APPENDIX 3C

UNDERGROUND TEST LEVEL CONFIGURATIONS IDENTIFIED DURING THE REECo LITERATURE SEARCH FOR HISTORICAL ESF CONFIGURATIONS

92030325 - Part 2

This appendix provides a brief description of the nine underground test level configurations that were identified by REECo during their literature search for historical ESF configurations.

Underground Test Level Configuration A

Configuration A is used with a single access (shaft or ramp) and consists of the following breakout excavations:

- Breakout room at 1800-foot depth, characterizes unsaturated zone (UZ) in the thermal unit TSw2,
- Breakout room at 3500-foot depth, characterizes saturated zone (SZ) in the thermal unit TRw,
- Two breakout rooms, the first at 1800-foot and the second at 3500-foot depth, characterize both UZ and SZ,
- One breakout room at varying depths (1200, 1480, 1520, 1600, 1700 feet) in UZ, and one breakout room at varying depths (1800, 2000, 2250, 3100, 3500 feet) in SZ.

Underground Test Level Configuration B

Configuration B is used with conventionally sunk shaft (Title II, 1983-1984) and consists of the following breakout excavations:

- UDBR at 520-foot depth, to characterize the upper portion of the UZ;
- MTL, also called lower demonstration breakout room, at 1200-foot depth, to provide areas for tests and the lateral borehole drilling to the faults;
- Calico Hills breakout room at 1480-foot depth, to provide areas for lateral borehole drilling in the Calico Hills unit.

Underground Test Level Configuration C

Configuration C is used in SAND84-1261, Recommendation for a Second Access for the Yucca Mountain Exploratory Shaft Facility, and consists of the following breakout excavations:

- UDBR at 520-foot depth;
- Underground disposal level at 940 foot depth, for men and materials and use as an escape route;
- MTL at 1200-foot depth;
- Calico Hills breakout room at 1480-foot depth.

Underground Test Level Configuration D

Configuration D is used with one 12-foot internal diameter conventionally sunk shaft along with a 6-foot internal diameter ventilation shaft at the old location in Coyote Wash (Revised Title II, 1985) and consists of the following breakout excavations:

- UDBR at 520-foot depth,
- MTL at 1200-foot depth,
- Calico Hills breakout room at 1480-foot depth.

Underground Test Level Configuration E

Configuration E is used with one 12-foot internal diameter conventionally sunk shaft along with a 6-foot internal diameter ventilation shaft at the old location and consists of the following breakout excavations:

- UDBR at 520-foot depth,
- MTL at 1020-foot depth,
- Calico Hills breakout room at 1400-foot depth.

Underground Test Level Configuration F

Configuration F is used with two conventionally sunk shafts with internal diameters of 12 feet (ES-2 relocated ES-1/ES-2 name switch) and 15 feet (ES-1) and consists of the following breakout excavations:

- UDBR at 520-foot depth,
- MTL at 1020-foot depth,
- Calico Hills breakout room at 1400-foot depth.

Underground Test Level Configuration G

Configuration G is used with two 12-foot internal diameter conventionally sunk shafts (Title I, 50%, April 1988) and consists of the following breakout excavations:

- UDBR at 600-foot depth,
- MTL at 1055-foot depth,
- Optional Calico Hills breakout room at 1565-foot depth.

Underground Test Level Configuration H

Configuration H is used is used with two 12-foot internal diameter conventionally sunk shafts (Title I, 100%) and consists of the following level excavations:

- UDBR at 600-foot depth,
- MTL at 1055-foot depth,
- Optional Calico Hills breakout room at 1565-foot depth.

Underground Test Level Configuration I

Configuration I is used with two 12-foot internal diameter conventionally sunk shafts (Title II General Arrangements, September 1989) at the new location and consists of the following breakout excavations:

- UDBR at 600-foot depth,
- MTL at 1055-foot depth,
- Optional Calico Hills breakout room at 1565-foot depth.

APPENDIX 3D

HISTORICAL REPOSITORY CONFIGURATIONS IDENTIFIED DURING THE PBQ&D LITERATURE SEARCH

This appendix provides a brief description of the 15 historical repository configurations and their various subsets identified during the PBQ&D literature search.

Historical Repository Configuration R-1 Initial Preconceptual Design - Vertical Emplacement

This repository configuration is of an initial preconceptual design with vertical emplacement in offset or staggered emplacement panels that was developed in 1983-84. The underground layout is based on panels approximately 1600 feet wide x 1400 feet deep, with emplacement drifts oriented N35E and access drifts oriented N55W. The emplacement drift spacing is 100 feet center-to-center, with a heat density of less than 50 kW per acre. Each emplacement drift has 50 emplacement boreholes, 30 feet deep and spaced 30 feet center-to-center along the emplacement drift. Major features include; 15-foot x 20-foot waste ramp, 25-foot men, materials, and muck shaft, 16-foot mine development exhaust shaft, 16-foot waste emplacement exhaust shaft, 20-foot mine development intake shaft, and a 12-foot exploratory shaft. All excavation was to be done using drill and blast techniques.

Subsets 1 and 2 called for a 22-foot-diameter shaft for waste emplacement from other surface sites. Subsets 3 and 4 called for a 10% ramp for waste emplacement from other surface sites. Subsets 5, 6, 7, and 8 called for a 25-foot-diameter for mining from other surface sites. Subsets 9 and 10 called for a 10% ramp for mining from other surface sites. Subset 11 called for a 20% ramp for mining from another surface site.

Historical Repository Configuration R-2 Initial Preconceptual Design - Horizontal Emplacement

This repository configuration consists of an initial preconceptual design with horizontal emplacement in emplacement panels that was developed in 1983-84. The underground layout is based on panels approximately 1600 feet wide by 1400 feet deep containing 700 waste canisters at 3.4 kW per canister. The boreholes are spaced at 157 feet center-to-center. The basic horizontal configuration has 20 emplacement boreholes per panel.

Ten of these boreholes are placed on each side of an emplacement drift 20 feet wide by 15 feet high. Each borehole will hold 35 waste canisters. The blind ends of emplacement boreholes in adjacent panels are separated by 100 feet. Underground support facilities will be in the western boundary. The ESF is intended to be at a lower level than the repository level. The layout in R-2 has a smaller mining capacity than Configuration R-1. Major features include; 15-foot x 20-foot waste ramp, 20-foot men, materials, and muck shaft, 10-foot mine development exhaust shaft, 14-foot waste exhaust shaft, 14-foot mine development intake shaft, and a 12-foot exploratory shaft. All excavation was to be done using drill and blast techniques.

Subsets 1 and 2 called for a 22-foot-diameter shaft for waste emplacement from other surface sites. Subsets 3 and 4 called for a 10% ramp for waste emplacement from other surface sites. Subsets 5, 6, 7, and 8 called for a 25-foot diameter for mining from other surface sites. Subsets 9 and 10 called for a 10% ramp for mining from other surface sites. Subset 11 called for a 20% ramp for mining from another surface site.

Historical Repository Configuration R-3 Two-Stage Repository Development at Yucca Mountain

The layout for Configuration R-3 calls for six means of access, two ramps and four shafts. One 12-foot-diameter shaft and one 6-foot-diameter shaft are sunk to the ESF. During repository development, the exploratory shaft is used for limited muck handling and during waste emplacement both exploratory shafts serve as air intakes for the waste emplacement area. Additionally, the two access ramps (19-foot and 24-foot-diameter) will handle muck and waste. A 25-foot-diameter men-and-materials shaft allows access for personnel and supplies. A 20-foot-diameter waste-emplacement exhaust shaft exhausts air from the emplacement system through HEPA filters. The typical emplacement area layout is based on a system of panels 660 feet wide by 3100 feet long. To meet the criteria for an areal power density (APD) of 57 kW per acre and for canister heat loads, vertical emplacement drifts are spaced at 150 feet center-to-center and emplacement holes are spaced 13 feet center-to-center. Major features include: 12-foot-diameter drill and blast exploratory shaft; 6-foot-diameter raise-bored exploratory shaft; 20-foot-diameter drill and blast men-and-materials shaft; 20-foot-diameter drill and blast waste-emplacement area exhaust shaft; 24-foot-diameter TBM

waste-handling ramp; and 19-foot-diameter TBM tuff ramp. The construction method to be employed in the repository was drill and blast with the exceptions noted above for the accesses.

There were 53 subsets identified for Configuration R-3. These include the following combinations:

- single 12-foot-diameter exploratory shaft,
- 12-foot-diameter exploratory shaft and 6-foot-diameter second shaft,
- 16-foot-diameter exploratory shaft and 6-foot-diameter second shaft,
- 12-foot-diameter exploratory shaft and 25-foot-diameter second shaft,
- 16-foot-diameter exploratory shaft and 25-foot-diameter shaft,
- 12-foot-diameter exploratory shaft and 19-foot-diameter muck-handling ramp,
- 16-foot-diameter exploratory shaft and 19-foot-diameter muck-handling ramp,
- 12-foot-diameter exploratory shaft and 24 foot-diameter waste-handling ramp,
- 16-foot-diameter exploratory shaft and 24-foot-diameter waste-handling ramp,
- 465-foot muck-handling ramp and 6700-foot waste-handling ramp, located north of the central boundary,
- 4700-foot muck-handling ramp and 6900-foot waste-handling ramp, located east of the central boundary,
- 4700-foot muck-handling ramp and 7500-foot waste-handling ramp, located east of the central boundary,
- single waste canister in vertical position, and
- 34 waste canisters in horizontal position.

Historical Repository Configuration R-4 Conceptual Design for SCP - Complete Separation of DHLW From Spent Fuel

In 1985, the first conceptual design for the SCP was developed. Spent fuel and defense high-level waste (DHLW) are completely separated. The DHLW is positioned in the northeast corner of the primary area at a somewhat lower elevation. The DHLW vertical emplacement is arranged in two staggered rows. The spent fuel is emplaced in the rest of the repository. The DHLW would be close to the ESF facilities. The 12-foot

and 6-foot-diameter ESF shafts are used for ventilation intake during waste emplacement, and during repository development the 12-foot-diameter ESF shaft is used for limited muck handling. The waste emplacement panels were to be 1400 feet wide with 77 vertically emplaced waste canisters per emplacement drift. Emplacement hole spacing was to be 15 feet. Drift spacing was to be 112 feet. Major features include a 25-foot-diameter TBM waste ramp, a 19-foot x 25-foot TBM tuff ramp, a 20-foot-diameter drill and blast emplacement exhaust shaft, a 20-foot-diameter drill and blast men-and-materials shaft, a 12-foot-diameter drill and blast exploratory shaft, and a 6-foot-diameter raise-bored exploratory shaft. The construction method used is TBM for ramps and mains, drill and blast for all others except the 6-foot raise bore.

There is one subset of Historical Repository Configuration R-4. This subset entails horizontal emplacement.

Historical Repository Configuration R-5 Site Characterization Plan Conceptual Design report (SCP-CDR)

This conceptual design for the repository was developed from March 1984 through September 1986; the SCP-CDR was published in 1987. In this design, the DHLW and spent fuel are commingled. There are six accesses, four shafts and two ramps. There was a QA program associated with this design. The principal excavation method was drill and blast with limited TBM excavation. Configuration R-5 is very similar to R-4, except that spent fuel and DHLW are commingled. The typical panel width is 1400 feet. There are dual-access drifts that extend the length of the panel to intersect the perimeter drift. Two-panel access drifts are required to maintain separate ventilation systems, one for development and one for emplacement. The standoff distance from the mains to the closest waste container in the panel is approximately 200 feet. A midpanel drift runs parallel to the access drift, dividing the panel into two 700-foot segments. Major features include a 23-foot-diameter TBM waste ramp, a 25-foot-diameter TBM tuff ramp, a 20-foot-diameter drill and blast men-and-materials shaft, a 20-foot-diameter drill and blast emplacement exhaust shaft, a 12-foot-diameter drill and blast exploratory shaft, and a 6-foot-diameter raise-bored exploratory shaft. The construction methods are TBM for ramps and mains and drill and blast for emplacement areas.

There were 63 subsets identified for Historical Repository Configuration R-5. These include combinations of the following:

- 21-foot-diameter waste-handling ramp,
- Vertical shaft for waste-handling,
- 20-foot-diameter waste-emplacement exhaust shaft,
- Waste-emplacement exhaust ramp,
- 24-foot-diameter tuff ramp at 17.9% grade,
- 18-foot-diameter tuff shaft,
- 20-foot-diameter men-and-materials shaft,
- 20-foot-wide by 15-foot-high ramp at 8% grade for men-and-materials,
- Entry from the north across Drill Hole Wash Fault,
- Entry near northeast corner of underground repository,
- Entry inside northeast corner of underground repository,
- Entry from east near repository shaft,
- Single waste container in vertical position,
- 14 spent-fuel containers in a horizontal position and 18 DHLW-containers in a horizontal position.

Historical Repository Configuration R-6 SCP-CDR Layout Adjusted For Raised TSw1/TSw2 Geologic Boundary

Historical Repository Configuration R-6 represents one of seven closely related variations of the SCP-CDR repository layout where the elevations of all underground facilities have been adjusted by various amounts to conform to a higher (in elevation), less restrictive geologic boundary than was used for the SCP-CDR layout. A planar layout geometry is used to establish drift gradients and simplify the repository layout. A planar layout geometry is used to establish drift gradients in contrast to the varying geometry that was adopted for the target horizon (TSw2). The plan appearance of all subsurface facilities in the SCP-CDR (Configuration R-5) remains unchanged in Configuration R-6. All emplacement panels have identical plan dimensions but are oriented at different gradients to match the planar layout geometry. Major features include: a 23-foot-diameter TBM waste ramp, a 25-foot-diameter TBM tuff ramp, a 20-foot-diameter drill and blast men-and-materials shaft, a 20-foot-diameter drill and blast emplacement exhaust shaft, a 12-foot-diameter drill and blast exploratory shaft, and a

second 12-foot-diameter exploratory shaft. The construction methods used are TBM for ramps, mains and perimeter drift, and drill and blast for all other repository areas.

There are six subsets of Configuration R-6. Configuration R-6 is one of seven layout variations that were examined, all of which preserve the SCP-CDR mining concepts and plan appearance. The main features that vary between the subsets of R-6 are the entry point elevation (El. 3100, 3200, or 3300 feet), and layout geometry (two parallel planes or two pairs of parallel planes). The planar layout geometry applied to R-6 and subsets differs from the SCP-CDR layout in which drift gradients were deliberately allowed to conform to the geology to preserve and demonstrate mining flexibility in the presence of geologic uncertainty. The conformal approach of the SCP-CDR places the least stringent demands on the accuracy of the geologic models.

Historical Repository Configuration R-7 TBM Layout 1, 4 Blocks

Historical Repository Configuration R-7 is one of a series of layouts that were developed in concept using the revised TSw1/TSw2 contact. These layouts are considered by the A/E to be credible alternatives to the SCP-CDR layout; they meet performance goals and can be built safely, using TBMs to excavate waste-emplacement drifts at grades of 1%. Configuration R-7 has two pairs of independent blocks at two separate elevations. The blocks do not overlap, are regular in shape, and are composed of independent modular panels in which the average emplacement-drift and emplacement-hole spacing are equivalent to those used in the SCP-CDR. Curved entries for each panel of four emplacement drifts permit the use of an integrated rail transport system for development and waste handling. The two lower blocks, at the approximate elevation of 3300 feet, contain eight and seven panels, with four emplacement drifts per panel. The emplacement drifts are spaced at 126 feet center-to-center. Vertical or angled boreholes for spent fuel are drilled at 15-foot center-to-center with holes drilled between for DHLW. The APD is less than 57 kW per acre. The two upper blocks, at an approximate elevation of 3600 feet, contain seven and six panels, again with four emplacement drifts per panel. The drift spacing, borehole spacing, and APD are the same as the lower blocks. The ESF dedicated area is enveloped, and Block Zero to the east of the ESF area provides space for the first five years' emplacements. Major features include: a 25.5-foot-diameter TBM waste ramp, a

25.5-foot-diameter TBM tuff ramp, a 25-foot-diameter up-ream or V-mole men-and-materials shaft, a 25-foot-diameter up-ream or drill and blast emplacement exhaust shaft, a 12-foot-diameter drill and blast exploratory shaft, and a second 12-foot-diameter drill and blast exploratory shaft.

There is one subset for Configuration R-7. This subset contains four main blocks, but instead of rounded entries suitable for rail transportation, all panel entries are at right angles off main intakes to the blocks. A TBM erection and dismantling chamber would be needed for each emplacement drift within a block, or these panel entries could be constructed using drill and blast with trackless equipment.

Historical Repository Configuration R-8 TBM Layout 2, 3 Blocks (Avoids Ghost Dance Fault)

Historical Repository Configuration R-8 is one of a series of layouts that were developed using the revised TSw1/TSw2 contact. These layouts are considered by the A/E to be credible alternatives to the SCP-CDR layout; they meet performance goals and can be built safely, using TBMs to excavate waste emplacement drifts at grades of 1 percent. Configuration R-8 has one large upper block and a pair of diagonally linked lower blocks at separate elevations. The blocks do not overlap in plan, are regular in shape, and are composed of independent modular panels in which the average emplacement drift and and emplacement-hole spacing is equivalent to that used in the SCP-CDR. Curved entries for each panel of four emplacement drifts permit the use of an integrated rail transport system for development and waste handling. The two lower blocks, at approximate elevation 3250 feet, contain five and seven panels, with four emplacement drifts per panel. The emplacement drifts are spaced at 126 feet center-to-center. Vertical or angled boreholes for spent fuel are drilled at 15-foot center-to-center with holes drilled between for DHLW. The APD is less than 57 kW per acre. The upper block, at an approximate elevation of 3550 feet, contain nine long panels, again with four emplacement drifts per panel. The drift spacing, borehole spacing, and APD are the same as the lower blocks. A 300-foot barrier is left to contain the Ghost Dance Fault. The ESF dedicated area is enveloped, and Block Zero to the east of the ESF area provides space for the first five years' emplacements. Major features include a 300-foot standoff from the Ghost Dance Fault, a 25.5-foot-diameter TBM waste ramp,

a 25.5-foot-diameter TBM tuff ramp, a 25-foot-diameter up-ream or V-mole men-and-materials shaft, a 25-foot-diameter up-ream or drill and blast emplacement exhaust shaft, a 12-foot-diameter drill and blast exploratory shaft, and a second 12-foot-diameter drill and blast exploratory shaft.

There is one subset for Configuration R-8. This subset contains three main blocks but instead of rounded entries suitable for rail transportation, all panel entries are at right angles off main intakes to the blocks. A TBM erection and dismantling chamber would be needed for each emplacement drift within a block, or these panel entries could be constructed using drill and blast with trackless equipment.

Historical Repository Configuration R-9 TBM Layout 3, SCP-CDR Outline and Elevation

Historical Repository Configuration R-9 consists of the SCP-CDR perimeter drift bounding emplacement drifts reoriented perpendicular to the mains. The drifts are constructed at 126-foot centers in a sequence progressing from north to south. The alignment and gradient of the mains remains unchanged, but a fourth main is added as an emplacement intake. Gradients are as steep as in the SCP-CDR, precluding the use of rail transportation. This configuration does not have the independent blocks of Configurations R-7 and R-8, but is constructed in panels like the SCP-CDR layout. There are 12 full panels oriented east to west from perimeter drift to perimeter drift, and three shorter panels from the west perimeter drift to the mains. There are six emplacement drifts in each panel. Emplacement drifts are constructed across the full repository width between perimeter drifts. Mining and emplacement accesses remain unchanged at the north end of the repository. Mains are kept in advance, with the tuff main connected to a possible future ventilation shaft at the south end. This configuration was designed for vertical emplacement of commingled waste with an APD less than 57 kW per acre. Major features include a 25.5-foot-diameter TBM waste ramp, a 25.5-foot-diameter TBM tuff ramp, a 25-foot-diameter up-ream or V-mole men-and-materials shaft, a 25-foot-diameter up-ream or drill and blast shaft, a 12-foot-diameter drill and blast exploratory shaft, and a second 12-foot-diameter drill and blast exploratory shaft. The major construction method is TBM with drill and blast to be used for panel cross cuts.

Configuration R-9 is one of three subsets which include constructing the layout as described above, using drill and blast techniques, constructing (using TBMs) the emplacement drifts on one side of the mains only, and progressing in the "circular" fashion described in the SCP-CDR (R-5).

Historical Repository Configuration R-10 TBM Layout 4, SCP-CDR Outline Raised to NEW TSw1/TSw2 Interface

Historical Repository Configuration R-10 incorporates the SCP-CDR perimeter drift to bound emplacement drifts that have been reoriented perpendicular to the mains. Gradients of emplacement drifts are flattened to about 3 to 4 percent by taking advantage of the possible new location of the TSw1/TSw2 interface. The drifts are constructed at 126-foot centers in a sequence progressing from north to south. The alignment and gradient of the mains remains unchanged, but a fourth main is added as an emplacement intake. Gradients are not as steep as in Configuration R-9, and with further analysis, could possibly be flat enough to allow the integrated use of rail transport throughout the repository. This configuration does not have independent blocks as in Configurations R-7 and R-8, but is constructed in panels as is the SCP-CDR layout. There are 12 full panels, oriented E-W from perimeter drift to perimeter drift, and 3 shorter panels from the west perimeter drift to the mains. There are six emplacement drifts in each panel. Emplacement drifts are constructed across the full repository width between perimeter drifts. Mining and emplacement accesses remain unchanged at the north end of the repository. Mains are kept in advance, with the tuff main connected to a possible future ventilation shaft at the south end. This configuration was designed for vertical emplacement of commingled waste with an APD less than 57 kW per acre. Major features include flattened grades, a 25.5-foot-diameter TBM waste ramp, a 25.5-foot-diameter TBM tuff ramp, a 25-foot-diameter up-ream or V-mole men-and-materials shaft, a 25-foot-diameter up-ream or drill and blast shaft, a 12-foot-diameter drill and blast exploratory shaft, and a second 12-foot-diameter drill and blast exploratory shaft. The major construction method is TBM with drill and blast to be used for panel cross cuts.

No subsets were developed for Configuration R-10.

Historical Repository Configuration R-11 TBM Layout 5, SCP-CDR Outline and Elevation - Mining From South

Historical Repository Configuration R-11 is based on the SCP-CDR boundaries, and emplacement drifts are bounded by the SCP-CDR perimeter drift. The waste ramp, waste main, and bearing of the mains are the same as in the SCP-CDR design. Waste-emplacement drifts run perpendicular to the mains from the west to the east perimeter drifts of the repository (full width) and are constructed by TBMs. The spacing between emplacement drifts is 126 feet center-to-center. The emplacement shops are at the north end and development shops are at the south end. All waste transport and emplacement activities come from the north end, and development activities from the south end, providing a natural separation. A ramp is needed at the south end for tuff removal. Four mains are needed, and emplacement advances from north to south. Development initially takes place by constructing the main accesses. Panels are then formed on the retreat from the north end to the south leaving a buffer between emplacement and development. Emplacement drifts are driven at right angles to the mains with TBMs. As a TBM reaches the repository boundary, it will reverse direction with a fairly short radius curve and drive another emplacement drift in the opposite direction. Major features include a 25-foot-diameter TBM waste ramp, a 25-foot-diameter TBM tuff ramp, a 25-foot-diameter V-mole or up-ream men-and-materials shaft, a 25-foot-diameter V-mole or up-ream emplacement exhaust shaft, a 12-foot-diameter drill and blast exploratory shaft, and a second 12-foot-diameter drill and blast exploratory shaft.

No subsets were identified for Configuration R-11.

Historical Repository Configuration R-12 TBM Layout 6, Two Blocks Integrated With ESF

Historical Repository Configuration R-12 consists of a lower block at elevations ranging from 3231 feet to 3279 feet and an upper block at elevations ranging from 3530 feet to 3655 feet. Both blocks are west of the Ghost Dance Fault, with the ESF east of the fault. The blocks are constructed by TBM. There are four access openings including the ESF. The ESF consists of the tuff ramp and a 16-foot-diameter shaft. Part of the repository men-and-materials shops will be developed as part of the ESF for mining

operations. Towards the end of repository construction, the 16-foot ESF shaft will be enlarged to 25 feet to serve as emplacement ventilation exhaust. Both the tuff ramp and waste ramp split off at the higher level to intersect the upper block at a near-flat gradient. They also continue down at the initial gradient to reach the lower block. The lower block contains seven panels with four emplacement drifts per panel. The emplacement drifts are spaced at 126 feet center-to-center with vertical emplacement boreholes 7.5 feet on center. The APD is less than 57 kW per acre. The upper block contains nine long panels with four emplacement drifts per panel. The drift spacing, borehole spacing, and APD are the same as for the lower block. For ventilation purposes the upper panels are divided in half. A 300-foot barrier is maintained between the repository and the Ghost Dance Fault. The primary construction method is TBM with a minor amount of drill and blast. Major features include a 25-foot-diameter TBM waste ramp, a 25-foot-diameter TBM tuff ramp, a 25-foot-diameter up-ream or V-mole men-and-materials shaft, a 16-foot-diameter drill and blast exploratory shaft/emplacement exhaust shaft (later enlarged using V-mole to 25 feet).

