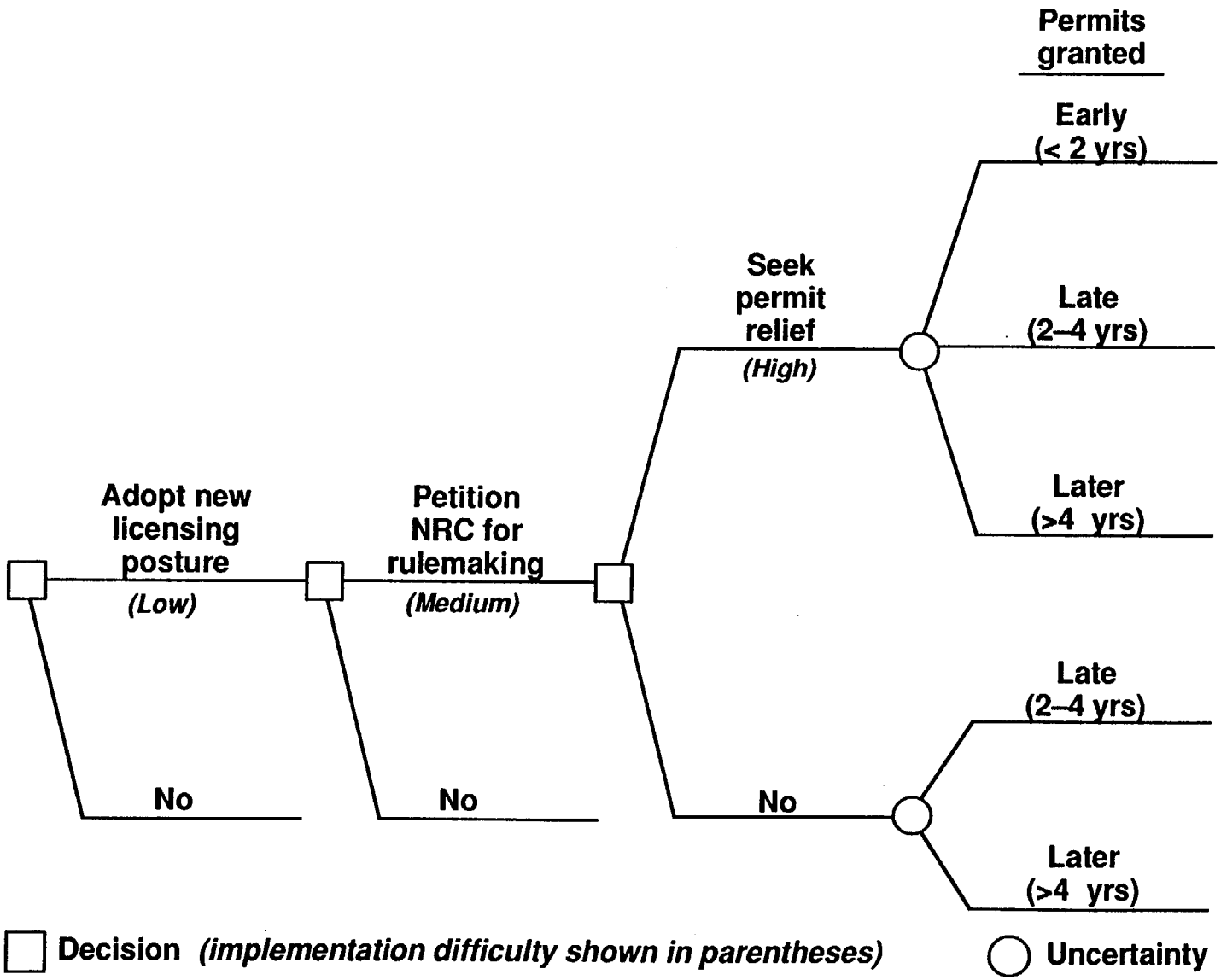
The Alternatives incorporated in this recommendation were judged to be of potential benefit in terms of one or more of the study criteria, and to have little potential for negative impact to the program. If implemented in the near-term, the alternatives could make the program more responsive to outside influences and reduce current schedule uncertainties. These alternatives are seen as helpful or essential to the implementation of Recommendation 2. Although no quantitative analysis of these alternatives has been performed, the ATLAS Task Force recommends that future work on these alternatives focus on detailed planning and actions necessary for their timely implementation. A management issue with alternatives in this phase of the program is the availability of resources to develop and implement the ideas with tight OCRWM funding constraints and competition for resources between the MRS and repository activities.

Table 1 listed three recommended strategies in the Licensing Organization and Planning category. The first strategy, "Adopt New Licensing Posture," comprises six alternatives, all of which are considered to have low implementation difficulty. While quantitative evaluation of the combination of alternatives in Strategy 1 was not done as part of this effort, qualitative evaluation shows that all of the alternatives are compatible and should be considered together in subsequent analysis.

The next strategy, "Petition NRC for Rulemaking" adds three medium implementation difficulty alternatives to the package of alternatives in Strategy 1. Thus, Strategy 2 includes all of Strategy 1 plus two new alternatives: petitioning the NRC for rulemaking to resolve issues, to modify performance constraints and to allow emphasis on waste package. This relationship between Strategies 1 and 2 is illustrated in the decision tree shown in Figure 2. The first decision at the left side of the diagram represents a DOE choice regarding adoption of a new licensing posture. If the decision is "no," the task force assumes no further licensing organization and planning strategies would be pursued (with the possible exception of permit relief). Conversely, if increased emphasis on the EBS is not sought in Strategy 1, then a rulemaking on the EBS would not be desired. Further, since completion of the ATLAS evaluations, the need for a rulemaking on the EBS has been reduced through clarification of waste package requirements in NRC staff position 60-001 (NRC 1990).

The third strategy, "Seek Relief from Permitting Delays," is a high implementation difficulty strategy. Although Figure 2 suggests a sequential relationship, this strategy may be pursued simultaneously with the first two. The uncertainty nodes (circles) on the right-hand side of Figure 2 represent

Figure 2. **Decision tree for licensing organization and planning strategies**



the uncertainty regarding how soon the DOE will obtain necessary permits. Note the assumption that if permit relief is sought, early permits (within the next two years) may be feasible. The permits also might be late (2-4 years) or later (greater than four years). However, if the DOE does not seek permit relief, the task force assumed that the current legal process will continue for at least two years resulting in significant damage to current schedules.

A decision to attempt to obtain permits through means other than litigation and the outcome of the attempt were seen as major factors in future opportunities to improve the OCRWM schedule. For example, early (with respect to the potential for future slip) permits could result in obtaining early site data. Early site data, if positive, could enable alternatives in the site characterization and construction category with potential for schedule improvement to be successfully implemented. Conversely, if permits are to be delayed for long periods, alternatives focusing on analog data may be more important. Early site data, if negative, could allow for early abandonment of the site and conservation of OCRWM resources. Program options based on permits and site access are included in Recommendation 2.

RECOMMENDATION 2 - EVALUATE CONTINGENCIES IN SITE CHARACTERIZATION AND CONSTRUCTION STRATEGIES

It is recommended that planning for later stages in the repository program (i.e., during site characterization and construction) consider additional alternative licensing strategies to respond to potential external constraints and unforseen site data. In some instances, strategies in this recommendation can only be considered assuming certain necessary or enabling strategies from previous recommendations are successfully implemented. For example, SC&C scenarios requiring rulemaking activity may be precluded if DOE does not seek an active role in rulemaking.

The recommendation to evaluate a flexible basis for site characterization is based on DOE efforts to re-examine the basis for technical decisions on the ESF, SBT, and Calico Hills characterization activities. The scope of these efforts should be expanded to focus on the impact that key program uncertainties (i.e., permit delays and outcomes of Strategies 1 and 2) could have on technical planning activities. Contingency plans based on external constraints and schedule uncertainties should be developed as an integral part of ongoing technical planning activities.

Adoption of a flexible testing strategy was identified by the screening evaluation as being of low implementation difficulty and having potential for schedule improvement. If implemented, this recommendation could minimize schedule delays in the event of adverse outcomes from actions taken in Recommendation 1. Information needed to evaluate a robust set of site characterization licensing, and construction alternatives described below would also be available.

A strategy called "phased licensing" which seeks fuel acceptance (possibly in very robust waste packages prior to resolution of postclosure issues) would require NRC approval and was considered to be of medium implementation difficulty. A secondary opportunity for a phased approach is in the acceptance of construction prior to granting of an operating license.

If phased licensing is not approved, a number of high implementation difficulty strategies were identified as contingencies. For example, DOE could apply for a license for an independent surface facility at the site. Of course, the NWPA would require additional amendment to make such an option possible. This alternative would provide engineered surface storage for waste while waiting for the underground repository to be licensed. Alternatively, assuming that the Yucca Mountain site is found suitable based on early site characterization studies, available information could be used to prepare the license application earlier than in the base case schedule.

The role of an ESF in the characterization strategy could also be expanded as an in situ research and testing facility at the proposed repository level. A Test and Evaluation Facility (TEF) is an option in the NWPA, Section 211, to provide for emplacement of solidified HLW or spent fuel (up to 100 MTU). Each of these contingencies would need to be evaluated assuming a variety of potential future program conditions as a result of Recommendations 1 and 2.

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1.0 BACKGROUND AND INTRODUCTION

The Secretary of Energy made a commitment to the U.S. Congress to identify ways to receive spent fuel at a licensed repository earlier than the year 2010 while still satisfying all technical and regulatory requirements (DOE, 1989a). The Yucca Mountain Project Office (Project Office) established a task force to evaluate Alternatives To The Current License Application Strategy (ATLAS). This report describes initiatives and overall strategies which the ATLAS task force recommends for further evaluation and implementation by the Office of Civilian Radioactive Waste Management (OCRWM). This report also documents the methodology used by the ATLAS task force for identification and preliminary evaluation or screening of alternative strategies.

1.1 OVERVIEW AND BASIS OF THE ATLAS EFFORT

The OSIR directed the Project Office to identify and evaluate alternatives to current OCRWM license application strategies. The Project Office responded by forming the ATLAS task force. The ATLAS task force developed and followed an OSIR-approved implementation plan (YMPO, 1990a) under quality assurance controls approved by the Project Office (YMPO, 1990b,c). A summary of these controlling documents, relationships to other OCRWM activities and a brief description of the current OCRWM schedule and licensing strategy is described in this section.

1.1.1 SCOPE AND BASIS FOR ATLAS TASK FORCE

The ATLAS task force was asked to develop a set of preliminary recommendations for credible alternatives to a base case licensing strategy. In these alternatives the license application for the geologic repository will be submitted to the U.S. Nuclear Regulatory Commission (NRC) earlier than the currently planned date of 2001 and that fuel could be accepted at a licensed facility before 2010. The task force also considered contingencies and aspects of interim storage of high-level waste (HLW). Potential alternative licensing strategies were identified by a broad group of Project Office, OCRWM, and industry consultants. The ATLAS task force employed decision analysis techniques to develop recommended strategies from the suggested alternatives. Decision analysis techniques for combining qualitative and quantitative information on alternatives were applied to the extent practicable. Their use was limited by the large number of alternatives and the lack of detailed information about the alternatives. The detailed evaluation of alternatives was beyond the scope of the ATLAS effort.

In general, the ATLAS task force sought alternative strategies that would improve schedule through implementation of the following:

- Processes to evaluate site suitability and demonstrate regulatory compliance

- Alternative sets of licensing activities
- Alternative approaches to prioritization of testing
- Options for repository and waste package design
- Modification of legal and regulatory constraints to allow more rapid completion of the license application
- Earlier start of waste acceptance dates for a licensed facility
- Receipt of HLW at non-repository sites

The ATLAS task force focused on identifying alternative strategies with the potential to shorten the repository schedule by more than one year while protecting public health and safety. The one year criterion was selected based on significance and, also, the accuracy of available analytical resources. Strategies that would significantly reduce uncertainties in the current base case schedule were also identified.

Decision analysis techniques were used to identify preferred alternative strategies for the preliminary recommendations in this report. The decision analysis technique described in this report considered changes in total project schedule duration, changes in project cost, and changes in the likelihood of successfully completing program objectives. Where possible, numerical values were assigned to relevant parameters using structured expert judgment and critical path analysis techniques.

The evaluation of ATLAS scenarios was conducted on the basis of two assumptions: (1) that the current planned scope of work would be adequate to allow the NRC to grant repository construction authorization in accordance with current laws, regulations, and with consideration of applicable precedents from nuclear power plant licensing; and (2) that results of early site suitability evaluations will result in a recommendation to proceed with development of underground testing activities. If the site is not found suitable, the current schedule would be invalidated and DOE would need to provide recommendations to, and receive further direction from, Congress as required by the Nuclear Waste Policy Amendments Act (NWPAA).

The ATLAS task force assumed cost impacts were of secondary importance since a shorter schedule will logically reduce the total resources required for the repository project (except where major design changes are proposed as a means to reduce or otherwise compress the scope of site characterization testing). The waste fund viability was assumed to be unaffected.

The ATLAS task force is composed of a small core team that was responsible for conducting the evaluations. The core team prepared the methodology to be used, formulated the recommendations to management, and prepared the draft recommendation package (this report) for review by OCRWM management. The expertise of the core team is augmented by an extended core team that provides expertise in site characterization, performance assessment, decision analysis, regulatory compliance, and licensing of nuclear facilities. Individuals with nuclear industry licensing experience were involved in core team activities to ensure that the utility perspective

in the repository program was considered by the core team. Brief resumes of the core team and attendance lists for the ATLAS workshops are provided in Appendix D of this report.

1.1.2 RELATIONSHIP OF ATLAS TO OTHER OCRWM PLANNING ACTIVITIES

The ATLAS task is being conducted in coordination with other ongoing activities to evaluate changes in the OCRWM planning base and strategy. The intent of this coordination is to allow the ATLAS task force to evaluate the potential OCRWM program schedule impacts that could arise from significant changes to the site characterization strategy described in the Site Characterization Plan for Yucca Mountain (DOE, 1989). There are three DOE/Yucca Mountain Project studies examining options and priorities for characterization of the Yucca Mountain site. These studies are:

- Surface-Based Testing Prioritization Task
- ESF Alternatives Task
- Risk/Benefit Analysis of Alternative Strategies for Characterizing the Calico Hills Unit at Yucca Mountain

These studies seek to optimize various technical strategies (besides schedule) within the current licensing strategy. The studies are interdependent due to physical and functional interfaces that constrain their ultimate recommendations.

The ATLAS task force reviewed the progress of the three studies to identify technical strategies that affect program schedule. Conversely, alternative licensing strategies identified by the ATLAS task force have been provided to the other study groups for their review and evaluation of the potential impacts that these ideas would have on the current site characterization strategy (see Section 4.1).

The ATLAS task force also considered the ideas under development by the Office of External Relations and Policy as related in the "Strategic Planning Initiatives" document and the OCRWM mission plan document. Drafts of these documents were reviewed by the ATLAS core team to identify potential alternative licensing strategies. The results of this review are reflected in the strategies described in this report.

1.1.3 MANAGEMENT CONTROLS AND QUALITY ASSURANCE

The ATLAS task force was managed by designated staff of the DOE/Yucca Mountain Project and the Technical and Management Support Services (T&MSS) contractor. These staff members led, directed, and were members of the ATLAS core team. The core team, in turn, coordinated the activities of the extended core team and the scheduling staff, decision analysis consultant, and technical-regulatory consultants. The core team had the primary responsibility for conducting the evaluation.

Project Office and OSIR management provided for review of the recommendations developed by the core team. The review confirmed that the products met the requirements of the implementation plan (YMPO, 1990a).

The activities of the ATLAS Task Force were governed by the Nevada Nuclear Waste Storage Investigations (NNWSI) Project Quality Assurance Plan (YMPO, 1990b). The ATLAS Task Force operated under approved quality assurance grading (YMPO, 1990c) and quality assurance requirements (YMPO, 1990d) documents.

1.2 OCRWM BASE CASE LICENSING STRATEGY

In order to define and evaluate alternatives to the current licensing strategy, a reference description of OCRWM base case licensing strategy was developed. This description includes identification of significant features of the strategy, relevant regulatory requirements, and potential impediments to its implementation. Definition of alternative strategies deal mainly with areas where distinct differences occur between the base case and the alternative. Where a scenario does not mention a consideration addressed in the base case description, it may be assumed that the alternative does not differ from the base case in that consideration.

1.2.1 BASE CASE LICENSING STRATEGY FEATURES

The Nuclear Waste Policy Act of 1982, as amended (Nuclear Waste Amendments Act of 1987), requires the Secretary of the DOE to "submit to the Commission [U.S. Nuclear Regulatory Commission] an application for a construction authorization . . . not later than 90 days after the date on which the [site] recommendation by the President . . . is effective[1] (NWPA section 114.(b))." The regulations of the U.S. Nuclear Regulatory Commission

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[1] The point where the "recommendation is effective" is determined by a sequence of events (shown below) that are spelled out in the Act:

a. The Secretary completes public hearings near the site.
b. Site characterization activities are completed.
c. The Secretary decides to recommend approval of the site to the President.
d. The Secretary notifies the Governor and Legislature of the host state.
e. After 30 days, the Secretary recommends the site to the President.
f. The President recommends the site to Congress.
g. A "notice of disapproval" challenge in Congress is allowed by the Governor and the Legislature of the host state.
h. The site designation is permitted to take effect under Section 115 of the Act.

(Commission) in 10 CFR Part 60, Disposal of High-Level Radioactive Wastes in a Geologic Repository, describe application requirements and define its content in Section 60.21. The objective of the baseline licensing strategy is to satisfy the above law and implementing regulations.

In order to submit a license application within 90 days of a site recommendation becoming effective, the license application must be ready for submission when the Secretary notifies the Governor and Legislature of the host state. It is essential, therefore, that the license application be developed in parallel with site characterization activities, updating it, as appropriate, to reflect accumulating site characterization information, anticipating that the site will prove to be an acceptable location for the repository. This parallelism between site characterization and preparation of the license application is the basis for many alternative licensing strategies identified by the ATLAS task force. For these strategies, it was assumed that improved site characterization schedules would improve license application submittal schedules. Additionally, if at any point site characterization results indicate that the site is not acceptable, the license application preparation activity can be halted.

The current license application strategy will be implemented in accordance with the plans and procedures of the OCRWM Mined Geologic Disposal System (MGDS) document hierarchy. The Technical Support Documentation Management Plan (TSDMP) (DOE, draft, in preparation) will describe activities for developing information for the license application. The TSDMP strategy is to follow the site characterization program results closely and to convert site information, as it becomes available, into segments of the license application. In this manner, the license application can be completed shortly after site characterization activities end.

The DOE and the NRC, through written agreements, have agreed to share information in the prelicensing activities in an attempt to reach early resolution of licensing concerns. Processes that are currently available to the NRC center around review and evaluation of technical and topical reports, review of DOE positions and assessments during site characterization (without relation to a license application docket), and rulemaking. Rulemaking is the name given to actions or requests to revise regulations initiated either by the NRC, the DOE, or other interested party.

License application segments requiring design information will be based on the license application design and will reference the License Application Design Report. Performance assessments to demonstrate compliance with regulations will include those current as of the license application cutoff date. Final performance assessment and design iterations will be issued, as they are developed, as supplements to the License Application. Site confirmatory test results will also be issued as they become available.

1.2.2 POTENTIAL LICENSING IMPEDIMENTS

This section presents an overview of potential impediments to the base case licensing, construction and subsequent operation, and closure of a high-level nuclear waste repository.

1.2.2.1 Regulatory and Institutional

There are many similarities between the regulations that govern the high-level nuclear waste repository and those that govern commercial nuclear power stations. There are also many new and untested regulations and regulatory concepts. Since a goal of the regulations is to ensure the health and safety of the public, it is expected that there will be close examination of the regulations in this first airing. Therefore, when breaking new regulatory ground such as in the current case, regulatory issues must be anticipated and planned for well in advance. This includes development of institutional structures and interactions related to the repository.

Highlights of the primary laws and regulations relative to the high-level nuclear waste repository licensing process are discussed below.

Nuclear Waste Policy Act, As Amended (NWPAA)

The NWPAA specifically redirected the nuclear waste program to characterize the Yucca Mountain site and authorized the development of a Monitored Retrievable Storage (MRS) facility. Further amendment of the Act will be necessary to implement the MRS under the base case schedule.

10 CFR Part 2 Negotiated Rulemaking - Submission and Management of Records and Documents Related to the Licensing of a Geologic Repository for the Disposal of High-Level Radioactive Waste (LSS)

In general, this rulemaking, combined with the general provisions of Part 2, places special requirements on the record management and information management practices, procedures, and systems of the high-level waste repository program. This rulemaking also implicitly demands well-organized, effective licensing, compliance, configuration management and litigation support programs. Conceptually, implementation of the LSS could result in significant schedule delay if not expectively undertaken. For example, unless the Board and NRC LSS administrator certify that DOE has complied with the LSS requirements, the NRC will not docket the License Application.

10 CFR Part 60 - Disposal of High-Level Radioactive Waste in Geologic Repositories

10 CFR Part 60 prescribes the rules governing the licensing of a geologic repository for high-level nuclear waste. In general, there are a number of provisions that are similar to those in 10 CFR Part 50 relative to the commercial nuclear power industry. However, there is no precedent for assuming that the regulations will be addressed and interpreted by the Office of Nuclear Material Safety and Safeguards in a manner similar to the prior interpretation by the Office of Reactor Regulation.

1.2.2.2 Intervention

The high-level nuclear waste repository program will face well organized, planned, and effective scrutiny by interested parties. This involvement by interested parties in the licensing process is called intervention. When this attention is combined with an in-depth knowledge of the regulations and regulatory process, and supported and supplemented by government bodies with special standing, it can require considerable resources of time and staff to be fully accommodated. It is therefore important that intervention be fully understood.

There are three primary intervention opportunities:

1. Public Persuasion.
2. Active Non-cooperation.
3. Procedural Intervention.

The first category takes the form of speeches, newspaper letters/ articles, picketing and other such public persuasion tactics. The political and legislative environment in which the high-level waste repository exists makes this strategy more effective than it normally would be. The second category, active non-cooperation, is currently being used by the State of Nevada, which refuses to issue permits for site activities. The third category, procedural intervention, is the type more typically thought of in considering intervention. This category includes involvement in the licensing process in accordance with Subpart G, Rules of General Applicability, Part 2, Rules of Practice for Domestic Licensing Proceedings, of the NRC's regulations (Title 10 CFR, Chapter I). In the high-level nuclear waste repository licensing process, intervention may be complicated due to the special status allocated to the States and Indian tribes.

Procedural intervention will relevant during preparation, public comment resolution, and approval of the Environmental Impact Statement (IS) after the DOE submits the license application. Lawsuits may be filed to challenge the propriety of the EIS. The hearing board presiding over the licensing proceeding will have a major impact on the delays that may result from intervention in this area. Considerations that may still impact the timeliness of the proceedings (although they are not, in themselves, unique to the repository) include:

- Extensive and extended allegations
- Prolonged discovery
- Challenges to credibility of information, witnesses, processes, systems, etc.
- Expert witness contentions
- Extensive interrogatories
- Appeal to the due process regulations
- Numerous lawsuits; use of litigation outside the licensing process

1.3 OCRWM BASELINE SCHEDULE FOR ATLAS EVALUATIONS

The base case strategy serving as the reference point for the evaluation of recommended alternative licensing strategies includes submission of the license application in 2001 and receipt of fuel beginning in 2010. Supporting these goals are surface-based drilling to start January 1991, Exploratory Shaft Facility (ESF) Construction to start November 1992, in situ testing at depth to start April 1996, Site Recommendation Report submitted to the President by April 2001, Site Designation by July 2001, and License Application (LA) submittal in October 2001. This strategy is "Option D" from the OCRWM planning base.

The current OCRWM Program Schedule Baseline (January 1990) is the source of the milestones and schedule dates for achieving the base case (Option D) licensing strategy objectives. The milestones and dates shown in Table 4, Base Case Licensing Strategy-Key/Major Milestones, are taken from the Program Schedule Baseline - Repository Milestones, Summary Milestone Listing. Major activities corresponding to these milestones are shown in Figure 3.

The MRS schedule is also shown in Figure 3. This assumes that a volunteer siting strategy is feasible and that Congress approves of a facility that is "delinked" from the repository schedule.

Table 4. Base case licensing strategy - key/major milestones

OCRWM Milestone	WBS Number	Date	Baseline Milestone Title
		SITE CHARACTERIZATION PHASE	
RYI08	1.2.3.1	02-Jan-91	Start new surface-based testing
RM233	1.2.2.4	01-Oct-92	Start waste package advanced conceptual design
RM645	1.2.6.2	30-Jun-92	Start ESF site preparation
RN430	1.2.4.1	01-Oct-92	Start repository advanced conceptual design
RM652	1.2.6.4	30-Nov-92	Start ESF shaft collar construction
RT074	1.2.2.4	30-Jun-96	Start waste package License Application Design
RM458	1.2.4.1	30-Jun-96	Start repository License Application Design
R5161	1.2.5.3	31-Mar-01	Issue final Environmental Impact Statement
R5190	1.2.5.3	30-Apr-01	Issue Record of Decision
R5200	1.2.5.2	30-Apr-01	Issue Site Recommendation Report to President
R5181	1.2.5.2	30-Oct-01	Submit License Application to the NRC
		LICENSE REVIEW/CONSTRUCTION PHASES	
R4185	1.2.4.1	30-Oct-01	Start repository final procurement and construction design
R4390	1.2.4.3	30-Oct-04	Start repository construction
R5291	1.2.5.2	30-Apr-08	Submit updated LA to receive and possess waste
R4490	1.2.4.4	30-Jan-10	Start repository waste emplacement

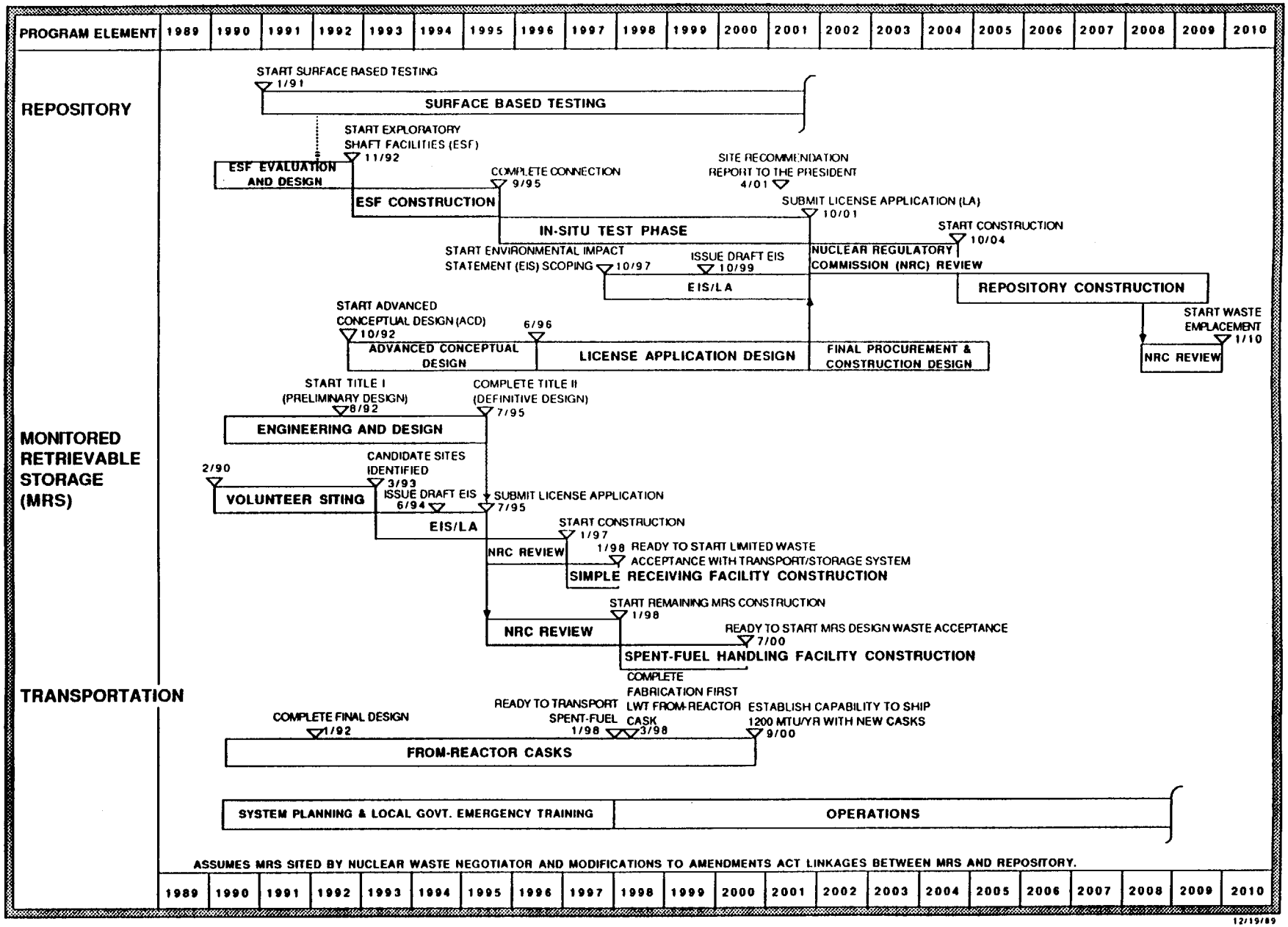


Figure 3. OCRWM Base Case Schedule

2.0 APPROACH

This section summarizes the approach adopted by the ATLAS Task Force for identifying and screening alternative licensing strategies. The team's systematic process produced a list of strategies recommended for further consideration and evaluation.

The time and resources available to the core team accommodated careful definition and rigorous screening of the suggested strategies, but did not permit the detailed evaluation and planning necessary to select and implement any particular alternatives. The effort completed here should be viewed as a scoping and screening study which narrowed the field of diverse alternatives and provides focus for any future analytic effort on the strategies with the greatest potential benefit.

Section 2.1 provides an overview of the approach taken during the analysis of alternative licensing strategies. Section 2.2 then describes the methodology used to provide the preliminary evaluation and screening of the identified alternatives.

2.1 OVERVIEW OF ATLAS ACTIVITIES

The effort was divided into three tasks:

1. Identify alternative licensing strategies.

2. Evaluate and rank the strategies, screening out inferior alternatives.

3. Recommend strategies for in-depth analysis.

The sequence of Project tasks and the activities they comprise are illustrated in Figure 4. The following paragraphs describe these tasks, with particular emphasis on the sequence of activities conducted in each task.