One subset was identified for Configuration R-12. This subset contains two main blocks, but instead of rounded entries suitable for rail transportation, all panel entries are perpendicular off main intakes to the blocks. A TBM erection and dismantling chamber would be needed for each emplacement drift within a block, or panels could be constructed by drill and blast with trackless equipment.

Historical Repository Configuration R-13 TBM Layout 7, Four Panels Within SCP-CDR Area

Historical Repository Configuration R-13 was developed as a very preliminary concept to show four stepped panels oriented approximately east to west, with 2,500-foot-long emplacement drifts constructed by TBMs that are oriented roughly north to south. No specific arrangements for erection/dismantlement facilities were considered. This layout assumes that the new higher TSw1/TSw2 interface and gradients for emplacement drifts are flatter than those in the SCP-CDR (R-5). Panels are entered at the east end from the mains. The ESF is located adjacent to the bottom of the tuff and waste ramps used for tuff haulage and waste transport. The men-and-materials shaft is located east of the ESF and the exhaust shaft is northwest of the bottom of the ramps.

This configuration has four waste emplacement blocks. The ESF includes two shafts, one of which will be enlarged to become the emplacement exhaust shaft for the repository. The primary method of construction is with TBM; however, there is also an unspecified amount of drill and blast. APD is less than 57 kW per acre for vertical emplacement of commingled waste. Major features include a 25-foot-diameter TBM waste ramp, a 25-foot-diameter TBM tuff ramp, a 25-foot-diameter up-ream or V-mole men-and-materials shaft, and a 25-foot-diameter up-ream or V-mole emplacement exhaust shaft (originally the ESF shaft, later enlarged).

No subsets of Historical Repository Configuration R-13 were identified.

Historical Repository Configuration R-14 TBM Layout 8, 1984 Version

Historical Repository Configuration R-14 was developed in 1984 in parallel with other initial concepts under consideration for the SCP-CDR. Horizontal and vertical emplacement options were both examined for this configuration. This configuration uses the same repository boundary as the SCP-CDR, an extended perimeter drift, and approximately the same ramp and shaft accesses. Two waste-emplacement areas are utilized, one to the southeast of the northeast to southwest-oriented mains, and the other on the northwest side of the mains. It uses all available space in the northwest corner between the Solitario Canyon and Drill Hole Wash Fault Systems. The emplacement orientation is vertical, with commingling of waste forms. Major features include a 24.5-foot-diameter TBM waste ramp, a 17-foot-diameter TBM tuff ramp, a 25-foot-diameter drill and blast men-and-materials shaft, a 25-foot-diameter emplacement exhaust shaft, a 12-foot-diameter drill and blast exploratory shaft, and a 6-foot-diameter exploratory shaft.

Three subsets were identified for Configuration R-14. Emplacement drifts were oriented north to south as an alternative to east to west. Horizontal emplacement options were briefly developed for north to south and east to west configurations. The specific subsets are an east to west emplacement drift, a horizontal emplacement, a north to south emplacement drift, a vertical emplacement, and a north to south emplacement drift with horizontal emplacement.

Historical Repository Configuration R-15 Preconceptual Horizontal Emplacement Configuration

Historical Repository Configuration R-15 was developed during 1984. It is a horizontal emplacement case that uses waste and tuff ramp accesses from the surface; men-and-materials and emplacement exhaust shafts; waste, tuff, and service mains; and exploratory shafts at the same location as the SCP-CDR (R-5). In addition, a pair of mains (tuff and waste) are driven in the northwest section of the repository that make the layout distinctly different from the other historical repository configurations. The layout of Configuration R-15 has about 16 emplacement panels. The control layout boundary encompasses 1960 acres and was determined by analyses of overburden, thickness, faults, and groundwater. Emplacement drifts are spaced 1428 feet apart and driven east and west from the mains. These emplacement drifts intersect a perimeter emplacement exhaust drift within the repository boundary. An additional pair of mains (tuff and waste) are driven on the west side of the repository to access the western extremities of the last three blocks on the north. This configuration is based on design criteria of an areal heat load of 57 kW per acre, a maximum allowable temperature of 390 degrees Fahrenheit one meter from the canister borehole, drilling of and retrieval from horizontal boreholes up to 700 feet long, and a canister assembly of 16.9 feet. The emplacement boreholes are drilled 110 feet apart, 700 feet long with 60 feet between hole ends. A maximum of 34 canisters are emplaced in each borehole. Major features include a TBM waste ramp (size unavailable), a TBM tuff ramp (size unavailable), a drill and blast men-and-materials shaft (size unavailable), a drill and blast emplacement exhaust shaft (size unavailable), a 12-foot-diameter drill and blast exploratory shaft, and a 6-foot-diameter exploratory shaft.

There is one subset for Configuration R-15. The subset is for a vertical emplacement configuration using the same repository boundary, and 19 emplacement panels, but not employing the second set of mains in the northwest area. The vertical emplacement facility uses panel access and midpanel drifts to the perimeter drift, with emplacement drifts driven at 113-foot centers. Emplacement hole spacing was 16 feet between holes, with a 12-foot standoff to panel access drifts and a 170-foot standoff to the mains.

APPENDIX 3E

TWENTY-FOUR PRELIMINARY NEW OPTIONS

This appendix includes sketches and data sheets for the 24 preliminary new options developed by the ESF-AS Task-4 participants plus a summary sheet describing the type and number of accesses for each of the 24 preliminary new options.

ACCESS SUMMARY

GROUP A. DRILL & BLAST, SINGLE LEVEL REPOSITORY

	DESCRIPTIVE TITLE	ESF ACCESSES			REPOSITORY ACCESSES *		
		SHAFTS	RAMPS	SUBTOTAL	SHAFTS	RAMPS	TOTAL
A1	MTL N., SHAFT/TUFF RAMP	1	1	2	3	2	5
A2	MTL N., SHAFT/SHAFT	2	-	2	4	2	6
A3	MTL N., SHAFT/WASTE RAMP	1	1	2	3	2	5
A4	MTL N., SHAFT/SHAFT/TUFF RAMP	2	1	3	3	2	5
A5	MTL S., SHAFT/TUFF RAMP	1	1	2	3	2	5
A6	MTL S., SHAFT/WASTE RAMP	1	1	2	3	2	5
A7	MTL N., TUFF RAMP/WASTE RAMP	-	2	2	2	2	4
A8	MTL S., TUFF RAMP/WASTE RAMP	-	2	2	2	2	4
A9	MTL S., SHAFT/TUFF RAMP	1	1	2	2	3	5
A10	MTL S., SHAFT/TUFF RAMP	1	1	2	3	2	5

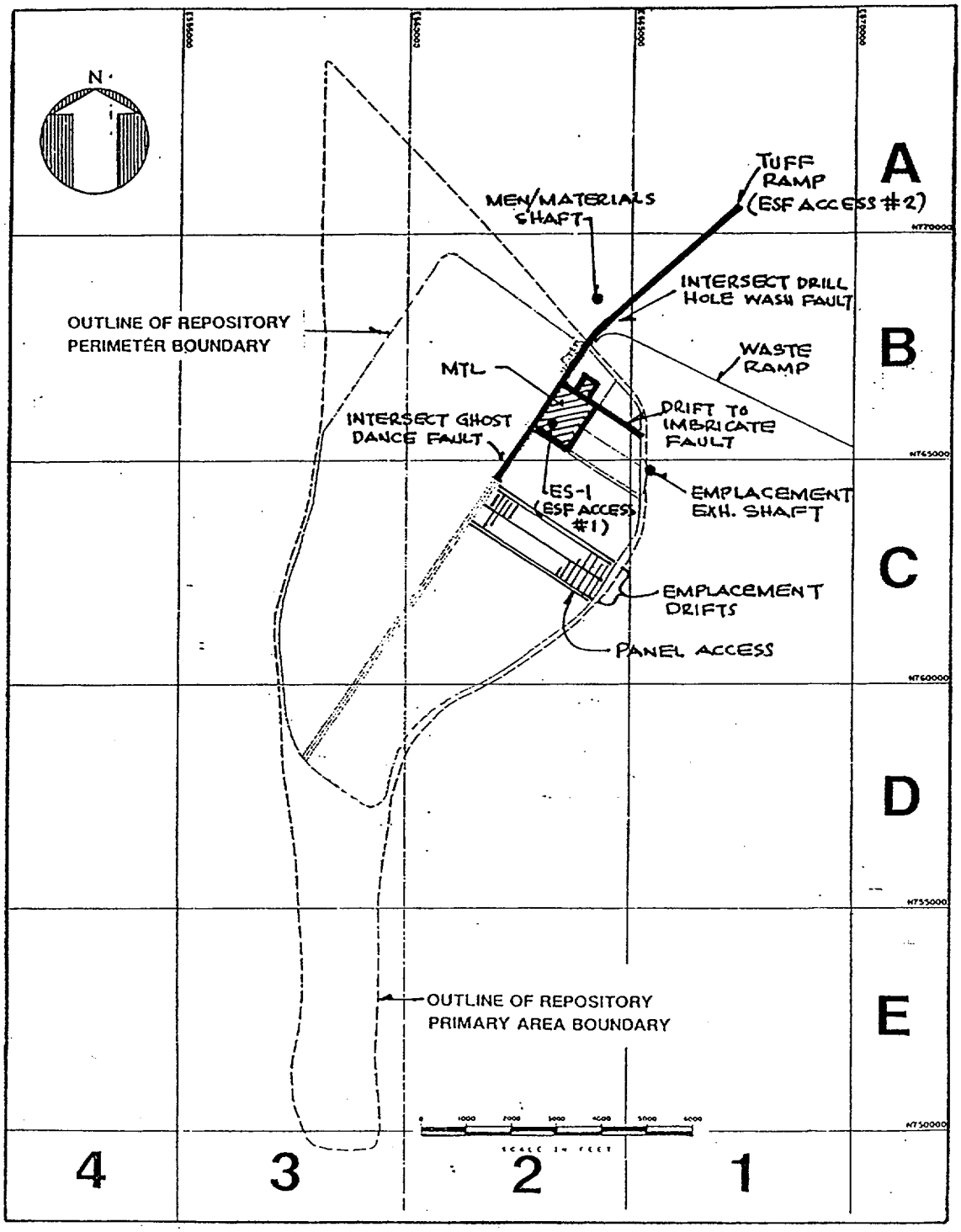
GROUP B. TBM, SINGLE LEVEL REPOSITORY

	DESCRIPTIVE TITLE	ESF ACCESSES			REPOSITORY ACCESSES *		
		SHAFTS	RAMPS	SUBTOTAL	SHAFTS	RAMPS	TOTAL
B1	MTL N. SHAFT/TUFF RAMP	1	1	2	3	2	5
B2	MTL N. SHAFT/SHAFT	2	-	2	3	2	5
B3	MTL N. SHAFT/WASTE RAMP	1	1	2	3	2	5
B4	MTL S., SHAFT/TUFF RAMP	1	1	2	3	2	5
B5	MTL S., SHAFT/WASTE RAMP	1	1	2	3	2	5
B6	MTL N., TUFF RAMP/WASTE RAMP	-	2	2	2	2	4
B7	MTL S., TUFF RAMP/WASTE RAMP	-	2	2	2	2	4
B8	MTL S., SHAFT/TUFF RAMP	1	1	2	2	3	5
B9	MTL S., SHAFT/TUFF RAMP	1	1	2	3	2	5

GROUP C. TBM, STEP BLOCK REPOSITORY

	DESCRIPTIVE TITLE	ESF ACCESSES			REPOSITORY ACCESSES *		
		SHAFTS	RAMPS	SUBTOTAL	SHAFTS	RAMPS	TOTAL
C1	MTL N. SHAFT/TUFF RAMP	1	1	2	2	2	4
C2	MTL N. SHAFT/SHAFT	2	-	2	3	2	5
C3	MTL N. SHAFT/WASTE RAMP	1	1	2	2	2	4
C4	MTL S., SHAFT/TUFF RAMP	1	1	2	3	2	5
C5	MTL N., TUFF RAMP/WASTE RAMP	-	2	2	2	2	4

*INCLUDES ESF ACCESSES,VENT., M/M, TUFF, AND WASTE



LEGEND:

ESF - EXPLORATORY SHAFT FACILITY
MTL - MAIN TEST LEVEL
D&B - DRILL AND BLAST
TBM - TUNNEL BORING MACHINE
MECH - MECHANICAL MINING

- INDICATES DRILL AND BLAST EXCAVATED MTL.

- INDICATES MECHANICALLY EXCAVATED MTL.

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A1 MTL N., SHAFT/TUFF RAMP

PRELIMINARY NEW OPTION # A1

OPTION DESCRIPTION MTL NORTH, SHAFT / TUFF RAMP

ESF ACCESSES 2 TOTAL ACCESSES 5

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #2	RAMP
	SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.		25' DIA.
	CONSTRUCTION	D&B	TBM	MECH.	MECH.		TBM
	LOCATION SURFACE	B2	A1	B2	C1		B1
	UNDERGROUND	B2	B2	B2	C1		B2
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE		NONE

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING,PERSONNEL	NONE
	REPOSITORY OPERATIONS	VENTILATION	TUFF RAMP	NONE

REPOSITORY LAYOUT FEATURES		
	MINING METHODS MAINS	TBM
	PERIMETER DRIFT	TBM
	PANEL ACCESS	D&B
	EMPL. DRIFTS	D&B
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
	EMPLACEMENT DRIFT ORIENTATION	N 34 E

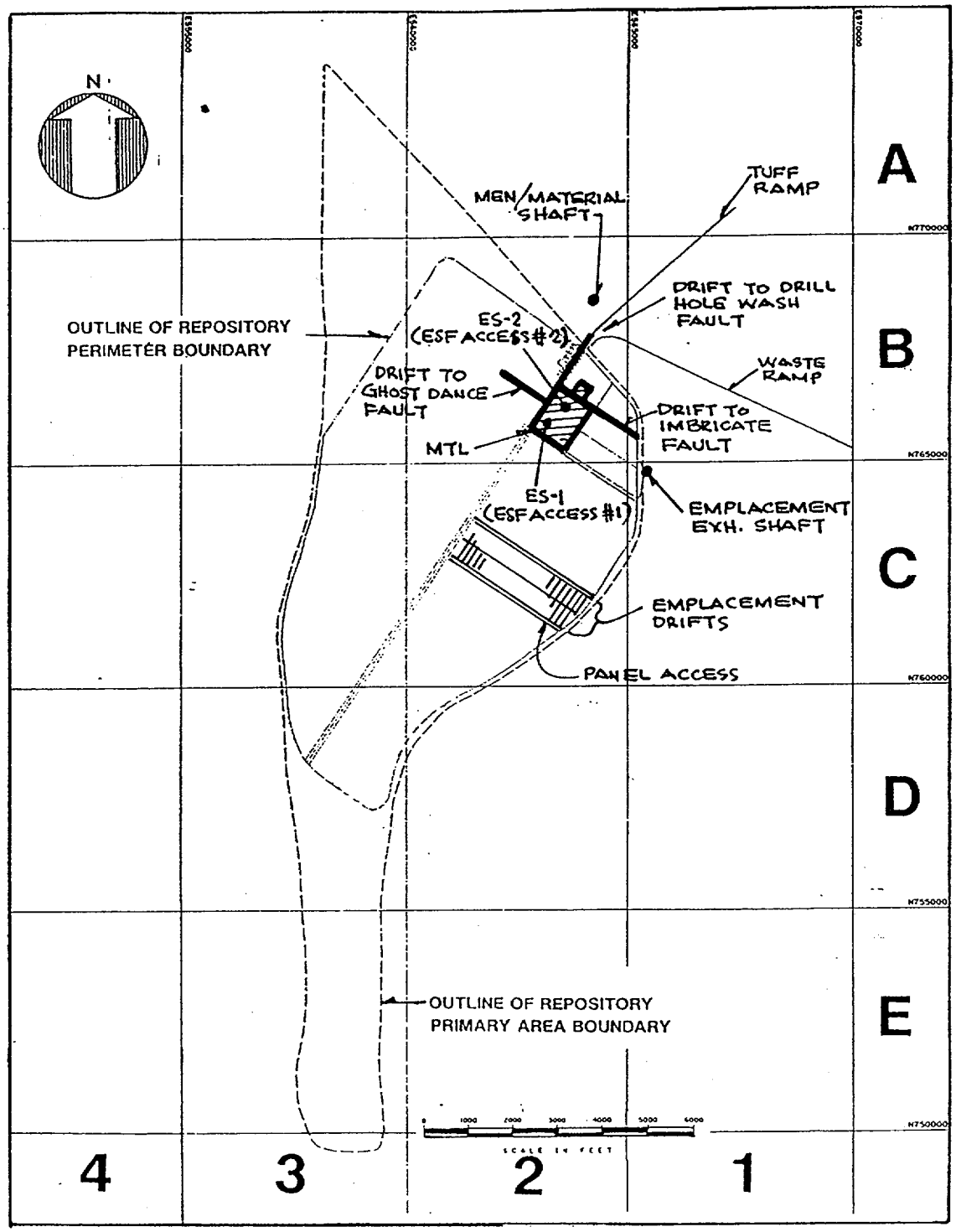
TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	D&B AND TBM
MTL	D&B
MTL LOCATION	B2
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT GHOST DANCE FAULT IMBRICATE FAULT

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

A1 MTL N., SHAFT/TUFF RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A2 MTL N., SHAFT/SHAFT

PRELIMINARY NEW OPTION # A2

OPTION DESCRIPTION MTL NORTH, SHAFT / SHAFT

ESF ACCESSES 2 TOTAL ACCESSES 6

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	SHAFT	SHAFT	SHAFT	RAMP	RAMP
	SIZE (APPX.)	16' DIA.	16' DIA.	25' DIA.	25' DIA.	25' DIA.	25' DIA.
	CONSTRUCTION	D&B	D&B	MECH.	MECH.	TBM	TBM
	LOCATION SURFACE	B2	B2	B2	C1	A1	B1
	UNDERGROUND	B2	B2	B2	C1	B2	B2
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE	NONE	NONE

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
	REPOSITORY OPERATIONS	VENTILATION	VENTILATION	NONE

REPOSITORY LAYOUT FEATURES		
	MINING METHODS MAINS	TBM
	PERIMETER DRIFT	TBM
	PANEL ACCESS	D&B
	EMPL. DRIFTS	D&B
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
	EMPLACEMENT DRIFT ORIENTATION	N 34 E

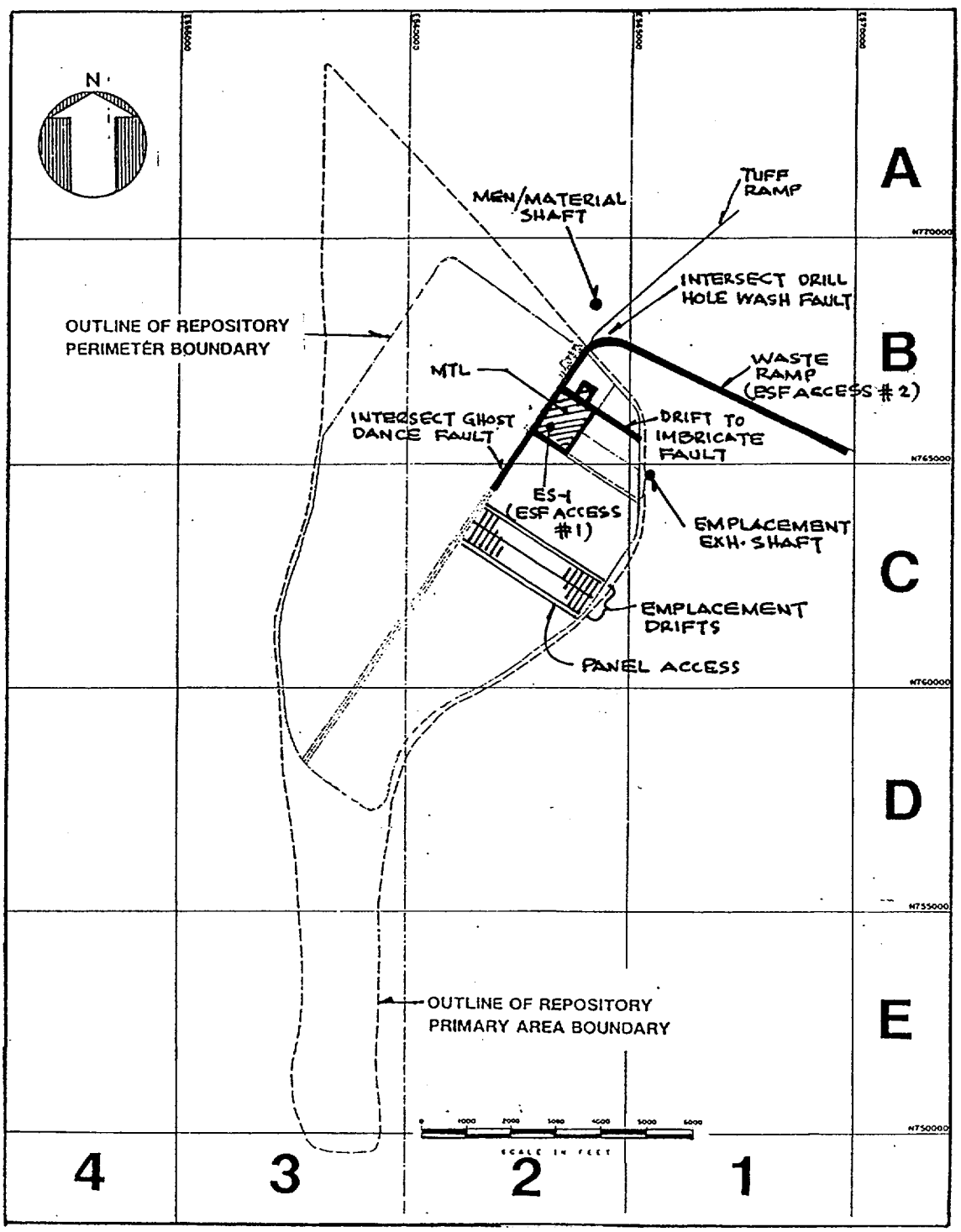
TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	D&B
MTL	D&B
MTL LOCATION	B2
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT GHOST DANCE FAULT IMBRICATE FAULT

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

A2 MTL N., SHAFT/SHAFT



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A3 MTL N., SHAFT/WASTE RAMP

PRELIMINARY NEW OPTION # A3

OPTION DESCRIPTION MTL NORTH, SHAFT / WASTE RAMP

ESF ACCESSES 2 TOTAL ACCESSES 5

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	RAMP	SHAFT	SHAFT	RAMP	SEE ESF ACCESS #2
	SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.	25' DIA.	
	CONSTRUCTION	D&B	TBM	MECH.	MECH.	TBM	
	LOCATION SURFACE	B2	B1	B2	C1	A1	
	UNDERGROUND	B2	B2	B2	C1	B2	
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE	NONE	

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING,PERSONNEL	NONE
	REPOSITORY OPERATIONS	VENTILATION	WASTE RAMP	NONE