2.1.1 IDENTIFY ALTERNATIVE LICENSING STRATEGIES

In the first task, the ATLAS core team conducted a series of workshops to identify promising alternatives in the following categories:

- Performance standards
- Performance allocation
- NRC licensing and legislative processes
- Site characterization activities
- Institutional constraints
- Organizational structure
- Design, construction, and operation strategies
- Outreach

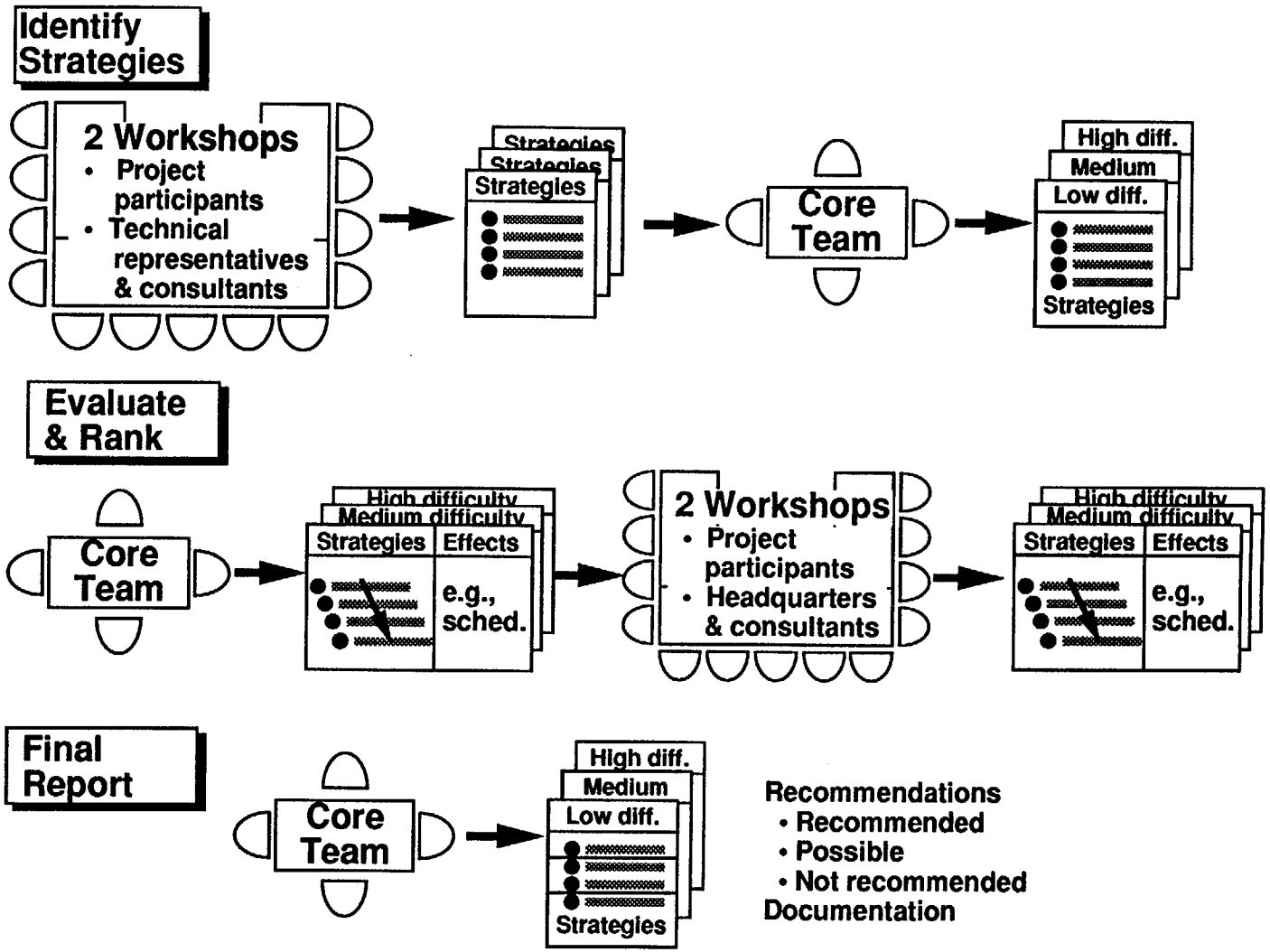


Figure 4. Overview of ATLAS Activities

Workshop participants were drawn from diverse backgrounds, including senior Yucca Mountain Project staff, technical representatives from participating Project organizations, DOE Headquarters staff, and outside consultants and advisors. Appendix D provides brief resumes of ATLAS core team members and attendance lists for major workshops.

The ATLAS alternative identification workshops were conducted as "brainstorming" sessions, designed to promote diverse and creative alternatives. To avoid stifling good ideas, the workshop ground rules prevented evaluation or criticism of strategies suggested by participants. At the close of each workshop, authors of the alternatives were asked to provide a one-page write-up that included: an action-oriented title, a brief strategy description, a summary of the possible effects on program success, schedule, and cost, and a list of possible impediments to implementation.

Following the workshops the ATLAS core team categorized and refined the alternatives. First, the alternatives were grouped according to their potential area and timing of impact on the program. This produced a total of 33 alternative licensing and management strategies. These groupings are described in Appendix A. Management alternatives not directly related to licensing are found in Appendix B.

Next, the alternatives were categorized according to the decision-making authority required for implementation. Three classes were created: low, medium, and high implementation difficulty. These classes reflect whether or not the DOE had decision-making authority (low implementation difficulty) or needed the concurrence of other agencies such as the NRC and EPA (medium difficulty) or bodies such as the U.S. Congress and the Courts (high difficulty). (The symbols in Figure 4 abbreviate the levels as "low," "medium," and "high." Table 5 gives examples of the three levels of difficulty.)

Table 5. Implementation Difficulty

Implementation Difficulty Class	Type of Strategy	Authority
Low	Affects completion of site work within base (SCP) case surface and in situ testing concepts and planned scope	DOE
Medium	Affects surface and in situ testing concepts, scope, and regulations	DOE/NRC/others
High	Affects fundamental relationships and legal frameworks	Congress, Courts, etc.

2.1.2 EVALUATE AND RANK ALTERNATIVE LICENSING STRATEGIES

The next step, as shown in Figure 4, was to evaluate and rank the strategies. In this report, the term "strategy" is used to refer to a combination of the 33 alternatives identified in the workshops. Unfortunately, there are over a million possible combinations. Clearly, in-depth evaluation of all such strategies was not feasible within project schedule and resources. Therefore, the core team undertook a very careful preliminary evaluation and screening process to identify the best candidates for further evaluation. The screening process is described in Section 2.2.

The core team used the screening process to make a preliminary evaluation and ranking of 26 of the 33 alternatives. (Seven alternatives were suggestions to improve program management. These were not evaluated in the screening process, but they are described in Appendix B of this report.)

2.1.3 DEVELOP RECOMMENDATIONS FOR FURTHER EVALUATION

The preliminary evaluation and screening identified several potentially attractive strategies at each level of implementation difficulty. Many alternatives could be implemented independent of decisions whether to adopt other alternatives (e.g., actions to develop cooperative relationships with affected outside organizations). In some cases, the alternatives were best considered in combinations, or as contingencies in case specified events happened to the repository program. The process for selecting recommended strategies is described in Section 2.2.4 and in Section 4.

2.2 EVALUATION AND SCREENING METHODOLOGY

The analytic approach is based on decision analysis, a systematic, quantitative approach to aid decision making. Decision analysis is most useful when decisions are complicated by having many decision alternatives, uncertainties in the ultimate outcomes of the decisions, or value tradeoffs among conflicting objectives. The evaluation of alternative licensing strategies has all three of these complicating factors.

Because of the vast number of potential strategies, the core team adopted a systematic screening methodology to identify the best candidates for further evaluation. The screening process involved the normal steps of a decision analysis, but at a relatively high level of aggregation and with a focus on defining good alternatives, rather than on providing detailed models and analysis. A more in-depth decision analysis is a potential next step, but a more-detailed analysis effort would have been wasted without first completing the strategy definition and screening conducted and described herein.

2.2.1 EVALUATION CRITERIA

The evaluation began by identifying the major factors to be considered in choosing among alternative licensing strategies. Schedule and cost savings were obvious important factors, but other essential considerations emerged from early discussions. For example, the performance of the repository may be an issue when licensing strategies affect the extent or timing of testing, the design of the repository, or the basis for judging site suitability. Because the analysis focuses on alternative licensing strategies, the licensability of the repository is another essential consideration.

The discussions of essential factors to be considered in the evaluation produced four quantitative evaluation criteria:

1. Licensability - Probability that construction authorization and license to receive and possess are granted

2. Schedule - Expected change in the date of fuel receipt, relative to the current schedule, given that a license is granted

3. Costs - Incremental waste storage and disposal costs, now through closure of the repository. (This includes incremental spent fuel storage costs incurred at reactors if there are delays in accepting fuel at the repository.)

4. Performance - Public hazard, measured by a probability distribution on cumulative curies released (as would be produced by a performance assessment).

The relationships among these factors were identified in an influence diagram which is described in Appendix C. The process of constructing the diagram provided the systematic approach to identifying essential evaluation criteria and ensuring that the four major criteria above adequately represented important considerations.

In some cases, the effects of alternatives on the criteria were determined based on more detailed considerations. For example, schedule effects were first determined for affected elements of the repository program and then aggregated to produce an overall effect on the program schedule. Similarly, the probability that the license will be granted by the NRC was judged based on estimates of the effects of the alternative on:

- The projected performance of the repository and the credibility of performance estimates

- The perceptions of radiological hazard by oversight groups such as the NRC or the Nuclear Waste Technical Review Board (NWTRB)

- The perceptions of radiological hazard by the public, either in the State of Nevada or the United States as a whole.

After these effects were considered, the core team estimated the overall effect on the four criteria listed above. The relationships on which these estimates were based are shown in the influence diagram in Appendix C. The complete list of evaluation criteria and their definitions are also contained in Appendix C.

2.2.2 ASSESSMENT

The core team employed a systematic assessment process to elicit the effects of each of the 26 alternatives on the evaluation criteria. There were four steps in the assessment:

- Specify base case assumptions for the screening analysis (see Appendix C)
- Define the suggested alternative, including its purpose, method of implementation, and likely "pros" and "cons"
- Estimate the likely effects on subordinate evaluation criteria (e.g., perceptions of NWTRB or component cost or schedule)
- Estimate the overall effect on the four primary evaluation criteria

This assessment was, in most cases, the collective judgment of an extended core team (the core team augmented by technical specialists from within the Project). It was judged that this extended core team contained appropriate expertise to screen the alternatives.

In some cases, members of the core team differed on their estimates of effects on the criteria. In these cases, all judgments were recorded and an analysis was conducted to determine the sensitivity of evaluation results to alternate judgments.

As discussed later in Section 4, subsequent evaluation could be structured to analyze the alternatives in greater depth. This would require the analysis team to seek a broader range of expertise and to place a relatively greater emphasis on modeling the effects of a few of the most promising strategies.

2.2.3 SCREENING ANALYSIS

The preliminary evaluation produced a quantitative "score" for each alternative on each of the four major criteria. The next step in the analysis might have been to construct a multi-attribute utility function, which would have the effect of weighing the scores on each criterion to produce a weighted average score for each alternative. This may be an important step in subsequent analyses; however, in this case it was unnecessary due to the factor explained below.

During the evaluation it became apparent that several alternatives scored the same or better on all of the criteria when compared to the current baseline (or base case) alternative. Similarly, some of the alternatives were the same or worse on all dimensions when compared to the base case. Therefore, the screening analysis was based on an identification of those alternatives that scored consistently better or worse than the base case. Only about one quarter of the alternatives fell in between these "all good" or "all bad" categories. In light of these properties and the lack of detailed evaluations of the alternatives, weighting factors and figures of merit were not developed.

The screen analysis sorted alternatives into the following categories:

Symbol	Definition
+	No worse than the base case and sometimes better
?	Sometimes better and sometimes worse than the base case
-	No better than the base case and sometimes worse
NC	No change on all criteria relative to the base case

This sorting produced a list of individual alternatives that were entirely beneficial, at least based on the preliminary evaluation. This list of "+" alternatives provides an obvious list of potentially good strategies. However, many of the alternatives are complements or substitutes, so it is important to take the next step in the screening analysis, which is to combine selected alternatives into strategies and then screen those strategies according to the evaluation criteria.

The screening results were presented for review and comment in two additional workshops. The alternatives were refined further based on comments received in the workshops. In many cases, this screening and review process produced insights into the relative strengths and weaknesses of each alternative. This continuing refinement to the alternatives resulted in no ideas being discarded as "all bad."

2.2.4 FORMATION AND SCREENING OF STRATEGIES

The last step in the core team's analysis was to combine the best features of selected alternatives into licensing strategies. A key feature of these strategies is that they are responsive to changing conditions in the repository program. For example, strategies can be formulated to deal with various timings of permits to begin surface drilling.

Another key feature of the strategies in this analysis is their arrangement in increasing order of implementation difficulty. Low and medium difficulty strategies are suggested first. High difficulty strategies are suggested only when they have clear-cut and significant benefits, or when they are necessary to contend with unfavorable outcomes.

Section 4 shows how several of potential alternatives can be combined into effective strategies. The example in the section focuses primarily on combinations of the "+" alternatives, since these are the obvious first

candidates for further analysis. Decision trees are used to show the timing of these strategies and how they can be contingent on future events. This tree is explained in Section 4.

Section 4.4 provides a recommendation for potential next steps in the decision process for choosing among alternative licensing strategies. Part of the recommended process is to reevaluate the combinations of alternatives according to the evaluation criteria. This task was left to a subsequent analytic effort, which could examine a limited set of scenarios in sufficient detail to support the program decision making process (Alexander, 1990).

3.0 ALTERNATIVE LICENSING STRATEGIES

The ATLAS Task Force identified 33 alternatives to the current licensing and management strategy. Of the 33, 26 alternatives relate to licensing of the HLW repository. The remaining 7 relate to OCRWM program management. These alternatives were derived from the scenarios identified through the two ATLAS alternative identification workshops and reviews of OCRWM information from other planning activities described previously. The alternatives contain the original concepts first described in the workshops, but reflect development of logical composites of the scenarios following the workshops and further refinements during the evaluation process.

The alternatives have been grouped in Sections 3.1 to 3.3 based on an assessment of their potential difficulty of implementation. The low, medium, and high difficulty of implementation groups were used as shorthand for whether or not DOE had decision-making authority (low) or needed the concurrence of others (medium) or needed outside organizations (high) to take independent action on DOE's behalf. Detailed descriptions of the alternatives are contained in Appendix A.

The 26 licensing alternatives were evaluated in the preparation of recommendations for implementation. A screening evaluation of the alternatives based on their potential impact on program schedule, cost, and performance is included in Section 3.5. Details of these evaluations are provided in Appendix C.

Management related alternatives were identified but not evaluated in this process. Management alternatives are summarized in Section 3.4 with additional details provided in Appendix B.

3.1 LOW IMPLEMENTATION DIFFICULTY ALTERNATIVES

Eleven alternatives were evaluated to be of low implementation difficulty. These alternatives range from decisions to alter OCRWM relationships with the NRC to decisions to alter the site performance allocation and site characterizations strategy. They are briefly summarized below. The alpha-numeric labels provided with the scenario titles refer to the system used in Table 6 and Appendixes A and B to identify scenarios. Appendix A provides further details and scenario descriptions.

A1 - DEVELOP COOPERATIVE RELATIONSHIPS WITH AFFECTED PARTIES AND OUTSIDE ORGANIZATIONS

The DOE can benefit from significant improvements, in both quantity and quality, in its interactions with affected parties. Specific ideas contributed include:

- A Technical Coordination Program with states, industry, DOE E/M, and other international high-level waste programs
- DOE could start an immediate program of emergency response training.

- o Grant Affected Status to counties contiguous to the situs county containing potential transportation routes

- o Implement a comprehensive education program

A2 - DOE TAKES THE INITIATIVE IN LICENSING RELATIONSHIPS

This alternative combined with other enhanced licensing activities could make a substantial positive impact on the project licensing schedule since it seeks to reduce large schedule slippages caused by uncertainties in the licensing process. These uncertainties would be resolved to the extent practicable prior to docketing of the license applications. DOE can take the initiative and, through proper preparation and regulatory interactions, can seek to have more influence in the licensing process.

A6 REFINE THE BASE CASE SCHEDULE

In analysis of alternative scenarios, two factors that could have a significant effect on cost and schedule should be considered. First, the approach to the development of the long-range plan led to conclusions about the durations of many activities that may have resulted in an incorrect estimate of the schedule for the base case. The second factor that needs to be considered is the degree to which the schedule is controlled by external constraints on the program. This alternative should be evaluated in a general review of the factors influencing the schedule, rather than in terms of specific alternative strategies.

B1 - COMPLETE LINKAGE BETWEEN PERFORMANCE ALLOCATION AND SITE TESTING PROGRAM

To better focus the intent of the SCP technical program on data that is relevant to the most important information needs (technical and regulatory), an exercise to complete the linkage between performance allocation and the studies and site testing can be carried out. Performance allocation is the main tool by which the DOE determines it is gathering needed data to resolve performance and design issues. Allocations of performance were not "driven down" to the lowest levels of the several major site study programs in the SCP. The test strategies in the SCP are based upon a mixture of site characterization parameters derived from the performance and design issues resolution (IR) strategy, and principal investigator perceptions of the breadth and depth of technical data needed for adequate site characterization.

B3 - GREATER RELIANCE ON THE ENGINEERED BARRIER SYSTEM (EBS) UNDER CURRENT RULES

In this alternative strategy the allocation of performance is altered, solely as a result of DOE action, to rely more heavily on the engineered barrier system (EBS), in addition to natural barriers, to contain and isolate waste. The DOE proceeds to develop a more robust EBS without NRC rulemaking to "take credit" for increased performance in the subsystem performance

objectives of 10 CFR Part 60. Such action assumes a doubling of confidence in total-system performance.

B7 - GREATER RELIANCE ON GEOCHEMICAL BARRIERS

This alternative is not included as part of the following alternative strategy because a credible geochemistry program is already in place as part of the current technical planning basis. To act upon it, the DOE would need to revisit performance allocation in the SCP to allocate greater reliance on the geochemistry of volcanic tuffs for their potential in retarding radionuclide migration. The current strategy allocates all of the required performance to geohydrology. By changing the data requirements for the geohydrology program, this alternative could reduce the scope of geohydrologic testing and reduce the length of time needed to complete the systematic drilling program which is part of the SBT program.

B8 - GREATER RELIANCE ON NATURAL BARRIERS

This alternative gathers in three separate possible scenarios that have the overall effect of adopting even greater reliance on natural barriers at the site than assumed in the base case:

1. The robustness of the natural barriers at the site is assumed such that decreased reliance on the EBS would reduce the need for study and testing.

2. A decrease in protection to human health and safety is not a corollary because a trade-off occurs. The same total system performance is achieved with greater reliance on the natural barriers and less reliance on the EBS than in the base case.

3. More information regarding the saturated zone and less uncertainty in this information is relied upon for demonstrating compliance with regulatory performance objectives, particularly those associated with the effects of unanticipated processes and events. The current repository horizon is designed to be at least 200 meters below the ground surface (10 CFR 960, 4.2-5(d). The repository horizon could be brought closer to the surface and the distance for vertical ground-water travel to the saturated zone could be lengthened by as much as 100 meters.

C2 - EARLY CHARACTERIZATION OF CALICO HILLS UNIT

This licensing alternative defines an approach whereby the DOE could determine if greater reliance could be placed on the site's natural barriers, such as the Calico Hills unit. If feasible, this would provide increased confidence in meeting NRC's subsystem performance objectives (e.g., ground-water travel time) and EPA's total system performance objectives. It assumes that the optional characterization strategy that results from the Calico Hills Risk/Benefit analysis is acted upon as early as possible.

C3 - TOTAL SYSTEM CHARACTERIZATION WITH PARALLEL SURFACE-BASED TESTING (SBT) AND ESF (ORIGINAL SCP CONCEPT)

The base case schedule calls for two years of initial SBT to gather data pertaining to site suitability, and an ESF deferred until late 1992. The DOE could restart ESF Title II design immediately. This would involve the staffing up of architects/engineers. Design would currently begin on each of the means of access to the test level (shaft or ramp) and ESF layout employing construction options currently being considered in the ESF Alternatives Study (drill and blast or tunnel boring mining). Design could proceed in parallel with DOE efforts to select a preferred option from the ESF alternatives.

C5 - UNDERGROUND RESEARCH LABORATORY (URL)

Develop an underground research laboratory (URL) away from the repository block, but in the general vicinity of the site where the host-rock horizon is accessible, or in a geologic setting analogous to UZ tuff. Two concepts were advanced, a large URL and a relatively small facility consisting of a short single-entrance adit. Neither a large or small URL alternative replaces the ESF, but would allow the ESF to become a performance confirmation facility that is utilized during and after LA adjudication to meet the requirements of 10 CFR 60, Subpart F.

C7 - INCREASED EMPHASIS ON ANALOG FIELD/LABORATORY STUDIES

This alternative calls for a programmatically increased reliance on regional studies. Increase the emphasis on analog field and laboratory studies is increased for rocks that are (1) in a similar hydrogeologic setting; (2) similar to the proposed repository host-rock horizon; and (3) are both (1) and (2) and that have surface outcrops that are easily accessed and are off-block. With care, analog sites could be located where test methods and procedures could be developed for use at Yucca Mountain. Hardware and software could also be developed and subjected to prototype testing at analog sites, as well as in carefully designed bench-scale laboratory experiments.

3.2 MEDIUM IMPLEMENTATION DIFFICULTY ALTERNATIVES

Nine alternatives were evaluated to be of medium implementation difficulty. These alternatives range from decisions to implement a broad rulemaking program to application for approval to accept fuel prior to resolution of post-closure performance issues. In some cases, changes in regulations will be necessary for implementation of these alternatives. The alternatives are briefly summarized below.

A3 - DOE TAKES THE INITIATIVE IN RULEMAKING TO RESOLVE LICENSING ISSUES

This alternative is an extension of the alternative entitled "DOE takes the initiative in licensing relationships." In addition to the items described in the other alternative, the DOE could support a directed rule-making program to establish a position to prepare and defend the license application as well as provide a stable basis for regulatory activities during site characterization and design.

B2 - EMPHASIZE TOTAL SYSTEM PERFORMANCE

The most significant opportunity for DOE rulemaking raised in the process of scenarios elicitation for ATLAS was for DOE to pursue reliance on total system performance for determination of regulatory compliance. Exceptions to NRC's subsystem performance objectives can be made under the current regulations, if DOE can demonstrate compliance with the total system requirements in the EPA regulations. The presence of the subsystem requirements, however, are potential targets for litigation. The subsystem requirements are a manifestation of the "defense in depth" philosophy carried over from the design of nuclear power plants. A "defense in depth" emphasis (total + subsystem requirements) may result in failure to license any site for a MGDS, due to excess conservatism and the regulatory imposition of near-certainty of performance on a natural system.

In addition to potential NRC rulemaking activities, several ideas were brought forth specifically on the EPA standard.

1. Seek to convert the EPA 10,000 year curie release limit in 40 CFR 191 to a lifetime dose equivalent.

2. Reevaluate the EPA health affects assessment and risk benefit relationship in view of other trans-generational health risks.

3. Seek to modify the 40 CFR 191 standard for demonstrating compliance by use of probability distribution functions.

B4 - GREATER RELIANCE ON EBS WITH RULEMAKING AND DEFER ISSUE RESOLUTION TO CLOSURE (PHASED LICENSING)

In this alternative, the DOE would proceed to develop a more robust EBS and pursue rulemaking with the NRC to modify subsystem performance objectives to allow "credit" for enhanced subsystem performance. In addition, the DOE defers or extends the ESF in-situ site testing program for natural barriers so that it becomes predominantly a performance confirmation program (post-LA and preclosure). No less reliance on natural barriers is assumed than in the current base case, and no decrease in testing occurs.

B5 - GREATER RELIANCE ON EBS WITH RULEMAKING AND REDUCED SBT AND ESF TESTING

In this alternative, the DOE would proceed with development of a more robust EBS, while pursuing rulemaking with the NRC to modify subsystem

performance objectives to allow increased "credit" for EBS subsystem performance. In addition, the DOE reduces certain aspects of surface-based and ESF testing as part of an explicit strategy to place greater reliance on the EBS for containment and isolation.

Increased reliance on the EBS (with the exception of large-scale site modifications) will not affect the performance of natural barriers, just DOE knowledge and the degree of uncertainty in their performance. Credit may still be taken for natural barriers for total system performance, but reduced site characterization testing will increase uncertainties.

C1 - EARLY SUBMISSION OF THE LICENSE APPLICATION/CONCURRENT CHARACTERIZATION

Assuming that the Yucca Mountain site is found suitable based on early site characterization studies, the DOE would use available information to prepare the license application as early as possible with some SBT and either with or without an ESF. For example, the basis for early submission could consist of data from 5 or more boreholes to help qualify existing site data and clarify understanding of certain site features. Analog in situ test data from G-Tunnel could be qualified and used to the extent applicable if no ESF is constructed. If any inconsistent information is developed during later site characterization activities, provide this information to the NRC through application supplements.

C4 - PROCEDURAL ASPECTS OF DETERMINING "SITE SUITABILITY " PRIOR TO ESF

This alternative focuses on actions that address procedural options of making a site suitability decision. The Secretary of Energy's "60-day" report to Congress did not identify how site suitability would be determined. The SCP had assumed a parallel total system approach involving study of both natural (predominantly surface-based testing [SBT]) and engineered barriers (dominantly ESF) as well as the interactions between the two. The base case schedule resulting from the "60-day" report calls for an initial SBT program to search for unsuitable site conditions.

D1 - RESOLVE DISPOSAL ISSUES AS PART OF PERFORMANCE CONFIRMATION

This alternative proposes to conduct an initial site suitability evaluation and preliminary performance assessment as part of phased licensing to allow restricted storage in the repository. The use of the repository would either be restricted in terms of the type and amount of fuel that could be retrievably placed, the closure would be subject to a full performance assessment to support a closure amendment, or both. This amendment could take advantage of the extensive site specific information that would be available at the time of closure.

D3 - ACCEPT REPOSITORY CONSTRUCTION AS IT IS COMPLETED

Following issuance of the construction authorization, there is a potential that the time required for NRC review and issuance of the license to receive and possess could be shortened by execution of a "phased acceptance" agreement with the NRC. Such an agreement would implement a process whereby the NRC staff would conduct formal reviews at key stages in the construction of the repository rather than delay until the amended application is submitted. This formal staff review would, if successful, result in early NRC acceptance of the "as built" repository. If deficiencies are detected during the review, they could be corrected earlier, and possibly with less overall schedule and major design impact.

3.3 HIGH IMPLEMENTATION DIFFICULTY ALTERNATIVES

Six alternatives were evaluated to be of high implementation difficulty. These may require changes to laws, new Congressional action, or changes to regulations before they may be implemented. These alternatives range from seeking relief from permit delays to Congressional approval for surface storage of fuel at the Yucca Mountain site. The alternatives are briefly summarized below.

A4 - SEEK TO LIMIT NRC PRELICENSING ROLE AND TO BENEFIT BY MORE EFFICIENT INTERACTION WITH OVERSIGHT GROUPS

Two significant areas exist where the DOE could seek to move or evolve oversight groups into being more responsive to program needs. The first area would be to limit NRC involvement in prelicense application activities and combine meetings of oversight groups concerning OCRWM issues. Meetings of the ACNW and NWTRB would be far more efficient from a DOE perspective if issues were discussed and convergence could be reached in joint meetings. The second area is that DOE should seek to evolve the role of the NWTRB into that of an arbitrator.

A5 - INITIATE ACTIONS TO REDUCE DELAY IN PERMITTING APPROVAL PROCESS

The DOE could aggressively pursue all options to streamline the approval process after permit applications are submitted to the appropriate agencies. Emphasis should be placed on nonlitigation steps. For example, the Nuclear Waste Negotiator may be called upon to help determine the terms and conditions under which the state may let portions of the site characterization program proceed. Alternatively, the State of Nevada's refusal to process Yucca Mountain Project permit applications could be resolved by pursuing options to remove Nevada from the approval process. Regardless of actions taken, the DOE would continue to comply with applicable environmental requirements set forth by federal, state, and local requirements.

C6 - TEST AND EVALUATION FACILITY

A Test and Evaluation Facility (TEF) could be developed. A TEF is already recognized as an option in NWPA Section 211 to provide for the construction, operation, and maintenance of a geologic TEF to demonstrate the feasibility of geological disposal. A TEF differs in concept from a URL in that emplacement of solidified HLW or spent fuel (up to 100 MTU) can be accomplished. Otherwise the idea is similar to the URL concept; the TEF would be constructed in the vicinity of Yucca Mountain, off the proposed repository block and in the unsaturated zone, but in the same host-rock horizon.

C8 - EVOLVE ESF INTO AN HLW DEMONSTRATION FACILITY AS PART OF SITE CHARACTERIZATION

In the current characterization strategy, the ESF is as an in situ research and testing facility at the proposed repository level. As such, the ESF is a very utilitarian facility for the site program's technical needs. Current plans, however, do not include the use of HLW for in situ testing. The ESF's role can be modified to a "demonstration" facility analogous to the Climax test facility on the NTS. A demonstration facility might be akin to repository "construction scoping," where the emplacement of a small amount of HLW waste (10 MTU) could take place as part of a single-drift, underground test facility. The distinction between an evolved ESF and the URL and TEF concepts is that the ESF is constructed within the proposed repository block (on-block), while the others are off the repository block.

D2 - LICENSE THE SITE FOR SURFACE STORAGE PRIOR TO PERMANENT DISPOSAL

The DOE could apply for a license for an independent surface storage facility. This alternative would provide engineered surface storage for waste while waiting for the underground repository to be licensed. It is assumed that this storage license would be granted under 10 CFR Part 72. This concept would be a de facto MRS at the potential repository site.

D4 - EARLY ACCEPTANCE OF LIMITED QUANTITIES OF HLW FOR INTERIM STORAGE (MRS IN 1998)

Although currently not allowed under the NWPAA and current OCRWM schedules, An OCRWM goal reflected in the base case schedule is to begin receipt of spent fuel in 1998 at one or more interim storage locations separate from the repository site. The development and operation of an MRS is subject to requirements set forth in the Nuclear Waste Policy Amendments Act of 1987 (NWPAA). Potential innovations that may be applied in this alternative are listed below:

- The DOE may elect to seek negotiations directly with interested states, local governments, and Indian tribes
- The DOE may examine the possibility of siting the MRS at surplus federal facilities (e.g., military bases) scheduled for closure

- o Store spent fuel after 1998 at already licensed nuclear energy facilities and make payments to the facilities from the Nuclear Waste Fund

- o Concurrent with MRS siting efforts, the DOE could also develop and procure dual purpose (storage and transportation) cask technology

- o The DOE could seek changes to the NWPAA to modify the linkages between and constraints on site selection, licensing, construction, and operation for the MRS and the repository

3.4 MANAGEMENT ALTERNATIVES

Alternatives described in this section were identified during the ATLAS workshops and developed for potential evaluation. During the evaluation, however, the scope of these alternatives was obviously much broader than the development of licensing strategies. For this reason, the evaluation of these alternatives was not completed; they are included here for consideration as part of ongoing management process development activities.

E1 - DELEGATE AUTHORITY AND RESPONSIBILITY TO OCRWM COMPONENTS

OCRWM responsiveness and accountability would be enhanced through clearer delegation of authority, establishment of a framework of policy, and establishing leadership of licensing activities at the Project Office level. Implementation of this alternative could make licensing strategies more responsive to site information and external obstacles and promote autonomy needed for management accountability.

E2 - CONSOLIDATE PARTICIPANTS AND/OR HIRE MANAGEMENT AND INTEGRATION CONTRACTOR

Management structure and approach were identified as key items to the development and implementation of a responsive licensing strategy. Alternatives included potential combinations of change in the current participant mix and the possible addition of a management and operations contractor. A management and operations (M&O) contractor would be effective only if responsibilities are clearly defined and delineated. Better defining the roles, responsibilities, reporting chains, and authorities within DOE/OCRWM may be able to achieve the same objective.

E3 - CONTROL REVIEW AND APPROVAL PROCESSES

Accelerated preparation of needed technical information for licensing, and reduced delays in management reviews could result from:

- o Consolidation of the review processes

- o Delegation of authority and responsibility for completing the work under appropriate QA controls to the responsible contractor

E4 - CONTINGENCY PLAN FOR ALTERNATIVE REPOSITORY SITES

The NWPAA requires that DOE report back to Congress if the site is found unsuitable for development. This alternative proposes to develop a contingency plan for site characterization at an alternative site. This plan would form the basis for a report to Congress in the event that Yucca Mountain is found unsuitable.

E5 - ESTABLISH AN INDEPENDENT WASTE DISPOSAL CORPORATION

Separation of responsibilities for waste disposal/storage and the Nuclear Waste Negotiator, the delay in appointment of the Negotiator, federal employment laws, and competition for management attention in the DOE could be impeding OCRWM progress. To alleviate issues of this type, Congress could create a separate federal corporation to conduct the OCRWM activities. This corporation could be independent from many restrictive DOE policies related to personnel, procurement and institutional reviews. The corporation could report directly to the NWTRB or the Secretary of Energy and would replace both the current OCRWM and negotiator functions. This concept was originally discussed during the development of the current OCRWM structure.

E6 - FOCUS CURRENT RESOURCES TOWARD LICENSING

Potential improvements in the OCRWM schedule could come from using existing organizational resources more efficiently. Scenarios that are part of this alternative address better use of resources and retention of corporate memory. Specific scenarios include:

- o DOE and NRC could set up teleconferencing studios
- o Seek multi-year funding agreements
- o Formulate a program element to address and mitigate loss of key personnel
- o Repository design could be started later to conserve resources during early stages of site characterization for data collection

E7 - QA ENHANCEMENT RELATIVE TO SCIENTIFIC R&D

The repository program includes both "classical" design and construction activities, and site characterization that is best categorized as research, development, and prototype testing. The current QA approach is to apply nuclear QA practices (10 CFR 50 Appendix B; NQA-1) site characterization, as well as to design and construction. A greater emphasis in the program on the concept of scientific reproducibility rather than traceabiliity during site

characterization would greatly enhance scientific freedom, and minimize paperwork and procedural control.

3.5 EVALUATION OF ATLAS ALTERNATIVES

Table 6 shows the results of the core team's preliminary evaluation of the suggested licensing alternatives, grouped by implementation difficulty. Recall from Section 2.2.3 that the alternatives with a "+" evaluation were no worse than the base case (current) strategy: the same on some criteria and better on others.