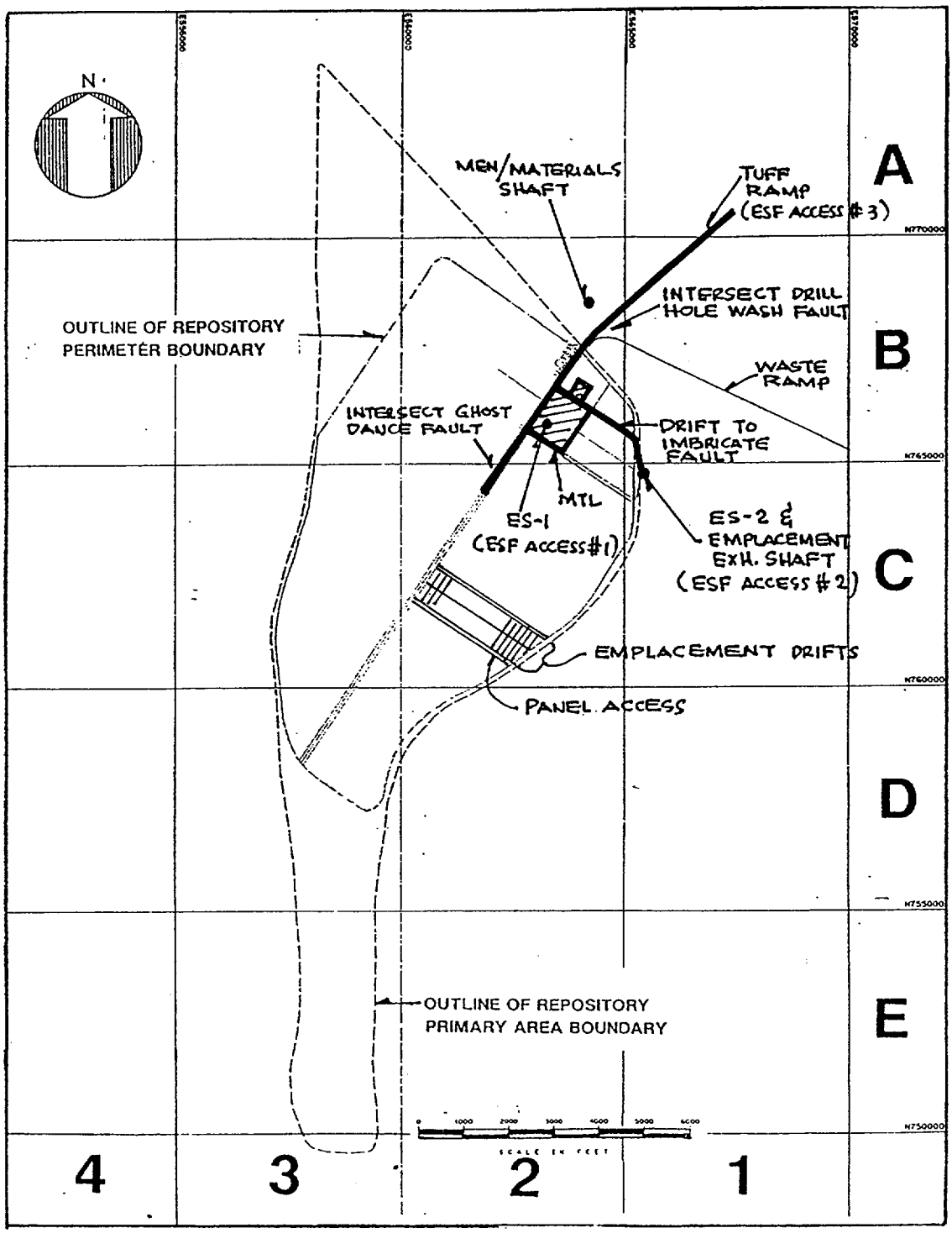
REPOSITORY LAYOUT FEATURES			TEST PROGRAM FEATURES	
	MINING METHODS MAINS	TBM	MINING METHODS EXPL. DRIFTS	D&B AND TBM
	PERIMETER DRIFT	TBM	MTL	D&B
	PANEL ACCESS	D&B	MTL LOCATION	B2
	EMPL. DRIFTS	D&B	ACCESS TO CALICO HILLS	SHAFT OR RAMP
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)	MTL ELEVATION	CORRESPONDS WITH REPOSITORY
	EMPLACEMENT DRIFT ORIENTATION	N 34 E	EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT GHOST DANCE FAULT IMBRICATE FAULT

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

A3 MTL N., SHAFT/WASTE RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A4 MTL N., SHAFT/SHAFT/TUFF RAMP

PRELIMINARY NEW OPTION # A4 (REV.1) (ESF FUNCTIONS WILL BE REASSIGNED ?)
OPTION DESCRIPTION MTL NORTH, SHAFT / SHAFT / TUFF RAMP
ESF ACCESSES 3 TOTAL ACCESSES 5

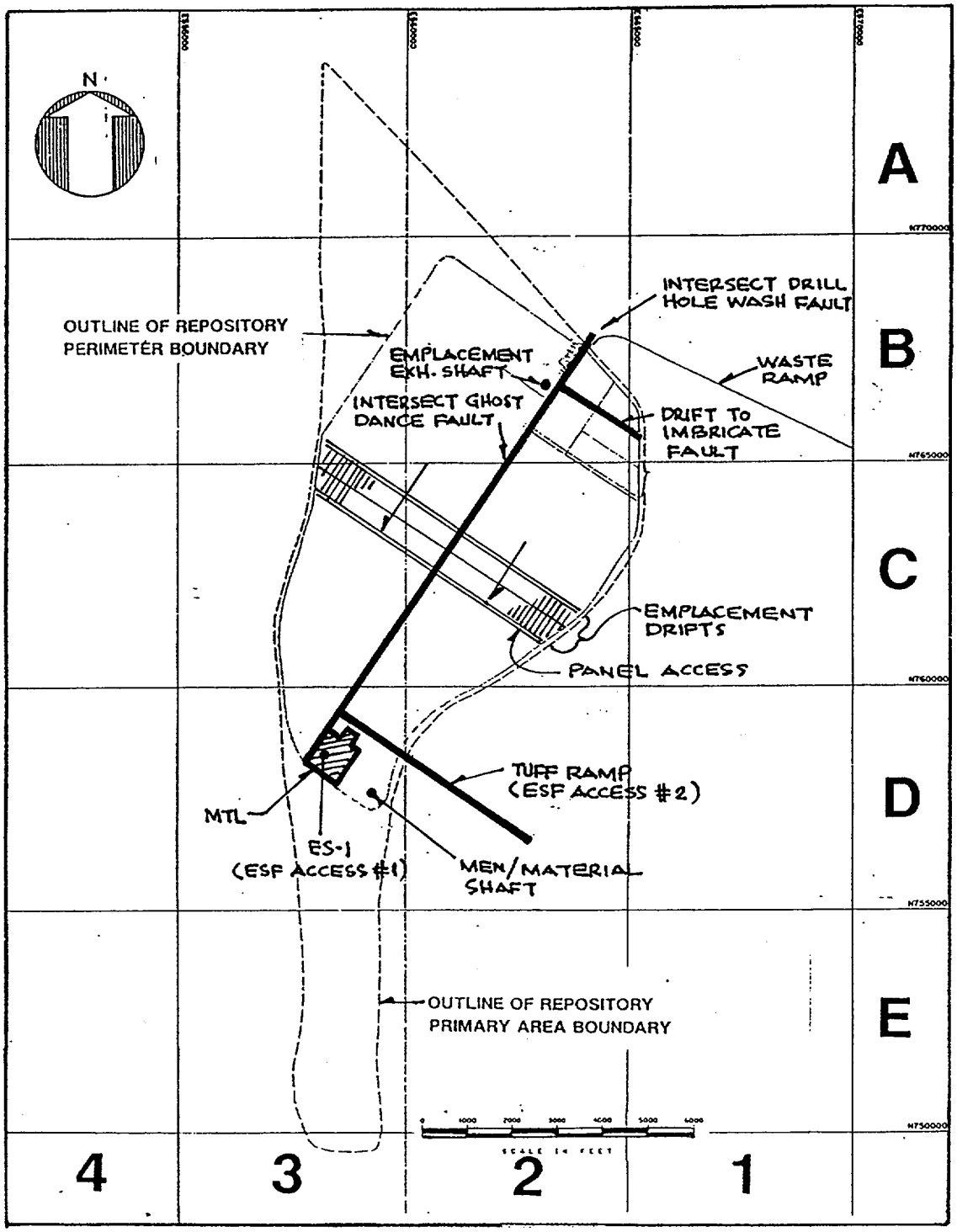
ACCESSES	ESF ACCESS #1	ESF ACCESS #2	ESF ACCESS #3	MEN & MATERIAL	EMPLACEMENT EXH.	TUFF	WASTE
TYPE	SHAFT	SHAFT	RAMP	SHAFT	SEE ESF ACCESS #2	SEE ESF ACCESS #3	RAMP
SIZE (APPX.)	16' DIA.	10' DIA. (ESF) 25' DIA. (REPOS.)	25' DIA.	25' DIA.			25' DIA.
CONSTRUCTION	D&B	MECH.	TBM	MECH.			TBM
LOCATION SURFACE	B2	C1	A1	B2			B1
LOCATION UNDERGROUND	B2	C1	B2	B2			B2
ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE			NONE

ESF FUNCTION IN REPOSITORY	ESF ACCESS #1	ESF ACCESS #2	MTL	ACCESS #3
REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION	NONE	VENTILATION, MUCK HANDLING, PERSONNEL
REPOSITORY OPERATIONS	VENTILATION	VENTILATION	NONE	TUFF RAMP

REPOSITORY LAYOUT FEATURES	
MINING METHODS	
MAINS	TBM
PERIMETER DRIFT	TBM
PANEL ACCESS	D&B
EMPL. DRIFTS	D&B
ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
EMPLACEMENT DRIFT ORIENTATION	N 34 E

TEST PROGRAM FEATURES	
MINING METHODS	
EXPL. DRIFTS	D&B AND TBM
MTL	D&B
MTL LOCATION	B2
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT GHOST DANCE FAULT IMBRICATE FAULT

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A4 MTL N., SHAFT/SHAFT/TUFF RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A5 MTL S., SHAFT/TUFF RAMP

PRELIMINARY NEW OPTION # A5

OPTION DESCRIPTION MTL SOUTH, SHAFT / TUFF RAMP

ESF ACCESSES 2 TOTAL ACCESSES 5

ACCESSES	ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
TYPE	SHAFT	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #2	RAMP
SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.		25' DIA.
CONSTRUCTION	D&B	TBM	MECH.	MECH.		TBM
LOCATION SURFACE	D3	D2	D3	B2		B1
UNDERGROUND	D3	D3	D3	B2		B2
ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE		NONE

ESF FUNCTION IN REPOSITORY	ESF ACCESS #1	ESF ACCESS #2	MTL
REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
REPOSITORY OPERATIONS	VENTILATION	TUFF RAMP	NONE

REPOSITORY LAYOUT FEATURES	
MINING METHODS MAINS	TBM
PERIMETER DRIFT	TBM
PANEL ACCESS	D&B
EMPL. DRIFTS	D&B (MINING FULL REPOS. WIDTH, RETREAT TO SOUTH
ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
EMPLACEMENT DRIFT ORIENTATION	N 34 E

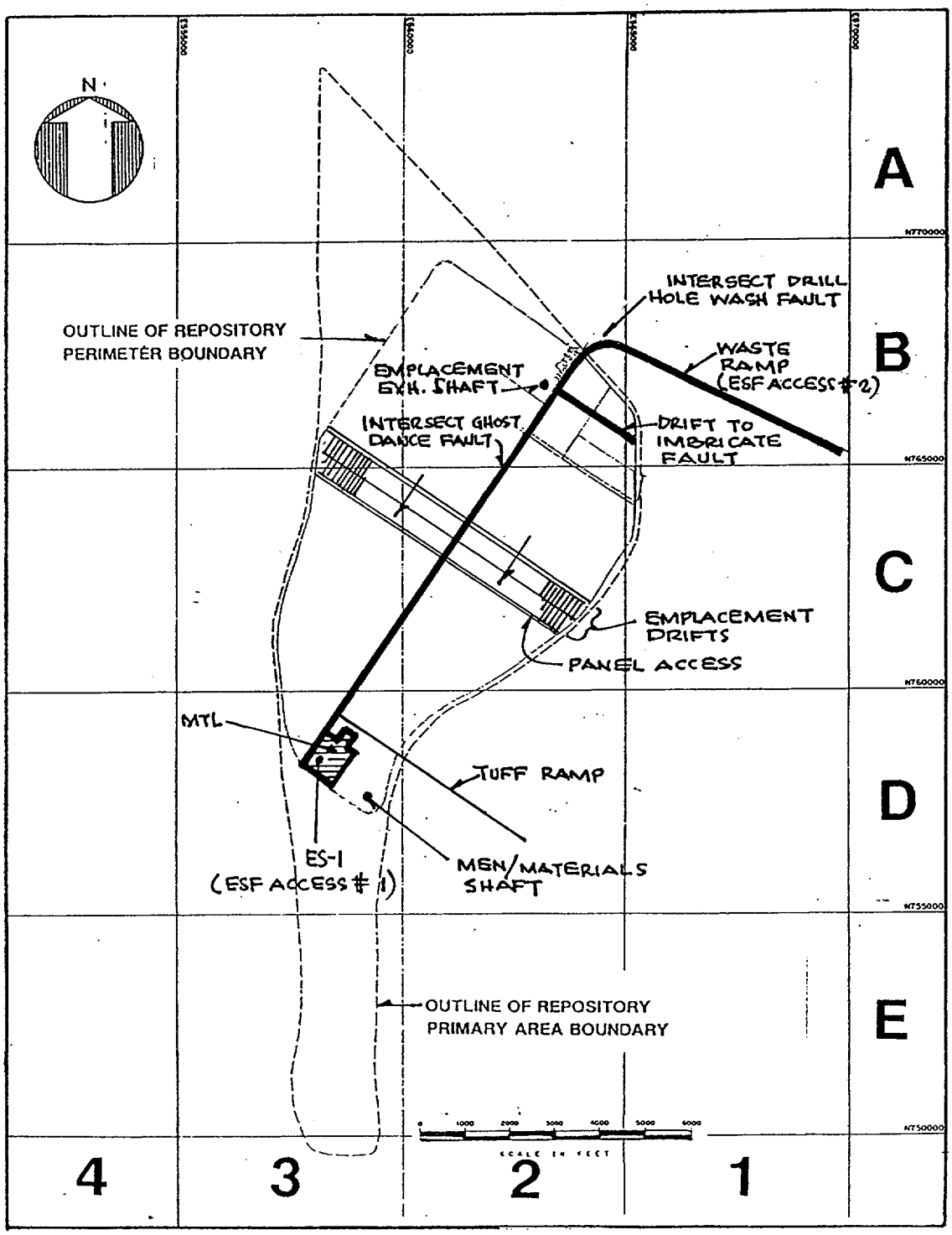
TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	D&B AND TBM
MTL	D&B
MTL LOCATION	D3
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT, DRIFT TO NORTH END

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

A5 MTL S., SHAFT/TUFF RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A6 MTL S., SHAFT/WASTE RAMP

PRELIMINARY NEW OPTION # A6
OPTION DESCRIPTION MTL SOUTH, SHAFT / WASTE RAMP
ESF ACCESSES 2 TOTAL ACCESSES 5

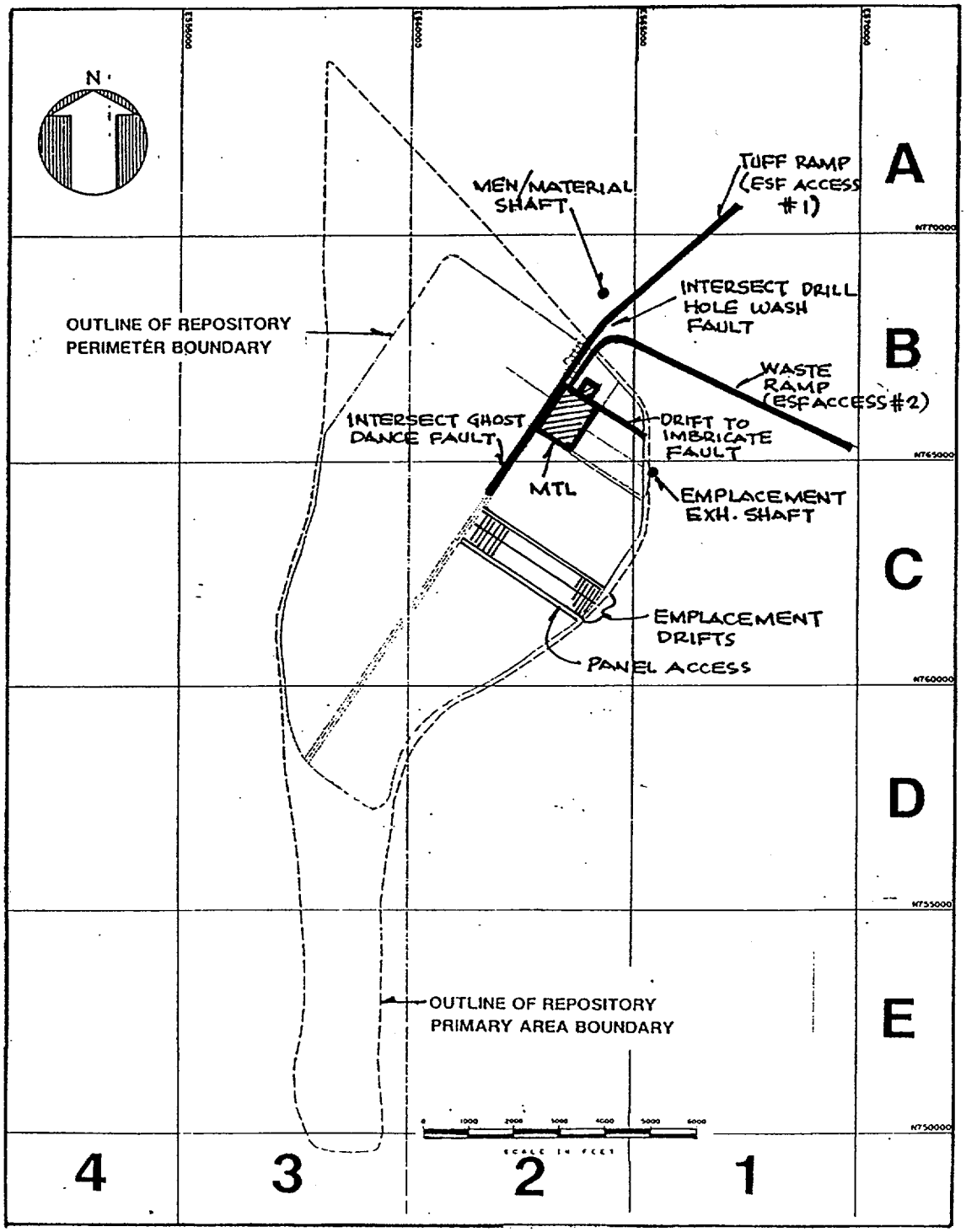
ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	RAMP	SHAFT	SHAFT	RAMP	SEE ESF ACCESS #2
	SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.	25' DIA.	
	CONSTRUCTION	D&B	TBM	MECH.	MECH.	TBM	
	LOCATION SURFACE	D3	B1	D3	B2	D2	
	UNDERGROUND	D3	B2	D3	B2	D3	
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE	NONE	

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
	REPOSITORY OPERATIONS	VENTILATION	WASTE RAMP	NONE

REPOSITORY LAYOUT FEATURES		
	MINING METHODS MAINS	TBM
	PERIMETER DRIFT	TBM
	PANEL ACCESS	D&B
	EMPL. DRIFTS	D&B (MINING FULL REPOS. WIDTH, RETREAT TO SOUTH)
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
	EMPLACEMENT DRIFT ORIENTATION	N 34 E

TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	D&B AND TBM
MTL	D&B
MTL LOCATION	D3
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT, LONG DRIFT TO SOUTH

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A6 MTL S., SHAFT/WASTE RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A7 MTL N., TUFF RAMP/WASTE RAMP

PRELIMINARY NEW OPTION # A7

OPTION DESCRIPTION MTL NORTH, TUFF RAMP / WASTE RAMP

ESF ACCESSES 2 TOTAL ACCESSES 4

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	RAMP	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #1	SEE ESF ACCESS #2
	SIZE (APPX.)	25' DIA.	25' DIA.	25' DIA.	25' DIA.		
	CONSTRUCTION	TBM	TBM	MECH.	MECH.		
	LOCATION SURFACE	A1	B1	B2	C1		
	UNDERGROUND	B2	B2	B2	C1		
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	NONE	NONE		

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION, MUCK HANDLING, PERSONNEL	VENTILATION PERSONNEL	NONE
	REPOSITORY OPERATIONS	TUFF RAMP	WASTE RAMP	NONE

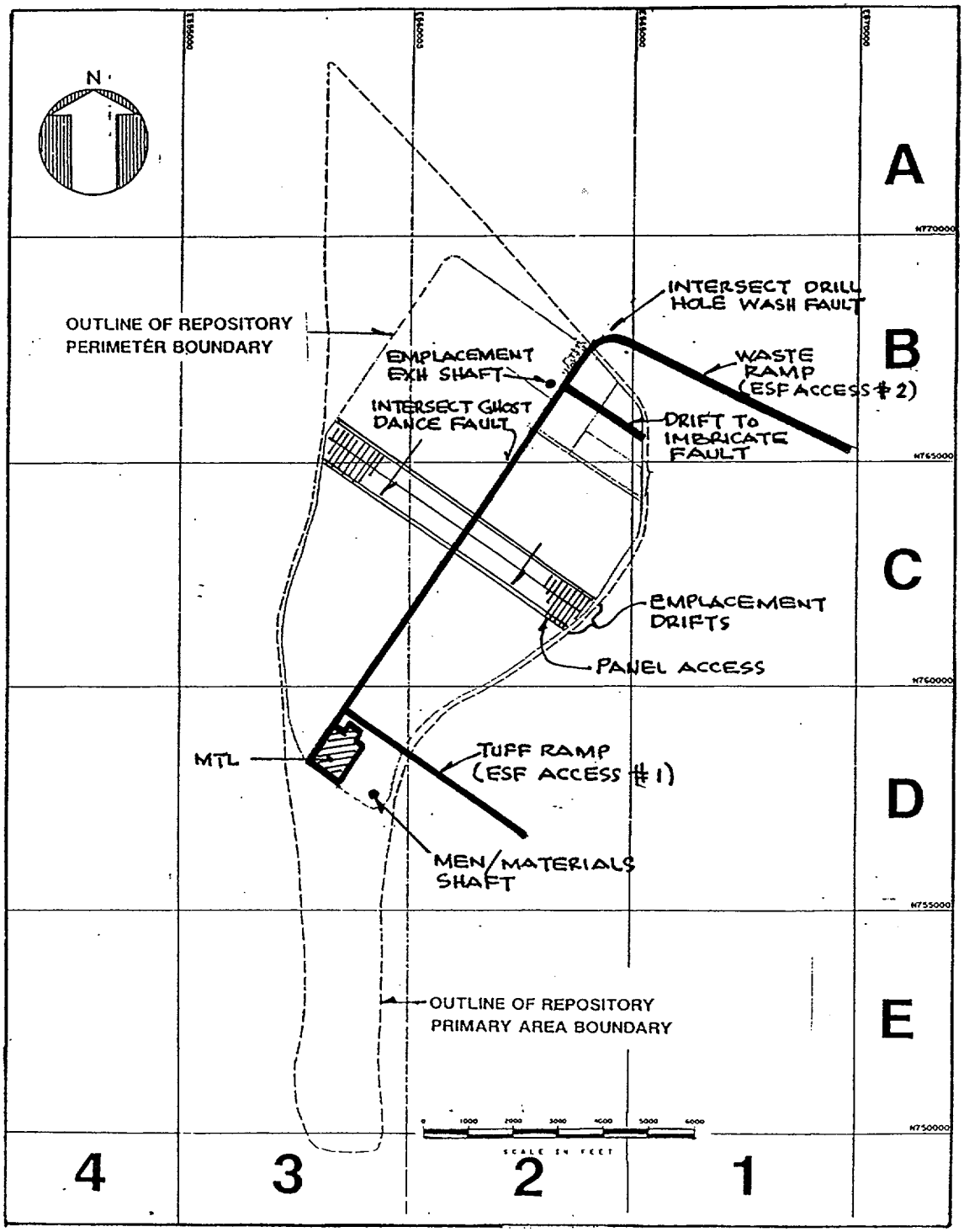
REPOSITORY LAYOUT FEATURES			TEST PROGRAM FEATURES	
	MINING METHODS MAINS	TBM	MINING METHODS EXPL. DRIFTS	D&B AND TBM
	PERIMETER DRIFT	TBM	MTL	D&B
	PANEL ACCESS	D&B	MTL LOCATION	B2
	EMPL. DRIFTS	D&B	ACCESS TO CALICO HILLS	RAMP
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)	MTL ELEVATION	CORRESPONDS WITH REPOSITORY
	EMPLACEMENT DRIFT ORIENTATION	N 34 E	EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

A7 MTL N., TUFF RAMP/WASTE RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A8 MTL S., TUFF RAMP/WASTE RAMP

PRELIMINARY NEW OPTION # A8

OPTION DESCRIPTION MTL SOUTH, TUFF RAMP / WASTE RAMP

ESF ACCESSES 2 TOTAL ACCESSES 4

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	RAMP	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #1	SEE ESF ACCESS #2
	SIZE (APPX.)	25' DIA.	25' DIA.	25' DIA.	25' DIA.		
	CONSTRUCTION	TBM	TBM	MECH.	MECH.		
	LOCATION SURFACE	D2	B1	D3	B2		
	UNDERGROUND	D3	B2	D3	B2		
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	NONE	NONE		

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION, MUCK HANDLING, PERSONNEL	VENTILATION PERSONNEL	NONE
	REPOSITORY OPERATIONS	TUFF RAMP	WASTE RAMP	NONE

REPOSITORY LAYOUT FEATURES		
	MINING METHODS MAINS	TBM
	PERIMETER DRIFT	TBM
	PANEL ACCESS	D&B
	EMPL. DRIFTS	D&B (MINING FULL REPOS. WIDTH, RETREAT TO SOUTH)
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
	EMPLACEMENT DRIFT ORIENTATION	N 34 E