The "?" evaluation represents cases where the alternative is better on some dimensions (compared to the base case) and worse on others. Therefore, ranking these alternatives within a category of implementation difficulty requires a trade-off among evaluation criteria. Some of these (e.g., A1) involve a classic trade-off between cost and schedule. Others, such as B4 and B5, improve schedule and performance at the expense of cost; again, tradeoffs are required. Still others (e.g., C1) involve more tradeoffs: in this case between improvements in schedule and cost, versus decreases in performance and the probability of license.

Subsequent evaluations could use a multi-attribute utility analysis to rank the "?" alternatives. Since the analysis here focused primarily on the "+" alternatives, a multiattribute analysis was not required for this screening process.

Table 6. Evaluation of licensing alternatives

	Licensing alternative	Implementation difficulty	Evaluation
A2)	Take initiative in licensing	Low	+
A6)	Refine base case schedule	Low	+
B1)	Link perf. alloc. & site testing	Low	+
B7)	Incr. reliance on geochem.	Low	+
B8)	Incr. reliance on natural barriers	Low	+
C2)	Test Calico Hills early	Low	+
C3)	Conduct joint SBT & ESF	Low	+
E1)	Delegate auth. to OCRWM comp.	Low	NR
E3)	Control review & approval	Low	NR
E6)	Focus resources toward licensing	Low	NR
A1)	Cooperate w/affected outs. orgs.	Low	?
B3)	Rely on EBS (w/o rule chg)	Low	?
C5)	Use off-block URL	Low	?
D4)	Prepare plan for backup site	Low	?
C7)	Emphasize analog studies	Low	NC
E2)	Consolidate participants and/or hire M&O contractor	Low	NR
A4)	Take initiative in rulemaking	Medium	+
B2)	Emphasize total system perf.	Medium	+
D1)	Phase license & perf. confirm.	Medium	+
D3)	Accept component as compl	Medium	+
B4)	Rely on EBS & defer tests	Medium	?
B5)	Rely on EBS & fewer tests	Medium	?
C1)	Submit LA after some SBT testing	Medium	?
C4)	Establ. site suit. before ESF	Medium	?
E7)	Refine QA for site characterization	Medium	NR
A5)	Reduce permitting delays	High	+
C6)	Use TEF with HLW	High	+
C8)	Use ESF as HLW demo	High	+
D2)	License site for interim storage	High	+
E5)	Form independent waste corp.	High	NR
A3)	Limit NRC prelicensing role	High	NC
D4)	Accept HLW at MRS in '98	High	NC
E4)	Prepare plan for backup site	High	NR

Evaluation key:

"+" The same as or better than the current strategy on all evaluation criteria

"?" Better than the current strategy on some evaluation criterion(a); worse on other(s)

"NC" The same as the current strategy on all evaluation criteria

"NR" Not rated in this evaluation. Refers to management alternatives.

4.0 RECOMMENDED STRATEGIES

This section presents the recommendations of the core team and the rationale behind the recommendations. Because the recommendations are alternative licensing strategies that deserve further analysis, Section 4.4 suggests the next steps for refining and evaluating the strategies.

4.1 BUILDING THE ALTERNATIVE LICENSING STRATEGIES

As mentioned in Section 2, over a million strategies could be formed from combinations of the 33 alternatives listed in Section 3. The core team reduced this total to a manageable number by grouping similar alternatives and then recommending that the highest-rated alternatives in Table 6 receive further consideration.

The groupings were made based on three characteristics: timing of the decisions, level of implementation difficulty, and preliminary evaluation in Section 3. Here, the use of the word "timing" refers to the particular stage of the program where the alternative becomes relevant and begins to influence the process. For example, an alternative dealing with repository construction activities would not affect planning or site characterization, but would come into play once construction work authorization is obtained. Timing was considered by first dividing the 26 alternatives that were evaluated into four groups, according to the stage of the program at which the alternatives are appropriate:

- A - Licensing organization
- B - Planning and design
- C - Site characterization
- D - Construction and operation

These four groups are used to categorize the descriptions of the alternatives in Appendix A and designations such as "C3" are used to identify the alternatives throughout the report. (C3 is the third alternative appropriate to site characterization.) Then two "timing" categories of strategies were created:

- Licensing Organization and Planning Strategies (LO&P Strategies)

- Site Characterization and Construction Strategies (SC&C Strategies)

Most of the alternatives in groups A and B were placed in the LO&P category; alternatives in C and D fit nicely into the SC&C category.

Alternatives in the first category do not depend strongly on site information or access. Thus, the LO&P strategies can be the focus of near-term efforts to improve licensing strategy. The strategies in this category also have the best chance of near-term payoff.

The alternatives in the SC&C category are dependent on the outcomes of some of the LO&P strategies and, in some cases, on the availability of site data. For this reason, the benefits of SC&C strategies are likely to be

realized later and, in some cases, only if there are unfavorable outcomes from the LO&P strategies.

The licensing alternatives in these two categories were sorted by implementation difficulty. Then all of the "+" alternatives from each difficulty level were selected for inclusion in the packages of recommended strategies. In some cases, alternatives with significant potential for schedule improvement but with uncertainty related to licensability or cost increases were also included in the recommendations. This was considered appropriate given the preliminary nature of the evaluations completed by the ATLAS task force. Alternatives included on this basis are designed as "options" in this report. Specific recommendations are described below.

4.2 LICENSING, ORGANIZATION, AND PLANNING STRATEGIES

Table 7 lists three recommended strategies in the LO&P category. The first package--adopt new licensing posture--comprises three alternatives and two options, all of which are low implementation difficulty. Each of the three alternatives has a "+" evaluation in Table 6, which means that preliminary evaluation shows them to be better than the current strategy in at least one respect and no worse in every other respect.

Alternative A1--Cooperating With Affected Outside Organizations and Alternative B3 - Pace greater emphasis on EBS under current rules are included as options on the list. They have a "?" evaluation because they could improve schedule, but at a net positive cost.

While quantitative evaluation of the combination of alternatives in Strategy 1 was beyond the resources of this effort, qualitative evaluation shows that all of the alternatives are compatible and should be considered together in subsequent analysis.

Because Strategy 1--Adopt New Licensing Posture--is low difficulty, the DOE can implement it under current authority. This implementation would involve application of one or more of the alternatives in the strategy. Strategy 2--petition the NRC for rulemaking--represents "the next level up in difficulty" from Strategy 1. Strategy 2 contains two medium-implementation-difficulty alternatives: petitioning the NRC for rulemaking to resolve issues, place greater emphasis on the EBS, and to emphasize total system performance. Logically, the DOE must adopt one or more alternatives from Strategy 1 to enable it to pursue Strategy 2. Therefore, Strategy 2 can also be said to be made up of the two medium difficulty alternatives and the low difficulty alternatives of Strategy 1.

The relationship between Strategies 1 and 2 is illustrated in the decision tree in Figure 5. The first decision at the left side of the diagram represents a choice by the DOE of whether or not to adopt the licensing posture by selecting one or more of the alternatives in Strategy 1. If the decision is "no," we assume that no actions pertaining to NRC rulemaking would be pursued. The DOE is still free to seek permit relief, which is represented by the decision node on the right side of Figure 5.

Table 7. Representative packages of licensing organization and planning strategies

Strategy	Description
1.	Adopt new licensing posture (low implementation difficulty) o A6 - Refine the Base-Case Schedule o A2 - Take Initiative in Licensing o B1 - Link Performance Allocation and Site Testing o B7 - Increase Reliance on Geochemical Barriers o (Option: A1 - Cooperate With Outside Organizations) o (Option: B3 - Place greater emphasis on EBS under current rules)
2.	Strategy 1 plus petition NRC for rulemaking (medium difficulty) o A3 - Take Initiative in Rulemaking to Resolve Licensing Issues o B2 - Emphasize Total System Performance o (Option: B4, B5 - Please greater emphasis on EBS with rulemaking)
3.	Seek permit relief (high difficulty) o A5 - Reduce Permit Delays

NOTE: Detailed descriptions of individual alternative scenarios are provided in Appendix A.

If the DOE adopts a new licensing posture, then the decision is whether to take the next step up in implementation difficulty and petition the NRC for rulemaking. These two decisions are not necessarily sequential in time; in fact, they may be made at the same time. However, the decision nodes in the tree are drawn sequentially to indicate that one would include the adoption of a new licensing posture along with a decision to petition the NRC for rulemaking. As at the first decision node, the DOE might choose the "no" branch at the second node, which would be the same as adopting only Strategy 1, adopting the new licensing posture. Strategy 2 in Table 7 is equivalent to taking the upper branches at the first two decision nodes.

The third decision node is to seek permit relief--a high-implementation-difficulty strategy. This strategy is included here because of the strong impact it may exert on the outcome of other strategies. This strategy is relatively independent of the first two and may be implemented regardless of action on the others. However, it is more likely that the DOE could argue for intervention in the permit arena if it is seen to be taking the

initiative in other areas as well. The decision tree shows the path of taking all the upper branches of the decision tree. As noted earlier, it is possible to seek permit relief without implementation of the other strategies. As the tree in Figure 5 is in compact, or collapsed, form the end states reflecting these other combinations of decision are now shown.

The symbols on the right-hand side of Figure 5 represent the uncertainty regarding how soon the DOE will obtain site access and necessary permits. This important uncertainty affects subsequent licensing strategies. Because this is an uncertainty rather than a DOE decision, a circle rather than a square is drawn at the root of the branches. Note the assumption that if permit relief is sought, early permits (within the next two years) may be feasible. Depending on the rate of progress in implementing the measures, the permits may still be delayed (2-4 years) or later (greater than four years). However, if the DOE does not seek permit relief, the ATLAS core team assumed that the current legal process will continue for at least two years.

The uncertainty about permit dates is a critical linkage between the near-term LO&P strategies and those that occur later (and which are discussed in the next section).

4.3 SITE CHARACTERIZATION AND CONSTRUCTION STRATEGIES

Later in the repository program--during site characterization and construction--there is another set of alternative licensing strategies to consider. Because they are considered later, and because they apply to different phases in the program, they may, in most cases, be considered independent of the strategy selected from Table 7. In other words, any of the independent strategies selected from Table 8 (site characterization and construction) could be evaluated without consideration of the outcome of strategies from Table 7. However, before the actions are taken, one should evaluate the net benefits and impacts of the combined strategy.

In some instances, strategies from Table 8 can be implemented only if certain necessary or enabling scenarios from Table 7 are successfully implemented. For example, SC&C scenarios requiring rulemaking activity are precluded if the DOE does not seek an active role in rulemaking.

Like Table 7, Table 8 lists three recommended strategies; however, here the strategy descriptions are more complicated because of their dependence on uncertain future events. Strategy 4, like Strategy 1, is a collection of low-implementation-difficulty actions that have potential for significant schedule benefits. This strategy is represented by the upper decision branch at the left-most node in Figure 6. Figure 6, like Figure 5, is presented in compact form that represents a limited number of possible paths. Other paths can be constructed using logical consideration of the effects of individual alternatives on subsequent decision nodes.

The next step up in difficulty is Strategy 5, which include Strategy 4 and the request that the NRC institute phased licensing and acceptance of repository components. We also recommend considering the option of an early submission of the license application after some initial site

Figure 5. **Decision tree for licensing organization and planning strategies**

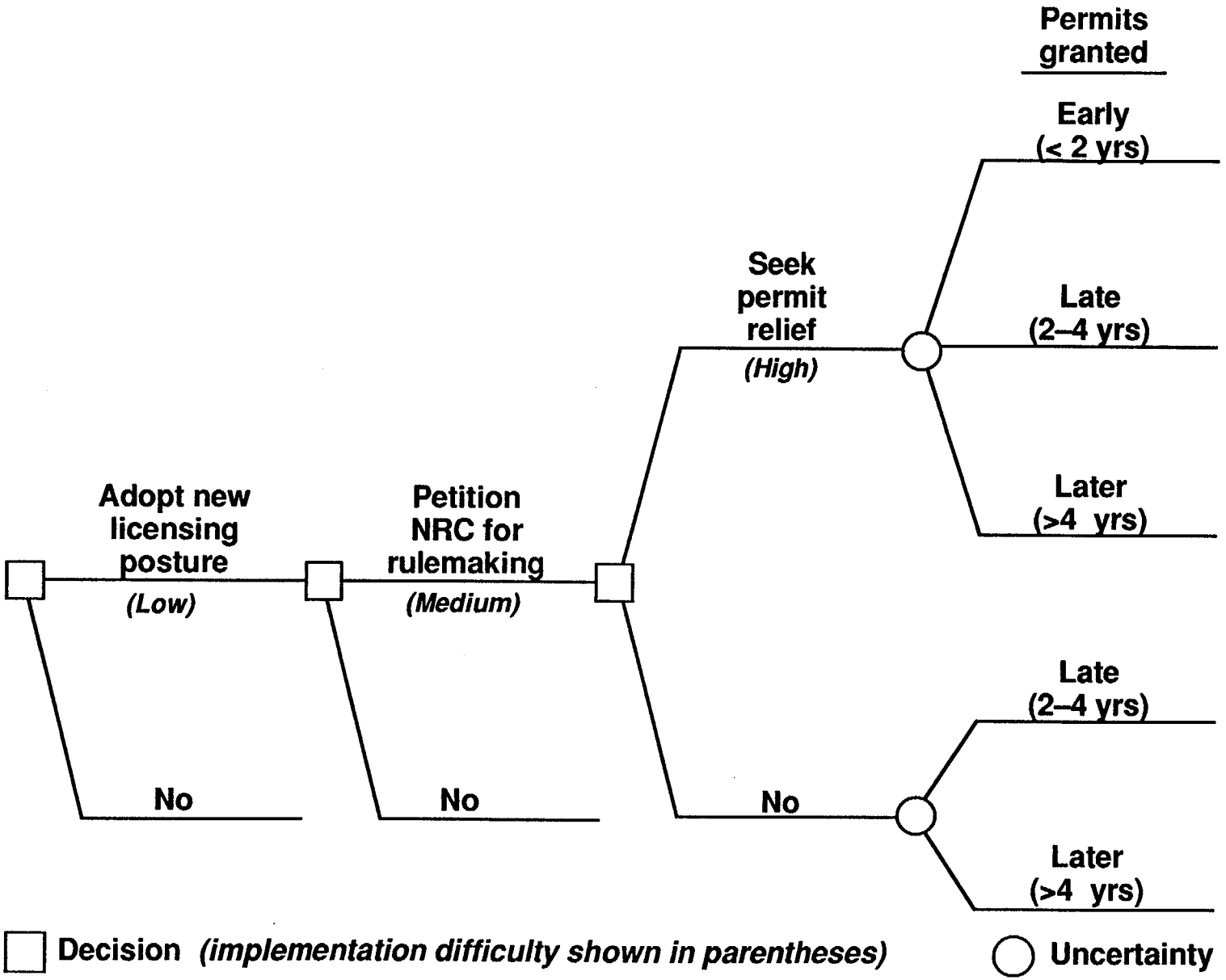


Table 8. Representative packages of site characterization and construction strategies

Strategy	Description
4.	Adopt flexible testing strategy (low implementation difficulty) o C2 - Test Calico Hills early o C3 - Conduct parallel surface-based testing (SBT) and Exploratory Shaft Facility (ESF) program o B8 - Increase reliance on natural barriers o (Option: B5 - Place Emphasis on EBS through Rulemaking and reduce testing)
5.	Strategy 4 plus request phased licensing (medium difficulty) o D1 - Seek phased licensing and performance confirmation o D3 - Accept repository components as completed o (Option: C1 - Submit license application after some surface-based testing) o (Option: B4 - Place emphasis on EBS through rulemaking and defer issue resolution to site closure)
6.	Strategy 5 plus contingent strategies (high difficulty) If permits granted early and phased approach not approved: o D2 - Seek Site Interim Storage If interim storage not approved: - C1 - Submit early license application (medium difficulty), or - C8 - ESF as high-level waste demo, or - Consider other options If permits granted late (2-4 years) and phased approach not approved: o C1 - Submit early license application (medium difficulty), or o C8 - ESF as high-level waste demo, or o Consider other options If permits granted later (>4 years) and phased approach not approved: o C6 - Use Test and Evaluation Facility with HLW, or o Consider other options

NOTE: Detailed Descriptions of individual alternative scenarios are provided in Appendix A.

characterization testing and greater emphasis on the EBS. This medium-difficulty strategy has significant schedule benefits if it is approved by the NRC.

The representation of Strategies 4 and 5 in the decision tree in Figure 6 is identical to the first two nodes in Figure 5. Then there are two uncertainty nodes, representing the same "permit granted" node as on Figure 5 and an uncertainty regarding whether the NRC will approve the phased licensing approach. This latter uncertainty is included because the benefits of subsequent strategies depend on the outcomes of both uncertainties.

The next strategy in the table is number 6)--Strategy 5 plus contingent strategies that depend on the permits and whether phased licensing is required. The best way to understand this dependence is in examination of the decision tree.

If phased licensing is approved, then there is no need to consider further the less-favorable licensing strategies. However, if it is not approved, other strategies may help mitigate the losses. If permits are granted early, but the phased licensing is not approved, then an appropriate strategy may be to seek approval of surface storage at the repository site. A positive outcome would be for this to be approved, in which case, the tree ends. If interim storage at the site is not approved, then three options are worthy of careful consideration. (It is not clear at this point which will be best. Subsequent evaluation is needed to compare these options.)

If permits are granted early, then there are three decisions to consider:

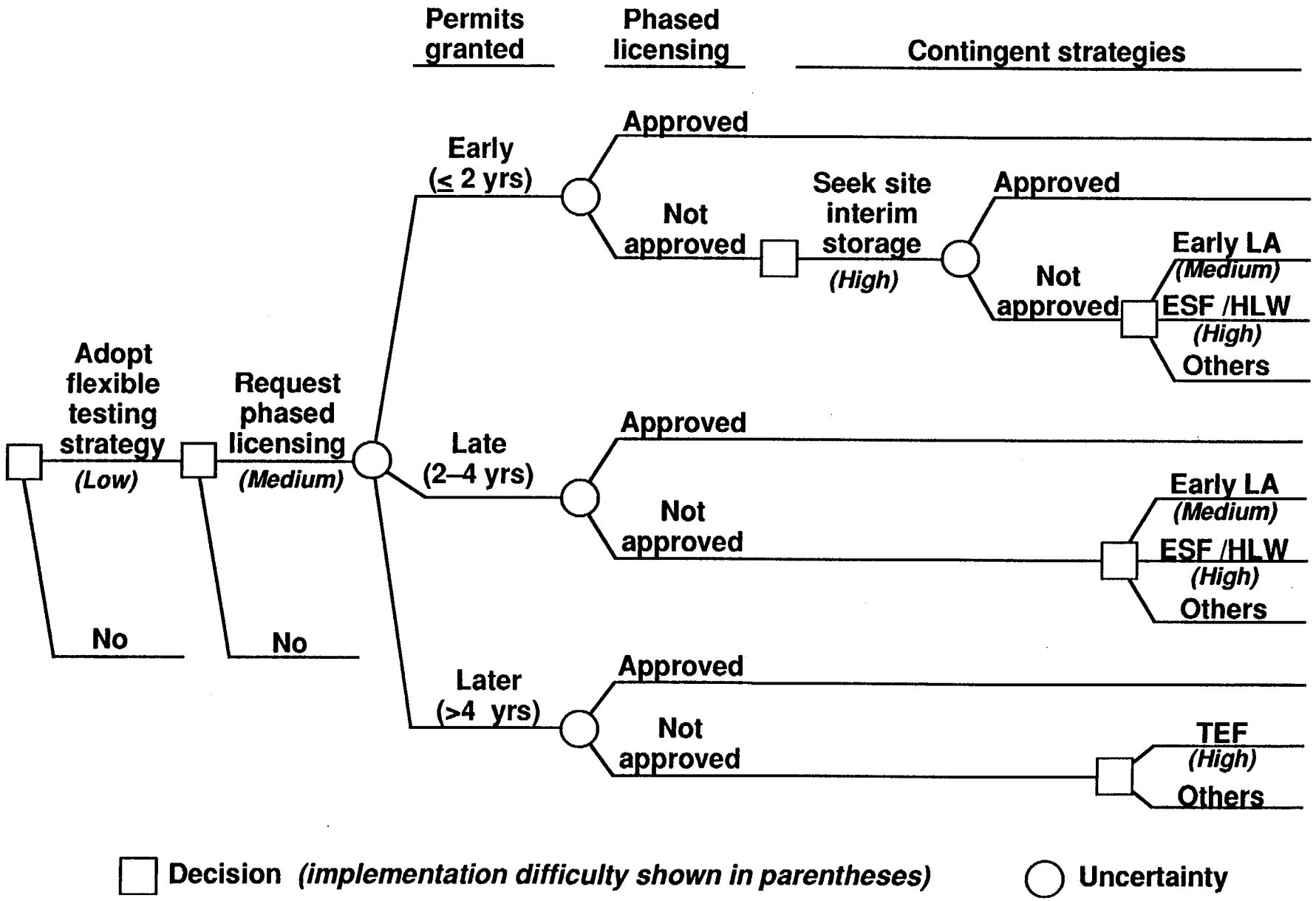
- Early submission of the license application
- Using the ESF as a demonstration with high-level waste
- Other options that may have "+" or "?" evaluation, but might well be suited to these conditions

These same alternatives are appropriate if the permits are obtained late. If the permits are very late, then the options to evaluate are:

- Using a Test and Evaluation Facility (TEF) to obtain HLW operating experience before site access is gained
- Other options that may have "+" or "?" evaluation but might well be suited to these conditions. For example, early license application or the options related to enhance engineered barriers may be modified for application here

The decision trees in Figures 5 and 6 can guide decision making. They also represent the strategies that need to be addressed in subsequent evaluation. The choice among the options portrayed in the tree also depends on DOE willingness to seek medium or high implementation difficulty strategies.

Figure 6. **Decision tree for site characterization and construction strategies**



4.4 RECOMMENDATIONS FOR FURTHER ANALYSIS

The systematic scoping process that produced the tables and decision trees in Sections 4.2 and 4.3 provides a representative set of recommended alternative licensing strategies. OCRWM may choose to evaluate these strategies in further detail in preparation for implementation decisions and actions (Alexander, 1990). Similarly, the management options listed in Table 3 and in Appendix B may also be evaluated.

Should further analysis be pursued, we recommend that the next steps include the following analytical activities:

1. DOE management should review the recommended strategies in Tables 7 and 8 and the management strategies in Table 3. Management should also review the criteria by which the alternatives were evaluated. They should then assemble an analysis team to evaluate selected alternative licensing strategies in depth relative to:

   - development of technical concepts
   - decision analyses
   - potential implementation plans and actions

2. The analysis team should establish a precise definition for each strategy. Many of the strategy descriptions in Appendix A are sufficient to characterize various alternatives but they are too broad to allow in-depth analysis of the effects of each or to allow development of implementation plans. Strategies 1, 2, and 3, although not supported by quantitative analyses, are obviously more beneficial and may only require development of a better definition aimed at implementation.

3. The decision analysis team should analyze the range of potential effects of the strategies on the evaluation criteria. This would include a careful analysis of the effects on schedule, cost, performance, and licensability. Often these effects will be uncertain, and the important uncertainties should be modeled explicitly. For example, some strategies will have a predictable effect on schedule. Others will affect schedule only by avoiding a potential slip. Both types of effects need to be analyzed on a consistent and comparable basis, taking into account the schedule uncertainties. This step is applicable to strategies.

4. The team should then assess tradeoffs among effects on cost, schedule performance, licensability, and implementation difficulty. Note that none of the proposed strategies would adversely impact public health and safety; tradeoffs would therefore be limited to other parameters. The analysis described in this report identified strategies that had beneficial effects on all criteria. An in-depth decision analysis will identify conflicting objectives and effects, and incorporate judgments about the relative importance of conflicting objectives.

5. Next, the team should focus their evaluations on Strategies 4, 5, and 6 using the information and analysis described in Steps 1-5. Any remaining issues in Strategies 1, 2, and 3 may also be resolved. The team should also determine the sensitivity of the evaluation of inputs such as the relative tradeoffs among effects of the strategies. Top-ranked alternative licensing strategies would be recommended for implementation.

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APPENDIX A

ALTERNATIVE LICENSING STRATEGY DESCRIPTIONS

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ALTERNATIVE LICENSING STRATEGY DESCRIPTIONS

This appendix describes alternative licensing strategies identified in the Yucca Mountain Project ATLAS Task Force workshops and related OCRWM management and planning documents such as the draft Strategic Planning Initiatives. The scenarios fell into logical groupings that reflect what stage in the lifecycle of the repository program the scenario would begin to affect the progress of the program. The stages recognized by the ATLAS Task Force are: A) Licensing Organization, which persists throughout the process; B) Planning and Design, which affects the scope of the later stages; C) Site Characterization; and D) Construction and Operation. A fifth grouping, E) Program Management, was identified for ideas that could save schedule, but include changes not directly related to licensing strategies. These ideas are discussed in Appendix B. The resulting list of alternative strategies includes the following:

The scenario descriptions include a definition of the scenario and its major elements, discussions of advantages, disadvantages, impediments to implementation, and the evaluation of the scenario.

Sections 2.0 and 3.0 of the report describe the process for evaluation and ranking of the strategies. The ATLAS extended core team evaluated these strategies in a series of workshops. The alternatives were evaluated as to potential schedule benefit, probability of successful licensing within the expected schedule, impact on the performance of the site, waste fund costs, utility costs as reflected in additional at-reactor storage, and perceptions of public risk. The strategies were also ranked by low, medium, or high difficulty of implementation. Where a schedule savings of one year or more is anticipated for a scenario, a critical path analysis is provided. The critical path analyses provide information about the reasonableness of the proposed savings relative to the base case schedule logic and may identify related actions necessary to implement the scenarios.

A1 - DEVELOP COOPERATIVE RELATIONSHIPS WITH AFFECTED PARTIES AND OUTSIDE ORGANIZATIONS

DOE can benefit from significant improvements in interactions with affected parties. The affected parties include technical, political, socioeconomic, industrial, regulatory, environmental, and citizen interests. The interests of each of these groups must be served, and, as appropriate, they must have opportunity for participation in predecisional activities. It is acknowledged that aspects of this alternative are already, or soon will be, part of the base case.

Specific ideas contributed include:

- Maintain a technical coordination program with states, industry, other DOE programs, and the Nevada University system. This would broaden the base for technical support and technical consensus for both DOE/OCRWM and DOE/EM programs. A program of technical workshops and grants to a spectrum of industry, university, state, and local investigators on particular topics of significance to radioactive and toxic substance clean-up and disposal could be completed. International cooperative evaluations are included in this scenario.

- DOE could start an immediate program of emergency response training through defense programs. This would alleviate a major issue related to transportation safety if early receipt of fuel became an adopted alternative. This program would be an extension of current WIPP activities and would have benefits to current and future shipping campaigns.

- Grant Affected Status to counties contiguous to the situs county in Nevada for Transportation Analyses. The DOE is currently responding to a suit from Esmeralda county for affected status. Several other counties have also applied for this designation and have been denied. Given the need for greater public involvement in the program, a commitment to this goal by the new OCRWM director and the need for local participation in the transportation program, the Secretary of Energy should accept proposals from counties in Nevada on the basis of studying transportation impacts.

- DOE could start an interaction program formed by working groups similar to standards organizations to address specific issues that do not seem amenable to rulemaking. Participants in these interactions could involve cognizant federal, state, industry, and other affected parties.

- Implement a comprehensive program of education aimed at improving understanding, needs and methods which could be employed to mitigate the impact of the Yucca Mountain Project. The focus of this program would address:

  - Public education on risks/benefits associated with the program.

  - Education of public school and university students on the issues and career opportunities associated with waste management.

- Training of the technical community in public outreach to enhance communications with the public concerning the Yucca Mountain Project.

- Providing the findings of characterization studies to the public in a form suitable for public education purposes to show the safety factors of repository storage of HLW. Provide comparative studies in a form suitable for public education purposes to show the hazards associated with shooting the waste into outer space, or leaving it dispersed at power reactors, for example.

Advantages

- o Granting affected status to additional units of local government would open new communication channels in Nevada about the project, participation in the siting of access routes could be improved and DOE will avoid the risk of alienation of local governments through the aggressive use of the legal process. Grant funds would be used by local governments to study issues related to potential HLW transportation.

- o Developing cooperative activities with outside organizations is a positive step both on a technical and public relations basis. These relationships could be used to discuss OCRWM actions on a predecisional basis. This may be effective in reducing litigation.

- o Education would assist licensing, and assist state and public acceptance of repository by placing HLW issues in context with other environmental concerns.

- o Develop a heightened public awareness as to societal risk/benefit and oversight of public health and safety.

- o Broaden the technical participation from those scientists and engineers solely under DOE, state, or foreign contract to a broader representation of environmental research and development.

- o The possibility that other potential host states may become interested as a result.

Disadvantages

- o Existing funds for local governments would need to be expanded.

- o DOE should not expect good cooperation from most outside parties. DOE will suffer from a lack of credibility, i.e., "this is just DOE PR," and will still face opposition by anti-nuclear groups despite a funding commitment.

- o In the past, extended involvement with outside penalties has delayed schedules rather than improve them.

Impediments to Implementation:

- o Additional funds may be required.
- o DOE has limited experience relative to public involvement and participation in public education.
- o Lack of integration between technical and institutional activities.
- o NWPAA requirements have not been fully defined.
  - NWPA, as amended, §116(c) -- Participation of States - Financial Assistance. [Consideration of impact mitigation - State.]
  - NWPA, as amended, §118(b) -- Participation of Indian Tribes - Financial Assistance. [Consideration of impact mitigation - Indian Tribes.]
  - NWPA, as amended, Subtitle F -- Benefits. [Formulation of benefit agreements with the State and Indian Tribes.]

Evaluation of this strategy

- o Schedule - Discussion of this alternative indicated that a savings of up to 1 year could be achieved depending on other actions taken in parallel. A nominal value of 0.5 years was used. If this alternative is not implemented, significant slips could occur in the base case schedule due to litigation that results from a perceived lack of DOE cooperation.
- o Licensing Probability - No direct effect. However, perceptions by both Nevada and other parts of the US were felt to be enhanced by this alternative due to their participation and the early emergency response training.
- o Site Performance - No effect.
- o Cost -
  - Waste Fund. Because the evaluation team could not agree on whether potential schedule savings would take place. No monetary figure was attached to the stated 0.5 year potential schedule savings.
  - Utilities. No evaluation was performed due to uncertainty of schedule savings.
- o Other comments and interfaces - The evaluation of this alternative generated much discussion and little consensus in regards to schedule benefit. It was agreed, however, that these ideas warranted further consideration from a management viewpoint as ways to improve program outreach.

A2 - DOE TAKES THE INITIATIVE IN LICENSING RELATIONSHIPS

This strategy, combined with the enhanced licensing activities discussed elsewhere in this appendix, can have a substantial positive impact on the project licensing schedule since it seeks to reduce large schedule slippages caused by uncertainties in the licensing process. These uncertainties would be addressed to the extent practicable, prior to docketing of the license application. By taking an "active" stance as opposed to a "reactive" stance, DOE can take the initiative and, through proper preparation and regulatory interactions, can seek to have more control in the licensing process. Specific aspects of this strategy include:

- o Licensing precedent indicates that an active process including developing a position, justifying the position, and actively maintaining the position, unless the NRC can present a defensible regulatory rationale to the contrary (i.e., not technical opinion), tends to result in the most equitable resolution of issues. Ultimately, however, NRC agreement with any proposed compliance strategy is needed.

  - Cultivate active approach to NRC interactions including assuming initiative for developing and defending positions.

  - Limit actions designed to respond to NRC "would likes" and technical opinion; assume related risks and responsibilities.

  - Limit NRC interactions to significant issues in a timely basis. Minimize general fact-finding, orientational/educational, and other low-benefit interactions. Revise procedural agreements, as appropriate.

  - DOE could aggressively seek NRC concurrence on its positions through negotiations with the NRC under existing agreements. Although not binding in the licensing process and hearings, the results will be persuasive if they are placed in the record.

- o DOE could immediately begin to prepare draft Position Papers on topics to be addressed in the Safety Analysis Report (SAR). The time and resources needed to place these basic building blocks in a license application is highly uncertain. The information in the SAR will be developed from topical reports, position papers, issue resolution reports, and other technical support documents that will be produced during the course of site characterization. It may be possible to develop agreements with the NRC in which these documents can be produced in a form that can serve as sections of the SAR and receive licensing review by the NRC as they are produced rather than at the end of the site characterization period. Although these reviews may in fact result in additional costs over that of the base case, the duration of the licensing hearings after site characterization may be decreased.

- o DOE could establish a strategy to anticipate, counteract, and overcome expected intervention. Once the intervention is understood and a strategy established, the needed organizational and program-

matic adjustments can be made within the project. Also, this strategy can be used to drive and support needed regulatory changes, litigation and legislation.

- There will be extensive litigation involving the OCRWM facilities, both within and external to the licensing process. OCRWM should prepare to support this litigation in the same way as it is preparing for the licensing process and technical reviews. Legal challenges based on permitting, due process, federal rules of evidence, discovery, freedom of information, and other such provisions of state and federal administrative law can be anticipated. Furthermore, within the licensing process, a barrage of non-issue oriented requests for information, technical questions, filings, allegations, etc. by numerous parties can be expected. A litigation support effort will enhance representation, and reduce the impact on key project resources.

- A large number of legal issues may be resolved early in the licensing process when they are not on the critical path. Doing so would avoid delays such as that being faced at the present time due to the refusal of the state of Nevada to cooperate. DOE/OCRWM could identify those specific issues which it expects to result in legal challenges and initiate interactions with the NRC to clarify them now as opposed to responding to last minute suits. Although this approach will not preclude last minute legal action by intervenors and the state of Nevada, it would provide the basis for quicker disposition of such challenges. Issues such as state's rights vs. federal authority; rights, powers, and duties of hearing participants; degree of proof (reasonable assurance) required for technical issues; availability of interlocutory review and numerous other such issues could be resolved well in advance.

- DOE should retain outside legal counsel to provide licensing and litigation support to OCRWM. This would provide expertise in dealing with NRC licensing from an applicant's perspective that is difficult (if not impossible) for DOE to obtain. The use of outside legal counsel should be driven by an internal litigation support effort. Such an effort will define not only issues to be addressed within the licensing process, but also those which will probably be contested in court outside the normal licensing process.

- Implement a program to preclude material false statements. Such a program ensures that all statements of fact made to regulatory agencies can be substantiated and factored into the licensing documentation and process. This will help avoid licensing issues which could arise due to lack of complete information to substantiate such statements of fact.

- Establish a lessons-learned program tied to the licensing/compliance strategy. There are many correlations between the licensing process and regulatory structure faced by the repository project and those faced by the commercial nuclear power industry. As such, the repository project can draw from the best programs, strategies and precedents (both legal and technical) developed in the commercial

nuclear power industry. For every regulatory requirement, commitment, guideline, etc. which the project must meet, there should be identified, wherever possible, the counterpart from the commercial nuclear power industry and any legal or technical precedents which have been developed. This will substantially enhance interactions between the project and the regulators.

- DOE should establish a system to track requirements and commitments made to NRC and procedures to ensure that those commitments are implemented and maintained. A Commitments Management System requires certain basic elements to be successful:

  a. A clear, concise definition of "commitment" and "open-item" and guidelines for their identification. At a minimum, this would include apparent requirements from NRC at all levels.

  b. A single point of control for commitment identification and coordination of interpretation.

  c. An ongoing compliance program which is well defined, delineated in procedures, understood and accepted.

  d. A close tie to the technical and MIS programs.

  e. A good information management system to provide accurate and timely information.

- Establish programs for dealing with differing internal opinion. A program for dealing with internal opinions, is essentially an allegations management program. Program would be tied to litigation support and compliance strategies so that key issues which may be raised by intervenors are anticipated. This program must be well maintained and corrective actions documented.

- DOE should create, publicize, and train staff to use a mechanism for anyone associated with the waste program, including contractor personnel, to report any safety concerns or allegations to a separate organization within DOE. The reports could be made anonymously. The organization receiving the reports would be charged with investigating the concerns, initiating appropriate corrective action, and providing feedback to the individual (if requested). DOE should also implement a formal program covering OCRWM, the Project Office, and its contractors for soliciting and resolving differing professional opinions on issues relating to the waste program. Similar programs were used by utilities during construction of nuclear power plants.

Advantages

- An active relationship with the NRC will help clarify and resolve issues prior to submission of the license application.

- Avoidance of unplanned schedule delays due to litigation.

- Addressing staff and contractor concerns early would aid in avoiding last minute allegations that could delay licensing and construction. Allow early identification of conflicting views within the program and provide forum for resolution.

- Make program more responsive to outside challenges.

- Downstream advantages of a modular SAR could shorten the licensing hearing.

Disadvantages

- Failure to establish an effective investigation and correction mechanism for staff and contractor concerns could itself generate significant controversy. Easy elevation of issues may involve management attention and resources on improperly posed issues that the concerned individual might want to withdraw after further study.

- Outside counsel is of limited effectiveness without substantive support from within the project.

- Increased costs likely for formal reviews of SAR modules.

- Inability of NRC to truly "close" issues prior to ASLB hearing.

- Some power plant licensing precedents (for example seismic design criteria) may not apply directly to the repository site.

Impediments to Implementation

- Some portions of the differing professional and internal opinion programs have been accomplished in relation to federal employees. The adequacy of existing rules for the OCRWM program should be reviewed.

- Additional resources may be required.

Evaluation of This Strategy

- Schedule - The schedule is estimated to be improved by at least one year. This alternative is also anticipated to avoid several years of potential slippages in the base case resulting from litigation. See attached critical path evaluation for further information.

- Licensing Probability - Increased; an improvement in the probability of a license at a particular point in time is anticipated due to an active stance toward issue convergence and/or resolution and control of work scope to focus on licensing.

- Site Performance - No effect.

- Cost -

  - **Waste** Fund. A 1-year schedule savings translates into a program savings of $300M. The additional savings from reduction in testing by this effort is estimated at $100M for a net savings of $400M.

  - Utilities. Savings of up to $200M would accrue due to schedule reductions.

- Other comments and interfaces - Some of the ideas are already being implemented and in addition may have some overlap with the spirit of the initiatives identified in "Focus Resources Toward Licensing" in Appendix B. However, there was unanimous support among the evaluation team for a systematic and broad approach to this issue.

CRITICAL PATH ANALYSIS

A2 - DOE TAKES THE INITIATIVE IN LICENSING RELATIONSHIPS

SCHEDULE ASSUMPTIONS:

- o LA Submittal 30-Oct-00: Schedule Savings = -1.0 Yr.;
- o More efficient program processes

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	01-Jul-92	-0.3	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	31-Dec-95	-0.5	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	02-Jan-91	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	01-Aug-92	-0.2	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	29-Feb-96	-0.3	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	30-Apr-00	-1.0	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	30-Oct-00	-1.0	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	31-Mar-00	-1.0	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	30-Apr-00	-1.0	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	31-Mar-92	-0.3	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	31-Aug-92	-0.3	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	30-Oct-00	-1.0	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Oct-03	-1.0	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Jan-09	-1.0	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Apr-07	-1.0	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case dates (years ahead of schedule);

Positive (+) values denote slippage re: Base Case dates (years behind schedule);

A3 - DOE TAKES THE INITIATIVE IN RULEMAKING TO RESOLVE LICENSING ISSUES

This alternative is an extension of the alternative entitled "DOE Takes the Initiative in Licensing Relationships". In addition to the items described in the other alternative, DOE could support a directed rulemaking program to establish a position to prepare and defend the LA as well as provide a stable basis for regulatory activities during site characterization and design. Examples of the types of rulemaking worthy of further study and/or action include those identified in "Emphasize Total System Performance." Topics would be selected carefully so that effort is not expended on minor concerns.

General actions needed in support of this action include:

- Utilize DOE prerogative to request rulemaking.
- Direct rulemaking towards mitigating unnecessary, redundant, or overly restrictive requirements, or clarifying regulations, e.g., the ground-water travel time subsystem performance requirement as applied to the unsaturated zone.
- Use rulemaking to assist in the resolution of major licensing issues by formalizing the process for early NRC review of key DOE positions with some level of confidence in their continued acceptance at time of LA. This is particularly critical in view of the length of the site characterization/design process. DOE should petition NRC for a "backfit" rule similar to that which has been applied to operating reactors.

Advantages

- Issues resolved through rulemaking would have better chance of staying resolved unless sufficient basis to change developed.
- Rulemaking provides opportunity to identify and definitively resolve important issues prior to adjudicatory hearings.
- Rulemaking aids site characterization and LA preparation by providing focus for addressing precise issues and information needs with a clear, continuing understanding of what is required.

Disadvantages

- A commitment to rulemaking and its supporting technical program requires major, and continuing, resource commitments and long-term planning.
- Results of rulemaking effort may not be favorable to DOE's position.
- May develop rules before sufficient site information is obtained thereby running a risk of developing a rule that is overly restrictive and difficult to revise.
- May result in perception that DOE is trying to ease requirements.

Impediments to Implementation

- The rulemaking process described in 10 CFR Part 2, subpart H may take 2 to 4 years.

- Additional resources may be required.

Evaluation of This Strategy

- Schedule - The evaluation team identified a schedule savings of 1.5 years compared to the base case or a 0.5 year improvement over the more active approach without rulemaking. Rulemaking is probably needed to avoid potential slippage of the base case schedule. See the attached critical path analysis for more information.

- Licensing Probability - Increased; A more active approach to rulemaking, while off the schedule critical path, was regarded as likely to increase the likelihood of obtaining a license through a more focused hearing process. The NRC and NWTRB would respond favorably due to fewer "pressure decisions" by having rulemaking, and attendant legal challenges, early. Nevada and the US were predicted to have a negative response due to perceptions of "cutting corners".

- Site Performance - No effect.

- Cost -

  - Waste Fund. Schedule-related cost savings of $450 million were estimated primarily because litigation challenge would take place off of the critical path. Savings due to reduced work and litigation costs were anticipated for a total savings of $600M.

  - Utilities. Schedule related cost savings of $300M were predicted.

- Other comments and interfaces - The core team felt that this was a positive thing to do, but these actions were identified in a separate alternative because they are more difficult than just taking an informal active stance which does not include rulemaking.

CRITICAL PATH ANALYSIS

A3 - DOE TAKES THE INITIATIVE IN RULEMAKING TO RESOLVE LICENSING ISSUES

SCHEDULING ASSUMPTIONS:

- LA Submittal 30-Apr-00: Schedule Savings = -1.5 Yrs.
- More efficient technical program
- Additional savings of -0.5 years in PA and design program relative to Scenario A2 - DOE Takes the Initiative in Licensing Relationships.

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	01-Jul-92	-0.3	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	30-Sep-95	-0.7	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	02-JAN-91	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	01-Aug-92	-0.2	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	30-Dec-95	-0.5	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	30-Oct-99	-1.5	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	30-Apr-00	-1.5	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	30-Sep-99	-1.5	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	30-Oct-99	-1.5	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	28-Feb-92	-0.3	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	31-Jul-92	-0.3	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	30-Apr-00	-1.5	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Apr-03	-1.5	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	31-Jul-08	-1.5	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Oct-06	-1.5	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Date (years ahead of schedule);

Positive (+) values denote slippage re: Base Case Date (years behind schedule).

A4 - SEEK TO LIMIT NRC PRE-LICENSING ROLE AND TO BENEFIT BY OVERSIGHT GROUP INTERACTION

Two significant areas exist where DOE should seek to move or evolve oversight groups into being more responsive to program needs. The first area may be to seek to limit NRC's role in the pre-licensing process. Formal NRC adjudicatory process will commence after LA submittal. A greater functional role for the NWTRB and other peer-review panels (NAS or NAE) to evaluate the technical adequacy of DOE's work could be pursued. The National Academy of Engineering (NAE) could replace or augment guidance by the National Academy of Sciences (NAS) in some aspects of the technical program, since the NAE is more attuned to engineering requirements and understands engineering concerns.

The second area is that DOE may seek to evolve the role of the NWTRB into a role that could be viewed as arbitrator. DOE can identify opportunities where the NWTRB could act in a role as "go-between" or "tie-breaker" in negotiation with NRC during rulemaking, issue convergence or resolution, or applicability of methodology toward regulatory compliance. DOE's prelicensing relationship with the NRC, and the desire to be responsive to other oversight groups and the public has obliged OCRWM to entertain reviews by virtually anyone. This drains resources and introduces significant uncertainty in scheduling. If the role of the NWTRB evolves to be more of an intermediary between DOE and NRC, then the need for such pervasive technical and programmatic review could perhaps be eased.

Advantages

- Modification of the NRC pre-licensing relationship may reduce the uncertainty in current plans and schedules.
- Stimulate exchange of ideas and resolution of differences.
- NAE will provide engineering problem solving perspective to mesh with scientific perspective of NAS.
- Improves focus of review activities and DOE actions for resolution of issues.

Disadvantages

- NWTRB and peer-review approach may be legally challenged, creating additional delays.
- Limited overview would diminish potential for consensus building among independent oversight groups.
- Uncertain effects of consequences of NWTRB review or results of other peer-reviews (i.e., mandatory recommendations, DOE action items).
- Additional review process for DOE to go through, depending on protocol establishing relationship of peer-review groups to program.

Impediments to Implementation

- Formal modification of NRC's role in the HLW program would require Congressional approval and revision of the Nuclear Waste Policy Act, i.e., prelicensing relationship is called out.

- Even with input from distinguished technical panels, Nevada and industry input and DOE response would still have to be incorporated into the program.

- Nevada and industry felt prerogative would have to be incorporated into the reviews.

- An arbitrator/negotiator panel which can render binding decisions is probably not feasible and could be challenged in court as being contrary to the intent of the Atomic Energy Act and contrary to the public interest.

Evaluation of This Scenario

- Schedule - The evaluation team identified no schedule savings from the base case. However, the group felt that some potential slip may be avoided through this type of activity, and that any effort conducive to issue convergence and/or closure was worth pursuit. No critical path analysis was performed.

- Licensing probability - No change from the base case, however, the perceptions of hazard by Nevada and US were thought to increase from "dilution" of NRC's role in the site characterization phase of the HLW program.

- Site performance - No change from the base case.

- Cost -

  - Waste fund. No change except for potential efficiency gains.

  - Utilities. No change.

- Other Comments and Interfaces - The group did not view extensive modification of the NRC's role in a licensing hearing to be at issue, rather, that NRC's role prior to LA submittal be more advisory and less formal. The group believed that the current trend in the DOE/NRC pre-licensing relationship tends toward "reaction" rather than "action" by DOE.

A5 - INITIATE ACTIONS TO REDUCE DELAY IN PERMIT APPROVAL PROCESS

DOE should aggressively pursue all options to streamline the approval process after permit applications are submitted to the appropriate agencies. Emphasis should be placed on non-litigative steps. For example, the Nuclear Waste Negotiator may be called upon to help determine the terms and conditions under which the state may let portions of the site characterization program proceed. Alternatively, the state of Nevada's refusal to process Yucca Mountain Project permit applications could be resolved by pursuing options to remove Nevada from the approval process. Regardless of actions taken, DOE must continue to comply with applicable environmental requirements set forth by federal, state, and local requirements.

Among the potential options that could be pursued in support of this alternative were:

1. Modification of the state and local government's role as affected units per NWPAA during site characterization.

2. Support revocation of federal flowdown authority to the State of Nevada.

3. Identify an independent federal agency (BLM for example) to process all Yucca Mountain permit applications.

4. Petition Congress to exempt site characterization from requiring permits based on the finding of no significant impacts in the Environmental Assessment for Yucca Mountain.

5. Pursue Presidential Exemption under the Clean Air and Clean Water Acts.

Advantages

- Negotiation may reduce opposition or generate support for start of some activities.

- Legislative, administrative, or Presidential overrides are more likely to resolve Nevada refusal in timely manner than litigation.

- Non-litigative solutions could avoid similar problems on permit applications yet to be filed.

- Shorten critical path to start the site characterization program.

Disadvantages

- Possibility that non-litigative approaches could slow down or adversely impact speed and/or outcome of litigation.

- State may file additional law suits against DOE and increase public resentment against the Yucca Mountain Project.

Impediments to Implementation

- Congressional and/or federal agency action would be required to revise the permit approval process.
  - The Project must comply with Federal Acts such as the Clean Air Act (42 USC 7401 seq), the Federal Water Pollution Control Act (33 USC 1251), and others. In order to be exempted or otherwise receive special treatment regarding permits for these Federal acts, Congressional or Federal agency action is required.
- Requirements expressed in DOE Orders
  - The requirements for meeting all environmental protection standards stems from DOE Order 5400.1, General Environmental Protection Program. The purpose of this order is to "assure compliance with Federal, State and local environmental protection laws and regulations." In Chapter I of the Order, an exemption procedure is provided, however, the wording of that procedure begins, "Requests for exemptions from applicable environmental protection standards are not encouraged."
  - The Yucca Mountain Project Environmental Protection Plan found in the Environmental Protection Implementation Plan, states on page 1-1 section 1.1 Purpose, "[this plan ensures] that facilities are operated and managed in a manner that will protect, maintain, and restore environmental quality; minimize potential threats to the environment and the public health; and comply with environmental regulations and DOE policies."

Scenario Evaluation

- Schedule - The evaluation team identified a nominal savings of 2 years from the base case, mainly through slip avoidance from continuation of current conditions. Critical path analysis is attached for the evaluation of the impact of delay in receipt of permits.
- Licensing probability - No change from the base case, however, the perceptions of hazard by Nevada and US were thought likely to increase if exemptions to existing Federal laws were pursued, simply because any reduction requirements would probably be viewed unfavorably.
- Site performance - No change from the base case.
- Cost -
  - Waste fund. A 2-year schedule savings translates into a program savings of $600M.
  - Utilities. A 2-year schedule savings translates into a savings of $400M.

CRITICAL PATH ANALYSIS

A5 - INITIATE ACTIONS TO REDUCE DELAY IN PERMIT APPROVAL PROCESS

SCHEDULE ASSUMPTIONS:

- LA Submittal 30-Jun-03: Overall Schedule Slip = +1.7 Yrs.;
- An assumed 2-Yr slip in Permits does not cause a 2-yr slip in the LA Submittal.

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	01-JUN-94	+1.7	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	28-Feb-98	+1.7	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	02-Jan-93	+2.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	01-Oct-92	0.0	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	30-Aug-96	+0.2	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	31-Dec-02	+1.7	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	30-Jun-03	+1.7	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	30-Nov-02	+1.7	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	31-Dec-02	+1.7	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	28-Feb-94	+1.7	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	31-Jul-94	+1.7	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	30-Jun-03	+1.7	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Jun-06	+1.7	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Sep-11	+1.7	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	31-Dec-09	+1.7	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);
Positive (+) values denote slippage re: Base Case Dates (years behind schedule).

A6 - REFINE THE BASE CASE SCHEDULE

In analysis of alternative strategies/scenarios, two factors that could have a significant effect on cost and schedule should be considered. First, the approach to the development of the long-range plan led to conclusions about the durations of many activities that may have resulted in an incorrect estimate of the schedule for the base case. For example, the decomposition of activities into subactivities and then assigning durations and sequencing for the subactivities inconsistent with the relationships among those subactivities within the activity led to extended durations for the activities.

The treatment of waste package performance assessment as a sequence of assessments which actually could occur in parallel led to a duration of 98 months rather than the more reasonable schedule of 36 months for this activity. A second example is the excessive conservatism applied to the estimates of durations. Such assumptions and conservation should be reviewed at some point to determine if the base case schedule might be significantly shortened (e.g., by more than a year). Such a review should consider the effect of these assumptions and conservatism not only upon the base case, but upon each of the alternative strategies. The review could, in fact, consider these effects in terms of additional alternative strategies.

The second factor that needs to be considered is the degree to which the schedule is controlled by external constraints on the program and the degree to which current activity durations merely occupy the time available. Although this factor may not apply in all cases, it may be sufficiently valid that evaluations of other factors may not truly reflect the value of specific strategies. This factor should be evaluated in a general review of the factors influencing the schedule rather than in terms of specific alternative strategies. Explicit recognition of additional outside constraints and conservation in the current base case would make for a more realistic and robust base case.

Advantages

- Scheduling conservatisms could lead to refinement of the base case and potentially off set potential schedule slippages identified in other alternatives.
- Schedule improvement could come with no effect on the technical or managerial activities.

Disadvantages

- None

Impediments to Implementation

- Resources needed to revisit long range plan.
- Current management procedures would need to be revised to explicitly identify external threats to mission schedule and success.

Other Comments and Interfaces

- This initiative is basic to many of the alternative strategies that have been identified. It is necessary to track progress and establish believable measure of progress for the program. The group believed that DOE repeatedly opens itself to criticism in program schedules that do not account for the influence of external factors.

B1 - COMPLETE LINKAGE BETWEEN PERFORMANCE ALLOCATION AND SITE TESTING PROGRAM

To better focus the intent of the SCP technical program on data that is relevant to the most important information needs (technical and regulatory), an exercise to complete the linkage between performance allocation and the studies and site testing can be carried out. Performance allocation is the main tool by which DOE determines it is gathering needed data to resolve performance and design issues. Allocations of performance were not "driven down" to the lowest levels of the several major site study programs in the SCP. The test strategies in the SCP are based upon a mixture of site characterization parameters derived from the performance and design issues resolution (IR) strategy, and principal investigator perceptions of the breadth and depth of technical data needed for an adequate characterization of the site.

A better integrated site characterization program would result from:

1. Completing the linkage from testing to design/performance issues for those studies that have not been linked, and to do so in a standardized parameter nomenclature applicable to all field test programs.

2. Resolve the many inconsistencies in the use of technical terms in different disciplines.

3. Derive a quantified performance allocation tied to 10 CFR Part 60 for each subsystem (repository, waste package, and site).

The IR strategy of the technical program was organized using a non-quantitative performance allocation that assigned levels of importance to various natural and engineered barriers. A quantitative allocation of performance to each subsystem component could be based on an integrated evaluation of 10 CFR Part 60 compliance. Quantitative performance allocation can be a tool to help better identify or weight those studies providing the most information pertaining to waste isolation, and separate out those studies that are basically descriptive which could perhaps be completed using data that undergoes qualification.

The current SBT priorities task is attempting to rank the SCP SBT program according to the importance of characterization parameters each study will gather and their relation to a determination of site suitability by means of a performance assessment. Once this exercise is complete, a natural extension or continuation of it would be to carry out the exercise described in this scenario.

Performance assessment calculation exercise (PACE)-90 exercises underway to identify parameter sensitivity for performance assessment models could also be used as a tool to help establish priorities for the testing program and separate-out descriptive or redundant testing from the SCP program.

Advantages

- Reduce scope of SCP by identifying those studies most important to demonstrate the site's waste isolation potential, and "other" studies

of a more descriptive nature that can be completed using existing data that is qualified.

- Improve defensibility and justification for site characterization planning basis.

- Better communication with technical community and oversight organizations as to the logic, purpose, and workability of the SCP.

- Accountability of site work will be easier to track in terms of schedule.

Disadvantages

- Redefinition of participant deliverables involves a significant rework of the technical baseline/LA supporting documents and deliverables for the SCP program.

- Yet another "replan the plan" exercise for an SCP that has been basically accepted by the NRC.

Impediments to Implementation

- Management issues may arise from reluctance of participants to undertake rescoping/replanning that may lead to cutback in their respective technical roles.

- Additional funding to undertake the task would be required.

Evaluation of This Scenario

- Schedule - The evaluation team identified a schedule savings on the base case of 1 year, due to the downstream advantages of having a more tightly organized test and evaluation program for the site. See attached critical path analysis for details.

- Licensing probability - No change from the base case.

- Site performance - No change from the base case.

- Cost -

  - Waste fund. A 1 year schedule savings translates into a program savings of $300M. Cost for the exercise could be comparable to the budget for the Surface-Based Testing Prioritization Task.

  - Utilities. A 1 year schedule savings would result in a $200M savings in at-reactor storage capacity.

CRITICAL PATH ANALYSIS

B1 - COMPLETE LINKAGE BETWEEN PERFORMANCE ALLOCATION AND SITE TESTING PROGRAM

SCHEDULE ASSUMPTIONS:

- LA Submittal 30-Oct-00: Schedule Savings = -1 yr.;
- Assumes that refinement of the technical program will yield efficiency improvements across the board.
- Earlier availability of required data to support the Technical Support Documentation for the SAR/LA.

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	01-Jul-92	-0.3	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	01-Dec-95	-0.5	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	02-Jan-91	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	01-Aug-92	-0.2	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	29-Feb-96	-0.3	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	30-Apr-00	-1.0	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	30-Oct-00	-1.0	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	31-Mar-00	-1.0	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	30-Apr-00	-1.0	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	31-Mar-92	-0.3	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	31-Aug-92	-0.3	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	30-Oct-00	-1.0	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Oct-03	-1.0	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Jan-09	-1.0	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Apr-07	-1.0	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);

Positive (+) values denote slippage re: Base Case Dates (years behind schedule);

B2 - EMPHASIZE TOTAL SYSTEM PERFORMANCE

The most significant opportunity for DOE rulemaking raised in the process of scenarios elicitation for ATLAS was for DOE to pursue reliance on total system performance for determination of regulatory compliance. Exceptions to NRC's subsystem performance objectives can be made under the current regulations, if DOE can demonstrate compliance with the total system requirements in the EPA regulations. The presence of the subsystem requirements, however, are potential targets for litigation. The subsystem requirements are a manifestation of the "defense in depth" philosophy carried over from the design of nuclear power plants. A "defense in depth" emphasis (total + subsystem) requirements may result in failure to license any site for a MGDS, due to excess conservatism and the regulatory imposition of near-certainty of performance on a natural system.

In addition to potential NRC rulemaking activities, several ideas were brought forth specifically on the EPA standard.

1. Seek to convert the EPA 10,000 year curie release limit in 40 CFR 191 to a lifetime dose equivalent.

2. Reevaluate the EPA health affects assessment and risk benefit relationship in view of other trans-generational health risks.

3. Seek to modify the 40 CFR 191 standard for demonstrating compliance by use of probability distribution functions.

Various suggestions for modifying performance allocation were elicited as a result of ATLAS core team workshops. Though unquantified with respect to schedule savings for each of the possible actions listed below, these ideas involve action by DOE to determine which are worth pursuit, followed by petitioning NRC to undertake various rulemaking actions. This would take place as part of, or as a result of, other actions. The various alternatives in this report assume that DOE will pursue modification of performance objectives, as appropriate, that were formulated with excessive conservatism or that impose unrealistic constraints on the process of licensing a geologic repository, without measurable benefit to public health and safety.

Excessively conservative performance standards or objectives, even if attainable, place an unnecessary burden on site characterization and performance assessment programs. Some requirements need clarification, or adaptation to the Yucca Mountain geologic setting (e.g. applicability of ground water travel time (GWTT) to unsaturated zone (UZ) flow when the requirement was designed for flow in the saturated zone). This is carried out by petitioning the parent agency to rescind or amend their requirements, or for exemption from their application. The resources that would be otherwise required to develop unnecessary information can be reallocated.

Pursuit of rulemaking was regarded by the group as necessary to preserve the base case schedule while such interaction was off the critical path. An impact on schedule from failure to pursue rulemaking early is likely to occur but could not be quantified. The potential opportunities for rulemaking actions include:

1. Modification of the carbon-14 limit in 40 CFR Part 191.

2. Elimination of Retrievability as a License Requirement for a MGDS. Retrievability would still remain as a design parameter and treated more as an off-normal condition than a normal operating phase which must conform to 10 CFR 20 and other regulations. Eliminating this scenario will greatly decrease the potential dose to workers and the public during the operation of the repository. This affects 10 CFR 60.111(b).

Advantages

- Increases cost effectiveness due to greater realism in goals.
- Produces earlier license application due to elimination of unnecessary characterization activities.
- Provides an explicit derivation of the dose standard that will be available for scrutiny in the licensing process.
- Provides the opportunity to use advances in predictive modeling.
- Eliminate a potentially difficult licensing obstacle of meeting 10 CFR 20 under the conditions of retrieving 70,000 metric tons of high-level waste for total operation period of the repository.

Disadvantages

- A change in requirements will generate a negative public perception.
- Nuclear topics may not be tolerated by the public at the same probability as other hazardous activities.
- An argument cannot be made that the carbon-14 limit and the 10,000 year curie limit are unattainable.
- An amendment of 40 CFR Part 191 is required. The EPA's record for promulgation of regulations indicates that, if successful, this action may not result in accelerating the licensing of the repository.

Impediments to Implementation

- A long process for altering the fundamental regulations would be needed.

Evaluation of This Scenario

- Schedule - Items identified in this alternative are corollaries to other actions, in large part. The evaluation team identified at least a 1 year schedule savings from the base case, which would result from reduction of scope in tests and analyses needed to determine compliance with NRC's subsystem performance objectives,

that are now part of the current technical planning basis. See attached critical path analysis for further information.

- o Licensing probability - Increased. If the subsystem performance objectives were no longer part of the regulatory framework then the probability of receiving a license was thought to increase because the opportunity for legal challenge would be reduced. The current NRC subsystem performance objectives allow exception to be taken to their compliance, if DOE can demonstrate compliance with the EPA standard. The group believed that removing the possibility for legal challenge (exceptions) would increase the probability of receiving a license. The perceptions of hazard by Nevada and US were through to increase due to apparent "relaxation" of existing requirements.

- o Site performance - no change from the base case.

- o Cost -

  - Waste fund. A 1 year schedule savings translates into a program savings of $300M.

  - Utilities. A 1 year schedule savings would result in a $200M savings in at-reactor storage cost.

CRITICAL PATH ANALYSIS

B2 - EMPHASIZE TOTAL SYSTEM PERFORMANCE

SCHEDULE ASSUMPTIONS:

- LA Submittal 30-Oct-00: Schedule Savings = -1 yr.
- Assumes less extensive PA required and less time required for WP LAD process
- Assumes availability of representative EBDT data to support PA
- ESF Title II final design and construction time reduced by 6 months

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	01-Oct-92	0.0	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	29-Feb-96	-0.3	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	02-Jan-91	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	01-Oct-92	0.0	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	31-May-96	-0.1	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	30-Apr-00	-1.0	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	30-Oct-00	-1.0	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	31-Mar-00	-1.0	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	30-Apr-00	-1.0	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	31-Mar-92	-0.3	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	31-Aug-92	-0.3	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	30-OCT-00	-1.0	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Oct-03	-1.0	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Jan-09	-1.0	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Apr-07	-1.0	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);

Positive (+) values denote slippage re: Base Case Dates (years behind schedule);

B3 - GREATER RELIANCE ON EBS UNDER CURRENT RULES

In this alternative strategy the allocation of performance is altered, solely as a result of DOE fiat, to rely more heavily on the engineered barrier system (EBS), in addition to natural barriers, to contain and isolate waste. DOE proceeds to develop a more robust EBS without negotiated rulemaking with NRC to "take credit" for increased performance in the subsystem performance objectives of 10 CFR Part 60. Such action assumes a doubling of total system performance with a matching decrease in uncertainty. Reliance on the natural barriers does not change from the base case and performance in evaluated from total system.

The elements of the engineered barrier system (EBS) include the waste package (waste form, disposal container, packing material) and the underground facility (emplacement hole configuration and closure, emplacement drifts, access drifts, backfill, but excluding shafts, boreholes, and their seals). The allocation of performance to these elements is described in the SCP, which also defines a program for site characterization based upon this qualitative allocation. This alternative could be complemented by the derivation of a quantitative performance allocation that is tied to the subsystem performance objectives in 10 CFR Part 60 (discussed in "Complete Linkage Between Performance Allocation and Site Testing Program" description).

"Greater reliance" for this and following alternatives pertaining to EBS was assumed to involve either or all of the following; 1) development of a "long-life" disposal container design that would maintain "substantially complete containment" throughout the 10,000 year period of containment and isolation, 2) development of an engineered geochemical barrier in the form of packing material as a component of the waste package or in the form of engineered backfill in the emplacement drifts, or 3) alter the repository underground facility arrangement in order to complement natural features of the site. Examples of these would be to engineer emplacement drifts so that near field water flux is diverted away from emplaced waste, or construct drainage tunnels to provide permanent drainage of perched water in the UZ.

Advantages

- Disposal container and engineered geochemical barrier development and characterization can proceed without near-term site access.

Disadvantages

- Only one of the multiple barriers, the engineered barrier, will be emphasized by the site characterization program. In licensing there may be reluctance to make a finding of reasonable assurance based upon evaluation of a single barrier.

- Evaluation of a "long-life" disposal container (10,000 yrs) involves an increase in in situ test duration upon which to base predictions of performance, i.e., an 80-year performance confirmation program for a 1,000-year container may require a proportionally increased in situ test program to achieve the same degree of certainty in a 10,000-year container performance.

- The costs of "long-life" disposal containers may be significantly higher than base case cost estimates.

Impediments to Implementation

- Significant deviation from the SCP and requisite reporting in semiannual progress reports (10 CFR 60.18(g)) will be required.

Evaluation of This Scenario

- Schedule - The evaluation team identified no savings to the base case schedule for the near-term. Although no schedule savings was identified the scenario had favorable impact on other ranking factors that may have the effect of expediting the licensing process downstream because of an EBS that is beyond requirements. No critical path analysis was prepared.