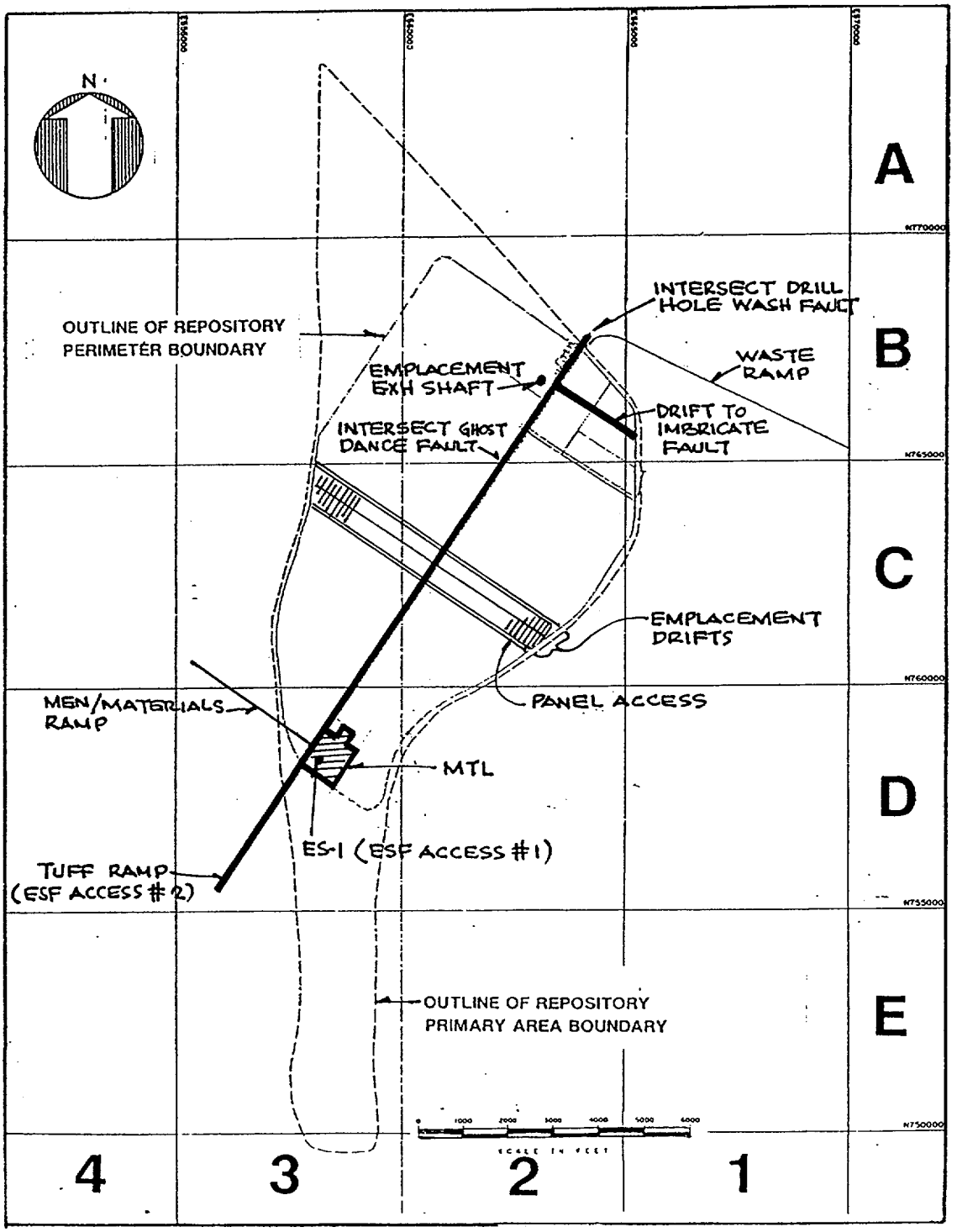
TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	D&B AND TBM
MTL	D&B
MTL LOCATION	D3
ACCESS TO CALICO HILLS	RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT, LONG NORTH-SOUTH DRIFT

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

A8 MTL S., TUFF RAMP/WASTE RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A9 MTL S., SHAFT/TUFF RAMP

PRELIMINARY NEW OPTION # A9

OPTION DESCRIPTION MTL SOUTH, SHAFT / TUFF RAMP

ESF ACCESSES 2 TOTAL ACCESSES 5

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	RAMP	RAMP	SHAFT	SEE ESF ACCESS #2	RAMP
	SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.		25' DIA.
	CONSTRUCTION	D&B	TBM	TBM	MECH.		TBM
	LOCATION SURFACE	D3	D3	C3	B2		B1
	UNDERGROUND	D3	D3	D3	B2		B2
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE		NONE

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
	REPOSITORY OPERATIONS	VENTILATION	TUFF RAMP	NONE

REPOSITORY LAYOUT FEATURES		
	MINING METHODS MAINS	TBM
	PERIMETER DRIFT	TBM
	PANEL ACCESS	D&B
	EMPL. DRIFTS	D&B (MINING FULL REPOS. WIDTH, RETREAT TO SOUTH)
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
	EMPLACEMENT DRIFT ORIENTATION	N 34 E

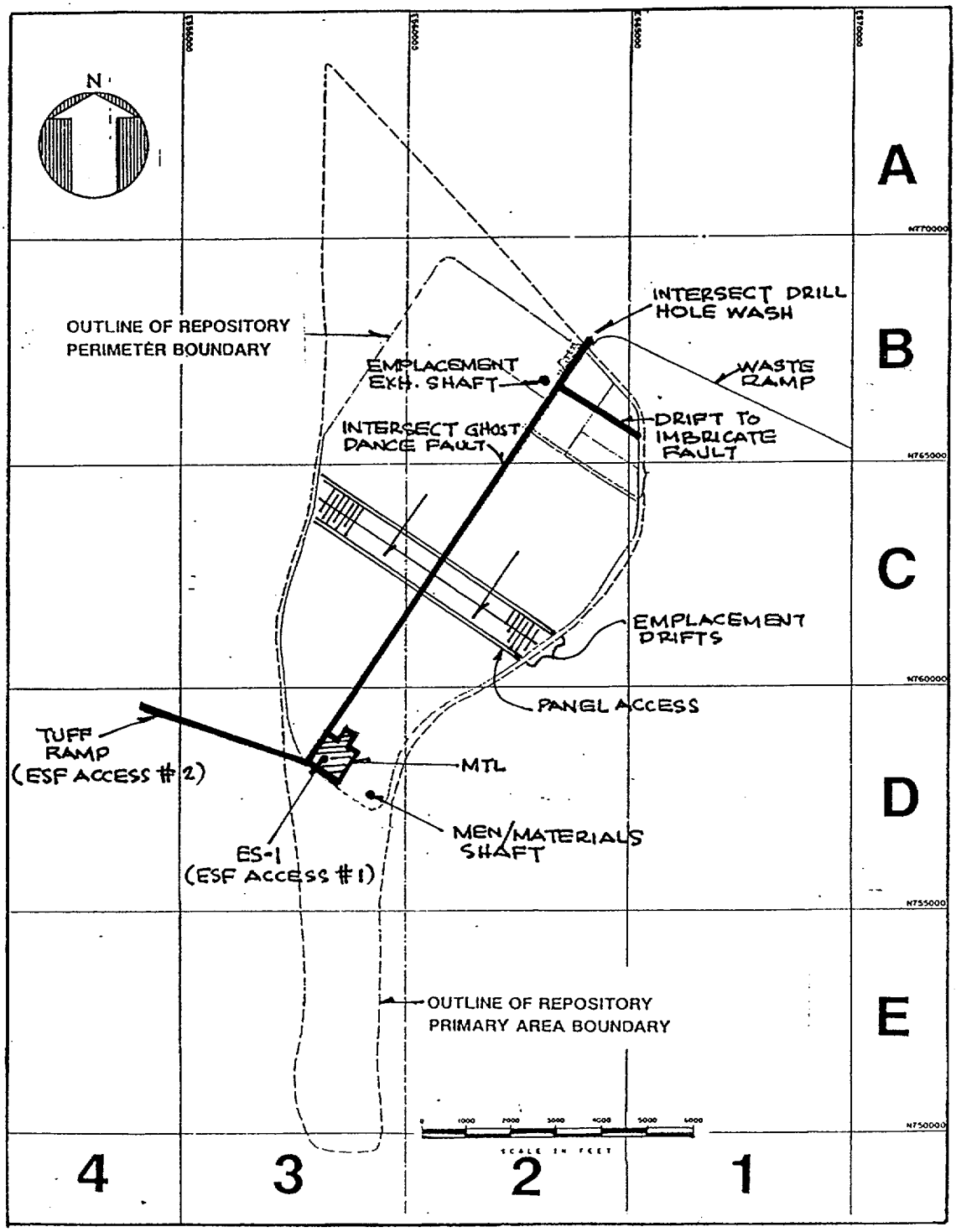
TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	D&B AND TBM
MTL	D&B
MTL LOCATION	D3
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT, LONG DRIFT TO NORTH

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

A9 MTL S., SHAFT/TUFF RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A10 MTL S., SHAFT/TUFF RAMP

PRELIMINARY NEW OPTION # A10

OPTION DESCRIPTION MTL SOUTH, SHAFT / TUFF RAMP

ESF ACCESSES 2 TOTAL ACCESSES 5

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #2	RAMP
	SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.		25' DIA.
	CONSTRUCTION	D&B	TBM	MECH.	MECH.		TBM
	LOCATION SURFACE	D3	D4	D3	B2		B1
	UNDERGROUND	D3	D3	D3	B2		B2
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE		NONE

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING,PERSONNEL	NONE
	REPOSITORY OPERATIONS	VENTILATION	TUFF RAMP	NONE

REPOSITORY LAYOUT FEATURES		
	MINING METHODS MAINS	TBM
	PERIMETER DRIFT	TBM
	PANEL ACCESS	D&B
	EMPL. DRIFTS	D&B (MINING FULL REPOS. WIDTH, RETREAT TO SOUTH)
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
	EMPLACEMENT DRIFT ORIENTATION	N 34 E

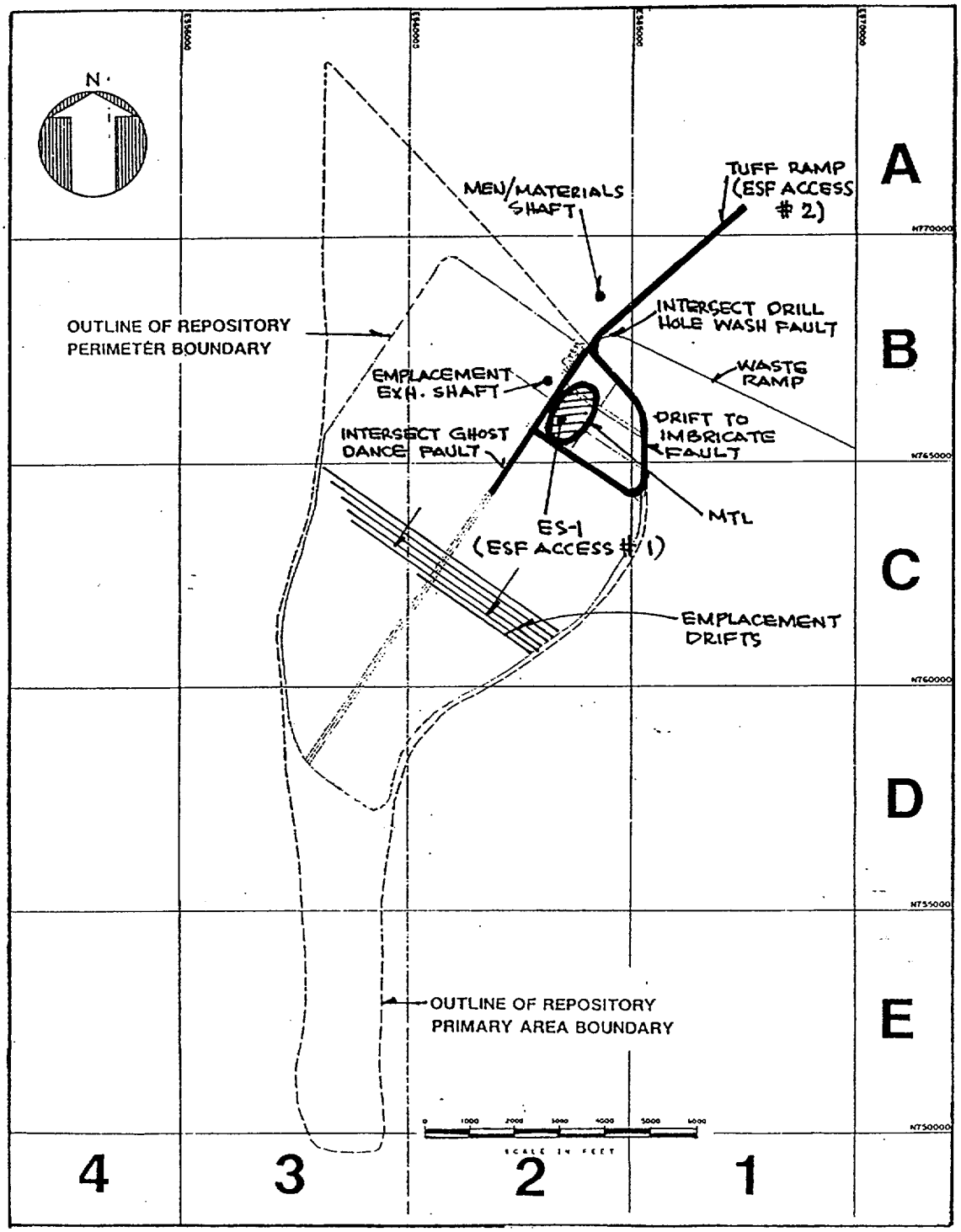
TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	D&B AND TBM
MTL	D&B
MTL LOCATION	D3
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT, LONG DRIFT TO NORTH

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

A10 MTL S., SHAFT/TUFF RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B1 MTL N., SHAFT/TUFF RAMP

PRELIMINARY NEW OPTION # B1

OPTION DESCRIPTION MTL NORTH, SHAFT / TUFF RAMP

ESF ACCESSES 2 TOTAL ACCESSES 5

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #2	RAMP
	SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.		25' DIA.
	CONSTRUCTION	D&B	TBM	MECH.	MECH.		TBM
	LOCATION SURFACE	B2	A1	B2	B2		B1
	UNDERGROUND	B2	B2	B2	B2		B2
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE		NONE

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
	REPOSITORY OPERATIONS	VENTILATION	TUFF RAMP	NONE

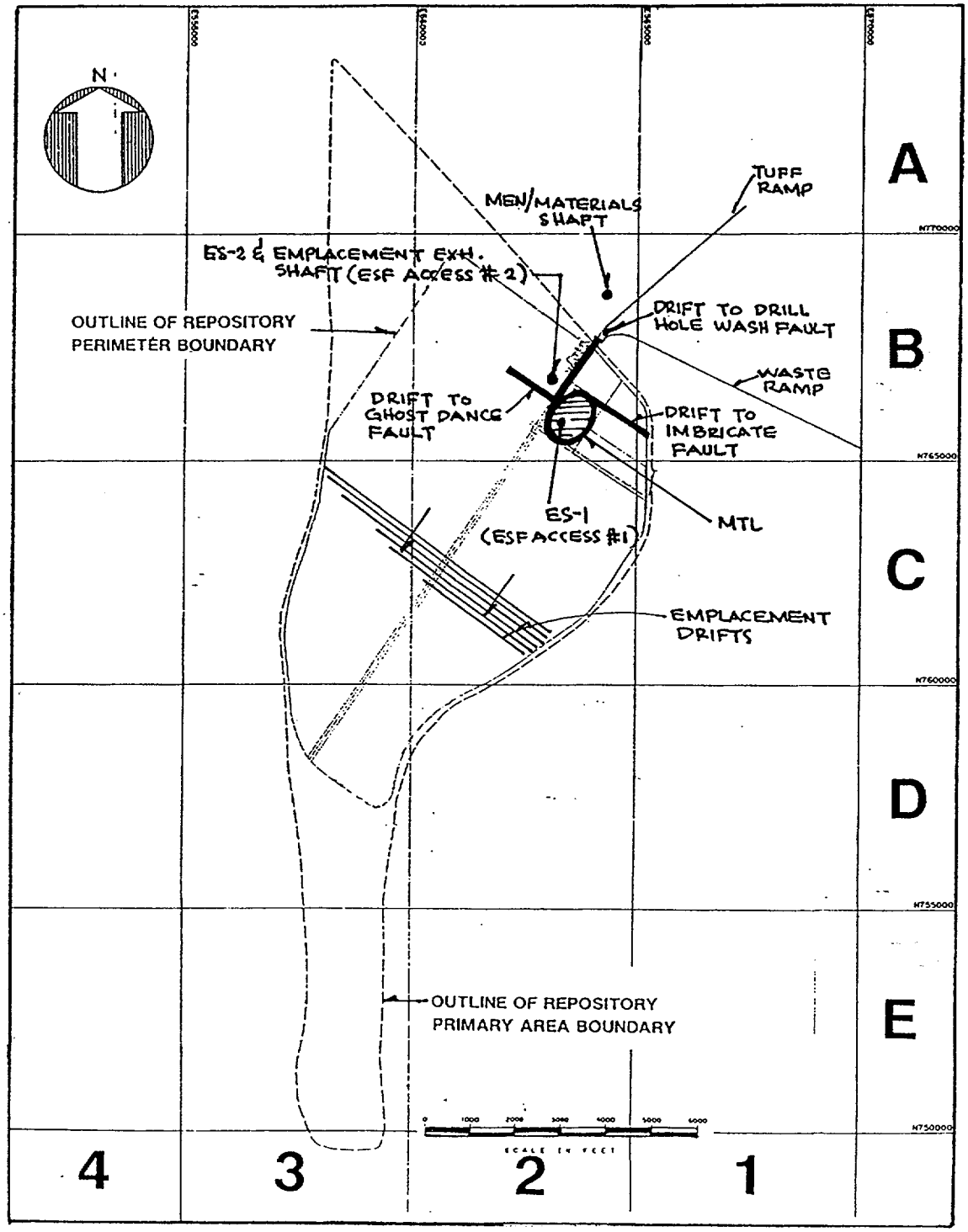
REPOSITORY LAYOUT FEATURES			TEST PROGRAM FEATURES	
	MINING METHODS MAINS	TBM	MINING METHODS EXPL. DRIFTS	MECH.
	PERIMETER DRIFT	TBM	MTL	MECH.
	PANEL ACCESS	NOT USED	MTL LOCATION	B2
	EMPL. DRIFTS	TBM	ACCESS TO CALICO HILLS	SHAFT OR RAMP
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)	MTL ELEVATION	CORRESPONDS WITH REPOSITORY
	EMPLACEMENT DRIFT ORIENTATION	N 56 W	EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

B1 MTL N., SHAFT/TUFF RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B2 MTL N., SHAFT/SHAFT

PRELIMINARY NEW OPTION # B2
OPTION DESCRIPTION MTL NORTH, SHAFT / SHAFT
ESF ACCESSES 2 TOTAL ACCESSES 5

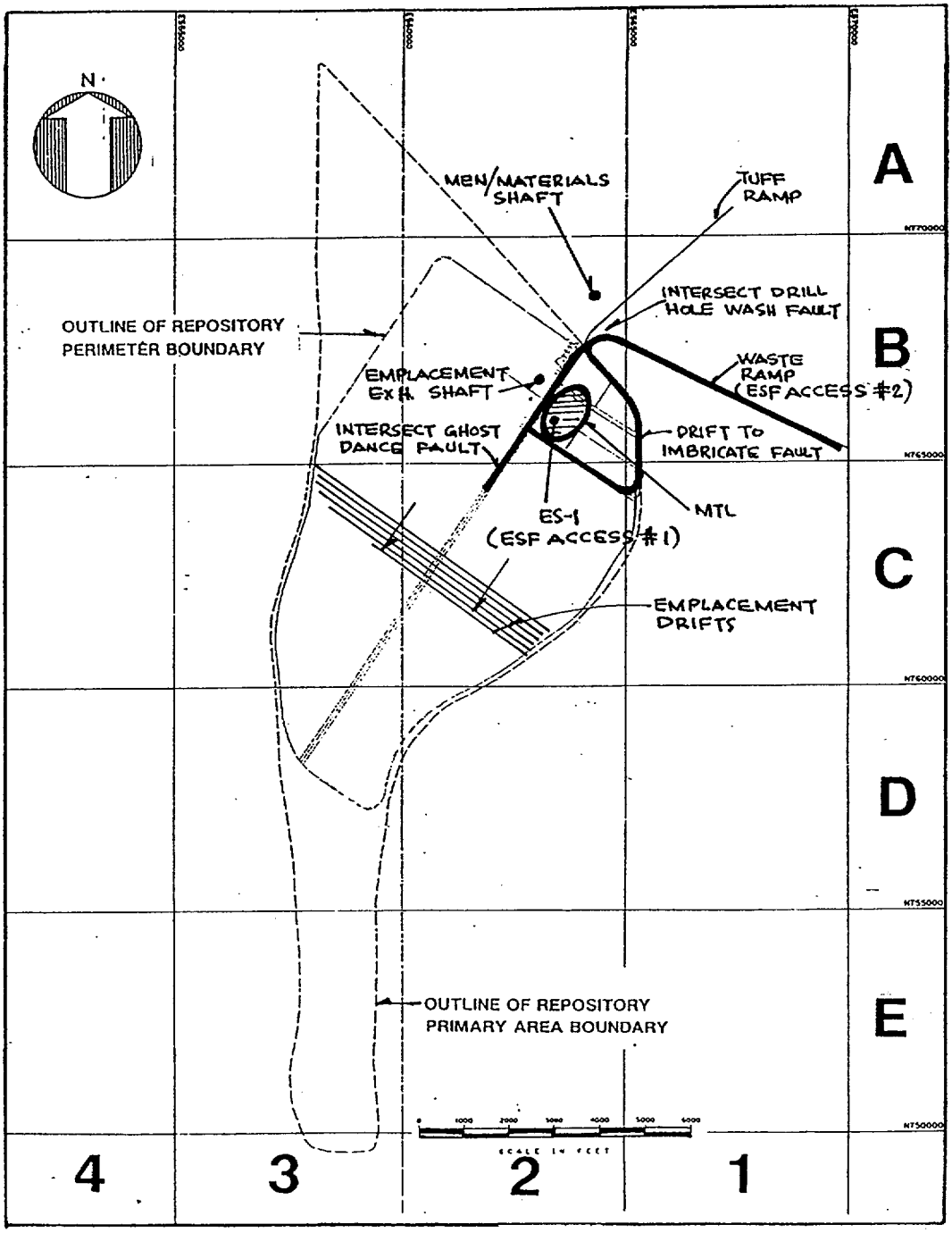
ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	SHAFT	SHAFT	SEE ESF ACCESS #2	RAMP	RAMP
	SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.		25' DIA.	25' DIA.
	CONSTRUCTION	D&B	MECH.	MECH.		TBM	TBM
	LOCATION SURFACE	B2	B2	B2		A1	B1
	UNDERGROUND	B2	B2	B2		B2	B2
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M) LOWER TBM	NONE		NONE	NONE

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
	REPOSITORY OPERATIONS	VENTILATION	EMPLACEMENT EXHAUST	NONE

REPOSITORY LAYOUT FEATURES		
	MINING METHODS MAINS	TBM
	PERIMETER DRIFT	TBM
	PANEL ACCESS	NOT USED
	EMPL. DRIFTS	TBM
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
	EMPLACEMENT DRIFT ORIENTATION	N 56 W

TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	MECH.
MTL	MECH.
MTL LOCATION	B2
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT GHOST DANCE FAULT IMBRICATE FAULT