- Licensing probability - Increased; due to reduced technical uncertainty resulting from a more robust EBS.

- Site performance - Increased; perhaps a doubling of total-system performance.

- Cost -

  - Waste fund. Increased scope of EBS design and impact of a more robust waste package in particular led to a very soft estimate of a $3B increase in lifecycle cost.

  - Utilities. No change.

B4 - GREATER RELIANCE ON EBS WITH RULEMAKING AND DEFER ISSUE RESOLUTION TO CLOSURE (PHASED LICENSING)

DOE proceeds to develop a more robust EBS and pursues rulemaking with the NRC to modify subsystem performance objectives to allow "credit" for enhanced subsystem performance. With the publication of NRC staff position 60-001 in July (NRC 1990), this may not be necessary for this alternative. In addition DOE defers or stretches-out the ESF in situ testing program so that it becomes dominantly a performance confirmation program (post-LA and pre-closure) with perhaps a larger period of retrievability. No less reliance on natural barriers is assumed than in the current base case, and no decrease in testing occurs. The focus of total-system performance for waste containment and isolation shifts to the EBS, but not in lieu of natural barriers.

The engineering development and testing necessary to implement this alternative can be completed on a significantly shorter schedule, since long-term tests such as for unsaturated zone geohydrology monitoring would be on-going up to the license closure amendment, and would not be in the critical path for a construction LA.

An extended period of retrievability, using possibly "self-shielded" waste packages instead of a bore hole emplacement mode could enhance the reversibility of the repository, allowing for retrieval of waste for much longer than the 50-year period required by 10 CFR 60.111(b). The self-shielded container strategy relies on packages that are placed on the floors of the emplacement drifts rather than into emplacement bore holes. The repository is kept open for monitoring and inspection for a period much longer than that needed to emplace all of the waste. DOE could petition for modification to the retrievability standard in 10 CFR 60.111(b).

If DOE defers its documentation of "reasonable assurance" for NRC's EBS subsystem performance objectives and/or total-system performance to the repository license closure amendment, there is a de facto phased process. Application of "phased" licensing has no precedent for an MGDS and will probably require changes to 10 CFR Part 2.

Advantages

- Self-shielded containers decrease cost of repository construction and waste emplacement.
- Disposal container and engineered geochemical barrier development and characterization can proceed without near-term site access.

Disadvantages

- Perception of decreased commitment to "defense in depth" concept.
- Evaluation of a "long-life" disposal container (10,000 yrs) involves an increase in in situ test duration upon which to base predictions of performance, i.e., an 80-year performance confirmation program for a 1,000-year container may require a proportionally increased in situ test program to achieve the same certainty in a 10,000-year container.
- Possible challenge to reasonable assurance of meeting performance criteria in adjudication resulting from change in emphasis to less reliance on geologic setting (isolation) and more reliance on EBS (containment).
- Increased cost for self-shielded waste package development, testing, design, and construction.
- The costs of "long-life" disposal containers may be significantly higher than base case cost estimates.
- Repository design changes to accommodate a longer retrievability period may increase underground facility costs.

Impediments to Implementation

- NRC may resist new allocations of performance desired by DOE. Extensive negotiation, rulemaking activities, and perhaps changes to 10 CFR 60 may be necessary.
  - 10 CFR 60.102(e) -- Technical Criteria - Concepts. [Defines isolation of waste.]

Evaluation of This Scenario

- Schedule - The evaluation team identified a schedule savings of 1 year on the base case, since a significant part (though not all) of the ESF testing program and its supporting documentation would be stretched-out beyond the time when repository construction and operation begins. See attached critical path analysis for further information.
- Licensing probability - Decreased; NRC may regard the LA as deficient if in situ testing strategy focuses on post-LA and pre-closure time frame.
- Site performance - Increased; perhaps a doubling of total system performance.

- Cost -

  - Waste fund. A 1 year schedule savings translates into a program savings of $300M that partially offsets the $3B cost for the robust EBS, giving a net increase of $2.7B.

  - Utilities. A 1 year schedule savings translates into a at-reactor storage savings of $200M.

CRITICAL PATH ANALYSIS

B4 - GREATER RELIANCE ON EBS WITH RULEMAKING AND DEFER RESOLUTION TO CLOSURE (STAGED LICENSING)

SCHEDULE ASSUMPTIONS:

- LA Submittal 30-Oct-00: Schedule Savings = -1.0 Yr.;
- Reduced reliance on ESF Activities: data available from ESF does not constrain design or PA leading to repository construction authorization.

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	01-JUL-92	-0.3	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	01-Dec-95	-0.5	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	No Change	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	01-Aug-92	-0.2	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	29-Feb-96	-0.3	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	30-Apr-00	-1.0	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	30-Oct-00	-1.0	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	31-Mar-00	-1.0	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	30-Apr-00	-1.0	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	No Change	0.0	Start ESF Site Preparation
RM652	1.2.6.4	30-NOV-92	No Change	0.0	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	30-Oct-00	-1.0	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Oct-03	-1.0	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Jan-09	-1.0	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Apr-07	-1.0	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);

Positive (+) values denote slippage re: Base Case Dates (years behind schedule).

B5 - GREATER RELIANCE ON EBS WITH RULEMAKING AND REDUCED SBT AND ESF TESTING

DOE proceeds with development of a more robust EBS, while pursuing rulemaking with the NRC to modify subsystem performance objectives to allow increased "credit" for EBS subsystem performance. With the publication of NRC Staff Position 60-001 in July (NRC 1990), this rulemaking may not be required. In addition, DOE reduces certain aspects of surface-based and ESF testing as part of a strategy to place greater reliance on the EBS for containment and isolation. Such a strategy seeks to modify the regulatory emphasis on natural barriers stated in 10 CFR 60.102(e)(2).

Increased reliance on the EBS (with the exception of large-scale site modifications) at the expense of a less comprehensive testing program for the natural barriers will not affect the performance of natural barriers, just the level of DOE knowledge of the barriers and the degree of uncertainty in their performance. Credit may still be taken for natural barriers for total-system performance, but reduced site characterization testing will increase uncertainties.

Advantages

- Disposal container and engineered geochemical barrier development and characterization can proceed without near-term site access.

Disadvantages

- Only one of the multiple barriers, the engineered barrier, will be emphasized by the site characterization program. In licensing there will be reluctance to make a finding of reasonable assurance based upon evaluation of a single barrier.

- Evaluation of a "long-life" disposal container (10,000 yrs) involves an increase in in situ test duration upon which to base predictions of performance, i.e., an 80-year performance confirmation program for a 1,000-year container may require a proportionally increased in situ test program to achieve the same certainty in a 10,000-year container.

- The costs of "long-life" disposal containers may be significantly higher than base case cost estimates.

- Possible challenge to reasonable assurance of meeting performance criteria in adjudication resulting from change in emphasis to less reliance on geologic setting (isolation) and more reliance on EBS (containment).

Impediment to Implementation

- Specific aspects of 10 CFR 60 are likely to require modification.

  - 10 CFR 60.102(e) -- Technical Criteria - Concepts. [Defines isolation of waste.]

- 10 CFR 60.113(a)(1)(ii)(A) -- Performance of Particular Barriers after Permanent Closure. [Defines the performance objectives of the engineered barrier.]

Evaluation of This Scenario

- o Schedule - The evaluation team identified a schedule savings of 3 years on the base case. For example, reduction of GWTT testing and other related site characterization study programs, would allow this significant shortening of the schedule. See attached critical path analysis for further information.

- o Licensing probability - Decreased; through cancellation of certain parts of SBT and ESF testing programs that are now part of the technical planning basis. The result is a characterization program of reduced scope. Cancellation or reduced scope of some currently planned SCP study programs results in a trade-off of increased uncertainties related to performance of the natural system in contrast to decreased uncertainties in the performance of a more robust EBS.

- o Site performance - Increased; from the base case but not to the degree assumed in the previous 2 alternatives. It is not the same because although a more robust waste package evolves, the cancellation of certain parts of the SBT and ESF testing programs will provide less data for use in evaluating the natural barriers and total system performance.

- o Cost -

  - Waste fund. Schedule related savings of $900M and reduction of site characterization scope to save $600M off set the $3B increase in EBS cost to give a net increase of $1.5B over the base case.

  - Utilities. A large savings in schedule could lead to a cost savings of up to $600M in at-reactor storage. However, the action of the MRS will likely reduce the potential savings since repository operations will begin soon enough that MRS capacity limits will not have impacted reactor storage.

CRITICAL PATH ANALYSIS

B5 - GREATER RELIANCE ON EBS WITH RULEMAKING AND REDUCED SBT AND ESF TESTING

SCHEDULE ASSUMPTIONS:

- LA Submittal 30-Oct-98: Schedule Savings = -3.0 Yrs.
- Reduced scope and reliance on Surface Based Testing (SBT) and ESF program
- Impacts design process and PA program and preparation of the Technical Support Documentation for the SAR/LA.

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	31-Dec-91	-0.7	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	30-Mar-95	-1.3	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	No Change	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	31-Dec-91	-0.7	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	31-Dec-94	-1.5	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	30-Apr-98	-3.0	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	30-Oct-98	-3.0	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	31-Mar-98	-3.0	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	30-Apr-98	-3.0	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	No Change	0.0	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	No Change	0.0	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	30-Oct-98	-3.0	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Oct-01	-3.0	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Jan-07	-3.0	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Apr-05	-3.0	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);

Positive (+) values denote slippage re: Base Case Dates (years behind schedule);

B6 - ALTER ENGINEERING TECHNICAL BASIS OF A MGDS

This alternative strategy involves alteration of the engineering technical basis for a mined geologic disposal system (MGDS). Two ideas were forwarded that called for large-scale engineered modifications of the site's natural barriers and features to accentuate their waste-isolation performance, 1) paving or similar alteration of the ground surface over the repository block to reduce infiltration of surface water, and 2) mining-out of repository block "overburden" with replacement by an equally thick engineered cover with known hydrologic performance properties.

Advantages

- Render complex site characterization issues moot by providing engineered system in place of natural barrier system.

Disadvantages

- The longevity of near-field engineered features in their relation to waste isolation potential, and large-scale site modifications must be established.
- Scant technical basis upon which to modify the SCP.
- Perpetuates the idea that DOE will carry out engineering "fixes" for a "bad" site, if major departures from the current concept of a MGDS takes place.

Impediments to Implementation

- The technical basis, regulatory framework, and institutional experience needed to evaluate these ideas is embryonic.

Evaluation of This Scenario

- Schedule - The evaluation team could not perform an informed estimate of the schedule savings to be had by this scenario, and it was shelved as interesting but beyond scope of ATLAS.

B7 - GREATER RELIANCE ON GEOCHEMICAL BARRIERS

This alternative is not included as part of the following alternative strategy because an extensive geochemistry program is already in place as part of the current technical planning basis. To "take credit" for it, DOE would need to revisit performance allocation in the SCP to allocate greater reliance on the geochemistry of volcanic tuffs for their potential in retarding radionuclide migration. The current strategy allocates all of the required performance to geohydrology. By changing the data requirements for the geohydrology program, this alternative could reduce the scope of testing in hydrology because if highly effective geochemical barriers exist between the repository horizon and the water table, fewer boreholes and shallower drilling that may result reduces the length of time needed to complete the systematic drilling program which lies on the critical path for SBT.

Advantages

- Could enhance regulatory compliance strategy of "defense in depth" to increase the probability of licensing.
- Could provide increased confidence in meeting subsystem performance objectives (GWTT, and the engineered barrier system) and total system performance objectives.
- A comprehensive geochemical study program is already part of the current technical planning basis.

Disadvantage

- Would increase scope of work in the geochemistry program to some degree.

Impediments to Implementation

- Would require modification of the SCP and regulatory compliance strategy.
- Funding for increased geochemistry work scope is not currently available.

Evaluation of This Scenario

- Schedule - The evaluation team identified no savings on the base case schedule, since a geochemistry program is already in place and would merely increase in scope. Other evaluation factors, however, were favorable. No critical path analysis was completed for this scenario.

- Licensing probability - Increased; Due to availability of data that appears likely to be favorable for the site's waste isolation potential that is not currently being relied upon to demonstrate regulatory compliance. Such data that is recognized to comprise an important aspect of the site's natural barriers would likely decreases uncertainty in determining compliance with subsystem or total system performance objectives.

- Site performance - No change from the base case.

- Cost -

  - Waste fund. A cost estimate of 30 percent (increase testing) over a nominal $7M/year geochemistry program expenditure with LA in 2001 totals $20M, but this cost is not significant relative to other alternatives evaluated.

  - Utilities. No change.

B8 - GREATER RELIANCE ON NATURAL BARRIERS

This alternative strategy consolidates in 3 separate alternatives or scenarios that have the overall effect of adopting even greater reliance on natural barriers at the site than assumed in the base case.

1. The functional hypothesis is adopted that the site is highly robust and has a very high likelihood of compliance with total-system requirements. Some of the engineered barriers that now require extensive testing and design effort would therefore not provide significant increases in performance. The site characterization program dealing with the study of natural barriers would be maintained. However, reduced reliance on engineered barriers would allow a reduction of scope in the development of the EBS. Protection to human health and safety is not compromised because the same total system performance is achieved with greater reliance on the natural barriers. It is assumed that the waste package related tests planned for the ESF which are on the critical path will provide limited information that would be helpful in demonstrating waste isolation and therefore could be reduced. Associated laboratory testing would also be eliminated.

2. More information regarding the saturated zone and less uncertainty in this information is relied upon for demonstrating compliance with regulatory performance objectives, particularly those associated with the effects of unanticipated processes and events. Information would be obtained to allow explicit evaluation of ground water and radionuclide travel time in the aquifer underlying the unsaturated units. While these increments may not be significant for expected conditions, they may be significant for disruptive conditions in which consideration of new pathways through the unsaturated zone will have to be considered in the licensing hearings.

3. The current repository horizon is designed to be at least 200 meters below the ground surface. The repository horizon could be brought closer to the surface and the distance for vertical ground water travel to the saturated zone could be lengthened by as much as 100 meters.

Advantages

- Reduced ESF and related lab testing would reduce costs related to EBS and waste package.

- Raised MGDS horizon would make repository access by ramp more efficient.

- Raised MGDS horizon would require shallower drilling and would shorten drilling schedule which is on critical path for SBT.

- Raised MGDS horizon could provide increased confidence in meeting the ground-water travel time subsystem and total system performance objectives.

- o Raised MGDS horizon would provide increased confidence that the water table will not rise and saturate the underground facility located in the unsaturated zone 10 CFR 60.122(c)(22).

- o Raised MGDS horizon would provide increased confidence that fully saturated voids contiguous with the water table do not encounter the underground facility.

- o Raised MGDS horizon would provide increased confidence that perched water bodies will not saturate portions of the underground facility or provide a faster flow path from an underground facility located in the unsaturated zone to the accessible environment.

- o Hydrologists have greater confidence in understanding ground water movement in the saturated zone.

Disadvantages

- o Raised MGDS horizon would increase concerns about erosion or it may diminish the benefit of lateral diversion of ground water.

- o Possible challenge to reasonable assurance of meeting performance criteria in adjudication resulting from change in emphasis to more reliance on geologic setting (isolation) and less reliance on EBS (containment).

- o Requires more and deeper drill holes to the saturated zone and rocks, and possible costs to qualify existing data.

Impediments to Implementation

- 10 CFR 122(b)(5) -- Siting Criteria. [Favorable condition on minimum depth.]

- 10 CFR 60.122(c)(16) -- Siting Criteria. [Potentially adverse condition on extreme erosion.]

Evaluation of This Scenario

- o Schedule - The evaluation team identified less than 1 year (0.7 year) savings from the base case for options 1 and 3, option 2 may increase schedule due to length of time for drilling deep holes (drilling program on critical path). The group agreed that the savings estimated for 1 and 3 was a "soft" number to indicate that these might be good ideas, but that its effect on schedule savings could not be gauged. Other ranking factors, however, were favorable. No critical path analysis was performed.

- o Licensing probability - No change from the base case for options.

- Site performance - Increased for 1 and 3. Raised MGDS assumes that a greater distance to the water table would have a proportional effect on the ground water travel time, and that current confidence in the waste isolation capability of the geologic setting, becomes even greater. Decreased for 2; specifically GWTT and geochemical retardation, performance assessments (DOE, 1986, [EA for Yucca Mountain]) have not shown the saturated zone, alone, to be an especially promising natural barrier.

- Cost -

  - Waste fund. No cost savings for 1 and 2 was claimed due to the "soft" estimate of schedule saved. Costs for deeper drilling would be higher than current base case estimates.

  - Utilities. No change.

C1 - EARLY SUBMISSION OF THE LICENSE APPLICATION/CONCURRENT CHARACTERIZATION

Assuming that the Yucca Mountain site is found suitable based on early site characterization studies, use available information to prepare the LA as early as possible with some SBT and either with or without an ESF. For example, early site characterization could consist of the drilling of 5 or more boreholes to help qualify existing site data and clarify understanding of certain site features. Analog in situ test data from G-Tunnel could be qualified and used to the extent applicable if no ESF is constructed. If any inconsistent information is developed during later site characterization activity, provide this information to the NRC through application supplements.

Advantages

- Achieves major program benchmark earlier.
- Potential for early construction authorization if LA can be submitted earlier.
- Eliminating the ESF may lower the repository cost if the repository is constructed based on analog and existing information, and compliance is demonstrated as construction proceeds and by performance confirmation program results.

Disadvantages

- Could be perceived as a gamble by DOE to cut corners or to save a "bad" site.
- Increases risk of an unfavorable decision to docket the LA.
- Costs and credibility involved in qualifying existing data to help support an early LA.
- Requests for additional information by NRC after docketing would not lower total cost of characterization because data would have to be gathered anyway in order to fulfill NRC requests.

Impediments to Implementation

- NWPA and 10 CFR Part 60 explicitly regard exploratory shaft construction as part of site characterization.
- Only qualified information may be used in the LA. Some existing data and cores would not be qualified.
- The NRC would need to agree to docket an application based on minimal new information.
  - 10 CFR 2.101(a)(3) -- Filing of Application. [Rules for NRC's docketing of applications.]

- Possible lack of in situ ESF test data from the Topopah Spring Tuff in an early LA.

Evaluation of This Strategy

- Schedule - This alternative was assumed to reduce the present schedule by 1.5 years. The tradeoff was that significantly more time would be needed for licensing activities than the base case due to the iterative nature of applying with incomplete information followed by NRC requests for additional data. See attached critical path evaluation for further information.

- Licensing Probability - Decreased; The risk of NRC not docketing the application along with the negative perceptions to be expected from oversight groups lead to the conclusion that this action would reduce the probability of receiving a license.

- Site Performance - Decreased; The strategy of applying with incomplete information and the prospect of doing PA calculations with less information lead to the prediction that site performance models would yield larger uncertainties that would reduce the confidence in the performance of the site.

- Cost -

  - Waste Fund. A total of $1 B was the estimated savings based on $450 M due to schedule reductions and a $550 M reduction in site characterization work and reduced staffing levels.

  - Utilities. Utility cost reductions were estimated at $300 M for the shortened schedule.

- Other comments and interfaces - There was significant dissent in the groups as to whether this was a viable alternative due to the licensing risks. This alternative could be combined with the more active licensing relationship with the NRC as a way to mitigate some of this risk.

CRITICAL PATH ANALYSIS

C1 - EARLY SUBMISSION OF THE LICENSE APPLICATION/CONCURRENT CHARACTERIZATION

SCHEDULE ASSUMPTIONS:

- LA Submittal 30-Apr-00: Schedule Savings = -1.5 Yrs.;
- SBT and ESF programs do not constrain completion of PA and design.
- Implies that any constraints imposed on LA submittal would be related to management actions.

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	31-Mar-92	-0.5	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	30-Jun-95	-1.0	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	02-Jan-91	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	31-Mar-92	-0.5	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	31-Jul-95	-0.9	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	30-Oct-99	-1.5	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	30-Apr-00	-1.5	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	30-Sep-99	-1.5	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	30-Oct-99	-1.5	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	30-Jun-92	0.0	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	30-Nov-92	0.0	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	30-Apr-00	-1.5	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Apr-03	-1.5	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Jul-08	-1.5	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Oct-06	-1.5	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);

Positive (+) values denote slippage re: Base Case Dates (years behind schedule).

C2 - EARLY CHARACTERIZATION OF CALICO HILLS UNIT

This alternative licensing strategy defines an approach whereby DOE could increase reliance on what is currently perceived to be the site's most important natural barrier, the Calico Hills unit. Whether rulemaking to modify emphasis on natural or engineered barriers in performance objectives is pursued or not, this strategy advocates that the most expeditious means decided upon to characterize this unit is carried out to provide increased confidence in meeting NRC's subsystem performance objectives and/or EPA's total system performance objectives. It assumes that the optimal characterization strategy that results from the Calico Hills Risk/Benefit analysis is acted upon as early as possible in the characterization program to determine just how effective this unit will be as a natural barrier to radionuclide migration. Should the Calico Hills unit be sufficiently effective, other site characterization activities would be reduced and submission of the LA would be expedited.

Several options for characterization of the Calico Hills unit are now under consideration by the Calico Hills Risk/Benefit study:

1. Outside access; southeast part of block, 2 accesses, extended drifting, no ESF connection, with additional SBT to augment characterization of unit.

2. Inside access, south part of block, 2 accesses, extended drifting, integrated with the ESF.

3. Inside access, northeast part of block, limited facility, integrated with the ESF (base case strategy of SCP).

4. Inside access, south part of block, limited facility, integrated with the ESF.

5. Inside access, northeast part of block, 2 accesses, extended drifting, integrated with ESF.

6. Outside access, southeast part of block, extensive drifting, no ESF connection with additional SBT to augment characterization on unit.

7. Outside access, southeast part of block, limited facility, no ESF connection, with additional SBT to augment characterization.

As part of the Calico Hills Risk/Benefit Analysis that is currently underway, a ranking of methodologies that can be used to characterize the unit will be made. A wide range of methods is under consideration by the Calico Hills task, from off-block simple adits driven into the outcrop, to very extensive tunneling on-block within the unit. This alternative assumes early evaluation of, 1) matrix mineralogy, 2) matrix hydrologic properties, 3) fracture characteristics (density, fillings, interconnectedness, aperture distributions, etc., 4) fracture hydrologic properties; and 5) radionuclide retardation properties for the Calico Hills unit.

Advantages

- Would provide early test of the hypothesis that the Calico Hills is a suitable and effective natural barrier.

- Could provide increased confidence in meeting subsystem performance objectives (the ground-water travel time) and total system performance objectives.

Disadvantages

- May preclude or require postponement of some testing in surface-based boreholes above the Calico Hills unit.

- Subsurface access to the Calico Hills unit will be difficult and costly.

Impediments to Implementation

- Scope of Calico Hills characterization is dependent on outcome of ESF Alternatives to complete and evaluate options in the Calico Hills Risk/Benefit analysis.

- Additional resources may be required that are contingent on the recommendations of the Calico Hills study.

Evaluation of This Scenario

- Schedule - The evaluation team identified a schedule savings of 2 years on the base case, assuming early characterization of the Calico Hills supports a conclusion that it will be the most significant barrier for radionuclide migration at the site. If the Topopah Spring Tuff is not allocated partial performance for meeting the GWTT requirement, there is no need to perform an extensive in situ testing program in the Topopah Spring Tuff for this purpose other than to obtain rock mechanical and engineering properties for repository design. See attached critical path analysis for further information.

- Licensing probability - No change from the base case, however, perceptions of hazard by Nevada and US were thought to be positive relative to the base case, due to a concerted effort by DOE to determine the value of the unit as a natural barrier (note: DOE continually points to the radionuclide retardation potential of the Calico Hills as being a primary reason Yucca Mountain remains under study as a potential location for a HLW repository and any effort by DOE to demonstrate the validity of this informed belief was therefore judged to be positive).

- Site performance - No change from the base case.

- Cost -

  - Waste fund. A 2 year schedule savings translates into a program savings of $600M. Also, cost is contingent on the characterization strategy adopted for the Calico Hills unit.

  - Utilities. A two year savings in schedule could lead to a cost savings of up to $400M in at-reactor storage.

CRITICAL PATH ANALYSIS

C2 - EARLY CHARACTERIZATION OF CALICO HILLS UNIT

SCHEDULE ASSUMPTIONS:

- LA Submittal 30-Oct-99: Schedule Savings = -2.0 Yrs.;
- Acceleration of information available to design process and PA
- ESF/Engineered Barrier Demonstration Tests do not constrain LA.

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	31-Dec-91	-0.7	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	31-Dec-94	-1.5	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	No Change	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	31-Jan-92	-0.6	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	28-Feb-95	-1.3	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	30-Apr-99	-2.0	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	30-Oct-99	-2.0	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	31-Mar-99	-2.0	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	30-Apr-99	-2.0	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	No Change	0.0	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	No Change	0.0	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	30-Oct-99	-2.0	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Oct-02	-2.0	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Jan-08	-2.0	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Apr-06	-2.0	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);
Positive (+) values denote slippage re: Base Case Dates (years behind schedule).

C3 - TOTAL SYSTEM CHARACTERIZATION WITH PARALLEL SURFACE-BASED TESTING (SBT) AND ESF (ORIGINAL SCP CONCEPT)

A. ESF

The base case schedule calls for two years of initial SBT to gather data pertaining to site suitability, and an ESF deferred until late 1992. DOE could restart ESF Title II design immediately (FY 91). This would involve the staffing up of architects/engineers. Design would currently begin on each of the means of access to the test level (shaft or ramp) and ESF layout employing construction options currently being considered in the ESF Alternatives Study.

The use of a staged design would be used in order to speed up construction start. Shaft construction (collar or ramp portal) can be initiated 1 year earlier than the presently scheduled base case date of October 1992. Current direction from OCRWM calls for restart of design in September 1990, to meet the start of shaft construction in November 1991.

B. SBT

Funding for the systematic drilling program should be a high-priority item, and allocation should allow the Project to increase the number of operating drill rigs and support crews to allow quicker initiation of the SCP study program. The site characterization program would benefit tremendously by emplacement of new boreholes and the gathering of new data as soon as possible.

The availability of long-lead time equipment is a significant uncertainty in the base case schedule. Budgets for capital equipment acquisition have been cut in the past to preserve program staff levels and significant schedule disruption could occur if major equipment items are unavailable when site access is acquired. In lieu of purchasing capital equipment, much recent attention has been spent investigating the option of leasing much of this equipment, as appropriate.

Advantages

- Earlier start of ESF construction allows earlier commencement of in situ testing.
- ESF and surface-based long-lead tests for performance confirmation program are begun earlier.
- SBT program completed sooner.

Disadvantages

- Accelerated, phased design process increases management control and planning and could result in some ESF design rework and increased cost.
- Parallel ESF design work with site data gathering (also assumed in the total-system approach in the SCP).

- Program could be criticized if long-lead time equipment acquisition pursued aggressively despite major delays due to litigation.

Impediments to Implementation

- Air quality and water use permits are required and the permitting impasse with the state would have to be solved.
- Current funding levels will not support early ESF.
- Current funding levels are inadequate for long-lead time acquisition of capital equipment.

Evaluation of This Scenario

- Schedule - The evaluation team agreed that OCRWM guidance and direction for restart of design will result in a 1 year reduction from the base case. Allocation of full resources to site characterization would result in a schedule savings of one-half year in that the same site data would be collected sooner, which would assist in the downstream part of licensing. See attached critical path analysis for further information.
- Licensing probability - No change from the base case.
- Site performance - No change from the base case.
- Cost -
  - Waste Fund. A 1.5 year schedule reduction translates into a program savings of $450M.
  - Utility. A 1.5 year schedule reduction would save $300M on at-reactor storage costs.

CRITICAL PATH ANALYSIS

C3 - TOTAL SYSTEM CHARACTERIZATION WITH PARALLEL SURFACE-BASED TESTING (SBT) AND ESF (ORIGINAL SCP CONCEPT)

SCHEDULE ASSUMPTIONS:

- LA Submittal 30-Apr-00; Schedule Savings = -1.5 years.
- Accelerated SBT program completion 2 years earlier.
- Accelerate start of ESF Title II design to October 1, 1990.

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	31-Mar-92	-0.5	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	30-Apr-95	-1.2	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	02-Jan-91	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	31-Jan-92	-0.7	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	31-Aug-95	-0.8	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	30-Oct-99	-1.5	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	30-Apr-00	-1.5	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	30-Sep-99	-1.5	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	30-Oct-99	-1.5	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	02-Dec-91	-0.6	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	30-Apr-92	-0.6	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	30-Apr-00	-1.5	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Apr-03	-1.5	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	31-Jul-08	-1.5	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Oct-06	-1.5	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);

Positive (+) values denote slippage re: Base Case Dates (years behind schedule).

C4 - PROCEDURAL ASPECTS OF DETERMINING "SITE SUITABILITY" PRIOR TO ESF

This alternative focuses on actions that address the procedural aspects of determining site suitability. The Secretary of Energy's "60-day" report to Congress did not identify how site suitability would be determined. The SCP had assumed a parallel total-system approach involving study of both natural (dominantly surface-based testing [SBT]) and engineered barriers (dominantly Exploratory Shaft Facility) as well as the interactions between the two. The base case schedule resulting from the "60-day" report calls for an initial SBT program to search for unsuitable site conditions.

Application of any aspect of 10 CFR 960 requires careful consideration because this regulation, given NWPAA, is a potential subject for litigation by intervenors. The operational assumption for this scenario is that attributes of the site remain favorable after two years of SBT.

A. DE FACTO FINDING

A finding of "site suitability" prior to proceeding with construction of exploratory shafts is not required by the NWPA. Since the Secretary's "60-day" report called for a decision point after 2 years of SBT (assuming site access is gained in 1991) on whether to proceed with an ESF in late-1992; how that decision is made and whether it needs to be documented has impact on preserving the base case schedule. If a decision to proceed with an ESF implies site suitability, an informal, de facto finding of such suitability can be made after a performance assessment (PA) exercise. De facto suitability is presumed through absence of evidence of site unsuitability. An informal, de facto, option has the potential of maintaining the base case schedule, since it will not be necessary for DOE to mobilize resources, prepare, review, and approve a major new programmatic document.

The data gathered through a program of surface-based testing requires some evaluation and interpretation after its acquisition. Iterative performance assessments (PA) can be used, prior to a decision regarding the ESF and throughout the remainder of characterization, to test the adequacy of data in relation to the reliance being placed (performance allocation) on various natural and designed subsystems for waste isolation.

As part of iterative PA exercises, a DOE peer-review panel, alone or in combination with third-party representation from the state, NWTRB, and the NRC, could examine the relationship between data uncertainty and conclusions for the major geotechnical programs. Discussion in the evaluation workshops strongly leaned toward framing a role for the NWTRB and/or NAS to perform an independent third-party review of any site suitability decision, rather than proceeding solely on DOE evaluation.

B. FORMAL FINDING

Another option is to adopt a formalized process ("formal finding", i.e., PA exercise and its documentation in a report) to document site suitability, after which the ESF could move forward. Mobilization of resources and production of a document will likely have impact on the base case schedule.

Advantages

- Involvement of an iterative PA/peer-review structure, framed in the role of a third-party with broad representation, has the potential of enhancing technical credibility of the DOE.
- Evolution of the NWTRB and/or NAS as a "framer of issues" for any site suitability decision would heighten the program's technical credibility.
- A "formal finding" might be of value in the out-year licensing process.
- De facto suitability option would allow earlier start of ESF by lessening the duration of the decision point after a 2 year SBT program.
- Iterative PA allows abandonment of an unsuitable site earlier.
- Commits ESF construction resources only after determination of site suitability.
- Interactive PA will aid prioritization of study programs for assessment of site suitability through SBT.
- Reinforces the stated DOE objective of abandoning an unsuitable site early as possible, should the data indicate.
- Iterative PA exercises should help the modelers become more aware of what data they will be receiving from PIs, and conversely, the PIs become more aware of what the modelers need.
- Quick response and rapid Project awareness of new, and "surprise," site data.

Disadvantages

- Iterative PA exercises and their documentation require a significant technical staff commitment that could be potentially disruptive of new data acquisition and analysis, depending on interval between interim PAs.
- A poorly conceived PA/peer-review process could lead to additional polarization of issues, rather than convergence.
- "Improper" (as viewed by intervenors) application or lack of documentation pertaining to implementation of a suitability determination process will likely result in litigation and schedule slip of unknown duration.
- Expert panel/peer review could evolve into just another requirement that DOE has levied upon itself.

- "Down time" for technical staff during preparation and publication of a "formal finding" would be costly.

- Technical validity of "formal finding" in absence of in situ data could be viewed as inadequate or incomplete.