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B2 MTL N., SHAFT/SHAFT



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B3 MTL N., SHAFT/WASTE RAMP

PRELIMINARY NEW OPTION # B3 (REV.1)
OPTION DESCRIPTION MTL NORTH, SHAFT / WASTE RAMP
ESF ACCESSES 2 TOTAL ACCESSES. 5

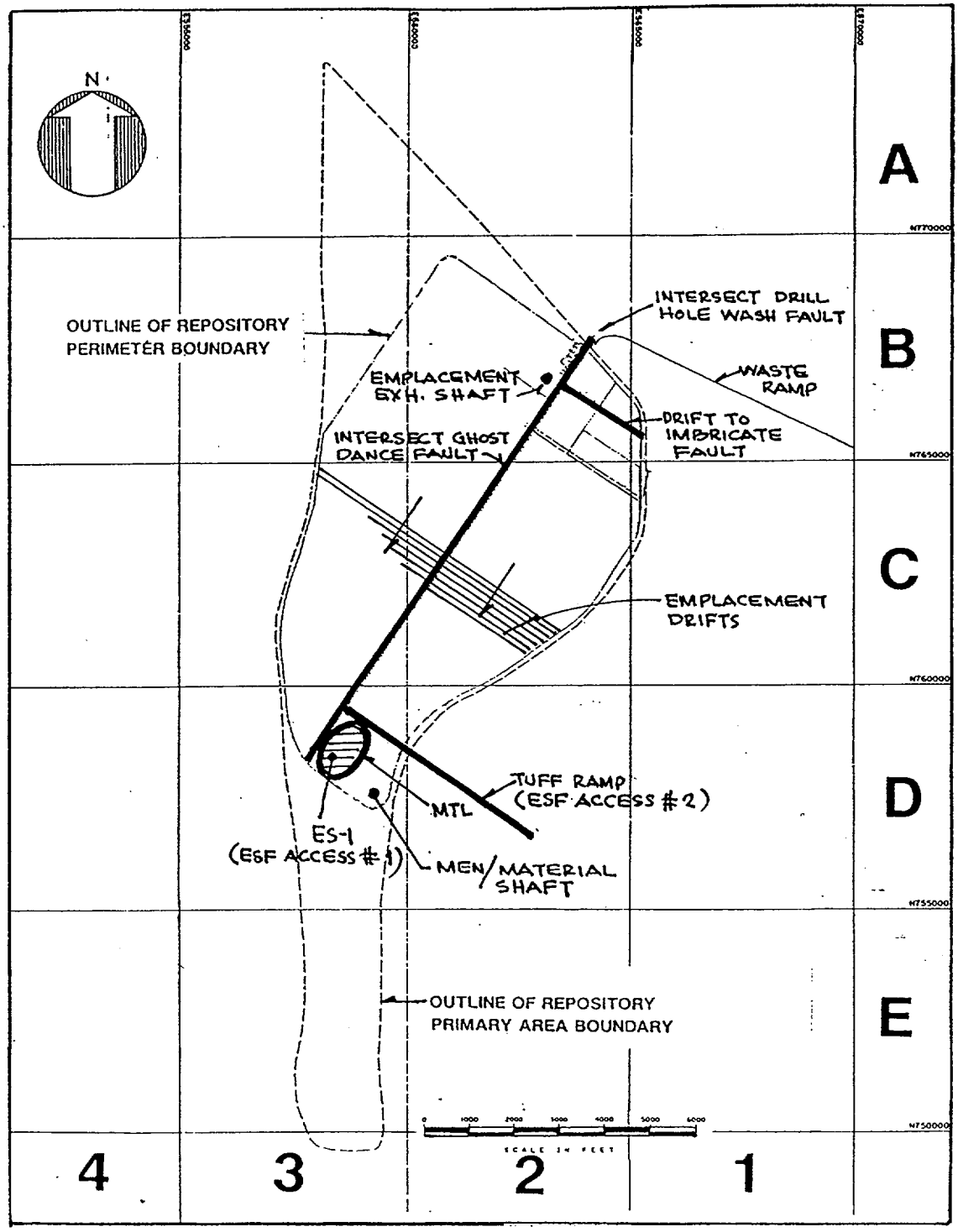
ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	RAMP	SHAFT	SHAFT	RAMP	SEE ESF ACCESS #2
	SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.	25' DIA.	
	CONSTRUCTION	MECH	TBM	MECH.	MECH.	TBM	
	LOCATION SURFACE	B2	B1	B2	B2	A1	
	UNDERGROUND	B2	B2	B2	B2	B2	
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE	NONE	

ESF FUNCTION IN REPOSITORY	ESF ACCESS #1	ESF ACCESS #2	MTL
REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
REPOSITORY OPERATIONS	VENTILATION	WASTE RAMP	NONE

REPOSITORY LAYOUT FEATURES	
MINING METHODS MAINS	TBM
PERIMETER DRIFT	TBM
PANEL ACCESS	NOT USED
EMPL. DRIFTS	TBM
ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
EMPLACEMENT DRIFT ORIENTATION	N 56 W

TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	MECH.
MTL	MECH.
MTL LOCATION	B2
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT GHOST DANCE FAULT IMBRICATE FAULT

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B3 MTL N., SHAFT/WASTE RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B4 MTL S., SHAFT/TUFF RAMP

PRELIMINARY NEW OPTION # B4

OPTION DESCRIPTION MTL SOUTH, SHAFT / TUFF RAMP

ESF ACCESSES 2 TOTAL ACCESSES 5

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #2	RAMP
	SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.		25' DIA.
	CONSTRUCTION	D&B	TBM	MECH.	MECH.		TBM
	LOCATION SURFACE	D3	D2	D3	B2		B1
	UNDERGROUND	D3	D3	D3	B2		B2
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE		NONE

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
	REPOSITORY OPERATIONS	VENTILATION	TUFF RAMP	NONE

REPOSITORY LAYOUT FEATURES		
	MINING METHODS MAINS	TBM
	PERIMETER DRIFT	TBM
	PANEL ACCESS	NOT USED
	EMPL. DRIFTS	TBM
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
	EMPLACEMENT DRIFT ORIENTATION	N 56 W

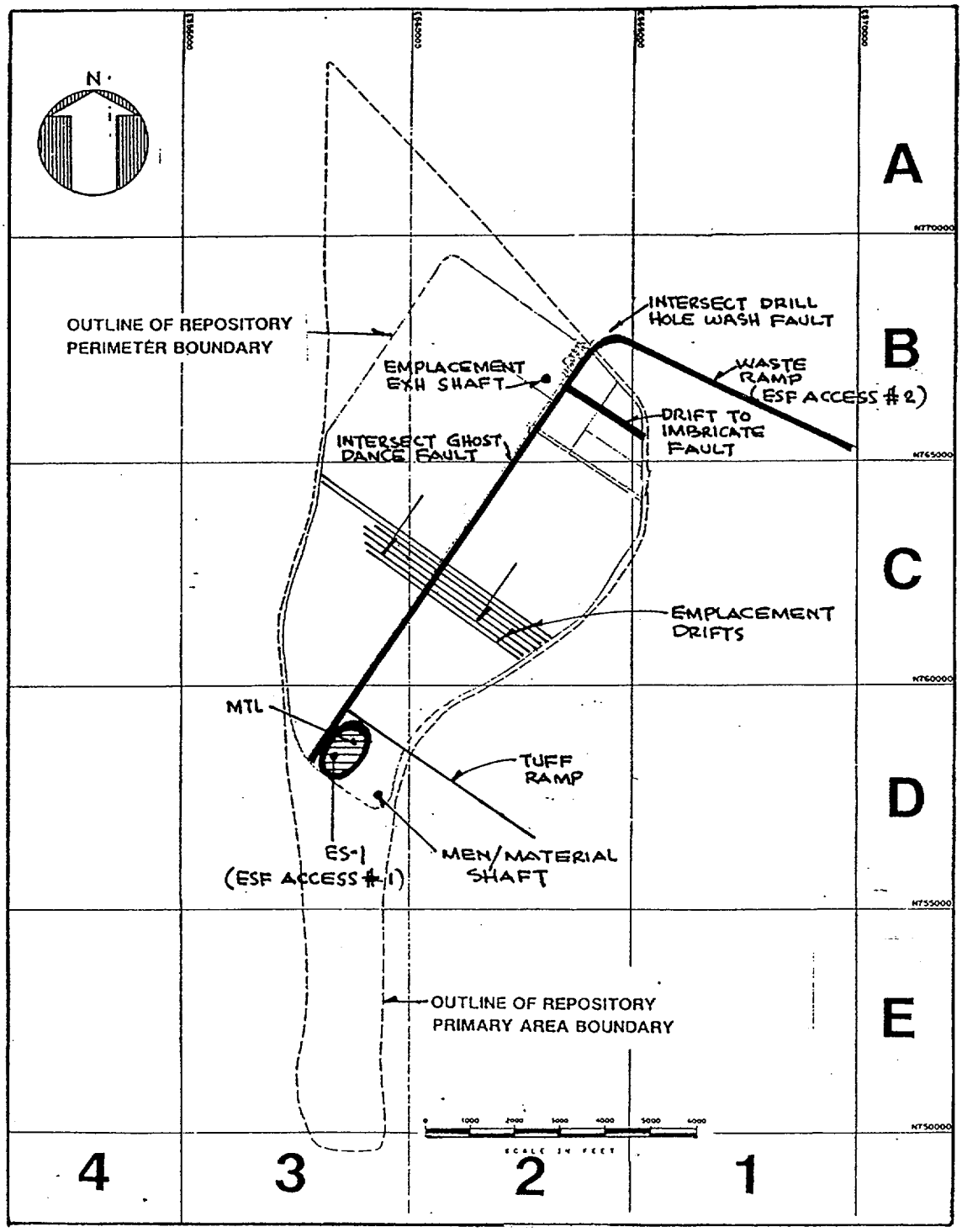
TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	MECH.
MTL	MECH.
MTL LOCATION	D3
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT,DRIFT TO NORTH END

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

B4 MTL S., SHAFT/TUFF RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B5 MTL S., SHAFT/WASTE RAMP

PRELIMINARY NEW OPTION # B5

OPTION DESCRIPTION MTL SOUTH, SHAFT / WASTE RAMP

ESF ACCESSES 2 TOTAL ACCESSES 5

ACCESSES	ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
TYPE	SHAFT	RAMP	SHAFT	SHAFT	RAMP	SEE ESF ACCESS #2
SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.	25' DIA.	
CONSTRUCTION	D&B	TBM	MECH.	MECH.	TBM	
LOCATION SURFACE	D3	B1	D3	B2	D2	
UNDERGROUND	D3	B2	D3	B2	D3	
ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE	NONE	

ESF FUNCTION IN REPOSITORY	ESF ACCESS #1	ESF ACCESS #2	MTL
REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
REPOSITORY OPERATIONS	VENTILATION	WASTE RAMP	NONE

REPOSITORY LAYOUT FEATURES	
MINING METHODS	
MAINS	TBM
PERIMETER DRIFT	TBM
PANEL ACCESS	NOT USED
EMPL. DRIFTS	TBM
ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
EMPLACEMENT DRIFT ORIENTATION	N 56 W

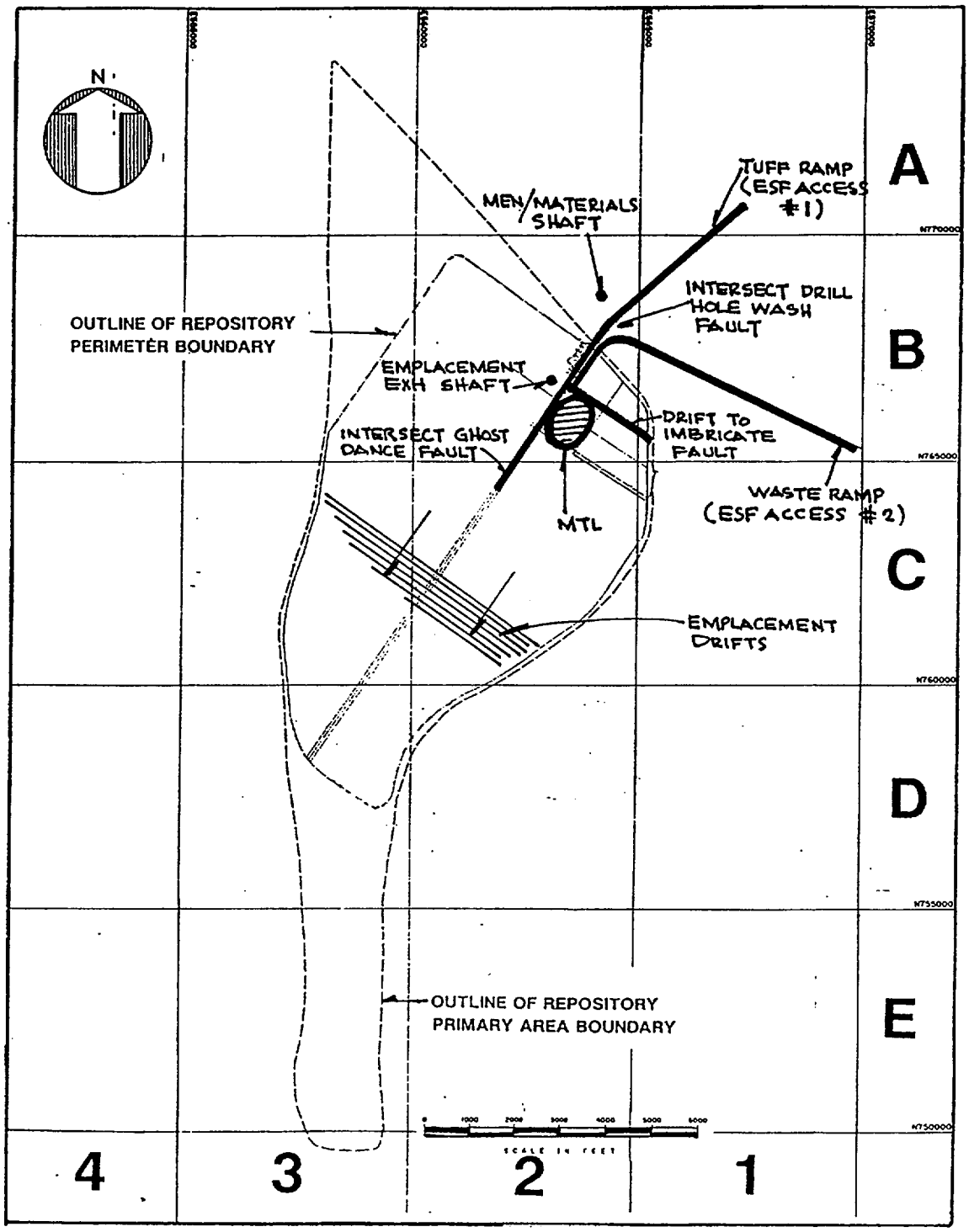
TEST PROGRAM FEATURES	
MINING METHODS	
EXPL. DRIFTS	MECH.
MTL	MECH.
MTL LOCATION	D3
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT, LONG DRIFT TO SOUTH

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

B5 MTL S., SHAFT/WASTE RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B6 MTL N., TUFF RAMP/WASTE RAMP

PRELIMINARY NEW OPTION # B6

OPTION DESCRIPTION MTL NORTH, TUFF RAMP / WASTE RAMP

ESF ACCESSES 2 TOTAL ACCESSES 4

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	RAMP	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #1	SEE ESF ACCESS #2
	SIZE (APPX.)	25' DIA.	25' DIA.	25' DIA.	25' DIA.		
	CONSTRUCTION	TBM	TBM	MECH.	MECH.		
	LOCATION SURFACE	A1	B1	B2	B2		
	UNDERGROUND	B2	B2	B2	B2		
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	NONE	NONE		

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION, MUCK HANDLING, PERSONNEL	VENTILATION PERSONNEL	NONE
	REPOSITORY OPERATIONS	TUFF RAMP	WASTE RAMP	NONE

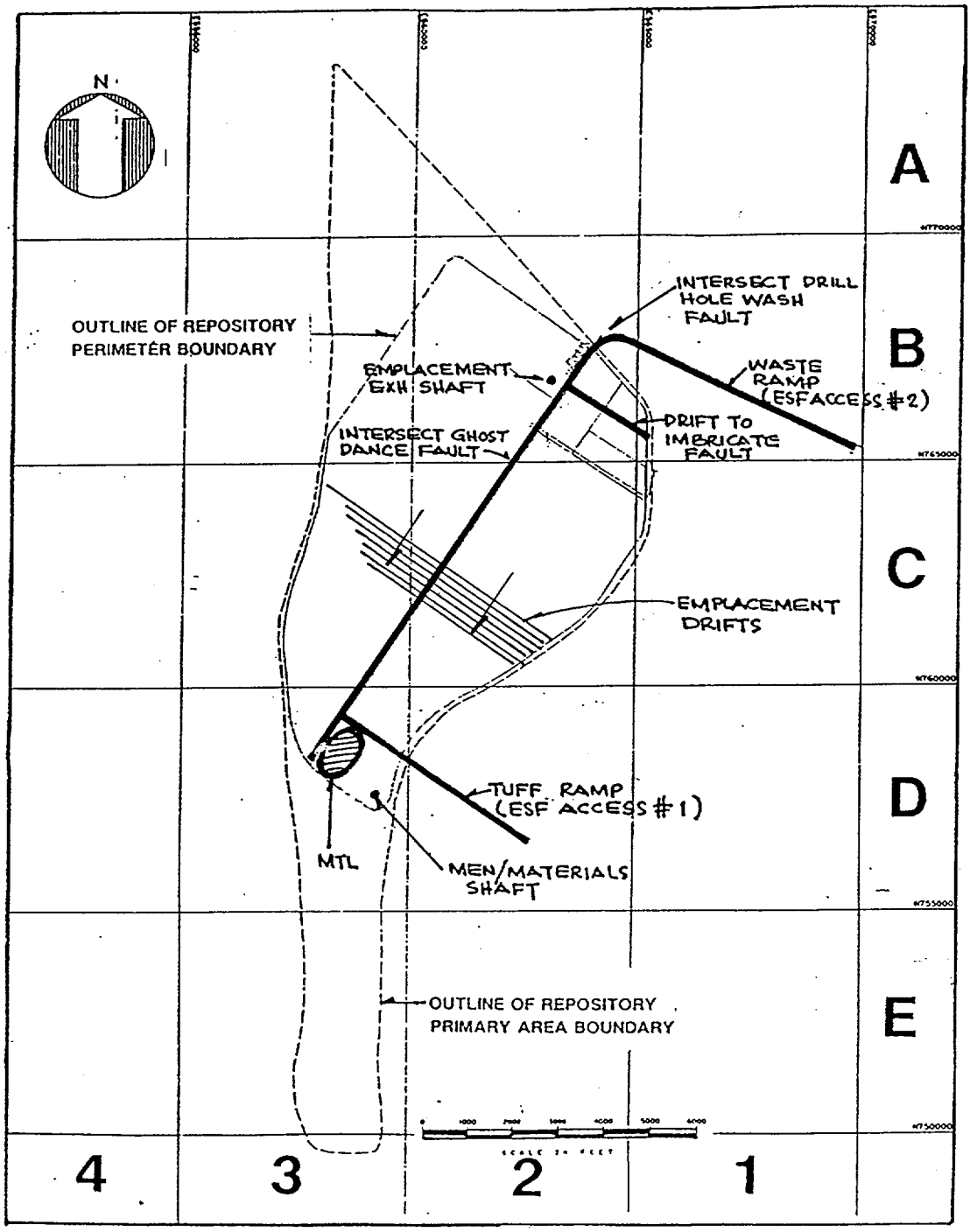
REPOSITORY LAYOUT FEATURES			TEST PROGRAM FEATURES	
	MINING METHODS MAINS	TBM	MINING METHODS EXPL. DRIFTS	MECH.
	PERIMETER DRIFT	TBM	MTL	MECH.
	PANEL ACCESS	NOT USED	MTL LOCATION	B2
	EMPL. DRIFTS	TBM	ACCESS TO CALICO HILLS	RAMP
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)	MTL ELEVATION	CORRESPONDS WITH REPOSITORY
	EMPLACEMENT DRIFT ORIENTATION	N 56 W	EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

B6 MTL N., TUFF RAMP/WASTE RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B7 MTL S., TUFF RAMP/WASTE RAMP

PRELIMINARY NEW OPTION # B7

OPTION DESCRIPTION MTL SOUTH, TUFF RAMP / WASTE RAMP

ESF ACCESSES 2 TOTAL ACCESSES 4

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	RAMP	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #1	SEE ESF ACCESS #2
	SIZE (APPX.)	25' DIA.	25' DIA.	25' DIA.	25' DIA.		
	CONSTRUCTION	TBM	TBM	MECH.	MECH.		
	LOCATION SURFACE	D2	B1	D3	B2		
	UNDERGROUND	D3	B2	D3	B2		
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	NONE	NONE		

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION, MUCK HANDLING, PERSONNEL	VENTILATION PERSONNEL	NONE
	REPOSITORY OPERATIONS	TUFF RAMP	WASTE RAMP	NONE

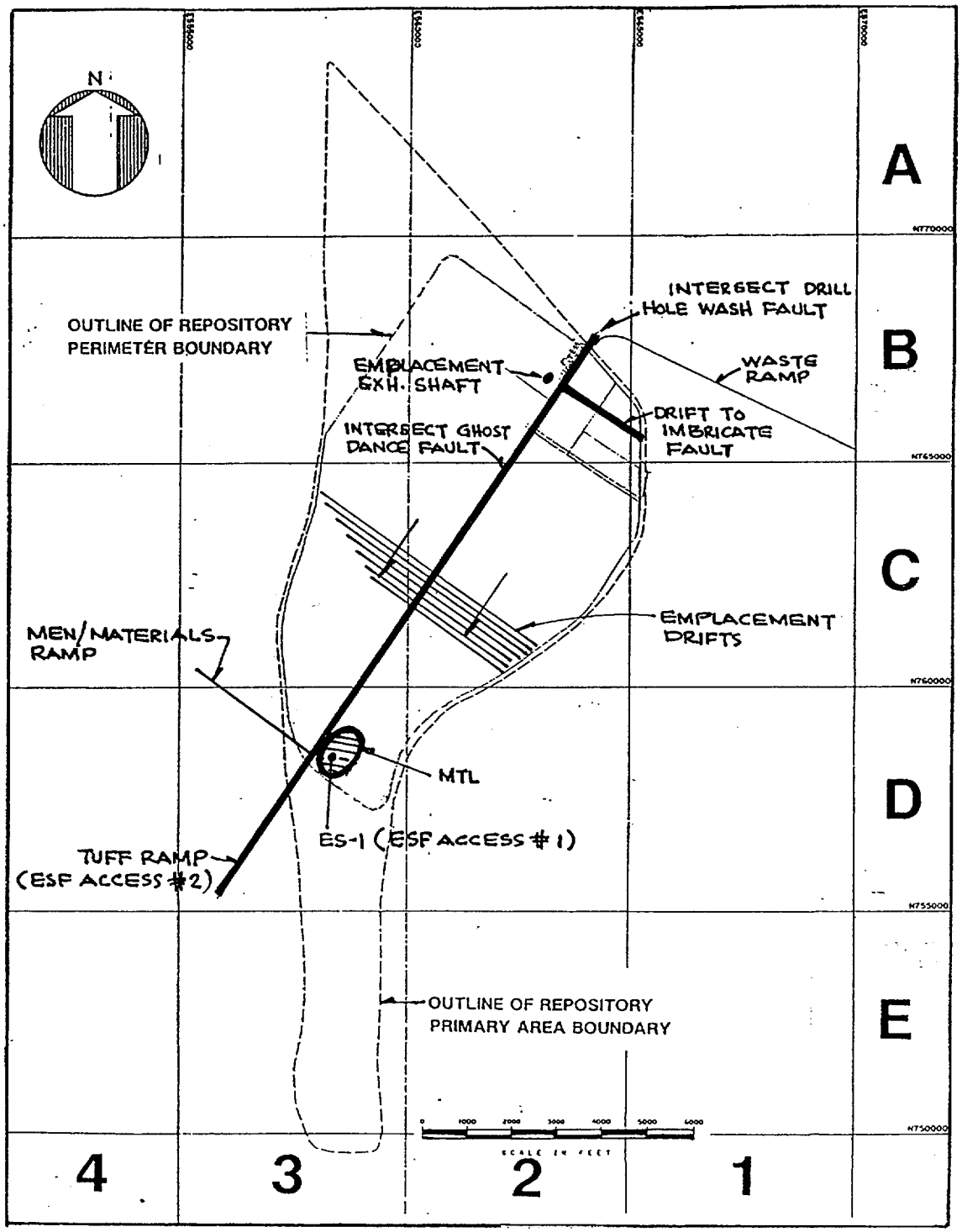
REPOSITORY LAYOUT FEATURES			TEST PROGRAM FEATURES	
	MINING METHODS MAINS	TBM	MINING METHODS EXPL. DRIFTS	MECH.
	PERIMETER DRIFT	TBM	MTL	MECH.
	PANEL ACCESS	NOT USED	MTL LOCATION	B3
	EMPL. DRIFTS	TBM	ACCESS TO CALICO HILLS	RAMP
	ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)	MTL ELEVATION	CORRESPONDS WITH REPOSITORY
	EMPLACEMENT DRIFT ORIENTATION	N 56 W	EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT, LONG NORTH-SOUTH DRIFT

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

B7 MTL S., TUFF RAMP/WASTE RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B8 MTL S., SHAFT/TUFF RAMP

PRELIMINARY NEW OPTION # B8
OPTION DESCRIPTION MTL SOUTH, SHAFT / TUFF RAMP
ESF ACCESSES 2 TOTAL ACCESSES 5

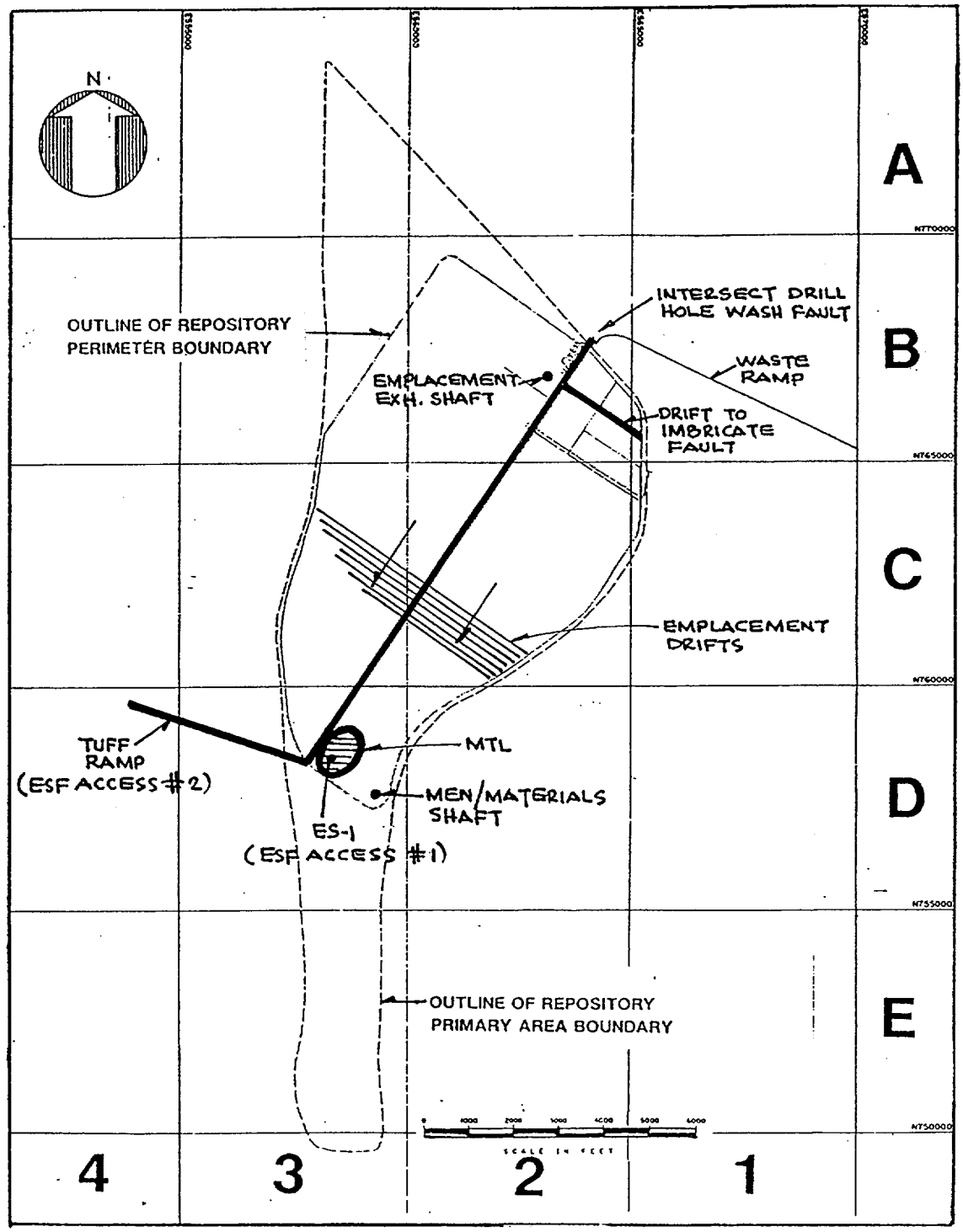
ACCESSES	ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
TYPE	SHAFT	RAMP	RAMP	SHAFT	SEE ESF ACCESS #2	RAMP
SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.		25' DIA.
CONSTRUCTION	D&B	TBM	MECH.	MECH.		TBM
LOCATION SURFACE	D3	D3	C3	B2		B1
LOCATION UNDERGROUND	D3	D3	D3	B2		B2
ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE		NONE

ESF FUNCTION IN REPOSITORY	ESF ACCESS #1	ESF ACCESS #2	MTL
REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
REPOSITORY OPERATIONS	VENTILATION	TUFF RAMP	NONE

REPOSITORY LAYOUT FEATURES	
MINING METHODS MAINS	TBM
PERIMETER DRIFT	TBM
PANEL ACCESS	NOT USED
EMPL. DRIFTS	TBM
ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
EMPLACEMENT DRIFT ORIENTATION	N 56 W

TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	MECH.
MTL	MECH.
MTL LOCATION	D3
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT,DRIFT TO NORTH END

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B8 MTL S., SHAFT/TUFF RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B9 MTL S., SHAFT/TUFF RAMP

PRELIMINARY NEW OPTION # B9

OPTION DESCRIPTION MTL SOUTH, SHAFT / TUFF RAMP

ESF ACCESSES 2 TOTAL ACCESSES 5

ACCESSES	ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
TYPE	SHAFT	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #2	RAMP
SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.		25' DIA.
CONSTRUCTION	D&B	TBM	MECH	MECH		TBM
LOCATION SURFACE	D3	D4	D3	B2		B1
UNDERGROUND	D3	D3	D3	B2		B2
ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE		NONE

ESF FUNCTION IN REPOSITORY	ESF ACCESS #1	ESF ACCESS #2	MTL
REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
REPOSITORY OPERATIONS	VENTILATION	TUFF RAMP	NONE

REPOSITORY LAYOUT FEATURES	
MINING METHODS MAINS	TBM
PERIMETER DRIFT	TBM
PANEL ACCESS	NOT USED
EMPL. DRIFTS	TBM
ELEVATION OF REPOSITORY	LOWER (SCP-CDR REF.)
EMPLACEMENT DRIFT ORIENTATION	N 56 W

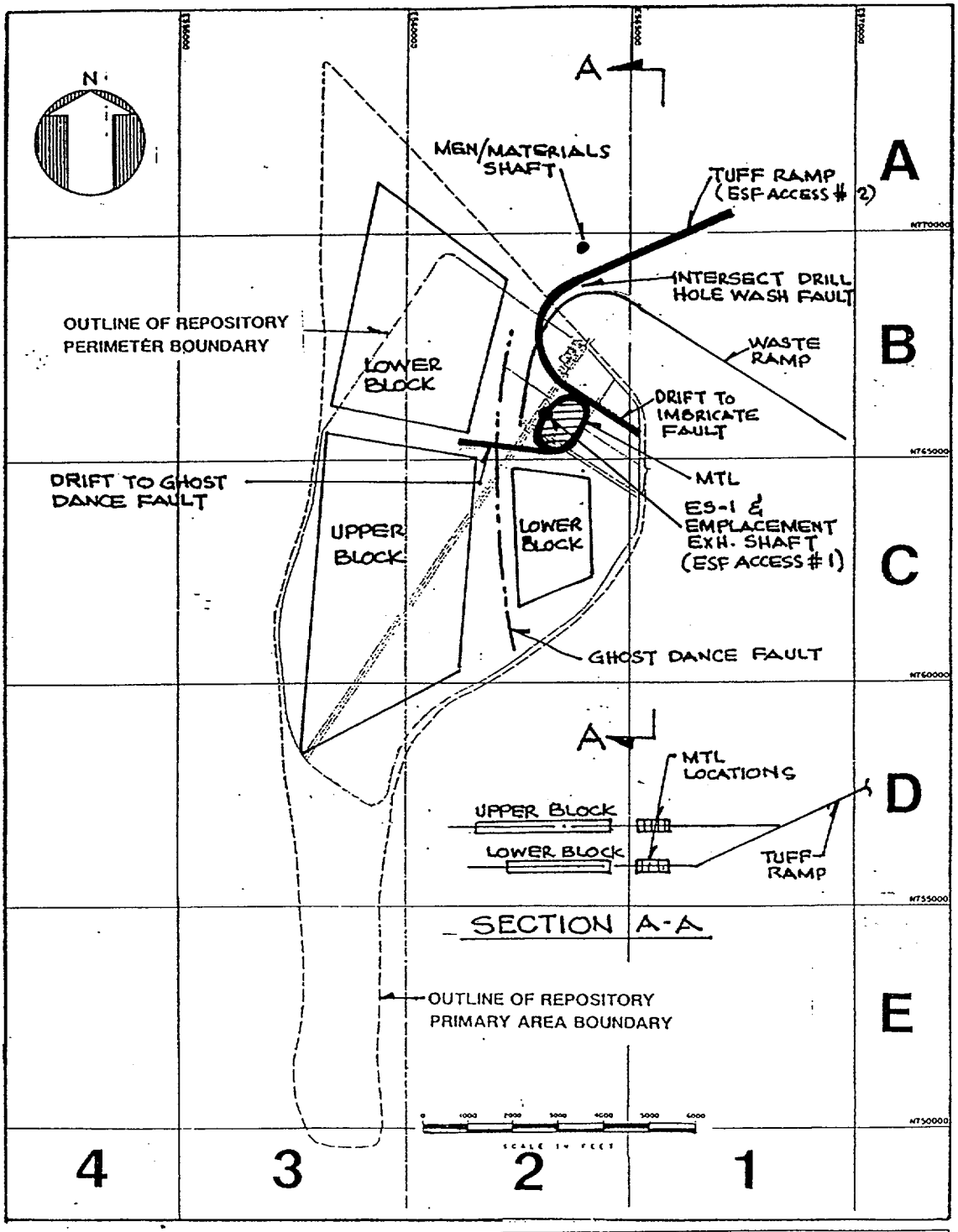
TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	MECH.
MTL	MECH.
MTL LOCATION	D3
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	CORRESPONDS WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT, DRIFT TO NORTH END

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

B9 MTL S., SHAFT/TUFF RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
C1 MTL N., SHAFT/TUFF RAMP

PRELIMINARY NEW OPTION # C1

OPTION DESCRIPTION MTL NORTH, SHAFT / TUFF RAMP

ESF ACCESSES 2 TOTAL ACCESSES 4

ACCESSES	ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
TYPE	SHAFT	RAMP	SHAFT	SEE ESF ACCESS #1	SEE ESF ACCESS #2	RAMP
SIZE (APPX.)	16' DIA. (ESF) 25' DIA. (REPOS.)	25' DIA.	25' DIA.			25' DIA.
CONSTRUCTION	D&B	TBM	MECH.			TBM
LOCATION SURFACE	B2	A1	B2			B1
UNDERGROUND	B2	B2	B2			B2
ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE			NONE

ESF FUNCTION IN REPOSITORY	ESF ACCESS #1	ESF ACCESS #2	MTL
REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
REPOSITORY OPERATIONS	EMPL. EXHAUST (25' DIA.)	TUFF RAMP	NONE

REPOSITORY LAYOUT FEATURES	
MINING METHODS MAINS	TBM
PERIMETER DRIFT	TBM
PANEL ACCESS	TBM
EMPL. DRIFTS	TBM
ELEVATION OF REPOSITORY	UPPER & LOWER MULTIPLE BLOCKS
EMPLACEMENT DRIFT ORIENTATION	N 0 E, N 12 E

TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	MECH.
MTL	MECH.
MTL LOCATION	B2
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	UPPER AND LOWER LEVELS CORRESPOND WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT

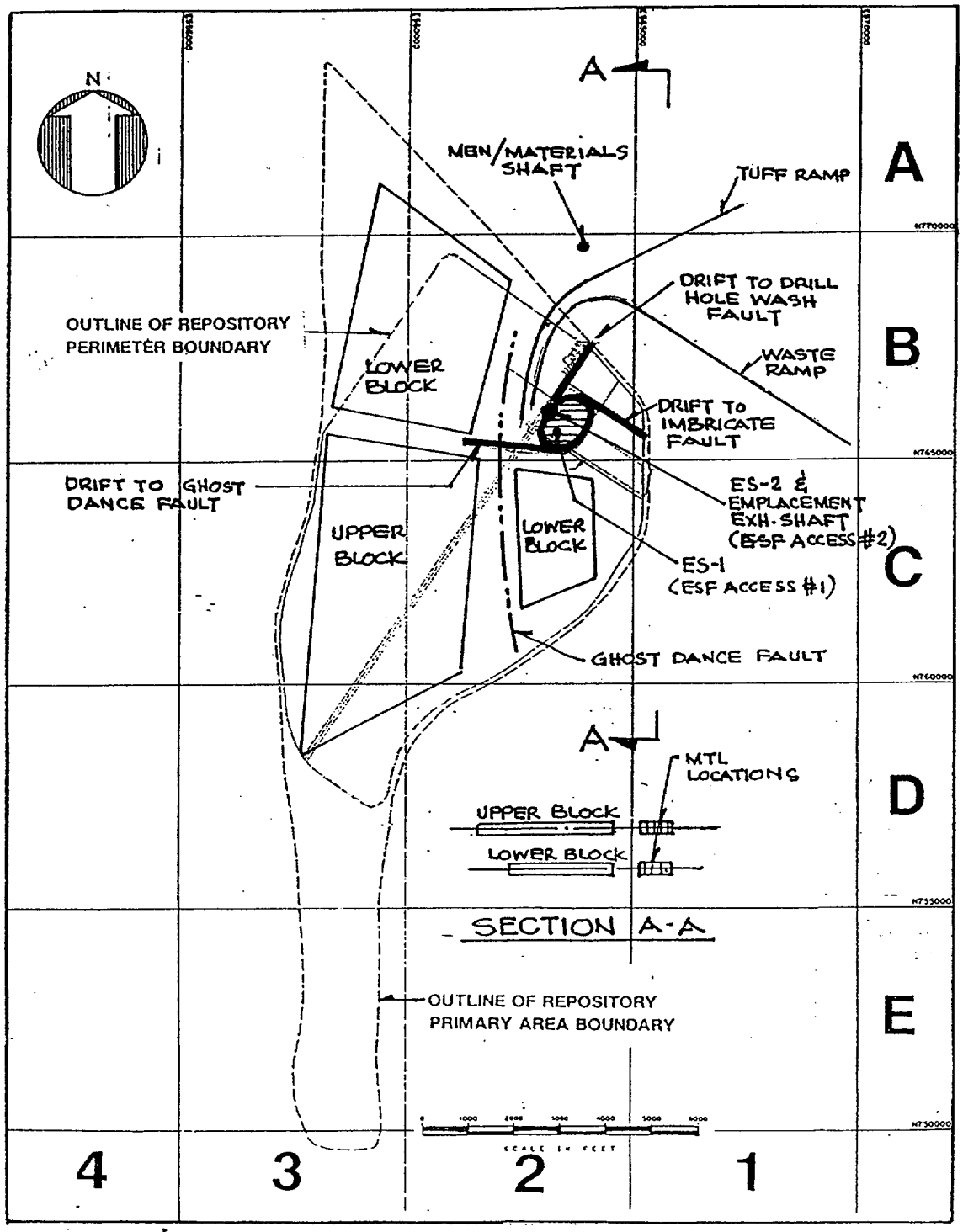
ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

C1 MTL N., SHAFT/TUFF RAMP

DATE_____



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
C2 MTL N., SHAFT/SHAFT

PRELIMINARY NEW OPTION # C2

OPTION DESCRIPTION MTL NORTH, SHAFT / SHAFT

ESF ACCESSES 2 TOTAL ACCESSES 5

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	SHAFT	SHAFT	SEE ESF ACCESS #2	RAMP	RAMP
	SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.		25' DIA.	25' DIA.
	CONSTRUCTION	D&B	MECH.	MECH.		TBM	TBM
	LOCATION SURFACE	B2	B2	B2		A1	B1
	UNDERGROUND	B2	B2	B2		B2	B2
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M) LOWER TBM	NONE		NONE	NONE

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION, MUCK HANDLING,PERSONNEL	VENTILATION PERSONNEL	NONE
	REPOSITORY OPERATIONS	VENTILATION	EMPL. EXHAUST	NONE

REPOSITORY LAYOUT FEATURES		
	MINING METHODS MAINS	TBM
	PERIMETER DRIFT	TBM
	PANEL ACCESS	TBM
	EMPL. DRIFTS	TBM
	ELEVATION OF REPOSITORY	UPPER & LOWER MULTIPLE BLOCKS
	EMPLACEMENT DRIFT ORIENTATION	N 0 E, N 12 E

TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	MECH.
MTL	MECH.
MTL LOCATION	B2
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	UPPER AND LOWER LEVELS CORRESPOND WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT GHOST DANCE FAULT IMBRICATE FAULT

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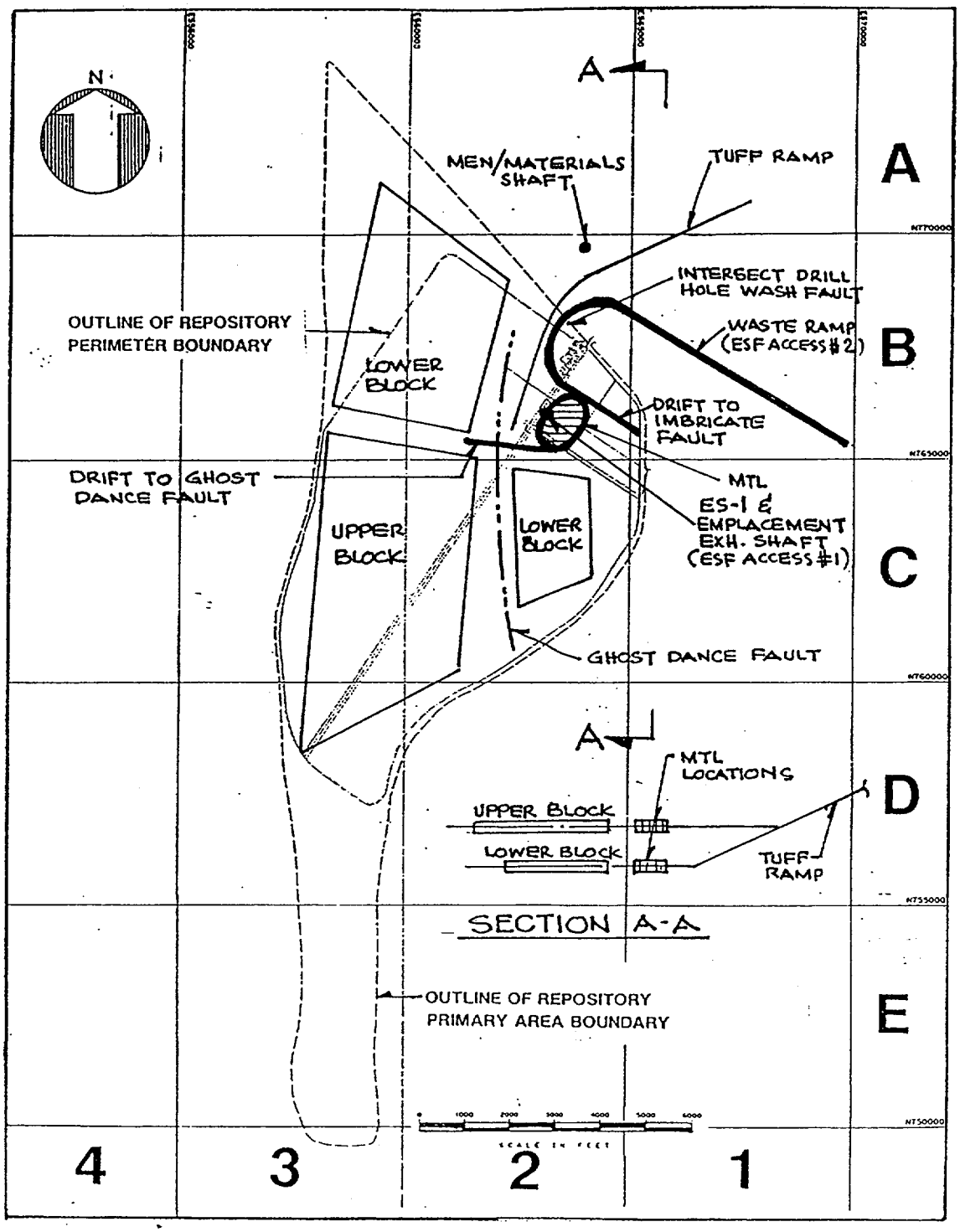
ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
C2 MTL N., SHAFT/SHAFT

DATE _____



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
C3 MTL N., SHAFT/WASTE RAMP

PRELIMINARY NEW OPTION # C3

OPTION DESCRIPTION MTL NORTH, SHAFT / WASTE RAMP

ESF ACCESSES 2 TOTAL ACCESSES 4

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	RAMP	SHAFT	SEE ESF ACCESS #1	RAMP	SEE ESF ACCESS #2
	SIZE (APPX.)	16' DIA. (ESF) 25' DIA. (REPOS.)	25' DIA.	25' DIA.		25' DIA.	
	CONSTRUCTION	D&B	TBM	MECH.		MECH.	
	LOCATION SURFACE	B2	B1	B2		A1	
	UNDERGROUND	B2	B2	B2		B2	
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE		NONE	

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING, PERSONNEL	NONE
	REPOSITORY OPERATIONS	EMPL. EXHAUST (25' DIA.)	WASTE RAMP	NONE

REPOSITORY LAYOUT FEATURES		
	MINING METHODS MAINS	TBM
	PERIMETER DRIFT	TBM
	PANEL ACCESS	TBM
	EMPL. DRIFTS	TBM
	ELEVATION OF REPOSITORY	UPPER & LOWER MULTIPLE BLOCKS
	EMPLACEMENT DRIFT ORIENTATION	N 0 E, N 12 E

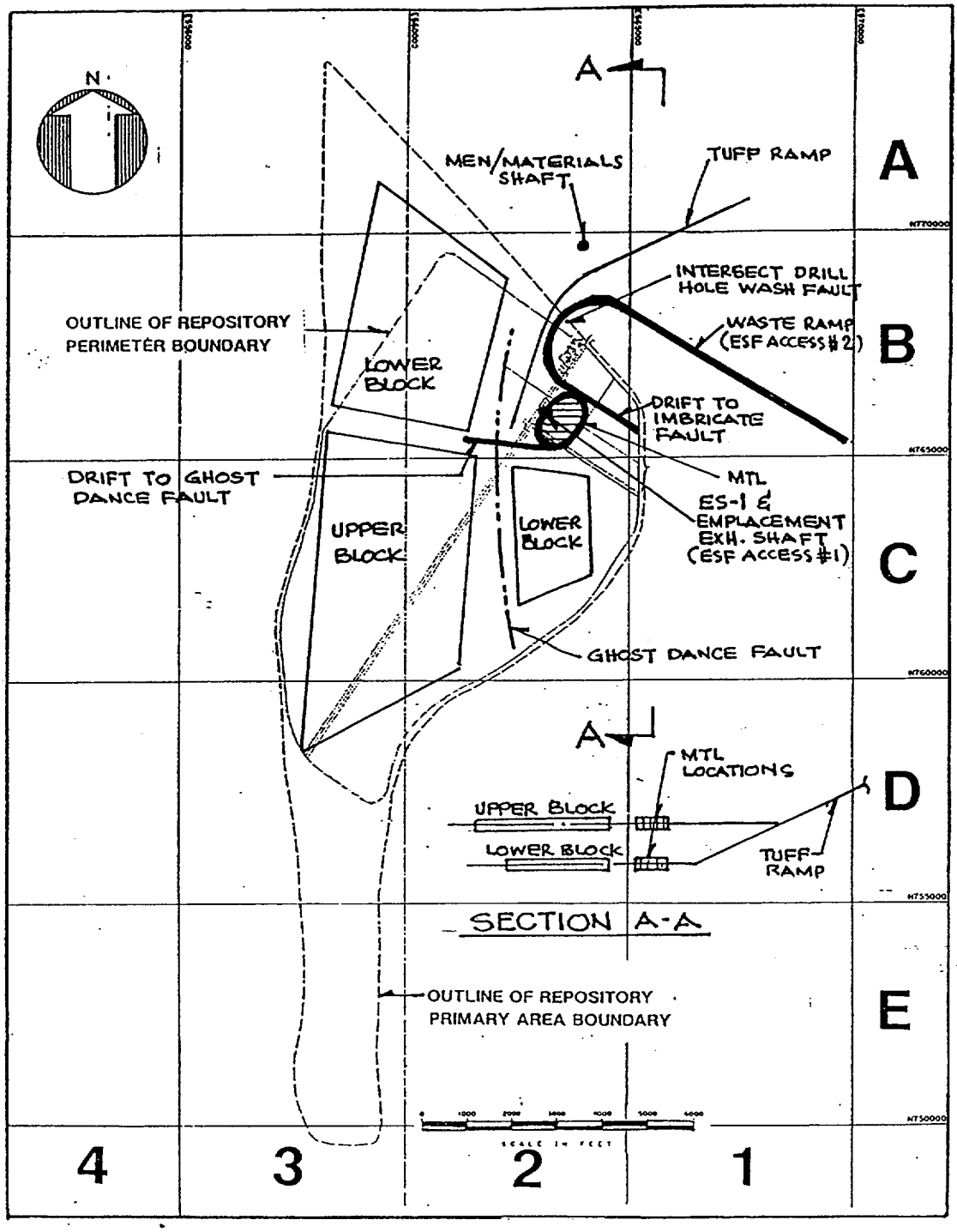
TEST PROGRAM FEATURES	
MINING METHODS EXPL. DRIFTS	MECH.
MTL	MECH.
MTL LOCATION	B2
ACCESS TO CALICO HILLS	SHAFT OR RAMP
MTL ELEVATION	UPPER AND LOWER LEVELS CORRESPOND WITH REPOSITORY
EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT GHOST DANCE FAULT IMBRICATE FAULT