- Potential to draw NRC into the review of a "formal finding."

- Might tend to rush, or be viewed as undue pressure, for PI's to render semiformal conclusions about the site with a data base perhaps not to their satisfaction.

Impediments to Implementation

- Funding to support staff needed to perform interactive PA and review panel responsibilities.

- Since 10 CFR 960 still applies to Yucca Mountain, DOE must examine how this regulation might affect schedules. The alternatives presented here as well as the base case assumed that 10 CFR 960 would not affect schedules.

Evaluation of This Scenario

- Schedule - The evaluation team determined that the base case schedule could be preserved, assuming some type of de facto suitability determination option was adopted. If a "formal finding" is adopted, a schedule slip on the base case of at minimum 1 year is likely. No critical path analysis was completed for this scenario.

- Licensing probability - The evaluation team's collective opinion was divided between the belief that a "formal finding" would increase the probability, and that there would be no change from the base case for a de facto process. The group could not come to a clear consensus on affect on perception of hazard might be.

- Site performance - No change from the base case.

- Cost -

  - Waste fund. A 1 year slip in the base case estimated for a "formal finding" would translate into a program cost of $300M.

  - Utilities. A 1 year slip would result in additional storage costs of $200M.

C5 - UNDERGROUND RESEARCH LABORATORY (URL)

Develop an underground research laboratory (URL) away from the repository block, but in the general vicinity of the site where the host-rock horizon is accessible, or in a geologic setting analogous to UZ tuff. Two concepts were advanced, a large URL and a relatively small facility consisting of a short single-entrance adit. Neither a large or small URL alternative replaces the ESF, but would evolve the purpose of the ESF to become a performance confirmation facility that is utilized during and after LA adjudication to meet the requirements of 10 CFR 60, Subpart F.

For purposes of this report, a URL differs from a Test and Evaluation Facility (TEF) in that no HLW would be emplaced in an URL for purposes of in situ test and evaluation.

a. In a geologic media similar to rocks at the Yucca Mountain site, for example, in the volcanic Bandelier tuffs near Los Alamos, NM, or at the Apache Leap site in Arizona, or alternately in volcanic rocks on or near NTS. A large URL facility could provide research alcoves available to scientists funded by the National Science Foundation or the Office of Basic Energy Sciences of the DOE. A large, multi-party funded URL could lend further credibility and wider familiarity and acceptance from the geoscience community for DOE's research program. Depending on the size of the facility, the amount of near-field or in situ test data that could be provided by a large URL facility would be offset by its construction time. Testing would begin close to the time ESF testing would begin according to the base case.

b. A small facility could be a simple adit to access the Topopah Spring Tuff from nearby, off-block outcrops. Such a facility is envisioned to be about 200 feet in length. The immediate start of a small test facility could accelerate acquisition of near-field geology data by several years (e.g., fracture-matrix flow, geochemical retardation).

c. A staged approach could also be used, whereby a larger off-block facility is constructed followed by a smaller near-site facility at, for example, Busted Butte or Yucca Wash.

d. Fund and restart G-Tunnel activities. The program already possesses a URL that is already built.

Advantages

- Location of a facility in the proposed host-rock, but off-block, could maximize testing to focus on technical issues through aggressive testing of the Topopah Spring Tuff, without impacting the capacity of the site (repository block) to isolate waste. The ESF must also address licensing issues because of its potential for incorporation into the repository and must therefore be more restrained in its testing program.

- Small facility is logistically simple and inexpensive.

- Reduced testing needs in ESF could shorten time to license application.

- Dedication of URL space to NSF/BES could allow independent confirmation to help consensus-building in the scientific community. DOE could demonstrate support for national scientific advancement.

- URL would provide an early program of prototype testing applicable to ESF, as would restart of G-Tunnel.

- Out-of-state URL could alleviate current permit impasse.

- The design and construction of an URL could be completed without the implementation of a NRC (10 CFR 50, App. B) type quality assurance program and would not have to conform to 10 CFR 60 design requirements.

Disadvantages

- Additional costs to program, depending on URL scope.

- Use of Waste Fund resources to finance URL used by other entities, such as NSF/BES may face legal challenge.

- A supportable argument will have to be made that URL data/experience is representative of Yucca Mountain conditions.

- Arguments on representativeness of data may force confirmation, in the ESF, of underground testing done in an URL. DOE could be criticized that work is duplicative and more costly than for single underground facility.

- Depending on how close an URL is to the repository block, an assessment of its potential to impact capability of the site to isolate waste may be required.

- Changing the mission of the ESF (through adoption of URL concept) from a primary site characterization effort to a more explicit performance confirmation role may lead to perception that ESF is start of repository.

- Specifically siting and building an URL may lag to an extent where the value of earlier in situ technical data (with or without HLW) is lost in comparison with construction of a "demonstration" ESF (Scenario "Evolve ESF into a HLW Demonstration Facility as Part of Site Characterization," p. A-67) or a base case ESF, where use of HLW for in situ testing as part of site characterization has been undertaken.

Impediments to Implementation

- In the case of an off-block URL, the need for air quality and water use permits from the state predominates.

- Congressional authorization for spending would need to be secured for a URL.

Evaluation of This Scenario

- Schedule - The evaluation team could not identify a schedule savings on the base case for either a large or small URL alone or in combination. Since a URL, as defined in this report, would not include multi-year in situ testing of emplaced HLW, no major advantage from a technical perspective is recognized. Slip avoidance on the base case schedule can be had by prompt restart of the G-Tunnel testing program. No critical path analysis was completed for this scenario.

- License probability - no change from the base case. Although the group identified a probable positive reaction from oversight groups regarding this alternative, the question of representativeness of data from a facility that was off-block remains a significant obstacle.

- Site performance - Increased; Analog research in a similar rock type in the UZ would provide much additional data pertaining to UZ processes, thus lowering technical uncertainty and also addressing the need for more generic research on the UZ in semi-arid climates. Potential for reduced testing at the site leading to reduced impact on the waste isolation capability of the site.

- Cost -

  - Waste fund. The costs of a URL would depend largely on concept and scope. A simple adit into an outcrop exposure of the Topopah Spring could be constructed for $500K, however construction of a deep mined facility with shaft access would be much more expensive (estimated at $200M). Potential schedule savings for downstream operations (testing not performed in the ESF) would be offset by the facility construction costs, which could vary considerably. In contrast, costs of operating G-Tunnel ($2M) and support of all activities conducted there ($3M) for one year totals $5M.

  - Utility. No impact.

- Other comments and interfaces - Congressional action would be necessary to authorize money for a new URL(s). State opposition would pose additional problems for implementation.

C6 - TEST AND EVALUATION FACILITY (TEF)

A. Optimum Utilization of G-Tunnel:

G-Tunnel is an existing, functional test facility in unsaturated zone volcanic rocks on Rainier Mesa, NTS, a geologic setting analogous to Yucca Mountain. As an alternative to constructing a new TEF, testing in the G-Tunnel facility could be restarted and, in addition to the interrupted testing activities, in situ testing could begin with emplaced borosilicate waste. Arrangements with NTS defense programs (DP) could be made to bear a more equitable cost of the site-specific research and development on this waste form and the package for it. An optimized test program using G-Tunnel as the TEF concept would benefit from a series of advantages, not the least of which would be to initiate payments by DP into civilian program activities. A newly constructed TEF would provide 16 years of in situ test data with HLW (assuming operational status in mid-1994). Evolution of the G-Tunnel mission now to include in situ testing of emplaced HLW would allow an additional 4 years to an in situ test program with HLW since G-Tunnel is already operational. This alternative allows the possibility of 20 years of in situ test data with emplaced borosilicate glass, in a geologic setting analogous to Yucca Mountain Topopah Spring Tuff.

B. New Facility:

Develop a Test and Evaluation Facility (TEF). A TEF is already recognized as an option in NWPA Section 211 to provide for the construction, operation, and maintenance of a geologic test and evaluation facility to demonstrate the feasibility of geological disposal. A TEF differs in concept from a URL in that emplacement of solidified HLW or spent fuel (up to 100 MTU) can be accommodated. Otherwise the idea is similar to the URL concept, in that it would be constructed in the vicinity of Yucca Mountain, off the proposed repository block and in the unsaturated zone, but in the same host-rock horizon. The process of locating a TEF is described in the NWPA and would allow the gathering of site-specific data with HLW prior to the 1995 ESF in situ test phase of the base case, and would provide a longer duration of information and data gathering with HLW emplaced in unsaturated zone volcanic tuff. The NWPA provision allowing waste emplacement of test and evaluation purposes potentially allows great savings for near-field geologic setting and waste package programs. A TEF could also vary in size and scale similar to the URL discussed in Scenario "Underground Research Laboratory," p. 52 (large, mined, shaft-accessed facility or small adit from outcrop).

If a TEF became operational in mid-1994, 16 years of in situ data could be gathered beyond the base case which assumes first waste emplacement in a repository, 6 years after construction. This schedule savings could be technically important, but it does not result in 16 years schedule savings from the base case critical path. This scenario is moot if the ESF is evolved into a demonstration facility per alternative "Evolve ESF into a HLW Demonstration Facility as Part of Site Characterization."

Advantages

- Location of a facility in the proposed host-rock but off-block could maximize testing to focus in on technical issues through aggressive testing of the Topopah Spring Tuff, without impacting the capacity of the site (repository block) to isolate waste. The ESF must also address licensing issues because of its potential for incorporation into the repository and must therefore be more restrained in its testing program.

- Reduced testing needs in ESF, that result from TEF research, could shorten time to license application.

- TEF would provide an early program of prototype testing applicable to ESF.

- G-Tunnel option; additional funding source for the G-Tunnel operations.

- G-Tunnel option; the prospect of very near-term (facility already on line) in situ testing with HLW.

- G-Tunnel option; permit issue moot since such activity is likely to be covered by existing NTS permit(s) because defense HLW and DP program money, and not spent fuel and Waste Fund money, would be used.

- The design and construction of a Test and Evaluation Facility could be completed without an NRC (NQA-1) quality assurance program and would not have to conform to 10 CFR 60 design requirements.

Disadvantages

- Significant additional costs to program.

- The argument will have to be made that TEF data/experience is representative of Yucca Mountain conditions.

- Arguments on representativeness of data may force repetition of underground testing done in an TEF in the ESF. DOE could be criticized that work is duplicative and more costly than for single underground facility.

- Depending on how close a TEF is to the repository block, an assessment of its potential to impact capability of the site to isolate waste will be required.

- Changing the mission of the ESF (through adoption of TEF concept) from a primary site characterization effort to a more explicit performance confirmation role may lead to perception that ESF is start of repository.

- Specifically siting and building a TEF may lag to an extent where the value of earlier in situ technical data (with or without HLW) is lost in comparison with construction of a "demonstration" ESF (Scenario "Evolve ESF into a HLW Demonstration Facility as Part of Site Characterization") or a base case ESF, where use of HLW for in situ testing as part of site characterization has not been adopted.

- Significant intervenor opposition should be expected to any emplacement of HLW in a TEF near located near the Yucca Mountain site.

Impediments to Implementation

- In the case of an off-block TEF, the need for air quality and water use permits from the state predominates.

- For the TEF, the stated time limits in the NWPA have expired. Even if Congress extended the schedules, the lengthen procedures for selecting a TEF site (preparation of siting guidelines, nominating sites, preparing environmental assessments for each site, etc.) would add at least two years to the base case. Unless Congress makes extensive changes to the NWPA, this alternative is not viable.

  - NWPA, as amended, Title II, Research, development, and Demonstration Regarding Disposal of High-Level Radioactive Waste and Spent Nuclear Fuel, §213 -- Identification of Sites, and §214 -- Siting Research and Related Activities. [Defining timing for the TEF facility.]

- Congressional authorization for spending would need to be secured for a TEF as a new component at the HLW program.

Evaluation of This Scenario

- Schedule - The evaluation team identified a schedule savings of 1 year on the base case for either TEF option, provided the TEF was operational for testing by mid-1994, a somewhat optimistic assumption for a newly constructed facility. The capacity for collecting 16 to 20 more years of in situ test data with HLW beyond the base case was readily acknowledged to be a major technical advantage, however such an advantage is in the reduction of near-field/waste package interaction technical uncertainty rather than schedule savings on the base case critical path. If selective tests were dropped from the ESF testing program that were longer-term, it would shorten critical path only to a point because excavation and rock mechanics testing that is Topopah-specific still has to take place in the ESF. See attached critical path analysis for further information.

- Licensing probability - Increased; Less technical uncertainty regarding near-field/waste package interactions would result from long-term in situ testing with HLW. The reaction of oversight groups was judged to be positive to this alternative. The perception of hazard in Nevada was negative relative to the base case, even though a significant track record exists as a result of the Climax demonstration, however, the perception of hazard to the US public was judged to be positive due to incremental demonstration of the technological capability to manage HLW.

- Site performance - Increased; assuming greater in situ experience with HLW results in the design of a more robust or resistant waste package and emplacement mode.

- Cost -

  - Waste fund. A 1 year schedule savings would translate into a program savings of $300M, which would be offset by the cost of constructing the facility (option 2 or (4), leaving no net change in cost. These additional costs are avoided in option 1, and the total operating and testing outlay for G-Tunnel in contrast, is $5M per year.

  - Utilities. A one year schedule savings would result in a $200M savings in at-reactor storage capacity.

- Other comments and interfaces - Congressional action would be necessary to authorize money for this type of facility. State opposition would pose additional problems for implementation.

CRITICAL PATH ANALYSIS

C6 - TEST AND EVALUATION FACILITY (TEF)

SCHEDULE ASSUMPTIONS:

- o No change to Base case LA Submittal 30-Oct-01;
- o Schedule Saving affects only post-LA Submittal: -1.0 Yr.;

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	No Change	0.0	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	No Change	0.0	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	No Change	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	No Change	0.0	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	No Change	0.0	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	No Change	0.0	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	No Change	0.0	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	No Change	0.0	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	No Change	0.0	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	No Change	0.0	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	No Change	0.0	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	No Change	0.0	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04			Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Jan-09	-1.0	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Apr-07	-1.0	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);
Positive (+) values denote slippage re: Base Case Dates (years behind schedule);

C7 - INCREASE EMPHASIS ON ANALOG FIELD/LABORATORY STUDIES

This alternative calls for a programmatically increased reliance on regional
studies. Increase the emphasis on analog field and laboratory studies for rocks that are, 1) in a similar hydrogeologic setting, 2) similar to the proposed repository host-rock horizon, and 3) are both 1 and 2 and that have surface outcrops that are off-block and easily accessed. With care, analog sites could be located where test methods and procedures could be developed for use at Yucca Mountain. Hardware and software could also be developed and subjected to prototype testing at analog sites as well as in carefully designed bench-scale laboratory experiments.

If the goal of testing is to establish an understanding of fundamental processes (such as fracture-matrix flow) or to understand relationships between rock properties, then analog sites should provide much information that is relevant to Yucca Mountain studies. Only those tests that characterize parameter variability at Yucca Mountain could not reasonably be conducted elsewhere at analog sites. As an example, one possibility could be to frame a cooperative testing agreement with the underground weapons testing programs on the Nevada Test Site (NTS) for increased study of radionuclide migration from underground tests, which is a natural laboratory setting available to the repository program.

This alternative also assumes increased support of cooperative interaction with generic and site specific work in foreign HLW programs, when that work has potential value to the U.S. program.

Advantages

- Analog site studies could explore wider range of variables (rainfall, percent UZ saturation, permeability) to bracket Yucca Mountain conditions.
- Analog site studies would have no direct impact on waste isolation potential of Yucca Mountain site.
- Near-term analog site studies have the potential to help retain key investigators who would be lost due to lack of field work in program.
- Could largely be accomplished on public lands with less state permit exposure as site-specific site characterization activities.
- Contributes to "reasonable assurance" of program.

Disadvantages

- Arguments on representativeness of data would have to be addressed.
- Although it would be a way to begin an analog surface based testing near the site, they are not part of the program's technical planning baseline.

- Potential for perception that DOE is "working around" the permit problem with the state.

Impediments to Implementation

- Permits will be needed for some testing at analog sites.
- Because such an expansion is not part of the technical baseline, no provision for funding exists.

Evaluation of This Strategy

- Schedule - the evaluation team identified no schedule savings on the base case. There was agreement that the scenario has technical merit in that a surface-based analog studies program would gather a variety of additional geotechnical data that would be relevant to a DOE determination of site suitability. Beyond the intrinsic value of gathering it, the group could not define what value this data would have on affecting the base case schedule critical path, since the base case assumes that planned data acquisition is adequate for a license. No critical path analysis was completed for this scenario.
- Licensing probability - Increased; more data as well as more varied data, would increase the probability of a license downstream, if DOE's LA was more solidly based as a result.
- Site performance - no change from the base case.
- Cost -
  - Waste fund. An additional cost to the program of 200 million was estimated for investigations as part of an analog test program, facilities, and operations.
  - Utilities. No change from the base case.

C8 - EVOLVE ESF INTO A HLW DEMONSTRATION FACILITY AS PART OF SITE CHARACTERIZATION

The role of an ESF in the characterization strategy is to be an in situ research and testing facility at the proposed repository level. As such, the ESF is a very utilitarian facility for the site program's technical needs. Current plans, however, do not include the use of HLW for in situ testing. The ESF's role can be modified to a "demonstration" facility analogous to the Climax test facility on the NTS. A demonstration facility might be akin to repository "construction scoping," where the emplacement of a small amount of HLW waste (10 MTU) could take place as part of a single-drift, underground test facility. The configuration and construction method for the ESF is under study as part of the ESF alternatives study, which is in the process of evaluating 17 potential options for proceeding with an ESF (Figure A-1).

The distinction between an evolved ESF and the URL and TEF concepts discussed elsewhere is that the ESF is constructed within the proposed repository block (on-block). An evolved ESF could allow an additional 15-16 years of in situ test data using HLW than that allowed by the base case (HLW emplacement in a repository 6 years after beginning construction [2010]).

This scenario may facilitate the concept of phased NRC licensing (Scenario "Resolve Disposal Issues as Part of Performance Confirmation").

Advantages

- Emphasis on demonstration takes small steps, rather than giant leap to full-operations, to test-out mechanics of an operational repository.
- Increased technical certainty in licensing, representativeness, and equilibration issues minimized by long span of in situ testing with HLW.

Disadvantages

- Feeds site pre-selection perception (only if constructed before a site suitability determination).
- Major intervenor resistance can be expected for any HLW emplacement regardless of quantity or purpose.
- Requires revision of SCP program if either demonstration ESF, URL or TEF option used on/near site.
- Operational viability is not an issue early in characterization, but in situ testing is.

Impediments to Implementation

- Section 113(c) of the NWPA limits the quantity of HLW to 10 metric tons.

YUCCA MOUNTAIN PROJECT

SUMMARY OF ESF/REPOSITORY OPTIONS

OPTION #		E.S.F.								REPOSITORY				
		ACCESS-1		ACCESS-2		MAIN TEST LEVEL				ACCESSES		CONSTRUCTION METHOD		
		SIZE	CONST. METHOD	SIZE	CONST. METHOD	LAYOUT	CONST. METHOD	LOCATION	ELE-VATION	SHAFTS	RAMPS (TBM)	RAMPS & DRIFTS	EMPL. AREA	TOTAL ACCESSES
1	BASE CASE	12' SHAFT	DRILL & BLAST	12' SHAFT	DRILL & BLAST	TITLE II G.A.	DRILL & BLAST	NE	SAME AS REPOS.	2 - 20'	1 - 25' 1 - 23'	TBM	DRILL & BLAST	6
2	A1	16' SHAFT	— " —	25' RAMP	TBM	MODIFIED T II G.A.	— " —	— " —	— " —	2 - 25'	1 - 25' + ESF	— " —	— " —	5
3	A2	16' SHAFT	— " —	16' SHAFT	DRILL & BLAST	— " —	— " —	— " —	— " —	— " —	2 - 25'	— " —	— " —	6
4	A4 REV. 1	16' SHAFT	— " —	12' SHAFT 25' RAMP	DRILL & BLAST TBM	— " —	— " —	— " —	— " —	1 - 25' ENLARGE ES - 2 25'	1 - 25' + ESF	— " —	— " —	5
5	A5	16' SHAFT	— " —	25' RAMP	TBM	— " —	— " —	S	— " —	2 - 25'	— " —	— " —	— " —	5
6	A7	25' RAMP	TBM	25' RAMP	— " —	— " —	— " —	NE	— " —	— " —	IN ESF	— " —	— " —	4
7	B3, REV. 2 —	16' SHAFT	· SBM · V-MOLE · BLIND BORE · RAISE BORE · DRILL/BLAST	— " —	— " —	— " —	MECH.	— " —	— " —	— " —	1 - 25' + ESF	— " —	TBM	5
8	B3, REV. 3 —													
9	B3, REV. 4 —													
10	B3, REV.5 —													
11	B3, REV. 6 —													
12	B4	16' SHAFT	DRILL & BLAST	— " —	— " —	— " —	— " —	S	— " —	— " —	— " —	— " —	— " —	5
13	B7	25' RAMP	TBM	— " —	— " —	— " —	— " —	— " —	— " —	— " —	IN ESF	— " —	— " —	4
14	B8	16' SHAFT	DRILL & BLAST	— " —	— " —	— " —	— " —	— " —	— " —	1 - 25'	2 - 25' + ESF	— " —	— " —	5
15	C1	16' SHAFT	— " —	— " —	— " —	TWO LEVEL	— " —	NE	TWO LEVELS SAME AS REPOS.	2 - 25' ENLARGE ES - 1 25'	1 - 25' + ESF	— " —	— " —	4
16	C4	16' SHAFT	— " —	— " —	— " —	— " —	— " —	S	— " —	2 - 25'	— " —	— " —	— " —	5
17	R11	12' SHAFT	— " —	12' SHAFT	DRILL & BLAST	TITLE II G.A.	DRILL & BLAST	NE	SAME AS REPOS.	2 - 25'	2 - 25'	— " —	— " —	6

Evaluation of This Scenario

- Schedule - The evaluation team identified a schedule savings of 1 year on the base case, assuming such a demonstration facility was operational by late 1995. This savings was considered "soft", or difficult to specifically isolate, and was attributed to an accumulation of factors. These factors include technical and institutional experiences stemming from the base case testing program being carried out beginning late-1995, and, 1) receipt of an NRC license to "receive and handle" a small quantity of HLW for in situ testing purposes in a demonstration facility, 2) the reduction of technical uncertainty regarding near-field/waste package interactions through use of HLW (and the more robust waste canister design and emplacement configuration that would result), and 3) the efficiencies gained in waste handling machinery that is tested-out during the demonstration period. See attached critical path analysis for further information.

- Licensing probability (full-scale license for a repository in a phased process) - Increased; due to institutional experience and reduction of technical uncertainty regarding near-field/waste package interactions. The reaction by oversight groups and perception of hazard by Nevada and the US was the same as the TEF alternative.

- Site performance - Increased; Greater in situ experience with HLW would result in the design of a more robust or resistant waste package and emplacement configuration.

- Cost -

  - Waste fund. A 1 year schedule savings translates into a program savings of $300M. Some part of this sum would be absorbed by design, construction, and operation of a HLW demonstration area in the ESF.

  - Utilities. A 1 year schedule savings translates into a storage savings of $200M.

CRITICAL PATH ANALYSIS

C8 - EVOLVE ESF INTO A HLW DEMONSTRATION FACILITY AS PART OF SITE CHARACTERIZATION

SCHEDULE ASSUMPTIONS:

- o No change to Base case LA Submittal 30-Oct-01;
- o Schedule Savings affects post-LA Submittal: -1.0 Yr.;

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	No Change	0.0	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	No Change	0.0	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	No Change	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	No Change	0.0	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	No Change	0.0	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	No Change	0.0	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	No Change	0.0	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	No Change	0.0	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	No Change	0.0	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	No Change	0.0	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	No Change	0.0	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	No Change	0.0	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Apr-04	-0.5	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Jan-09	-1.0	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Apr-07	-1.0	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);

Positive (+) values denote slippage re: Base Case Dates (years behind schedule);

D1 - RESOLVE DISPOSAL ISSUES AS PART OF PERFORMANCE CONFIRMATION

This alternative strategy proposes to conduct an initial site suitability evaluation and preliminary performance assessment as part of "phased" licensing to allow restricted storage in the repository. The use of the repository would either be restricted in terms of the type and amount of fuel that could be retrievably placed, or the closure would be subject to a full performance assessment to support a closure amendment. This amendment could take advantage of the extensive site specific information that would be available at that time. Specific ideas include:

1. Modify waste acceptance criteria; "cool-fuel"

   - The object of this strategy is to reduce environmental impacts of the repository and thus decrease uncertainties introduced by these impacts. While long-term and far-field effects would not be significantly changed, the short-term effects in the vicinity of the waste packages would be significantly decreased if waste that had been cooled for 40 or more years before accepted for emplacement at the repository.

   - Lower the initial source term for the repository by adjusting the waste specifications (lower burn-up or increased cooling time), limit the repository capacity, or limit the license term. Stress the advantage of gaining operating experience and confirmation information with a safer, lower source term, prior to eventual upgrading to full burn-up and capacity.

2. Defer issue resolution and reasonable assurance to closure

   - Defer licensing issue resolution or "reasonable assurance" to time of closure, after the repository is completed and loaded and a performance confirmation program implemented for many years. The repository would become an underground storage facility, subject to performance verification prior to closure.

Advantages

- "Cool fuel" can reduce uncertainty in duration of waste package containment integrity (meeting subsystem performance requirements) and downstream challenge during adjudication.

- Provides prototype operation to increase confidence if a limited capacity repository is approved.

- Provides relief from the need to demonstrate 10,000 year confidence immediately if a "storage contingent on performance confirmation" license is granted.

- Utilizes characterization data from entire site if the licensing is directed toward repository closure.

- Provides a positive public perception based on a reduced capacity, modular approach.

- Many of these elements could be imposed as license conditions under existing rules.

Disadvantages

- "Cool fuel" alters current concept that waste packages are likely to remain dry due to high temperature thermal loading.
- Increased cost of surface storage during cooling period.
- Defers final licensing decision to future generations if the licensing is directed toward repository closure.
- Limits utilities' fuel removal flexibility if burn-up or cooling time are limited.
- Increases the potential for additional hearings if an initial short-term license is granted, or phased acceptance is used.

Impediments to Implementation

- The provisions in the Nuclear Waste Policy Act, as amended, related to the siting and timing of a MRS facility, would need to be modified in line with achievement of the MRS elements of the base- case schedule.
  - NWPA, as amended, Subtitle C -- Monitored Retrievable Storage, §148(d)(1 to 3) -- Construction Authorization - Licensing Conditions. [Prescribes the ties between the MRS and the repository.]
- Options allowing some preliminary storage of a quantity of waste may be predicated on the availability of alternate storage sites if the necessity for retrieval arises.
  - NWPA, as amended, §114(a)(1)(E) -- Site Approval and Construction Authorization - Hearings and Presidential Recommendation. [The Secretary's recommendation to the President will include the Commissions comments on the sufficiency of site characterization analyses and design for inclusion in an application.]
  - 1- CFR 2.101(a)(3) -- Filing of Application. [Rules for NRC's docketing of applications.]
  - 10 CFR Part 60, Subpart F -- Performance Confirmation Program. [Defines the requirements of performance confirmation.]
- Specific aspects of 10 CFR 60 are likely to require modification.
  - 10 CFR 60.113(b)(2) -- Performance of Particular Barriers after Permanent Closure. Defines the period of thermal pulse domination as the period of interest to NRC.
- Rulemaking changes to 10 CFR Part 60 would be required.

Evaluation of This Strategy

- Schedule - Discussion on this alternative ranged from no savings to about one year. The value of 0.7 was used as an estimate for the analysis. An argument was also made that that this alternative could cause a schedule slip due to the extreme impediments to implementation. No critical path analysis was completed for this scenario.

- Licensing Probability - If impediments are overcome, the licensing probability would probably be equal to the base case. The reaction by oversight groups was neutral to positive relative to the base case; positive with the NWTRB since a program of permanent disposal would be proceeding in smaller, incremental steps. The perception of hazard by Nevada was judged to be less with the assumption that a "phased" approach provides more opportunities for formal review of DOE work.

- Site Performance - Not affected.

- Cost -

  - Waste Fund. Cost reduction estimated due to the schedule reduction. A value of $200M was estimated.

  - Utilities. A potential increase of $200M was estimated for the case of restricted fuel types due to reduced flexibility in the federal system. This may partially overcome by implementation of an optimized MRS strategy, or by a larger MRS capacity. However, costs of storage would shift to the MRS.

- Other comments and interfaces - This alternative was felt to be speculative due to the need for both a rulemaking and congressional action.

D2 - LICENSE THE SITE FOR SURFACE STORAGE PRIOR TO PERMANENT DISPOSAL

DOE could apply for a license for an independent surface facility at the Yucca Mountain site. This alternative would provide engineered surface storage for waste while waiting for the underground repository to be licensed. This storage license is assumed to be granted under 10 CFR Part 72. This concept would be a de facto MRS at the potential repository site.

Advantages

- o Provides extra time for sub-surface investigation if construction is authorized in parallel with completion of site characterization.
- o Reduces need for MRS program if the surface facility with maximum storage is built prior to licensing the repository.
- o Potential to reduce transportation impacts by co-location of MRS and repository facilities.

Disadvantages

- o Requires additional resource commitment to prepare partial amendment requests, and to support previous requests, not yet granted.
- o If site is not licensable for a repository, alternative disposal locations would be required.
- o Since this license would be granted under 10 CFR 72, the provisions of 10 CFR 100 Appendix A would apply to the surface storage facility.

Impediments to Implementation

- o The provisions in the Nuclear Waste Policy Act, as amended, related to the siting and timing of a MRS facility, would need to be modified.
  - NWPA, as amended, Subtitle C -- Monitored Retrievable Storage, §148(d)(1 to 3) -- Construction Authorization - Licensing Conditions. [Prescribes the ties between the MRS and the repository.]
- o Options allowing some preliminary storage of a quantity of waste may be predicted on the availability of alternate storage sites.

Evaluation of This Strategy

- o Schedule - Collocation of the MRS at the potential repository site would shorten the repository licensing schedule be as much as 3 years provided that obstacles to implementation can be overcome. The MRS at the repository site was assumed to replace a MRS at a new site and is anticipated to have no effect on the base case MRS schedule. See attached critical path analysis for further information.

- o Site Performance- No effect.

- o Licensing Probability- No effect on license probability for an MGDS. The perceptions of hazard from Nevada would be highly negative and that of the US would be positive due to the stigma of an unwanted facility.

- o Cost -

  - Waste Fund. This alternative is predicted to increase repository costs by $1B to cover the costs related to the surface facility development and increased licensing activities. However, since the remote MRS would not be needed, $3B could be saved for a net program savings of $2B.

  - Utilities. No effect.

- o Other comments and interfaces. The obstacles for implementation are very large for this alternative. Legal battles and hardening of public opposition to the DOE may offset some of the potential gains.

CRITICAL PATH ANALYSIS

D2 - LICENSE THE SITE FOR SURFACE STORAGE PRIOR TO PERMANENT DISPOSAL

SCHEDULE ASSUMPTIONS:

- o No change to Base case LA Submittal 30-Oct-01;
- o Schedule Saving affects post-LA submittal: Total savings = -3.0 yrs.;
- o Final Procurement and Design Period Reduced = -1.0 yr.
- o Surface Storage element of Repository Construction Reduced = -2.0 yrs.

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
SITE CHARACTERIZATION PHASE:					
RM233	1.2.2.4	01-Oct-92	No Change	0.0	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	No Change	0.0	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	No Change	0.0	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	No Change	0.0	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	No Change	0.0	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	No Change	0.0	Issue SRR to President
R5181	1.2.5.2	30-Oct-01	No Change	0.0	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	No Change	0.0	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	No Change	0.0	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	No Change	0.0	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	No Change	0.0	Start ESF Shaft Collar Construction
LICENSE REVIEW/CONSTRUCTION PHASES:					
R4185	1.2.4.1	30-Oct-01	No Change	0.0	Start Repository Final Procurement and Construction Design
R4390	1.2.4.3	30-Oct-04	30-Oct-03	-1.0	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Jan-07	-3.0	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Apr-05	-3.0	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);

Positive (+) values denote slippage re: Base Case Dates (years behind schedule).

D3 - ACCEPT REPOSITORY CONSTRUCTION AS IT IS COMPLETED

Following issuance of the construction authorization, there is a potential that the time required for NRC review and issuance of the license to receive and possess could be shortened by execution of a "phased acceptance" agreement with the NRC. Such an agreement would implement a process whereby the NRC staff would conduct formal reviews at key stages in the construction of the repository rather than delay until the amended application is submitted. This formal staff review would, if successful, result in early NRC acceptance of the "as built" repository. If deficiencies are detected during the review they could be corrected earlier, and possibly with less overall schedule and major design impact.