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

C3 MTL N., SHAFT/WASTE RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
C4 MTL S., SHAFT/TUFF RAMP

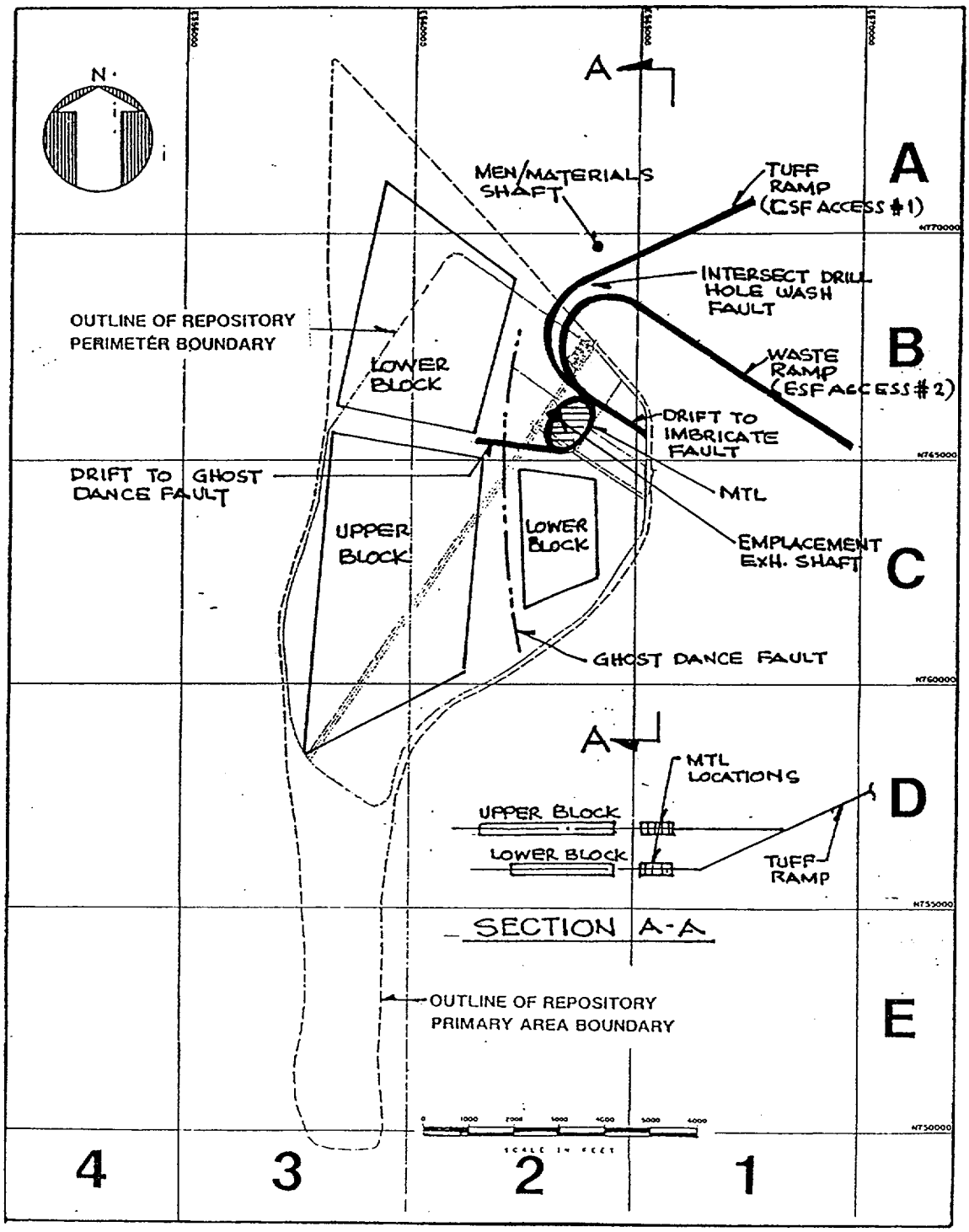
PRELIMINARY NEW OPTION # C4
OPTION DESCRIPTION MTL SOUTH, SHAFT / TUFF RAMP
ESF ACCESSES 2 TOTAL ACCESSES 5

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	SHAFT	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #2	RAMP
	SIZE (APPX.)	16' DIA.	25' DIA.	25' DIA.	25' DIA.		25' DIA.
	CONSTRUCTION	D&B	TBM	MECH.	MECH.		TBM
	LOCATION SURFACE	D3	D2	D3	B2		B1
	UNDERGROUND	D3	D3	D3	B2		B2
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	NONE	NONE		NONE

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION PERSONNEL	VENTILATION, MUCK HANDLING,PERSONNEL	NONE
	REPOSITORY OPERATIONS	VENTILATION	TUFF RAMP	NONE

REPOSITORY LAYOUT FEATURES			TEST PROGRAM FEATURES	
	MINING METHODS MAINS	TBM	MINING METHODS EXPL. DRIFTS	MECH.
	PERIMETER DRIFT	TBM	MTL	MECH.
	PANEL ACCESS	TBM	MTL LOCATION	D3
	EMPL. DRIFTS	TBM	ACCESS TO CALICO HILLS	SHAFT OR RAMP
	ELEVATION OF REPOSITORY	UPPER & LOWER MULTIPLE BLOCKS	MTL ELEVATION	UPPER AND LOWER LEVELS CORRESPOND WITH REPOSITORY
	EMPLACEMENT DRIFT ORIENTATION	N 0 E, N 12 E	EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT, LONG DRIFT TO NORTH

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
C4 MTL S., SHAFT/TUFF RAMP



NOTE: FOR LEGEND SEE OPTION A1

ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
C5 MTL N., TUFF RAMP/WASTE RAMP

PRELIMINARY NEW OPTION # C5

OPTION DESCRIPTION MTL NORTH, TUFF RAMP / WASTE RAMP

ESF ACCESSES 2 TOTAL ACCESSES 4

ACCESSES		ESF ACCESS #1	ESF ACCESS #2	MEN & MATERIAL	EMPLACEMENT EXHAUST	TUFF	WASTE
	TYPE	RAMP	RAMP	SHAFT	SHAFT	SEE ESF ACCESS #1	SEE ESF ACCESS #2
	SIZE (APPX.)	25' DIA.	25' DIA.	25' DIA.	25' DIA.		
	CONSTRUCTION	TBM	TBM	MECH.	MECH.		
	LOCATION SURFACE	A1	B1	B2	B2		
	UNDERGROUND	B2	B2	B2	B2		
	ESF FUNCTION	SCIENCE VENTILATION EMERG. EGRESS MUCK HANDLING	SCIENCE VENTILATION EMERG. EGRESS SERVICE (M/M)	NONE	NONE		

ESF FUNCTION IN REPOSITORY		ESF ACCESS #1	ESF ACCESS #2	MTL
	REPOSITIORY DEVELOPMENT	VENTILATION, MUCK HANDLING, PERSONNEL	VENTILATION PERSONNEL	NONE
	REPOSITORY OPERATIONS	TUFF RAMP	WASTE RAMP	NONE

REPOSITORY LAYOUT FEATURES			TEST PROGRAM FEATURES	
	MINING METHODS MAINS	TBM	MINING METHODS EXPL. DRIFTS	MECH.
	PERIMETER DRIFT	TBM	MTL	MECH.
	PANEL ACCESS	TBM	MTL LOCATION	B2
	EMPL. DRIFTS	TBM	ACCESS TO CALICO HILLS	RAMP
	ELEVATION OF REPOSITORY	UPPER & LOWER MULTIPLE BLOCKS	MTL ELEVATION	UPPER AND LOWER LEVELS CORRESPOND WITH REPOSITORY
	EMPLACEMENT DRIFT ORIENTATION	N 0 E, N 12 E	EXTENT OF EXPL. DRIFTING	DRILL HOLE WASH FAULT, GHOST DANCE FAULT, IMBRICATE FAULT

ESF ALTERNATIVES STUDY

TASK NO.4

PRELIMINARY NEW OPTIONS

C5 MTL N., TUFF RAMP/WASTE RAMP

APPENDIX 3F

GENERIC VARIATIONS FOR THE 24 PRELIMINARY NEW OPTIONS

This appendix includes "generic variations" for the 24 preliminary new options developed by the ESF-AS Task-4 participants. Generic variations were items uniquely identified for each of the options (such as mining method) that could be changed in a generic way to some other reasonable alternative.

GENERIC VARIATIONS OF SELECTED FEATURES
PRELIMINARY NEW OPTIONS-GROUP A

SHAFT SIZES

Approximate sizes are shown for each option. Actual sizes will be based on design needs.

RAMP SIZES

Approximate sizes are shown for each option. Actual sizes will be based on design needs.

SHAFT CONSTRUCTION METHOD

A method is shown for each option, but all options can use either drill and blast or mechanical excavation techniques.

RAMP CONSTRUCTION METHOD

A method is shown for each option, but all options can use either drill and blast or mechanical excavation techniques.

EXPLORATION DRIFTING TO REPOSITORY EXTREMITIES

Some options incorporate a long connecting (exploration) drift as a necessary feature of the concept. The other options can incorporate exploration drifts.

REPOSITORY ELEVATION WITHIN THE TSw2 HORIZON

An elevation or "vertical position" is shown for each option, but all options can use either the lower position (SCP-CDR reference) or the upper position (which is based on a revised interpretation of the TSw1/TSw2 interface and requires confirmation by surface-based testing).

ELEVATION COMPARED TO REPOSITORY ELEVATION

An MTL elevation or "vertical position" relative to the repository is shown for each option, but other elevations for the MTL can be accommodated.

DISTRIBUTED MTL TESTING

An MTL "plan view" location is shown for each option, but the flexibility exists to split out and relocate certain test activities to enhance characterization.

ORIENTATION OF THE EMPLACEMENT ROOMS

The orientation of the emplacement rooms is shown for each option, but a wide margin of flexibility exists within each option to accommodate changes.

MINING SEQUENCE

Some options show a mining sequence as a feature of the concept (such as retreat mining to the south), but most options can accommodate variations in the mining sequence (and the corresponding emplacement sequence).

GENERIC VARIATIONS OF SELECTED FEATURES
PRELIMINARY NEW OPTIONS-GROUP B

SHAFT SIZES

Approximate sizes are shown for each option. Actual sizes will be based on design needs.

RAMP SIZES

Approximate sizes are shown for each option. Actual sizes will be based on design needs.

SHAFT CONSTRUCTION METHOD

A method is shown for each option, but all options can use either drill and blast or mechanical excavation techniques.

RAMP CONSTRUCTION METHOD

A method is shown for each option, but all options can use either drill and blast or mechanical excavation techniques.

EXPLORATION DRIFTING TO REPOSITORY EXTREMITIES

Some options incorporate a long connecting (exploration) drift as a necessary feature of the concept. The other options can incorporate exploration drifts.

REPOSITORY ELEVATION WITHIN THE TSw2 HORIZON

An elevation or "vertical position" is shown for each option, but all options can use either the lower position (SCP-CDR reference) or the upper position (which is based on a revised interpretation of the TSw1/TSw2 interface and requires confirmation by surface-based testing).

ELEVATION COMPARED TO REPOSITORY ELEVATION

An MTL elevation or "vertical position" relative to the repository is shown for each option, but other elevations for the MTL can be accommodated.

DISTRIBUTED MTL TESTING

An MTL "plan view" location is shown for each option, but the flexibility exists to split out and relocate certain test activities to enhance characterization.

ORIENTATION OF THE EMPLACEMENT ROOMS

The orientation of the emplacement rooms is shown for each option, but a wide margin of flexibility exists within each option to accommodate changes.

MINING SEQUENCE

Some options show a mining sequence as a feature of the concept (such as retreat mining to the south), but most options can accommodate variations in the mining sequence (and the corresponding emplacement sequence).

GENERIC VARIATIONS OF SELECTED FEATURES
PRELIMINARY NEW OPTIONS-GROUP C

SHAFT SIZES

Approximate sizes are shown for each option. Actual sizes will be based on design needs.

RAMP SIZES

Approximate sizes are shown for each option. Actual sizes will be based on design needs.

SHAFT CONSTRUCTION METHOD

A method is shown for each option, but all options can use either drill and blast or mechanical excavation techniques.

RAMP CONSTRUCTION METHOD

A method is shown for each option, but all options can use either drill and blast or mechanical excavation techniques.

EXPLORATION DRIFTING TO REPOSITORY EXTREMITIES

One option incorporates a long connecting (exploration) drift as a necessary feature of the concept. The other options can incorporate exploration drifts.

REPOSITORY ELEVATION WITHIN THE TSw2 HORIZON

Two elevations or "vertical positions" (referred to as the upper and lower blocks) which utilize the additional TSw2 thickness are shown for each option. This additional thickness is based on a revised interpretation of the TSw1/TSw2 interface and requires confirmation by surface-based testing.

With further refinement, the 300-foot vertical distance between the blocks may be reduced by changing their vertical positions in the horizon . This may result in different vertical block positions, all at various elevations. For example, there may be an upper, middle and lower block, each 100 feet apart. The corresponding MTL(s) would be located in the best position(s) to suit characterization.

ELEVATION COMPARED TO REPOSITORY ELEVATION

Two MTL elevations or "vertical positions" corresponding to the repository block positions (upper and lower) are shown for each option. However, other elevations for the MTL can be accommodated. For example, a single upper MTL elevation, or a middle MTL elevation instead of MTLs at each block elevation, can be selected.

DISTRIBUTED MTL TESTING

An MTL "plan view" location is shown for each option, but the flexibility exists to split out and relocate certain test activities to enhance characterization. Because these options all use MTLs on two repository horizons, some distribution of MTL testing has already occurred.

ORIENTATION OF THE EMPLACEMENT ROOMS

The orientation of the emplacement rooms is shown for each option, but a wide margin of flexibility exists within each option to accommodate changes.

MINING SEQUENCE

All options can accommodate variations in the mining sequence (and the corresponding emplacement sequence).

APPENDIX 4A

SNL LETTER REPORT (SLTR) 90-4001

Sandia Letter Technical Report

SLTR90-4001

A Method for the Preliminary Screening of Options for the ESF Alternatives Study

Prepared by

Task 2 Committee of the ESF Alternatives Study

Approved:

Principal Investigator	Organization: 6314	Date: 3-7-90
Task Leader	Organization: 6311	Date: 3-7-90
Independent Technical Reviewer	Organization: 6316	Date: 3/7/90
Independent Technical Reviewer	Organization: 6312	Date: 2/8/90
SNL NWRT QA	Organization: SNL 6310	Date: 3/7/90
Division Supervisor	Organization: 6311	Date: 3-8-90
NWRT Department Manager	Organization: 6310	Date: 3-8-90

This work was conducted under WBS 1.2.6.1.1, PCA 5.0, Task 5.2, at QA Level I. This report is a product of DIM 242.

1.0 Introduction

The U.S. Department of Energy (DOE) has requested that the Yucca Mountain Project (YMP) conduct a study of alternative configurations and construction method options for the ESF. The scope of work required to complete this study is defined in Interaction Task Memo (ITM) 10. Under Task 2 of the study, as defined in ITM-10, a decision-aiding methodology is being developed. The methodology will be used to evaluate a number of ESF/repository options and develop a ranking of options based on their ability to meet defined objectives. Design Investigation Memo (DIM) 240 was issued to control the development and implementation of the methodology in the study. An initial concept for the decision method has been developed. The proposed method is based on a multi-attribute utility analysis, which provides a logical framework for evaluating and ranking the alternatives.

It is expected that, initially, proposed alternative designs will come primarily from the historic record (previously developed ESF and repository layouts). Additional options are being developed to address comments and concerns raised by the Nuclear Regulatory Commission (NRC), the Nuclear Waste Technology Review Board (NWTRB), the State of Nevada, and other agencies. Based on initial estimates from Task 4 (Options Development) of the study, the number of initial options may be quite large (more than 100). The mechanics of implementing the proposed decision process dictate that only a limited set of alternatives (perhaps no more than 10 to 12) can be considered in the final evaluation. In addition, it is desirable to ensure that the alternatives considered cover the widest possible range so that the recommended option will represent an optimum choice. To satisfy these two conditions, the committee working on Task 2 decided that an initial screening of available options would be necessary. As a result, DIM-242 was issued to guide the development and implementation of a screening process that would (1) reduce the number of potential alternatives to a manageable number for the final evaluation process, (2) define major design features and their ranges that should be considered when defining option possibilities, and (3) ensure that the set of options considered in the final evaluation spanned the range of possibilities.

This report documents the results of the design investigation conducted under DIM-242 and is intended to be a guide for conducting the screening process.

2.0 Approach to Preliminary Screening

The preliminary screening process involves a four-step program in which two screening functions occur. These steps are as follows:

1. Screen out options that can be shown to be in noncompliance with applicable regulations or requirements.

2. Classify the remaining options based on major features.

3. Choose a representative option from each class.

4. Recommend additional options to be developed, if necessary, to form a complete set for final evaluation.

The final product is a set of options that represents all reasonably conceived combinations of global concepts or ranges of major design features relevant to the scope of the decision.

2.1 Screening Noncomplying Options

Screening of noncomplying options is considered a higher level, or preliminary, screening activity based on noncompliance to criteria derived from:

1. testing and site characterization requirements, and

2. regulatory and nonregulatory design and performance requirements, including functional design requirements.

It is expected that the majority of affected options will be in the historical category (see Section 3.2), because the screening criteria will be based on present interpretation of requirements.

The main thrust of the ESF program is to characterize the site through a comprehensive testing program. As the project has developed, the individual interpretation of testing needs has changed and matured as the requirements for performance modeling have become more clearly defined. It is likely that ESF options developed early in the program will not accommodate the required tests as currently outlined in the Site Characterization Plan (SCP). Therefore, these earlier options may be dropped from further consideration as a result of preliminary screening.

Regulatory and design requirements provide a second classification for screening. These requirements are derived from federal, state, and local laws pertinent to the development of a mined geologic repository for nuclear waste as well as DOE orders and design documents applicable to the ESF and repository. Task 3 of the ESF Alternatives Study (ITM-10) will provide a complete compendium of these requirements. These requirements must be evaluated to determine which, if any, can be used in preliminary screening. Those used must be of a nature that an informed evaluator can determine to a high degree of assurance, without substantial analysis or calculation, whether or not a particular option meets the requirement.

By applying a preliminary screening process based on the two major areas of consideration discussed above, it is expected that obviously noncompliant options will be eliminated from further consideration and the reasons for elimination will have been completely documented. The remaining options will constitute a viable set of possibilities, all of which conform to basic requirements without any definitive nonfunctional features.

2.2 Consolidating Options

After the initial screening described in Section 2.1, a substantial number of options may still remain. These options will be consolidated and classified according to differences in major distinguishing features that are relevant to this study. A discussion of these features is given in Section 3.1. The number of classes defined will be the minimum deemed necessary to ensure that the final options set is complete, i.e., contains sufficient breadth of possible combinations and ranges of features. It is expected that many of the options considered will fall into several of the classes; assigning an option to more than one class is unrestricted. The specific criteria and rationale for defining these classes is discussed in Section 3.3.2.

2.3 Choosing Representative Options

After the alternatives have been assigned to classes, a representative option of each class will be chosen. The option chosen from each class is representative in the sense that it represents the range of the particular distinguishing feature for which that class was defined. That is, options in the same class may not be similar in all aspects but will be similar or the same relative to one particular feature that was used to define the class. The criteria for selecting a representative option from each class are discussed in Section 3.3.3. Once the selection of the final set is made, the options in the set will be checked against the list of distinguishing features and their desired ranges to ensure that each feature and its range is properly represented so that the final set is complete.

The representative option from each class will then be further developed by Task 4, if necessary, to provide sufficient information about the alternative so that the option can be scored against objectives. Only the representative option from each class will participate in the final evaluation and ranking process.

2.4 Recommending Additional Options

The classes of options defined as a result of the activity described in Sections 2.2 and 2.3 will represent as complete a set of options as possible within the restriction placed on the total number of classes that can be defined. A complete set of options is needed for the final evaluation to ensure that as broad a range of alternatives, differing by major relevant design features, is considered in the evaluation and ranking. The options remaining after initial screening (Section 2.1) may not represent a complete set in the sense that, after sorting into classes, some of the defined classes may not have any options in them. If this occurs, a recommendation to Task 4 will be made to develop an option with the major features characteristic of the empty class.

3.0 Defining Ingredients for the Preliminary Screening Process

This section discusses the ingredients or inputs required for the screening process: the options expected to be available for screening, the major distinguishing features of the options that will lead to the formation of options classes, and the criteria by which the screening and organizing into classes is to be accomplished.

3.1 Defining Major Features that Distinguish Options

To implement the portion of the screening process requiring that options be reduced to a representative set that can be accommodated in the final evaluation, a means of categorizing the alternatives is required. This section presents a set of major features relevant to the scope of the ESF Alternatives Study and explains how that set can be used to define what distinguishes one option from another.

The following are the major features that have been identified as distinguishing and relevant to the scope of the ESF Alternatives Study:

1. Location of access to the ESF
2. Access means
3. Construction method
4. Test Area Configuration
5. Repository/ESF Interface

These features are discussed in more detail in the following sections.

3.1.1 Location of Access to ESF and MTL

One distinguishing feature of the possible options to be considered is the location of the accesses used for the repository and particularly the subset of accesses used for the initial development of the ESF and the main test level (MTL). Location of the MTL within the general confines of the repository area is also of interest. Options with different locations of accesses and locations of ESF (which includes testing done in the accesses) are required to span the range of alternatives needed. Repository options should show a variety of access locations that are compatible with functional and other requirements that may be unique to the construction method, and are compatible with surface terrain and overburden requirements.

3.1.2 Access Means

Access means is the set of shafts and/or ramps used for repository development and operational needs and the subset of those accesses used for initial ESF development and operation. Options with different numbers and combinations of the basic access types are required for the evaluation set. In addition, options with different subsets of accesses used for initial ESF development are required.

3.1.3 Construction Method

Alternative repository and ESF construction methods must be considered. Options featuring different construction methods must be included in the final set. In some cases, the layout of ESF or repository depends on the construction method used. Therefore, some coupling is to be expected between construction method and repository and/or ESF configuration. The construction methods to be considered include drill and blast, machine excavation, and various combinations of the two.

3.1.4 Test Area Configuration

The current ESF configuration is defined by the SCP and the Title I design. The ESF Subsystems Design Requirements Document (SDRD) is a set of requirements specific to that configuration and as such depends directly on the drill and blast construction method and the two-shaft access configuration. The testing program is specified in detail in the SDRD (Appendix B) and contains a suite of 35 tests. These tests were defined in the activities of the SCP and were derived there in relation to the Key Issues, Issues, and Information Needs relative to the underground testing aspects of site characterization. For the purposes of the ESF Alternatives Study, test area configuration refers to the underground area where testing may be conducted as part of the ESF. This includes accesses to the underground, the MTL, and other drifts that may be constructed to explore specific geologic features or other portions of the site. Many different configurations compatible with the testing program defined in the SCP are possible. The test area configuration will depend somewhat on construction method, accesses chosen for the ESF, and location of the ESF within the repository area. It is desirable to have a range of test area configurations in the alternatives set used for the evaluation. This range of configurations should include different accesses and different uses of those accesses within the testing program, different MTL layout concepts, and different exploratory drifting concepts. An additional feature of the ESF configuration is that sufficient area to accommodate the testing program must be provided. This should include a minimum area for each test and appropriate standoff distances. Additional area must be provided in the event that unexpected geologic conditions are encountered, that tests require relocation, and that additional tests need to be conducted. Options with differing amounts of area available to the test program should be included in the evaluation set.

3.1.5 Repository/ESF Interface

This feature is defined by the degree to which the ESF is integrated into the initial repository development and subsequent operations. This feature is illustrated by an ESF ramp or shaft that is later used for material handling, personnel, ventilation, or for subsequent repository operations. The potential range of this feature runs from a totally isolated ESF to one in which all ESF accesses are used for initial repository

development. Intermediate to these extremes would be options where a set of accesses are devoted to the ESF through the initial period of repository construction and operation and then converted to repository accesses or ventilation openings. Options with different concepts of repository/ESF interface are required for the evaluation set.

3.1.6 Ranges for Major Features

The concept of a range for a distinguishing feature in the context of developing a suite of options for the final evaluation process is to indicate the anticipated spread of possible variations in a feature that could reasonably be included in the alternatives to be evaluated. The purpose of defining the ranges is to assure that the options presented or prepared include a reasonable complete span of those features that might, within the scope of this study, be expected to result in options being evaluated differently. Table 1 presents a summary of the expected ranges of the five major distinguishing features for options in this study.