Advantages

- Precedent for "phased acceptance" exists in nuclear industry (Vogtle).
- Provides opportunity for parallel activities and time saving if phased acceptance is allowed.
- Provides parallel time for correcting deficiencies with phased acceptance.

Disadvantages

- Phased acceptance would not preclude intervention on construction contentions.

Impediments to Implementation

- Careful definition of review points necessary for phased acceptance.

Evaluation of This Strategy

- Schedule - The evaluation team identified a schedule savings of 1 year on the base case, under the assumption that it will be easier to acquire a "receive and possess" license using this approach. See attached critical path analysis for further information.
- Licensing Probability - Perhaps Increased; Improved chances of a license due to close working relationships over an extended period of formal interactions that would be developed with the NRC under this approach. The reaction of oversight groups was judged to be neutral to positive; positive for the NWTRB because the core team believed the composition of the NWTRB, and their collective professional backgrounds, have tended to support the operational viability of HLW disposal in an MGDS.
- Site Performance - No change from the base case.

- Cost -

  - Waste Fund. A schedule related cost savings of $300 M could accrue.

  - Utilities. Schedule related cost savings of $200 M could accrue if the MRS is not built.

- Other comments and interfaces - This concept is applicable to the MRS or essentially any repository deployment scenario. It would likely accrue in addition to other "front end" savings since it focuses on the construction and granting of an operating license. The savings, however, are downstream and would have little effect on either the site characterization or license application activities.

CRITICAL PATH ANALYSIS

D3 - ACCEPT REPOSITORY CONSTRUCTION AS IT IS COMPLETED

SCHEDULE ASSUMPTIONS:

- o No change to Base case LA Submittal 30-Oct-01;
- o Schedule Saving affects post-LA Submittal: -1.0 Yr.;

SCHEDULE IMPACT ASSESSMENT:

OCRWM Milestn	WBS Number	Base Case Dates	Scenario Dates	Impact* In Yrs	Milestone Title
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R5190	1.2.5.3	30-Apr-01	No Change	0.0	Issue Record of Decision
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R4390	1.2.4.3	30-Oct-04	No Change	0.0	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	30-Jan-09	-1.0	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	30-Oct-07	-0.5	Submit Updated LA to Receive and Possess Waste

*Negative (-) values denote improvement re: Base Case Dates (years ahead of schedule);
Positive (+) values denote slippage re: Base Case Dates (years behind schedule);

D4 - EARLY ACCEPTANCE OF LIMITED QUANTITIES OF HLW FOR INTERIM STORAGE (MRS IN 1998)

An OCRWM goal reflected in the base case schedule is to begin receipt of spent fuel in 1998 at one or more interim storage locations separate from the repository site. This strategy will affect both the schedule and feasibility of the MGDS.

The development and operation of an MRS is subject to requirements set forth in the Nuclear Waste Policy Amendments Act of 1987 (Amendments Act) as summarized below. The Secretary (DOE management) is authorized by the Amendments Act to begin site selection activities for an MRS. However, under the Act the final selection may not be made until the repository site is recommended to the President. MRS operations may not begin until the construction authorization for the repository is granted. If repository construction is interrupted, the MRS may not receive additional spent fuel until construction resumes. Prior to licensed operation of the repository, no more than 10,000 metric tons of spent fuel may be received at the MRS. Thereafter, the MRS spent fuel inventory may not exceed 15,000 metric tons.

The Amendments Act also provided for the Office of the Nuclear Waste Negotiator to assist DOE management in the attempt to find a state or Indian tribe willing to host a repository or MRS facility. The negotiator has recently been confirmed. The base case schedule assumes an active role for the negotiator in finding a host for the MRS. The negotiator may work out agreements with the potential host state or Indian tribe to set terms and conditions for siting of a repository or MRS facility. The Office of the Nuclear Waste Negotiator is authorized for a five year period ending in January 1993.

Potential options that may be applied in this alternative strategy are listed below:

- The DOE either directly or through the negotiator may seek negotiations with interested states, local governments, and Indian tribes. In this initiative, the DOE would publish a request for expressions of interest in hosting the MRS. Respondents would submit proposals which would include the terms, conditions, and financial or other incentives under which the respondent would be willing to host the MRS.

- The DOE/negotiator may examine the possibility of siting the MRS at surplus federal facilities (e.g., military bases) scheduled for closure to take advantage of existing land and infrastructure and also to help local and state governments mitigate the economic impacts of such facility closure. This approach would be coordinated with the "direct negotiation" option outlined above.

- Store spent fuel after 1998 at already licensed nuclear energy facilities and make payments to the facilities from the Nuclear Waste Fund. This idea originates from bill S. 2258, "Independent Spent Nuclear Fuel Storage Act of 1990: proposed by Senators Richard Bryan and Harry Reid of Nevada. This alternative proposes to provide funds starting in 1998 for post 1998 spent fuel storage at already licensed nuclear power plan sites if DOE fails to meet the 1998 obligation. The funds would come from a 0.56 mill/kWh credit on payments due to the Nuclear Waste Fund. This strategy is an alternative to the DOE's concept of an MRS.

- Concurrent with MRS siting efforts, the DOE could also develop and procure dual purpose (storage and transportation) cask technology. The development may be conducted as a joint DOE-utility demonstration activity. The aims of this initiative would be to promote uniform handling and on-site temporary storage at reactor sites and to facilitate shipment, acceptance, and handling of casks at the MRS facility.

- The DOE seeks changes to the Amendments Act (NWPA as amended, §148(d)(1 to 3) to modify the linkages and constraints on site selection, licensing, construction, and operation for the MRS. Specific changes may include one or more of the following:

  - Selection of the MRS site before the recommendation of the repository site to the President.

  - Construction and operation of the MRS in advance of repository construction authorization.

  - Revision of the 10,000 metric ton storage limit at the MRS prior to repository operation.

  - Allowance of regional (e.g., eastern and western) MRS facilities.

  - Acceptance of fuel at a potential repository site following a DOE management review of potential site suitability prior to the site being recommended to the President for repository development.

Advantages

- The siting of an MRS would have implications to the credibility of the siting process at Yucca Mountain. Perceptions that Yucca Mountain is the DOE's only option for acceptance of fuel would be reduced. Evaluations of site suitability may be enhanced due to reduced political and legal obstacles.

- Efforts by the Nuclear Waste Negotiator for siting and construction of the MRS within the current requirements of the Amendments Act has the potential to prevent further delays to MRS operation by creating an environment more amenable to the site selection process.

- o Negotiation of an MRS siting agreement including the removal of the linkages between the MRS and repository schedules would contribute greatly toward early receipt of spent fuel. Should the DOE accelerate other aspects of the program so that recommendation of the repository site and NRC authorization of repository construction occur earlier, the MRS schedule may benefit accordingly.

- o At-reactor storage decreases or eliminates transportation of HLW.

Changing the Amendments Act to allow early operation of an MRS would allow:

- Honoring of contracts between the federal government and the utilities for the acceptance of waste (in 1998 per the base case).

- Acceleration of large-scale acceptance of spent fuel from reactor sites that would provide federal waste management system experience that could be applied to further system improvements and to repository licensing, and reduction of utility at-reactor storage costs.

Disadvantages

- o Potential schedule benefits are limited for enhanced efforts for MRS siting and construction of the MRS within the current requirements of the Amendments Act. In the absence of other measures, MRS operation would not be able to begin until the year 2004. Unilateral (that is, outside of a negotiated agreement with a potential host) modification of the linkages between repository and MRS development may create opposition to MRS siting that would complicate the siting process and negotiations.

- o Initiation of a siting process parallel to the repository could dilute DOE resources and focus resulting in further schedule slippages. Siting activities in other states could allow the formation of political coalitions and increased pressure to alter the OCRWM mission.

- o Utilities, not the federal government, would become the "long-term stewards" of the spent fuel. This stewardship would continue after the useful life of the plant.

- o Difficult licensing issues related to license renewal of existing plants, expanding onsite storage, and continued operation of existing plants would be introduced.

Impediments to Implementation

- o Congress would have to approve any benefit agreement negotiated with the potential host state or Indian tribe. Changing the Amendments Act to modify linkages and constraints would require significant congressional action and would likely raise opposition in potential host states or Indian tribes.

- NWPA, as amended, Subtitle C -- Monitored Retrievable Storage, §148(d) (1 to 3) -- Construction Authorization - Licensing Conditions. [Prescribes the ties between the MRS and the repository.]

- NWPA, as amended, Title IV -- Nuclear Waste Negotiator, §410 -- Termination of Office. [The Office of Negotiator ceases to exist in January 1993 unless the statute is changed.]

o Additional short term appropriations would be needed to avoid a reduction in the repository effort.

o At-reactor storage conflicts with the intent of Congress as expressed in the NWPA.

Evaluation of This Strategy

o Schedule - The early operation of the MRS is a feature of the baseline schedule. However, the schedule date will be met only if a sequence of high implementation difficulty actions occur, namely an MRS siting agreement is arranged with a potential host and Congress acts to alter the linkages between repository and MRS operations. If the current linkages continue, the MRS schedule will slip 6-7 years considering the repository schedule in the base case. Acceleration of the repository schedule through other schedules may allow a corresponding improvement in the MRS schedule. No critical path analysis was completed for this scenario.

o Licensing Probability - There would be no direct impact of the MRS on the probability of the repository receiving a license. However, the licensing processes will reflect interactions between the MRS as shipper and the repository as receiver of wastes. Indirect impacts on the probability of repository licensing will depend on the success or difficulty experienced in the MRS licensing effort. Positive experiences in MRS licensing are perceived to provide potential benefit to repository licensing.

o Site Performance - The existence of the MRS was not assumed to affect repository site performance. However, an MRS could facilitate waste aging (cooling) as addressed in Scenario "Resolve Disposal Issues as Part of Performance Confirmation."

o Cost -

- Waste Fund. A rough estimate of $3 billion from the waste fund would be utilized in the MRS. This value was considered a baseline value for all other scenarios.

- Utilities. Early receipt of spent fuel at the MRS would relieve much of the need for additional at-reactor storage. However limits to receipt rates and ultimate capacity at the MRS may lead to installation of additional at-reactor storage capacity, especially if appropriate allocation or "brokerage" of waste acceptance rights does not occur. Earlier later operation of the repository was assumed to allow avoidance of $200 M for new at-reactor storage for each year saved from the repository schedule. A one year delay would incur a similar cost.

o Other Comments and Interfaces - Success in siting and licensing an MRS would lend credibility to the evaluations of the repository. This is because the repository would not be viewed as the only option for near-term management of spent fuel and other HLW.

APPENDIX B

MANAGEMENT-RELATED INITIATIVES

APPENDIX B

MANAGEMENT-RELATED INITIATIVES

The ATLAS Task Force used a series of workshops to identify alternative licensing strategies that could improve project schedule. The protocol for elicitation of alternatives for ATLAS did not preclude management-related scenarios. Some scenarios were offered in regards to ways that DOE could improve its management structure to accomplish the goals of the repository program, in light of all of the technical and regulatory challenges incumbent upon it.

Management related ideas were not evaluated as alternative licensing strategies like those in Appendix A. However, they have been retained in the report for information purposes. The process of acquiring a license for an MGDS is not simply the demonstration of regulatory compliance. Program management may anticipate and prepare contingency measures for problems as diverse as intervention or budget constraints.

Management-related ideas gathered in by ATLAS are included in this Appendix B as suggestions that may be worthy of further consideration as part of DOE management's program review. The identification of alternatives by the labels E1, E2, etc., corresponds with the grouping scheme discussed in Appendix A.

E1 - DELEGATE AUTHORITY AND RESPONSIBILITY TO OCRWM COMPONENTS

This initiative is focused on enhancing the responsiveness and accountability of various parts of the OCRWM Program through clear delegation of authority, establishment of a framework of policy, and establishing leadership of licensing activities at the Project Office level. Implementation of this strategy could make licensing strategies more responsive to site information and external obstacles and promote autonomy needed for management accountability.

Scenarios in this strategy included:

- o Establish a management framework of policy and procedures to clearly define authority and responsibilities.
- o Transfer/delegate of responsibility and authority for repository program to the Project Office in Nevada. Establish Project Offices at candidate MRS sites when they are identified.
- o DOE should locate its primary regulatory and licensing operation at the Project Office. DOE/HQ would maintain policy oversight and contact with Congress and federal agencies (NRC, EPA, etc.). This contact and the issues and decisions related thereto would be driven by the project offices.

Advantages

- o Eliminate costly redundant and sometimes unnecessary work through better coordination and management.
- o Co-location of regulatory and licensing operations with the technical staff at the Project Office should increase responsiveness to project (and program) needs.
- o Enhance communications between the project and DOE regulatory/ licensing.
- o Enhance responsiveness to project needs.

Disadvantages

- o Physical separation between regulatory/licensing and DOE/HQ, Congress and federal agencies.

Impediments to Implementation

- o Current OCRWM culture and authority.

Other comments and interfaces

- o This is a basic operating philosophy that could serve to enhance the implementation of many alternative licensing strategies. The group acknowledges that effects of this alternative were very qualitative.

E2 - CONSOLIDATE PARTICIPANTS AND/OR HIRE MANAGEMENT AND INTEGRATION CONTRACTOR

Management structure and approach were identified as key items to the development and implementation of a responsive licensing strategy. Alternatives included potential combinations of change in the current participant mix and the possible addition of a management and operations contractor.

A management and operations (M&O) contractor would be effective only if responsibilities are clearly defined and delineated. Better defining the roles, responsibilities, reporting chains, and authorities within DOE/OCRWM may be able to achieve the same objective (See Strategy "Delegate Authority and Responsibility to OCRWM Components." However, an integration contractor (as opposed to an M&O contractor) could benefit DOE/OCRWM by reducing the management burden placed on DOE/OCRWM due to the number of entities involved. Alternatively, DOE itself or in conjunction with the use of an M&O contractor, could take more direct control of its participants. This control could include reducing the number of participating contractors and national labs.

Advantages

- Reduced management burden on DOE due to interactions with fewer organizations.

Disadvantages

- Potential for losing certain experts.
- Strong political pressure to continue funding of the national labs.
- Current OCRWM culture and authority.
- Potential need to commit additional resources.

Other comments and interfaces

- The need and benefit for this alternative is highly dependent on the clear definition of roles and responsibilities for participants. This alternative should be revisited after completion or as part of Strategy "Delegate Authority and Responsibility to OCRWM Components."

E3 - CONTROL REVIEW AND APPROVAL PROCESSES

This initiative seeks to accelerate preparation of needed technical information for licensing, and reduce delays in management reviews. Specific ideas related to implementation of this alternative include:

- DOE should shorten or eliminate the review and approval processes for major technical reports, including re-evaluation of the scope and timing of reviews, the number of reviewers, the purpose of review criteria, and of the logic for approval.

- Following current procedures, it is estimated that more than 2 years are required to implement a new field test or analysis. In contrast, utility companies under NQA-1 programs in reactor construction frequently begin new tests within several weeks of conception. The major difference in these durations lies in differences in process and authority; utilities use authorization by the responsible corporate officer and subcontract the responsibility for completing the work under appropriate QA controls to the responsible contractor. DOE uses an extensive review cycle and neither delegates authority for conducting tests nor designates the responsible participant to authorize work.

Advantages

- Reduce design schedule by altering approval logic to allow start of License Application Design before completion of the Advanced Conceptual Design Report.

- Integration of document reviews would allow resolution of conflicting comments before the document is altered.

- Increased work scope due to comments from individuals or specific groups would be avoided unless it supported project objectives.

Disadvantages

- Some individuals/organizations may be omitted for review, with loss of possibly valuable input.

- QA issues would need to be addressed.

Impediments to Implementation

- Current OCRWM culture and authority.

- Potential need to commit additional resources.

Other comments and interfaces

- This strategy is related to alternatives dealing with the clear definition of authority and responsibility. However, this strategy was felt to be viable even without a comprehensive initiative on these issues.

E4 - CONTINGENCY PLAN FOR ALTERNATIVE REPOSITORY SITES

The NWPAA requires that DOE report back to Congress if the site is found unsuitable for development. This alternative proposes to develop a contingency plan for site characterization at an alternative site. This plan would form the basis for a report to Congress in event that Yucca Mountain is found unsuitable.

It is proposed to develop a plan for the identification of alternative sites to Yucca Mountain. The scope of this activity is to revisit the site selection decisions involving first and second repository sites. This work would be assumed to start immediately and progress in sequence with site characterization at Yucca Mountain. For example, SBT would start at a backup site following the start of the ESF at Yucca Mountain. If Yucca Mountain is found unsuitable based on some combination of SBT/ESF results, the results of paper studies of other sites would form the basis for a recommendation to Congress for SBT at other sites. In this manner, delays in the program from problems with the Yucca Mountain site would be minimized. The Nuclear Waste Negotiator, if renewed by Congress, could also play a significant role in the identification of back up sites through the solicitation of volunteer states.

This activity is related to alternative approaches to increase reliance on engineered barriers and longer term fuel cooling prior to disposal that could be used if unexpected conditions are found at the site during characterization. These approaches do not address the need for a second site in the event that the site is found unsuitable. The basis for this initiative resulted from testimony to the Governors Commission on Nuclear Waste.

Advantages

- Improved perceptions of DOE management and Congress in actions taken in the NWPAA.
- Reduced potential for program slippage if Yucca Mountain found unsuitable.
- MRS siting may be enhanced due to perception of increased commitment to development of a disposal site.

Disadvantages

- This could provide the opportunity to develop a coalition between potential repository host sites.

Impediments to Implementation

- This alternative assumes that the MRS is successfully deployed to avoid significant schedule slippages in fuel acceptance.
- The Negotiator would need to be reauthorized to play a role in this effort.

- Nuclear Waste Policy Act of 1982, as amended (NWPA, as amended), Title IV -- Nuclear Waste Negotiator, §450 -- Termination of Office. [The Office of Negotiator ceases to exist in January 1993 unless the statute is changed.]

o DOE would need to discuss this with key congressional staff to avoid appearing to undermine the NWPAA.

- NWPA, as amended, §112 -- Recommendation of candidate sites. [Describes the means {to be} used to select candidate sites for characterization. This would have to be reactivated to allow a contingency site to be selected.]

- NWPA, as amended, §113(a) -- Site Characterization - In General. [Calls for the characterization of the Yucca Mountain site, only.]

- NWPA, as amended, §113(c)(3)(F) -- Site Characterization - Restrictions. [If the Yucca Mountain site is found unsuitable, the Secretary (DOE) must report to Congress, within 6 months, his recommendations for further action.]

- NWPA, as amended, Subtitle C -- Monitored Retrievable Storage, 148(d) (1 to 3) -- Construction Authorization - Licensing Conditions. [Prescribes the ties between the MRS and the repository.]

- NWPA, as amended, Subtitle E -- Siting a Second Repository, 161(a) - Congressional Action Required. [Prohibits siting activities for a second repository.]

o Additional resources may be required.

E5 - ESTABLISH AN INDEPENDENT WASTE DISPOSAL CORPORATION

This concept, originally proposed pursuant to Section 303 of the NWPA may be appropriate for further consideration because its attributes and characteristics relative to the criteria and program deficiencies against which it was evaluated in 1984, remain applicable today. The corporation would be chartered by Congress 1) to ensure safe, long term isolation of radioactive wastes from the environment in compliance with appropriate federal regulations; 2) to plan, construct, and operate all necessary waste management facilities in an expeditious fashion and with the stipulation that it begin accepting waste by 1998, 3) to cost effectively conduct its mission using waste fund fees, and 4) that it establish an Advisory Siting Council representative of all stakeholders.

Advantages

- Strong business orientation would encourage cost effective and timely completion of projects.
- The stockholder comprised Advisory Siting Council would ensure broad public support.
- Political influence would be largely absent, thus, increasing program credibility and ensuring stable policies and funding.
- Financial capability, accountability, and control would be significantly enhanced.
- Significant increases in internal flexibility would enable acquisition, assignment, and transfer of required professional staff to suit program needs and permit allocation/reallocation of financial and other resources among its activities in a timely and efficient manner.
- More effective discussions with the NRC and other regulators may result.

Disadvantages

- The efficient transition from OCRWM to the Congressionally chartered public corporation would require a period of time.

Impediments to Implementation

- Congressional action required to initiate this action.

E6 - FOCUS CURRENT RESOURCES TOWARD LICENSING

This initiative is focused on potential improvements in the OCRWM schedule that could come from using existing organizational resources more efficiently. Scenarios that are part of this alternative address better utilization of resources and retention of corporate memory. Specific scenarios include:

- DOE and NRC could set up teleconferencing studios in Washington and Las Vegas to allow face-to-face communications with all parties while, at the same time, reducing travel time.

- Combine meetings of oversight groups concerning OCRWM issues. Meetings of the ACNW and NWTRB would be far more efficient from a DOE perspective if issues were discussed and convergence could be reached in joint meetings. Combining meetings could reduce the number of meetings, travel time, preparation, and comment resolution time.

- A resource-loaded Long Range Plan (PACS system) could provide DOE with the mechanism to seek multi-year funding agreements. This would enhance licensing-related planning.

- Formulate a program element to address and mitigate loss of key personnel. Growth of DOE site cleanup programs will act as a major drain on OCRWM-DOE, OCRWM-national labs, and OCRWM-private contractor staff. Action items should include: (1) special recognition/salary incentives program, and (2) personnel rotation and cross-training activities.

- Repository design is unnecessarily long and could be started later (after SBT has obtained a significant QA qualified data base) allowing more time for gathering of site characterization information; the design period preceding the licensing application could be reduced to three to four years, i.e., Advanced Conceptual Design could be eliminated as a discrete design phase which becomes part of, or a phase in, the License Application Design.

Advantages

- Teleconferencing would improve productive work time for technical staff and reduce travel expenses. Also, increases the number of potential DOE/NRC interactions with minimal schedule impact.

- Multi-year funding would reduce the amount of time required to create the work authorization system each year. Working to the Long Range Plan will provide stability of direction. The DOE will be able to adjust the schedule based on funding limitations.

- Key staff would be recognized and retained.

Disadvantages

- Some personnel may be reluctant to utilize teleconferencing facility.
- Open meeting laws (Sunshine Act) could reduce logistical usefulness.

Impediments to Implementation

- Additional resources may be required.
- Difficult to implement special and meaningful key staff incentives in one participating federal agency.

Other comments and interfaces

- These issues, while not major drivers to schedule, were felt to be important to "program health". The delay of design activities was felt to be an extension of, of not part of, the base case. This alternative would have low implementation difficulty.

E7 - QA ENHANCEMENT RELATIVE TO SCIENTIFIC RESEARCH AND DEVELOPMENT

The repository program includes both "classical" design and construction activities, and what is best categorized as research, development, and prototype testing. The current QA approach is to apply nuclear QA practices (10 CFR 50 Appendix B; NQA-1) to R&D and the descriptive sciences during site characterization, as well as to design and construction. A greater understanding in the program of the concept of scientific reproducibility would greatly enhance scientific freedom, and minimize descriptive paperwork and the need for detailed procedural control. The "test of quality" in the scientific world is the reproducibility of results instead of a detailed documentation trail. Reproducability is essentially convergence toward a narrow range of measured parameters through multiple iterations of the same test method by the same or by different groups of investigators. Reproducability underpins a method of qualifying existing data, i.e., through "corroboration" per NUREG-1298.

NRC requirements mandate a detailed documentation trail to support a license application, but consideration should be given to a phased implementation of a Subpart G QA program. Full NQA-1 controls can be imposed later in site characterization after scoping studies, and prototype testing, and conceptual development is completed; when actual LA data collection is underway.

Given the repository program's history since passage of the NWPAA, there is a major opportunity to avoid slip in the base case with the successful implementation of a consistent "world view" for QA requirements that would prevent degradation of the base case schedule.

Advantages

- Data collection would continue in the early stages of site characterization, whether it can be used in a LA or not.
- Scientific community confidence and dedication would be increased; competition would be enhanced.
- Scientific creativity and innovation would increase.
- Progress may be more rapid since communication between peers will be improved.

Disadvantages

- Failure to control use of data collected before application of full QA controls in a "phased" approach would likely result in significant licensing risk and repetition of some parts of the site characterization program to satisfy regulatory requirements..

Impediments to Implementation

- Any "refinement" of the DOE's QA program that departs from NRC positions and guidance would have to be justified and approved.

Other Comments and Interfaces

There was much disagreement as to the nature and impact of the changes under this scenario. Definition of a more specific approach would be necessary for further evaluation of this scenario. The point was also made that to "start over" now with a significantly altered QA program, whatever its complexion, would have a significant impact on program health.

APPENDIX C

ALTERNATIVE IDENTIFICATION AND EVALUATION METHODOLOGY

APPENDIX C

ALTERNATIVE IDENTIFICATION AND EVALUATION METHODOLOGY

APPENDIX C.1 - DECISION-AIDING METHOD AND EVALUATION PROCESS

The ATLAS Task Force developed a systematic, analytic method for evaluating and screening alternative licensing strategies. Section 3 discusses the general approach and analytic method; this appendix provides additional detail, but does not repeat the material given in Section 3.

Factors Considered in the Evaluation

The task force developed the influence diagram in Figure C-1 to represent many of the important considerations in choosing among alternative licensing strategies. For example, the net benefits of the repository depend on its benefits and impacts (costs). Its benefit depends, in part, upon how soon it is available to receive spent fuel and the quantity of fuel ultimately accepted by the repository. (Since this study's focus is on a mined geologic disposal system, the abbreviation MGDS is used on the diagram to represent the repository.) The time to licensed operation depends on the time to license application and whether and when NRC issues a license. These factors, in turn, depend on--among other things--the general health of the repository program and the perceptions of the program by oversight groups such as the NRC, Nuclear Waste Technical Review Board, and by the general public. Perceptions of outside groups could be influenced by site characterization testing and performance assessment results.

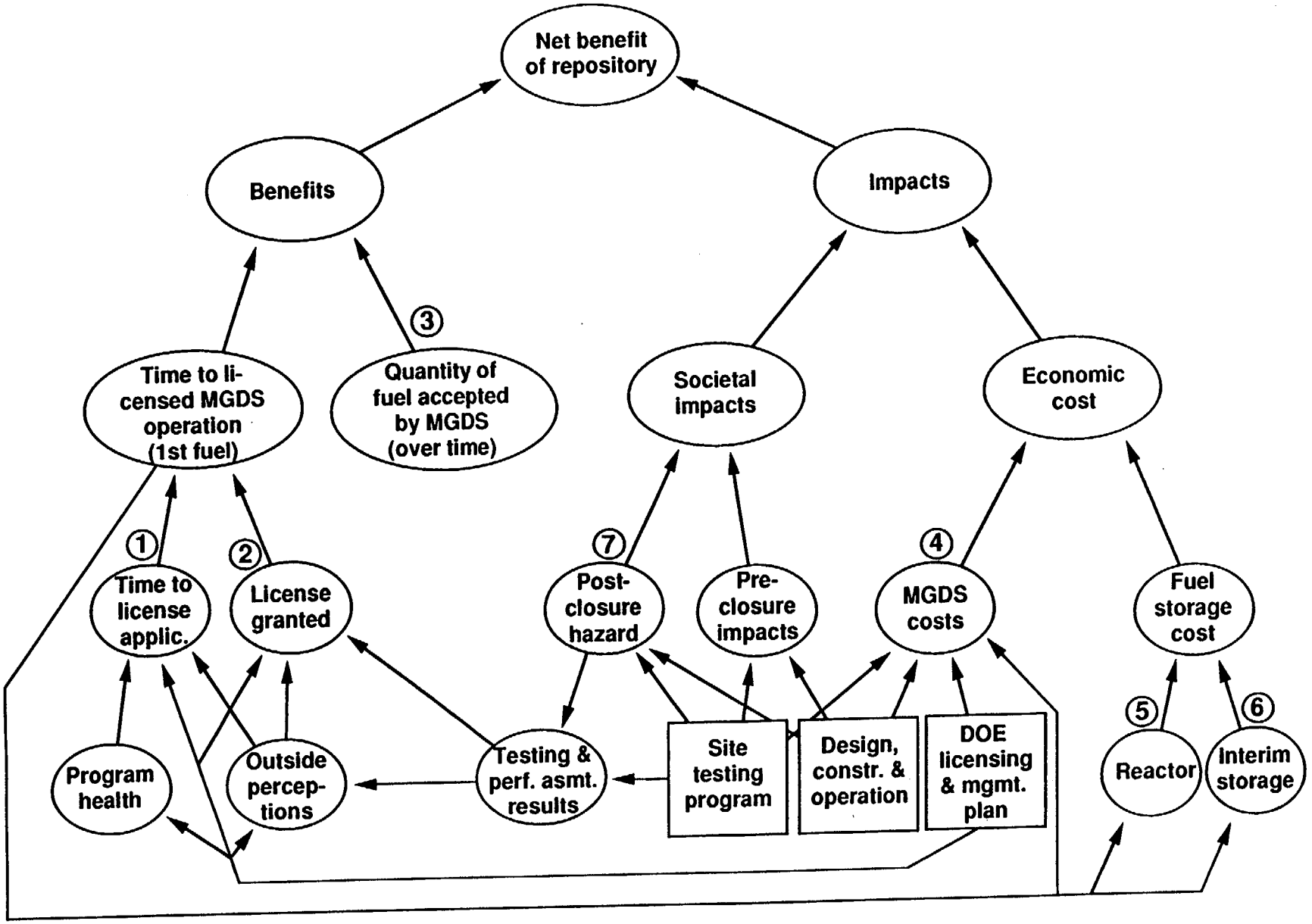
The potential negative consequences of the repository are divided into societal impacts and economic costs. Societal impacts include any risks to the public after the repository is closed, as well as pre-closure impacts, such as environmental or aesthetic effects, occupational hazards, and pre-closure health and safety hazards. Post-closure public risks are assumed to influence testing results, which in turn influence the outside perceptions of the hazard by oversight groups and the general public.

Economic costs include the costs associated with the MGDS, from the present to closure. They also include interim storage costs and costs to utilities for spent fuel that must be stored at reactor sites when the repository is not accepting spent fuel. Finally, several decisions (represented by squares in the diagram) affect MGDS costs and hazards. These relationships are indicated by arrows in the diagram.

Evaluation Criteria

From the influence diagram shown in Figure C-1, the task force developed a list of criteria for evaluating and screening alternative licensing strategies. Specifically, the task force selected seven of the factors that, collectively, could reflect most of the major (upper-level) effects of the alternative strategies being considered. These seven factors adequately reflected all of the major factors shown in the figure except pre-closure

Figure C-1. **ATLAS Influence Diagram**



impacts, which were not affected significantly by any of the licensing alternatives being considered.

The seven numbered factors served as evaluation criteria for screening suggested licensing alternatives. The following measures were used to quantify each of the seven evaluation criteria:

1. Expected change in the date of fuel receipt, relative to the current schedule, given that a license is granted.

2. Probability that an operating license is granted.

3. Quantity of fuel ultimately accepted, relative to the current plan.

4. Total costs for the mined, geologic disposal system (MGDS) through closure of the repository.

5. Incremental spent fuel storage costs incurred at reactors if there are delays in accepting fuel at the repository.

6. Incremental spent fuel storage costs at an interim storage facility if there are delays in accepting fuel at the repository.

7. Public hazard, measured by a probability distribution on cumulative curies released, such as would be produced by a performance assessment.

Table C-1 defines these criteria and gives examples of their use in the evaluation. The method for estimating costs for criteria 4, 5, and 6 are provided in Appendix C.3.

Preliminary Evaluation Results

The next step in the approach was to judge the effects of each licensing alternative on each criterion. This was done, for the most part, in group discussion by the extended core team. This task was difficult for many reasons:

- The suggested alternatives had to be defined carefully before effects could be judged. However, definitions of alternatives changed as strengths and weaknesses emerged from the evaluation discussions.

- The alternatives are very broad in scope, with wide-ranging effects. Members of the core team had some expertise in most areas of effects, but not all areas. Also, further in-depth analysis would be required in some areas to make better judgments of effects. This would require more area expertise than was available on the extended core team.

- The effects of many alternatives on criteria such as schedule change and cost impacts are uncertain. Our screening analysis was deterministic (i.e., single-valued) for schedule and cost criteria, and it was difficult to estimate an expected schedule or cost impact without a full-fledged probabilistic assessment.

Table C-1. EVALUATION CRITERIA FOR ALTERNATIVES TO THE CURRENT LICENSE APPLICATION STRATEGY

1. SCHEDULE CHANGE

Definition - Expected change in the date of receipt of first fuel
Measure - Expected number of years change in date

Value	Interpretation
0.0	Same schedule as in the base case plan
-1.0	Expected savings of one year in base case plan OR expected avoidance of slip (e.g., 5 prob. of 2 yr slip)
+1.0	Expected addition of one year in base case plan OR expected slip by one year

2. IMPACT ON PROBABILITY OF LICENSE

Definition - Impact on the probability that NRC will grant a DOE license application for full-scale operation.
Measure - Multiplier for the base case probability of license.

Value	Interpretation
1.0	Same probability as in the base case. (Note: the base case probability is not specified. In particular, it is not 1.0.)
.9	Probability lower than the base case by 10 percent
1.1	Probability higher than the base case by 10 percent

3. QUANTITY OF FUEL

Definition - Total capacity of repository (mined geologic disposal system).
Measure - Thousands of metric tons of fuel

Value	Interpretation
70	Base case capacity

4. COST THROUGH CLOSE

Definition - Cost to design, construct, operate, and close the repository.
Measure - Change in cost ($ billion)

Value	Interpretation
0.0	Same cost as in the base case.
-.3	$300 million cost savings relative to the base case

5. INTERIM STORAGE COST--AT REACTOR

Definition - Change in cost of storing spent fuel at reactor (borne by utility rate payers).
Measure - Change in cost ($ billion)

Value	Interpretation
0.0	Same probability as in the base case.
-.2	$200 million cost savings relative to the base case

6. INTERIM STORAGE COST--AT INTERIM STORAGE FACILITY

Definition - Change in the cost of storing fuel at an interim storage facility.
Measure - Change in cost ($ billion)

Value	Interpretation
0.0	Same cost as in the base case

7. PERFORMANCE

Definition - Change in total system performance (cumulative curies released), as would be calculated by a comprehensive performance assessment.
Measure - Multiplier that would shift the complementary cumulative probability distribution (CCPD) on cumulative curies released.

Value	Interpretation
1.0	Same CCDF as in the base case
.9	CCDF shifted toward **higher** risk by 10 percent
1.1	CCDF shifted toward **lower** risk by 10 percent

PERCEPTIONS OF HAZARDS HELD BY OUTSIDE GROUPS

Definition - Collective judgment of specified group regarding hazards posted by the repository. This is not a numbered criterion because its effect is included in Criterion 2, probability of a license. This measure is used to document some of the reasoning used to assess the impacts on the probability of a license being granted.
Measure - Constructed scale

Value	Interpretation
0	Same as in the base case
-1	Increased negative perception in the specified group
-2	Greatly increased neg. perception in the specified group
1	Increased positive perception in the specified group
2	Greatly increased pos. perception in the specified group

- Often it was difficult to judge directly the effect on a specific criterion. In these cases, effects were estimated for lower-level factors shown in the influence diagram in Figure C-1. Higher level effects were then estimated based on the lower-level judgments. This provided a more thorough and defensible assessment.

In spite of these difficulties, the approach provided sufficient structure and rigor to sift through the dozens of suggested alternatives and identify those worthy of more refined analysis. The evaluation discussions produced the desired evaluations, but they also fostered refinement and redefinition of the alternatives than would normally be possible if (as is usually done), the alternatives were screened by one or two persons.

The results of the evaluation are shown in Table C-2. Each row in the table shows the task force's preliminary evaluation of each alternative described in Appendix A. Numerical evaluations are provided for six of the seven evaluation criteria:

Column	Description
1	Identifying letters used in Appendix A
2	Names from Appendix A
3	Schedule change--criterion 1 in Table C-1
4	Impact on probability of license--criterion 2 in Table C-1, estimated by method in Appendix C-3
5	DOE cost change--sum of criteria 4 and 6 in Table C-1
6	Utility reactor storage--criterion 5 in Table C-1, estimated by method in Appendix C-3
7	Sum of columns 5 and 6
8	Performance measured by EPA standard--criterion 7 in Table C-1
9-12	Perceptions of hazards...in Table C-1
13	Implementation difficulty, as explained in Section 3.1.1
14	Overall evaluation, as explained in Section 3.2.4
	Note that criterion 3 in Table C-1 is not shown because it does not vary

The shaded columns in Table C-2 represent the four primary criteria used to determine the overall preliminary evaluation.

Interpreting this table requires a thorough understanding of the definition of each alternative (see Appendix A) and the evaluation criteria in Table C-1. in addition, it is quite likely that someone who is very familiar with the definitions and criteria would assign different numbers than shown in Table C-2. A more important consideration in screening, however, is whether the relative comparisons among alternatives remain the same when examined by others. The task force made every effort to ensure the accuracy of relative comparisons, consistent with the available resources.

All of the entries for the alternatives shown in Table C-2 are values relative to the base case. For example, an evaluation of -1 for schedule means an expected one-year savings (or expected one-year avoidance of slippage) relative to the base case schedule. An impact on the probability of license of 1.1 means that the task force judged the base case probability

Table C-2. **ATLAS Evaluation**

Alternative	License: Sched. change (years)	License: Impact on prob. of license	Cost: DOE cost change (billion)	Cost: Utility reactor storage (billion)	Cost: Total DOE +util. (billion)	Performance: EPA com-pliance	Performance: Outside perceptions NRC	TRB	NV	US	Impl. Diff.	Over-all eval.
Base case	0.0	1.00	$24.0	$0.6	$24.6	1.00	0	0	0	0		
A) Licensing Organization												
A1) Cooperate w/ affected outs. orgs.	-0.5	1.00	$0.2	-$0.1	$0.1	1.00	0	0	1	1	L	?
A2) Take initiative in licensing	-1.0	1.10	-$0.4	-$0.2	-$0.6	1.00	1	1	0	0	L	+
A3) Take initiative in rulemaking	-1.5	1.10	-$0.6	-$0.3	-$0.9	1.00	2	1	-1	-1	M	+
A4) Limit NRC pre-licensing role	0.0	1.00	$0.0	$0.0	$0.0	1.00	-1	1	-2	-1	H	NC
A5) Reduce permitting delays	-2.0	1.00	-$0.6	-$0.4	-$1.0	1.00	0	0	-2	-1	H	+
A6) Refine base case schedule	-1.0	1.00	-$0.3	-$0.2	-$0.5	1.00	0	0	0	0	L	+
B) Planning & Design												
B1) Link perf. alloc. & site testing	-1.0	1.00	-$0.3	-$0.2	-$0.5	1.00	0	1	0	0	L	+
B2) Emphasize total system perf.	-1.0	1.10	-$0.3	-$0.2	-$0.5	1.00	-1	0	-1	-1	M	+
B3) Rely on EBS (w/o rule change)	0.0	1.10	$3.0	$0.0	$3.0	2.00	0	1	0	1	L	?
B4) Rely on EBS & defer tests	-1.0	0.90	$2.8	-$0.2	$2.6	2.00	1	1	-1	1	M	?
B5) Rely on EBS & fewer tests	-3.0	0.80	$1.5	-$0.6	$0.9	1.50	1	1	-2	1	M	?
B6) Alter engineering basis for site	Did not evaluate this strategy											
B7) Incr. reliance on geochem.	0.0	1.10	$0.0	$0.0	$0.0	1.00	0	0	0	0	L	+
B8) Incr. reliance on natural barriers	-0.7	1.00	$0.0	-$0.1	-$0.1	1.20	0	0	-1	1	L	+
C) Site Characterization												
C1) Submit LA after some testing	-1.5	0.80	-$1.0	-$0.3	-$1.3	0.90	-2	-1	-2	-1	M	?
C2) Test Calico Hills early	-2.0	1.00	-$0.6	-$0.4	-$1.0	1.00	0	1	1	1	L	+
C3) Conduct joint SBT & ESF	-1.5	1.00	-$0.5	-$0.3	-$0.8	1.00	0	0	0	0	L	+
C4) Establ. site suitability before ESF	1.0	1.05	$0.3	$0.2	$0.5	1.00	0.5	0.5	0.5	0.5	M	?
C5) Use off-block URL	0.0	1.00	$0.2	$0.0	$0.2	1.05	1	1	0	0	L	?

Table C-2. (continued) **ATLAS Evaluation**

Alternative	License: Sched. change (years)	License: Impact on prob. of license	Cost: DOE cost change (billion)	Cost: Utility reactor storage (billion)	Cost: Total DOE +util. (billion)	Performance: EPA com-pliance	Performance: Outside perceptions NRC	TRB	NV	US	Impl. Diff.	Over-all eval.
C6) Use TEF with HLW	-1.0	1.10	$0.0	-$0.2	-$0.2	1.10	1	1	-1	1	H	+
C7) Emphasize analog studies	0.0	1.00	$0.0	$0.0	$0.0	1.00	1	1	0	0	L	NC
C8) Use ESF as HLW demo	-1.0	1.10	-$0.3	-$0.2	-$0.5	1.10	1	1	-1	1	H	+
D) Construction & Operation												
D1) Phase license & perf. confirm.	-0.7	1.00	-$0.2	$0.2	$0.0	1.00	0	1	1	0	M	+
D2) License site for interim storage	-3.0	1.00	-$2.0	-$0.6	-$2.6	1.00	0	2	-2	1	H	+
D3) Accept components as completed	-1.0	1.10	-$0.3	-$0.2	-$0.5	1.00	0	1	0	0	M	+
D4) Accept HLW at MRS in '98	0.0	1.00	$0.0	$0.0	$0.0	1.00	0	0	0	0	H	NC
E) Program Management												
E1) Delegate auth. to OCRWM comp.												
E2) Consol. participants and/or M&O												
E3) Control review & approval												
E4) Prepare plan for backup site												
E5) Form independent waste corp.												
E6) Focus resources toward licensing												
E7) Refine QA for site characteriz.												

of license went up by 10 percent (say from 60 percent to 66 percent). However, the task force did not specify the current probability of a license. The base case probability of license was taken to be 1.0. This means "1.0 times whatever it is judged to be today," rather than "100 percent, or certainty." The same approach was taken for the probability of meeting the EPA performance standard if a complete performance assessment were available today.

Comparison of Alternatives

The next step in the process is to compare the relative strengths and weaknesses of alternatives--compared to the base case and compared to each other. This would normally be done by constructing a multiattribute utility function--assigning relative weights to the evaluation criteria, determining potential interactions among them (called "utility dependence") and adjusting weights accordingly, and then determining an overall score for each alternative based on the evaluations in Table C-2 and the assigned weights.

This approach was not taken in this screening analysis, for two reasons:

- Many alternatives were better than the base case on one or more criteria and no worse on others. The task force felt that all of these superior alternatives should be investigated in subsequent analysis.

- The subsequent analysis will most likely construct a multiattribute utility function for comparing alternative licensing strategies. Due to the limited resources available to this task force, the utility function task was left to the subsequent effort. Resources were invested, instead, in the definitions and preliminary evaluations of the alternatives.

Therefore, following the method outlined in Sections 4 and 5 of the report, the task force identified all of the superior alternatives (+) and combined them into the alternative licensing strategies discussed in Section 5.

APPENDIX C.2 - CRITICAL PATH ANALYSES

GENERAL INFORMATION

The following is a discussion of the general methodology used in the analysis of the impact of expected schedule changes to the Base Case (Option "D") schedule. The impact analysis, which addressed only those alternative strategies which affected target dates by more than one year (+ or -), identified potential variations to the OCRWM Program Schedule Baseline (January 1990). A comparison of the alternative strategy schedule dates to the Base Case targets as well as the impact to the schedule in terms of + or - years (or portions thereof) is provided for each selected alternative strategy.

The Base Case milestones and target dates selected for the comparison are shown in Table C-3, Base Case Licensing Strategy, Key/Major Milestones.

APPLICATION

Pre-LA Submittal Impact Analysis

1. In order to provide a basis for analysis, a computer-based schedule database (160 activities) was established for each selected alternative strategy where the schedule impact affected Base Case target milestones prior to the LA Submittal date of 30 Oct 01.

2. In each selected alternative strategy, the LA Submittal target date was changed to reflect the expected schedule change indicated by the specific alternative strategy assumptions (reference the alternative strategy write-ups).

3. Logic relationships were adjusted (e.g., changed from a "constraint" relationship to an "information only" feed), where appropriate, to reflect the schedule assumptions indicated for each selected alternatives (reference the alternative strategy write-ups).

4. Critical path analysis was then performed to identify WBS areas which were affected by the "revised" LA Submittal date. This provided the information needed to indicate (1) which Base Case "target" milestones were impacted and (2) the date at which a "new" target date would have to be established in order to meet the "revised" LA Submittal date (and ultimately, the new "receipt of first fuel" date).

5. The difference between the base case target dates and the "revised" target dates is shown in + or - years (or some decimal thereof).

Post-LA Submittal Impact Analysis

1. Since representative schedule details were not available for post-LA Submittal activities, a computer-based database was not utilized for the post-LA Submittal impact analysis.

2. The "revised" target dates were identified and "manually" established per the expected schedule change as indicated in the specific assumptions for each selected alternative strategy (reference the alternative strategy write-ups).

3. The difference between the base case target dates and the "revised" target dates is shown in + or - years (or some decimal thereof).

Table C-3. BASE CASE LICENSING STRATEGY - Key/Major Milestones

OCRWM Baseline Milestone	WBS Number	Date	Milestone Title
		SITE CHARACTERIZATION PHASE	
RM233	1.2.2.4	01-Oct-92	Start Waste Package ACD
RT074	1.2.2.4	30-Jun-96	Start Waste Package LAD
RYI08	1.2.3.1	02-Jan-91	Start New Surface-Based Testing
RN430	1.2.4.1	01-Oct-92	Start Repository ACD
RM458	1.2.4.1	30-Jun-96	Start Repository LAD
R5200	1.2.5.2	30-Apr-01	Issue Site Recommendation Report to President
R5181	1.2.5.2	30-Oct-01	Submit LA to the NRC
R5161	1.2.5.3	31-Mar-01	Issue Final EIS
R5190	1.2.5.3	30-Apr-01	Issue Record of Decision
RM645	1.2.6.2	30-Jun-92	Start ESF Site Preparation
RM652	1.2.6.4	30-Nov-92	Start ESF Shaft Collar (ES-1) Construction
		LICENSE REVIEW/CONSTRUCTION PHASES	
R4185	1.2.4.1	30-Oct-01	Start Repository Final Procurement & Construction Design
R4390	1.2.4.3	30-Oct-04	Start Repository Construction
R4490	1.2.4.4	30-Jan-10	Start Repository Waste Emplacement
R5291	1.2.5.2	30-Apr-08	Submit Updated LA to Receive & Possess Waste

APPENDIX C.3 - ESTIMATES OF COST IMPACTS FOR ATLAS SCENARIOS

The evaluation of the ATLAS scenarios required estimates of cost impacts in three areas:

- o Waste Fund Repository Program Costs
- o Waste Fund Other (MRS) Costs
- o Utility Costs for Additional At-Reactor Storage

These costs are assumed to be affected by the program schedule. Due to the lack of data for precise evaluation of such costs, the simple estimates defined below were used. Consistent with the simplicity of the estimates, the scenario evaluation used the cost data to define trends rather than detailed comparisons of alternatives. Once the scenarios are defined in greater detail, more detailed cost estimates should be prepared for use in comparisons.

Repository Program Cost Savings

The impact to cost savings or increases to the repository program from changes to the schedule was estimated from cost data presented in the 1989 Total System Life Cycle Cost study (Reference). Two cases were examined which reflect different levels of activity. The first case considered fixed costs related to maintenance of program organizations separate from field work and detailed engineering activities. The other case considered peak costs which included both fixed costs and variable costs associated with the scope of the field and design work accomplished during the year. Section 3 and Appendix C of the TSLCC describes the Development and Evaluation Cost component that includes these fixed costs and the costs of site characterization and design.

In the TSLCC estimate the annual cost figures for the development of the first repository reach a peak of $500-$600 million per year during the period when both site characterization and design are occurring. For the ATLAS evaluations the figure of $500 million per year was used to represent scenarios that eliminated site characterization work scope from the base case to effect a schedule reduction.

Prior to the start of site characterization and also following the submission of the license application the TSLCC estimates annual costs of from below $300 million up to nearly $500 million. Based on recent program experience, $300 million per year was chosen to reflect the fixed cost element of the program. Changes that allowed completion of a given work scope in a shorter time period were assigned savings of $300 million per year saved, since the fixed element of the cost would be avoided for the period of time eliminated from the schedule.

MRS Costs

Depending on configuration for the Monitored Retrievable Storage (MRS) facility, the TSLCC study gives estimates of $1.8 billion to $3.1 billion for the MRS. Since the MRS is a feature of the base case schedule and its development is not a significant factor in the evaluated scenarios, a detailed analysis of MRS costs was not attempted. A value of $3 billion is cited in the evaluations. This will be conservative if a simple storage-only MRS configuration is constructed.

Other Storage Costs

Should the MRS not be built or if the MRS should reach storage capacity long before the repository is available, some utilities may develop interim spent fuel storage. Such storage would be funded by the affected utilities. Most of the cost would be incurred in the acquisition of the storage capacity; operating costs thereafter would be relatively minor. The DOE (Reference 2) estimated the costs of At-Reactor Storage needed for various combinations of repository and MRS configurations and start up dates. Using costs for current technology storage casks and at-reactor storage requirements from the MRS Study the impact of a one year change in repository start up will be between $150-$200 million. That is, if the repository is available 1 year sooner, the utilities may be able to avoid $150-$200 million expense in construction of additional at-reactor storage.

The ATLAS evaluation used the conservative value of $200 million savings per year saved. The benefit for large schedule savings would be lower than this amount since the MRS will reduce the requirements for at-reactor storage until such time that it reaches capacity. No detailed study of this effect was attempted. The influence of timing between MRS and repository operation on at-reactor storage cost should be examined further.

References For Appendix C.3

U.S. Department of Energy, "Analysis of the Total System Life Cycle Cost for the Civilian Radioactive Waste Management Program," DOE/RW-0236, Office of Civilian Radioactive Waste Management, Washington, D.C., May, 1989.

U.S. Department of Energy, "MRS Study Task G - "

APPENDIX D

CORE TEAM VITAE AND WORKSHOP ATTENDANCE LISTS

April 9, 1990

VITAE

W. B. (BILL) ANDREWS

Education: Masters of Business Administration
B.S. Mechanical Engineering

Work Summary:

Mr. Andrews has been employed in the nuclear industry for 14 years. In that time he has worked under contract to the U.S. Department of Energy at the Hanford Site, the Nuclear Regulatory Commission, the U.S. Department of Transportation, and private companies.

Mr. Andrews licensing experience includes leadership of teams to prioritize and resolve generic reactor safety issues, implement the "back fit" rule at NRC regional offices, regulate the highway routing of high-level waste, mitigate pipe cracks and the development of alternatives to current OCRWM licensing strategy. He has also made significant contributions to nuclear power plant safety analysis reports, preclosure safety analyses, transportation risk analyses, cask conceptual design, insider sabotage assessments and rail access siting.

Mr. Andrews is a licensed Professional Engineer.

April 9, 1990

VITAE

CANDACE L. BIDDISON

Education: B.S., Geology and Mineralogy, Ohio State University (1978);
Certificate in Business Management, American Management Association, University of Nevada, Las Vegas (1984)

Work Summary:

Ms. Biddison has been employed for five years with SAIC. In that time, she has been involved in technical planning and reporting, cost control analysis, and related management activities as part of the Yucca Mountain Project. Ms. Biddison has provided geological technical support in the evaluation of site-specific issues to be addressed in developing test plans for the collection of geologic data needed to characterize the Yucca Mountain site. She has been involved in the identification of program element interfaces and inter-activity logic, based on the developing test plans, and the subsequent development of scheduling networks for these activities. Currently, she is supporting technical interactions with the Nuclear Regulatory Commission and the Nuclear Waste Technical Review Board.

Prior to her employment with SAIC, Ms. Biddison was employed for seven years as a geologist in petroleum resource development projects and during that time has served as Assistant Project Manager for a major gas research program involved in the economic development of natural gas production from low-permeability, tight gas sand reservoirs.

April 9, 1990

VITAE

THOMAS W. (TOM) BJERSTEDT

Education: Ph.D. Geology, West Virginia University
M.S. Geology, Kent State University
B.S. Geology, Kent State University
A.A. Lakeland Community College

Work Summary:

U.S. DOE, Regulatory Interactions Branch, Regulatory and Site Evaluation Division, Yucca Mountain Project Office.

St. Lawrence University, NY; Visiting Assistant Professor, courses taught: stratigraphy, invertebrate paleontology, geoscience and nuclear waste management, Florida Keys field course, Adirondak field geology course.

West Virginia University, WV; Visiting Lecturer; courses taught: historical geology.

Post-doc Research; research and proposal writing in pursuit of NRC's RFP for the "Center for Nuclear Waste Regulatory Analysis."

April 9, 1990

VITAE

GEORGE D. DYMMEL

Education: B.S. Chemistry, Illinois Institute of Technology

Work Summary:

Mr. Dymmel has 37 years experience in the nuclear energy field in fuel reprocessing, process systems, fuel management, decontamination and decommissioning, and radioactive waste management. Mr. Dymmel also has over 20 years management experience with project engineering and operations responsibility. He has worked effectively with architect/engineering firms, utilities, equipment fabricators, constructors, and government agencies. Mr. Dymmel has also completed the Quality Assurance (QA) Auditing Program of Science Applications International Corporation (SAIC) and has served as a technical advisor during QA audits.

April 9, 1990

VITAE

MICHAEL A. GLORA

Education: B.A. Zoology

Work Summary:

Mr. Glora has approximately 20 years of experience in nuclear licensing and regulatory compliance. In addition, before concentrating on the licensing area, he had 10 years applied experience in health physics.

Mr. Glora was employed at the nuclear fuel fabrication plant of the Babcock and Wilcox Co. (B&W) as Health & Safety Supervisor and Manager of Safety, Licensing and Safeguards. While at B&W he was responsible for all regulatory activities including licensing, environmental permitting, nuclear materials transportation, industrial and radiological safety, and compliance with NRC regulations and license specifications. Mr. Glora maintained the plant's nuclear materials license including renewal,and the successful management of several major amendments leading to increased plant capacity based on unique processes that had not previously been licensed in the United States.

Mr. Glora joined the high-level waste disposal program at the Battelle Project Management Division where he served as manager of the Licensing Program Office and Regulatory Department. He is currently Manager of the Nuclear Regulatory Compliance Department. While with the HLW program, Mr. Glora's responsibilities have included NRC interactions, review and implementation of regulatory requirements, including 10 CFR 60 and 40 CFR 191, development of regulatory plans and strategies, regulatory review of program materials, and participation in the Confidence Rulemaking Proceeding.

April 9, 1990

VITAE

C. CHARLES HERRINGTON

Education: B.S. Chemical Engineering

Work Summary:

Mr. Herrington has been employed in the nuclear industry for 28 years. In that time he has worked with defense production reactor operation, defense chemical separations, private experimental reactor operation, commercial nuclear product development and production, commercial fuel reprocessing engineering, and nuclear licensing.

In his 16 years in the licensing field, Mr. Herrington has worked with fuel reprocessing, independent spent fuel storage, reactor fuel storage expansion, spent fuel transportation cask certification, dry storage cask evaluation, and high-level waste disposal.

Mr. Herrington has held personal licenses as a senior reactor operator and a fuel recovery plant operator.

April 9, 1990

VITAE

DURWARD I. (DEWEY) HULBERT

Education: B.S. Mechanical Engineering

Work Summary:

Mr. Hulbert has 36 years of nuclear project and engineering experience involving all aspects of the fuel cycle, activities from applied research through to operation and maintenance, and on applications ranging from specialty space reactors through to central station power plants.

Mr. Hulbert's career has had a predominant technical orientation and has included strategic and technical interaction with the public, regulatory agencies, and county through federal agencies. His 26 years of management experience, including 4 years of project management, has included responsibilities in the engineering, technical assurance, safety analysis, and licensing disciplines.

April 9, 1990

VITAE

BRUCE R. JUDD

Education: Ph.D., Stanford University, Engineering-Economic Systems
M.S., Stanford University, Engineering-Economic Systems
B.S., Northwestern University, Science Engineering

Work Summary:

Dr. Judd's specialty is developing innovative methods to analyze and solve public policy and business decisions where uncertainty and conflicting values are major factors. He has consulted to the Department of Energy, the Nuclear Regulatory Commission, the Atomic Energy Commission, the Environmental Protection Agency, and state government agencies such as the California Energy and Public Utilities Commissions. For most of these organizations he developed and applied systematic frameworks for analyzing the benefits, costs, and risks associated with important public policy choices.

Mr. Judd is a frequent lecturer in decision analysis for a variety of organizations. In 1987, he created Strategic Decisions Group's Decision Education Center and served as its first director. Now he develops and presents management education programs in decision analysis for the Center, which offers these programs to help organizations improve the quality of their decision-making.

At Stanford University, Bruce has taught the M.B.A. course in decision analysis in the Graduate School of Business for 10 years. He has lectured in executive education programs at Stanford and at the University of California at Berkeley. He also has developed and taught specialized courses for IBM, the U.S. Department of Energy, and the U.S. Navy.

April 9, 1990

VITAE

LARRY B. LA MONICA

Education: M.S. Chemical Engineering

Work Summary:

Mr. La Monica has worked in the nuclear industry for 12 years. During that period he has performed technical, safety, and alternative assessments for DOE and NRC in uranium milling, enrichment, commercial and defense fuel fabrication, unirradiated uranium scrap recycling, and waste management system planning and design for both LLW and HLW. Recent DOE program experience includes repository engineering and management efforts on the Salt Repository and Yucca Mountain Projects.

April 17, 1990

VITAE

WILLIAM MICHAELS

Education: B.A., Mathematics, Pennsylvania State University

Work Summary:

Mr. Michaels has over 27 years experience in program management related areas including (1) management control system design, development, and implementation, (2) Cost and Schedule Control System Criteria (C/SCSC) compliance (U.S DOE Order 2250.1, U.S. DODI 7000.2, the Canadian Government C/SCSC Compliance matrix), and (3) evaluation/application of management information system approaches to current operating conditions. His background and experience have emphasized the utilization of integrated cost/schedule control systems in areas of planning and scheduling, performance measurement and analysis, baseline maintenance and change control, and funds management/analysis. Work environments have included waste management, nuclear/non-nuclear energy systems, construction, aerospace/aircraft and shipbuilding programs.

Prior to joining SAIC in June 1989, Mr. Michaels spent 4 years as a senior consultant in Program Management environments. He was also a Planning and Scheduling Supervisor for a DOE Program Management Contractor on a major remedial action program, as well as a senior staff member of Program Planning and Control for the Energy Systems Group of a major international corporation.

April 9, 1990

VITAE

MARTHA W. PENDLETON

Education: M.S. Geology
B.S. Geology

Work Summary:

Ms. Pendleton has over 15 years experience in engineering geology and critical facility siting. During this time, she has worked for the Nuclear Regulatory Commission (NRC), Dames and Moore, Roy F. Weston, and Science Applications International Corporation.

Ms. Pendleton's regulatory experience includes collection and analysis of geologic data under a 10 CFR Part 50 quality assurance program, contributions to nuclear power plant safety analysis reports in the area of geology, participation in rulemaking for the high level waste management program and providing expert advise to the NRC on geologic issues in waste management. She participated in the postclosure multivariate utility analysis of sites for characterization for the first radioactive waste repository and has been involved in developing plans for site characterization activities that are structured to resolve performance and design issues in the repository program.

Ms. Pendleton is a registered professional geologist.

April 9, 1990

VITAE

THOMAS H. PYSTO

Education: B.S. Wildlife Management

Work Summary:

Mr. Pysto is presently working in the Environmental Compliance and Permitting Department. His work duties include coordinating and interfacing engineering activities with permitting requirements. He is involved with obtaining the applicable permits, preparing environmental compliance procedures, and conducting regulatory compliance inspections.

Mr. Pysto's prior experience has been as a Project Environmental Biologist for Occidental Petroleum Corporation on their experimental mine site. His duties included conducting environmental compliance inspections, reviewing and updating permits, resolving environmental compliance problems, and working with the various engineering departments to ensure environmental requirements were incorporated into all work plans. Mr. Pysto has also worked for the U.S. Bureau of Land Management and the Colorado Division of Wildlife conducting field studies.

Mr. Pysto is a certified Wildlife Biologist.

April 9, 1990

VITAE

JEAN L. YOUNKER

Education: Ph.D. Geology
M.S. Physical Science
M.S. Geology
B.S. Physical Sciences

Work Summary:

Dr. Younker has over 16 years experience coordinating geotechnical activities and teaching university courses in geoscience. During this time, she has worked under contract to the U.S. Department of Energy at Lawrence Livermore National Laboratory and various universities.

Dr. Younker's regulatory experience includes coordinating the development of the Site Characterization Plan for the Yucca Mountain Site, coordinating and participating in regulatory interactions with the Nuclear Regulatory Commission, the Advisory Committee on Nuclear Waste, and the Nuclear Waste Technical Review Board. Dr. Younker participated in the development of the Yucca Mountain Project Issues Hierarchy, a summary of the regulations and requirements for licensing a high-level nuclear waste repository. She also coordinated the geologic input for the Yucca Mountain Project Environmental Assessment, including evaluations of favorable and potentially adverse conditions and disqualifying and qualifying conditions for the Yucca Mountain Site.

Attendees of ATLAS Task Force Workshop to Identify Alternatives
February 14, 1990
March 1, 1990

M. J. Aldrich	LANL
Bill Andrews	SAIC
Mike Bauser	EEI/UWaste
Candace Biddison	SAIC
Thomas Bjerstedt	DOE/YMP
Maxwell Blanchard	DOE/YMP
Jerry Boak	SAIC
Tony Buono	USGS
D. M. Caldwell	Golder
Robert W. Craig	USGS
J. Marshall Davenport	SAIC
David C. Dobson	DOE/YMP
George Dymmel	DOE/YMP
Roxanne Edwards	DOE/YMP
Jerry Frazier	SAIC
Carl Gertz	DOE/YMP
Mike Glora	SAIC
Chris Henkel	EEI/UWaste
Richard Herbst	LANL
Dwight Hoxie	USGS
Tom Hunter	SNL
Leslie Jardine	LLNL
Bruce Judd	Decision Analysis Co.
Jerry King	SAIC
Larry LaMonica	SAIC
Jay Mukhersee	DOE/YMP
Franklin Peters	OCRWM (RW-2)
Tom Pysto	SAIC
Larry Ramspott	LLNL
Larry Rickertsen	Weston
W. J. Roberds	Golder
John Shaler	SAIC
Jay Silberg	EEI/UWaste
Scott Sinnock	SNL/LV
Bill Sprecher	DOE/OCRWM
Michael Voegele	SAIC
Sue Volek	SAIC
Robert Williams	EPRI
Ed Wilmot	DOE/YMP
Bill Wilson	USGS
Jean L. Younker	SAIC

Attendees of ATLAS Extended Core Group Workshop
April 18, 1990
May 3, 1990
May 23, 1990
May 31, 1990

Don Alexander	DOE/HQ
Bill Andrews	SAIC/T&MSS
Lake Barrett	DOE/HQ
Robert Barton	DOE/YMP
Ken Beall	SAIC/T&MSS
Lester Berkowitz	Weston
Candace Biddison	SAIC/T&MSS
Tom Bjerstedt	DOE/YMP
Stephan Brocoum	DOE/HQ
Julie Canepa	Los Alamos
K. Michael Cline	Weston
Scott Dann	Weston
Jim Danna	Weston
Linda Desell	DOE/HQ
George Dymmel	DOE/YMP
Carl Gertz	DOE/YMP
Larry Hayes	USGS
Dick Herbst	Los Alamos
Chuck Herrington	SAIC/T&MSS
Dwight Hoxie	USGS
Dewey Hulbert	SAIC/T&MSS
Tom Hunter	SNL
Tom Isaacs	DOE/HQ
Leslie Jardine	LLNL
Deborah Jerez	Weston
Bruce Judd	Decision Analysis Co.
Lew Killpack	Weston
Jerry King	SAIC/T&MSS
Larry LaMonica	SAIC/T&MSS
Mike Lugo	Weston
Corinne Macoluso	DOE/HQ
August Matthusen	SAIC/T&MSS
William Michaels	SAIC/T&MSS
David Michlewicz	Weston
John Nelson	SAIC/T&MSS
Tom Pysto	SAIC/T&MSS
Larry Rickertsen	Weston
Robert Saunders	WEC
John Shaler	SAIC/T&MSS
Ralph Stein	DOE/HQ
Jane Stockey	DOE/HQ
Jim Teak	SAIC/T&MSS
John Treadwell	SAIC/T&MSS
Jeff Weaver	SAIC/T&MSS
Jim Weston	SAIC/T&MSS
Jean Younker	SAIC/T&MSS