3.2 Options/Alternatives Available

Options or alternatives available are composed of historical alternatives (those produced prior to the inception of this study), and additional alternatives that have been developed as a result of ideas generated during the course of this study. Additional alternatives also include options that utilize acceptable features of historic alternatives and combine them with new desirable features to replace some of the original and possibly disqualifying aspects.

3.2.1 Historical Options

Historical options include ESF/repository designs or concepts that have been formally documented. They consist of alternatives with different access locations, different types of accesses (ramp/shaft combinations), vertical and horizontal emplacement configurations for the repository, and a range of construction methods from drill and blast to the use of tunnel boring machines (TBM).

The alternate repository designs range from drill and blast layouts to all-rail/TBM layouts. All ESF options developed in this historical series have been predicated on the assumption that the repository will be constructed by drill and blast methods, and that the elevation, orientation, location, and outline of the repository will be as generally defined and described in the SCP-CDR.

A total of 15 distinct historical alternative repository designs or concepts have been identified to date. These were developed between 1983 and 1989. Each of these basic alternatives has several variations that vary the location, number, type, or size of the accesses to the repository and the ESF.

TABLE 1

EXPECTED RANGES OF THE FIVE MAJOR FEATURES FOR ESF OPTIONS

Feature	Range
Location	At least two different locations for the ESF MTL and the accesses used to develop the MTL should be considered.
Access Means	The ESF must have at least two means of access. The range of alternatives should include two shafts, two ramps, a shaft and a ramp, and options with more than two accesses. The set of accesses for the repository should vary in number with some options having fewer accesses than the SCP/CDR.
Construction Method	ESF and repository construction methods should include the combinations of both constructed by drill and blast, both constructed by mechanical mining methods (including the accesses to the ESF), and at least one or more configurations that are constructed by a combination of both methods, i.e., one ESF access drill and blast, one ESF access machine mined, ESF MTL drill and blast, and repository machine mined. The combination of a drill and blast repository with a machine mined ESF is considered unreasonable.
Test Area Configuration	Test area configuration will differ by configuration of the MTL, which depends on construction method, configuration and extent of proposed exploratory drifting, and by the length of access to the MTL (dependent on the location of the MTL relative to the location of the accesses) that provides for construction phase testing.
Repository/ESF Interface	A totally isolated or nonintegrated ESF is considered not to be a reasonable alternative. Therefore, options should range from those where integration of the ESF is incidental (i.e., accesses constructed for the ESF are not really necessary to the repository but are eventually used) to options where the ESF accesses are later converted to integral repository functions.

In association with the repository designs (plus variations) described above, approximately 13 distinct design options (51 options including subcases of distinct options) were developed for the ESF. These options include several alternatives with a single-shaft or two-shaft access, and one alternative with ESF access by a combination of a shaft and a ramp.

3.2.2 Additional Options

Additional options have been developed taking into account comments and recommendations made by the NRC, the NWTRB and others. Among these are alternatives developed to maximize the use of totally mechanized methods of excavation (e.g., TBMs to develop emplacement drifts); alternatives developed to combine desirable features from different options (e.g., using a ramp plus single-shaft access to the ESF, and later enlarging the shaft for use as a repository ventilation exhaust shaft); and alternatives developed to obtain maximum benefit from the thicker geologic horizon between the vitrophyre (TSw3) and the more recent estimates of the top of the TSw2.

A total of some 30 or so additional options (repository/ESF combinations) have been examined during the initial part of this study. These options are aimed at integrating ESF/repository construction to provide relevant and needed site characterization information at the earliest time frame and to provide a safe working environment for ESF construction and testing, and for repository development and operation.

3.3 Criteria for Screening, Consolidating, and Choosing Representative Options

In this section the criteria and/or method to be used to screen the initial available options, consolidate the remaining options into classes, and to choose a representative option from each class are described.

3.3.1 Noncompliance Screening Criteria

The initial screening of historical and other alternatives currently available will first involve a screening based on noncompliance with regulatory, testing, or other programmatic requirements. Because of the evolving nature of the repository and ESF design efforts, it is anticipated that some of the historical options may not meet current requirements. Many ESF alternatives were established before the SCP was finalized and released. Therefore, before submitting any of the current options for final evaluation, it is necessary to provide some assurance that the options will meet the fundamental regulatory and site characterization requirements.

As part of the ESF Alternatives Study, an extensive review of all regulatory, design, and testing requirements is being conducted (under Task 3). The requirements from this effort will be evaluated and sorted according to their ability to potentially be a discriminating factor when evaluating alternatives. As a result of the evaluation, a limited set of requirements will be established that includes those deemed to be most

discriminatory. From this set, only those regulations and requirements that can be used to examine an option on a "go" or "no-go" basis will be used for the initial screening. Whether or not the option meets the stated requirement must be obvious and not a matter of subjective judgment. This process is not intended to nor will it screen out any option on the basis of perceived performance characteristics that may not meet current requirements, or on the basis of meeting other requirements that can be evaluated only by subjective judgment at present (because of lack of site data or complete analyses).

The regulatory requirements considered for this study are taken from the applicable Federal and State Codes. Table 2 is a partial listing of the Federal and State regulations reviewed for the purpose of determining whether any requirements in those regulations could be used for initial screening. From these regulations, containing hundreds of regulatory requirements, it is expected that only a few (<10) may be used for initial screening.

Initial screening will also be done against current testing requirements. The requirements used will be developed from SCP testing needs, the proposed tests themselves, and requirements developed from Appendix B of the SDRD (Testing Requirements). Testing requirements include the ability to conduct the tests defined in the SCP. A summary of these tests is provided in Table 3. Some of the tests, as defined, are ESF-location or construction-method specific. These tests may change depending on the alternative selected. However, each test is based on a hierarchy of Issues and Information Needs that must be addressed. Thus, it is expected that, while some tests may change or some new test may be required depending on the particular alternative chosen, the basic testing program must be conducted. The first criterion, then, is to determine whether the defined testing program can be conducted within a given option. This can be done on a test-by-test basis or by using a more general criterion. For example, the testing program requires a minimum amount of developed area in the MTL and other places to ensure that tests can be conducted without interference. Therefore, one criterion for screening ESF options is that they have the minimum required developed area to conduct the current test program. Options will be evaluated on the basis of their current conceptual layout, i.e., the fact that additional development of the MTL of a given option could be done to satisfy the minimum requirements, will not be considered. Only what is currently defined regarding that option will be used as an evaluation basis.

Other functional and programmatic requirements could also be considered for use as screening criteria. The requirements from the Repository Design Requirements (RDR) and the SDRD will be evaluated to determine their suitability for use as screening criteria.

TABLE 2

PARTIAL LIST OF FEDERAL AND STATE REGULATIONS REVIEWED

Nuclear Regulatory Commission	
Standards for Protection Against Radiation	10 CFR 20
Disposal of High-Level Radioactive Wastes in Geologic Repositories	10 CFR 60
Department of Energy	
General Guidelines for Recommendation of Sites for Nuclear Waste Repositories	10 CFR 960
Occupational Safety and Health Administration, Department of Labor	
Occupational Safety and Health Standards	29 CFR 1910
Mine Safety and Health Administration, Department of Labor	
Electric Motor-Driven Mine Equipment and Accessories	30 CFR 18
Mobile Diesel-Powered Equipment for Noncoal Mines	30 CFR 32
Mobile Diesel-Powered Transportation Equipment for Gassy Noncoal Mines and Tunnels	30 CFR 36
Safety and Health Standards - Underground Metal and Nonmetal Mines	30 CFR 57
State of Nevada	
Mining Code	NRS Title 46
State of California	
California Administrative Code Tunnel Safety Order	CTSO Title 8
California Administrative Code Mine Safety Order	CMSO Title 8

TABLE 3

SUMMARY OF ESF TESTING FROM SCP (12/88), ESF SDRD APPENDIX B, AND TITLE I DESIGN (YMP/88-20)

	SCP Activity Title	SCP Section Reference	ESF Testing Conducted in the MTL
1.	*Geologic Mapping of the Exploratory Shaft and Drifts-Con. and In.	8.3.1.4.2.2.4	Y
2.	*Mineralogy and Petrology of Candidate Host Rock-Con. and In.	8.3.1.3.2.1.1 8.3.1.3.2.1.3 8.3.1.3.2.2.1	Y
3.	*Seismic Tomography/ Vertical Seismic Profiling-Con.	8.3.1.4.2.2.5	Y
4.	*Shaft Convergence-Con.	8.3.1.15.1.5.1	No
5.	*Demonstration Breakout Rooms-Con.	8.3.1.15.1.5.2	Y
6.	Sequential Drift Mining	8.3.1.15.1.5.3	Y
7.	Heater Experiment in Unit TSw1	8.3.1.15.1.6.1	No
8.	Canister-Scale Heater Experiment	8.3.1.15.1.6.2	Y
9.	Yucca Mountain Heated Block	8.3.1.15.1.6.3	Y
10.	Thermal Stress Measurements	8.3.1.15.1.6.4	Y
11.	Heated Room Experiment	8.3.1.15.1.6.5	Y
12.	Development and Demonstration of Required Equipment	8.3.2.5.6	Y
13.	Plate Loading Tests	8.3.1.15.1.7.1	Y

TABLE 3

SUMMARY OF ESF TESTING FROM SCP (12/88), ESF SDRD APPENDIX B, AND TITLE I DESIGN (YMP/88-20) (Continued)

SCP Activity Title	SCP Section Reference	ESF Testing Conducted in the MTL
14. Rock-Mass Strength Experiment	8.3.1.15.1.7.2	Y
15. Evaluation of Mining Methods	8.3.1.15.1.8.1	Y
16. Monitoring of Ground Support Systems	8.3.1.15.1.8.2	Y
17. Monitoring Drift Stability	8.3.1.15.1.8.3	Y
18. Air Quality and Ventilation Experiment	8.3.1.15.1.8.4	Y
19. *In-Situ Testing of Seal Components-Con. and In.	8.3.3.2.2.3	Y
20. *Overcore Stress Experiments in the Exploratory Shaft Facility-Con.	8.3.1.15.2.1.2	Y
21. *Matrix Hydrologic Properties Testing Con. and In.	8.3.1.2.2.3.1	Y
22* Intact-Fracture Test in the Exploratory Shaft Facility-Con. and In.	8.3.1.2.2.4.1	Y
23. Percolation Tests in the Exploratory Shaft Facility	8.3.1.2.2.4.2	Y
24. Bulk-Permeability Test in the Exploratory Shaft Facility	8.3.1.2.2.4.3	Y

TABLE 3

SUMMARY OF ESF TESTING FROM SCP (12/88), ESF SDRD APPENDIX B, AND TITLE I DESIGN (YMP/88-20) (Continued)

SCP Activity Title		SCP Section Reference	ESF Testing Conducted in the MTL
25*	Radial Borehole Tests in the Exploratory Shaft Facility-Con.	8.3.1.2.2.4.4	N
26*	Excavation Effects Test in the Exploratory Shaft Facility-Con.	8.3.1.2.2.4.5	Y
27.	Calico Hills Test in the Exploratory Shaft Facility	8.3.1.2.2.4.6	Y
28*	Perched-Water Test in the Exploratory Shaft Facility-Con. and In.	8.3.1.2.2.4.7	Y
29*	Hydrochemistry Tests in the Exploratory Shaft Facility-Con. and In.	8.3.1.2.2.4.8	Y
30.	Diffusion Tests in the Exploratory Shaft Facility	8.3.1.2.2.5.1	Y
31*	Chloride and Chlorine -36 Measurements of Percolation at Yucca Mountain-Con.	8.3.1.2.2.2.1	Y
32.	Engineered Barrier System Field Tests	8.3.4.2.4.4	Y
33*	Laboratory Tests (Thermal and Mechanical) Using Samples Obtained from the ESF-Con. and In.	8.3.1.15.1.1.4	Y

TABLE 3

SUMMARY OF ESF TESTING FROM SCP (12/88), ESF SDRD APPENDIX B, AND TITLE I DESIGN (YMP/88-20)
(Concluded)

SCP Activity Title	SCP Section Reference	ESF Testing Conducted in the MTL
34. Multipurpose-Borehole Testing Near the ESF	8.3.1.2.2.4.9	Y
35. Hydrologic Properties of Major Faults Encountered in Main Test Level of the Exploratory Shaft Facility	8.3.1.2.2.4.10	

*Con. = Construction Phase Tests (15).
Con. and In. denotes construction phase and in-situ phase test.
All others are in-situ phase.

3.3.2 Consolidation and Grouping Criteria

After screening for noncompliance, it is expected that a large number of options will still be available for consideration. To reduce the complexity of selecting a representative set of options for the final evaluation, a consolidation/grouping strategy has been adopted. This strategy consists of grouping alternatives into classes. Each class is defined by a particular range of one of the distinguishing features defined in Section 3.1. In doing this, it is inevitable that most options will fall into two or more classes. No order or prioritization should be inferred by the fact that an option falls into a greater number of classes than another option. The number and definition of the classes required are based on the principle that the options selected for the final evaluation must represent a sufficiently broad range of reasonable alternatives for each major feature. Based on this principle, the following classes are defined for grouping the options:

Each alternative will be placed in at least one or more of the above 12 classes.

TABLE 4

CLASSES

Class	Feature	Definition
1	Location	Location of the accesses and ESF approximately in the SCP-CDR configuration
2	Location	ESF and at least one ESF access in a location substantially different from that of Class 1
3	Access Means	Total number of accesses less than SCP-CDR
4	Access Means	ESF access by two or more shafts
5	Access Means	ESF access by two or more ramps
6	Access Means	ESF access by at least one shaft and one ramp
7	Construction Method	Construction of the repository and ESF substantially by drill and blast. This would include options with machine mined ramps and mains but with the emplacement areas developed by drill and blast.
8	Construction	All construction (including ESF and accesses Method except for some testing alcoves, etc.) by mechanical mining
9	Construction	Combination of mechanical and drill and blast Method methods, e.g., one shaft and ESF constructed by drill and blast, with the remainder constructed by mechanical mining (including the second ESF access)
10	Test Area Configuration	ESF layout (including exploratory drifting and designated test area) similar to the Title I or early Title II concepts
11	Test Area Configuration	ESF layout substantially different from Class 10, Configuration, which may include size or scope of designated test areas
12	ESF/Repository Interface	Options that integrate repository and ESF accesses

3.3.3 Criteria for Choosing Representative Options

The classes, from which the representative option set is chosen, represent option groups with the same range of a particular feature or combination of features. One option from each class will be selected for inclusion in the final evaluation process. An option may be included in one or more of the defined classes depending on the range of features the option has. However, the same option cannot be selected from more than one class to be part of the final set. The procedure and criteria for selecting an option from each class is as follows:

1. If any class has only one option, that option will be selected to represent the class.

2. If more than one option is available in each class for which an option has yet to be selected, one class at a time will be examined and an option chosen. The option chosen will be selected on the basis of best developed and most representative of the range of distinguishing features for which that class was defined.

3. After an option is selected from one class, it will be eliminated from consideration in any other class. Thus, after several selections have been made, some classes might be reduced to a single member, in which case rule 1 would apply.

4. If there is a class with no options, it will be recommended that an option be developed that could be assigned to that class.

After an option has been selected from each class, an evaluation will be done to ensure that the ranges of distinguishing features necessary to have a complete set (Table 1) are covered by the options selected. If not, additional options will be recommended for development and inclusion in the final evaluation set.

4.0 Implementation of the Screening Process

This section provides some additional procedural details as to how the screening process will be conducted. Selected members of the Methodology Lead Group (MLG) (defined in DIM-240) along with some additional personnel from project participants will form the screening panel. The Principal Investigator for DIM-242 will be responsible for selecting the panel.

4.1 Noncompliance Screening

The first step in the options screening process will be a screening against regulatory, programmatic, and testing requirements for which it can be easily determined whether or not an option is in compliance. The steps necessary to conduct this screening follow:

1. A listing of regulatory and programmatic requirements will be provided to the MLG by Task 3 of the ESF Alternatives Study (requirements researched

and listed under DIM-244). The requirements on this list will be evaluated for their potential to discriminate nonqualifying options on a go or no-go basis. Only those few requirements that satisfy the go/no-go discriminatory basis will be selected for use. A checklist for each option will be prepared containing the requirements selected for screening. The screening panel will evaluate each option against the checklist. If any requirement on the checklist receives a "no" evaluation, it will be dropped from further consideration. For any "no" evaluation, a short explanation or justification will be provided.

2. The Test Manager's Office (LANL) will provide a current list of tests and an evaluation of the current testing program as to the minimum underground developed area (including contingency area and area required for additional testing, if necessary) to conduct the tests. The list of tests will show which tests are:

   a. not dependent on ESF location, configuration, or construction method;

   b. dependent on ESF location;

   c. dependent on ESF configuration; or

   d. dependent on ESF construction method.

Each repository/ESF option will be evaluated against the required tests, taking into account the potential sensitivity of each test. The option will be evaluated to determine whether sufficient test space is available. If it is determined that the testing program cannot reasonably be conducted within the ESF option, that option will be dropped from consideration. Justification will be provided for the deletion of any option.

4.2 Consolidation and Grouping

To organize the remaining options into classes, a matrix chart will be used that lists the options by identification number down the left side with the classes identified in Section 3.3.2 across the top. Each option will be evaluated as to the major distinguishing features listed in Section 3.1. As a result of this evaluation, the option will be assigned to the appropriate classes (more than one class is likely for each option). Figure 1 is an illustration of the grouping matrix.

4.3 Select Representative Options

To select the set of representative options, the algorithm defined in Section 3.3.3 will be applied to the grouping matrix (Figure 1). The options selected as representative of the range of features of interest to this study will be from the set submitted for final, more detailed evaluation. If no option falls in a particular class, it will be

	Class											
Option	1	2	3	4	5	6	7	8	9	10	11	12
A	X		X			X			X			
B	X		X			X	X			X		X
C		X	X			X		X	X			X
D	X		X			X	X				X	X

Figure 1. Illustration of Grouping Option by Classes

recommended that an additional option be developed that has the feature of that class.

The options selected will be further evaluated against the desirable ranges of features to ensure that, indeed, the options set is complete. If it is determined that some range of features is not adequately represented, then a recommendation will be made to develop an additional option with the desirable feature.

It should be emphasized that it is not the intent of the grouping and selection process to select the "best" options for final evaluation. The fact that an option is not selected even though it may have fared better in the final evaluation than an option in the same class that is selected should not affect the evaluation process used in this study. The options selected should be thought of as representing certain sets of features and not as complete designs. The final evaluation will result in the selection of a preferred representative option, which means a preferred set of range features. These features will form the basis for the designs of the ESF and repository, but the details of the design will be left to the design process.

5.0 Documentation of Results from the Screening

Each stage of the screening process will be documented to a degree that is sufficient for an independent reviewer to understand and follow the process. A summary letter report will be submitted to the DIM-242 file along with the supporting documentation. Supporting documentation may include

1. copies of sketches and background information available for each option that is subjected to screening;

2. rationale for selecting regulatory and testing requirements used for initial screening;

3. noncompliance screening checklists for each option;

4. matrix of options sorted by classes similar to Figure 1;

5. rationale for selecting representative option from each class;

6. check of final options set against the ranges of features;

7. identification and rationale for additional options that may need to be developed to form a complete set; and

8. identification and brief description of the options selected to form the final evaluation set.

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SAIC	M. Parsons
6310	T. O. Hunter
6310	105/12611/SLTR90-4001/Q1
6310	60/12611/DIM-242/1.4/Q1 (XREF)
6310	60/12611/DIM-240/1.4/Q1 (XREF)
6310	65/12611/ITM-010/1.4/Q1 (XREF)
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6311	A. W. Dennis
6311	E. R. Gruer
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Appendix

Information from the Reference Information Base Used in this Report

This report contains no information from the Reference Information Base.

Candidate Information for the Reference Information Base

This report contains no candidate information for the Reference Information Base.

Candidate Information for the Site & Engineering Properties Data Base

This report contains no candidate information for the Site and Engineering Properties Data Base.

APPENDIX 4B

LIST OF DOCUMENTS AND RECORDS RELEVANT TO THE SCREENING PROCESS

SUPPORTING DOCUMENTATION FOR SAND91-0025 - RECORDS PACKAGES, SECTION 4

	Records Management System Number (RMS)	Title	Date	Source/ Org.	File Code
1.		Transcripts of the Panel Meetings for Initial Screening of Options	4/2/91	S. J. Bauer	60/12611/ DIM242/1.1/QA
2.	016079	Design Investigation Memo (DIM) 241, Selection of Panel Members	2/19/90	S. J. Bauer	60/12611/ DIM241/1.0/QA
3.	016638	DIM 242, Preliminary Screening	3/26/90	L.S. Costin	60/12611/ DIM242/1.0/QA
4.	017230	DIM 243, ESF-Repository Options	5/15/90	E.R. Gruer	60/12611/ DIM243/1.0/QA
5.	018705	DIM 244, Requirements	7/11/90	M.W. Parsons SAIC	60/12611/ DIM244/1.0/QA
6.	016791	Memo to File: Results of the Initial Screening of Options for the ESF-AS with Attachments	4/10/90	L.S. Costin	60/12611/ DIM242/1.4/QA

RESULTS OF THE INITIAL SCREENING
OF OPTIONS FOR THE ESF-AS

SUMMARY OF ATTACHMENTS

Attachment	Contents	Pages
Volume I		
1	Divider page--viewgraphs used in instruction of panel verification of reading SLTR90-4001	
	Verification of instruction SLTR90-4001	32
2	Divider page--daily attendance sheets for screening meeting	6
3	Divider page--regulatory and functional requirements screening forms for ESF historical options (19 forms)	58
4	Divider page--testing screening forms for ESF historical options (7 forms) Calculation of Test Area (DOP 3-10 forms) Table 3a (supplement to SLTR90-4001 Table 3	30
5	Divider page--regulatory and functional requirement screening forms for historical repository options (8 forms)	25
6	Divider page--testing screening forms for repository historical options (8 forms) area calculation (DOP 3-10 sheets) Fax of TMO ESF area calculation	74
7	Divider page--option class matrix	4
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Volume II		
11	ESF Historical Options	261
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12	Historical Repository Options	323
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13	Preliminary New Options	56

APPENDIX 4C

REGULATORY AND TESTING SCREENING CRITERIA AND RESULTS OF STEP 1

ESF Alternatives Study

Initial Screening of Options
Based on Site Characterization
(Testing) Requirements

Option Identifier _____

Criterion 1:

Background:
Table 3 of SLTR90-4001 provides a listing of the 35 tests proposed for the ESF, based on Sections 8.3 and 8.4 of the SCP. Supplementary Table 3a provides an assessment of which tests may be affected by changes in ESF location, configuration or construction method from the reference (Title I) ESF design. In performing the evaluation, only the option configuration as presented can be considered. Do not consider what, if any, changes or additions to the option might make it more suitable for characterization testing.

Criterion:
Based on the information provided in the tables and the information needs required from the testing program (as designated in the appropriate SCP sections given in Table 3 of SLTR90-4001), can the underground characterization program be conducted within the ESF configuration specified by the option being evaluated?

A **YES** evaluation means that the underground characterization program could be conducted within the ESF option being evaluated, even though some tests may require modification because of differences between this option and the Title I ESF design for which the tests were specifically designed (i.e. the option allows sufficient testing to be conducted to address the information needs required of the underground characterization program.)

A **NO** evaluation means that under no circumstances could the underground characterization program be conducted within the ESF option being evaluated, even considering that tests could be modified, deleted, or added to the program to satisfy the information needs. Any option receiving a NO evaluation will be deleted from further consideration. A NO evaluation must be explained in the Comments section below.

An evaluation of **UNCERTAIN** means that it cannot be determined whether or not the ESF option is adequate to perform the characterization program.

Evaluation: _____

Criterion 2:

Background:
Based on an evaluation of the test area requirements for the underground characterization program as defined in Sections 8.3 and 8.4 of the SCP (including performance confirmation tests), it has been determined that the minimum rectangular area necessary to conduct the testing program is approximately 977,800 ft^2 (including allowances for flexibility, some additional tests that were not provided for in the Title I ESF design, and shop areas).

Considering allowances for additional flexibility and contingencies, the minimum area desired is approximately 1,860,260 ft^2.

Criterion:
Does the ESF/Repository option being evaluated have sufficient area designated and available for underground testing?

A **YES** evaluation means that the option has more than the minimum area desired (1,860,260 ft^2).

A **NO** evaluation means that the option has less than 75% of the minimum acceptable area available (.75 X 977,800 = 733,350 ft^2). A no evaluation should be substantiated by an attached calculation sheet (DOP 3-10) and will result in the option being eliminated from further consideration.

An **UNCERTAIN** evaluation means that the option has an available test area of more than 733,350 and less than 1,860,260 ft^2.

Evaluation: _____

Comments on evaluation:

Evaluators:

Name (Print)	Signature	Date

ESF Alternatives Study

Initial Regulatory and Functional Requirements Screening

Option Identifier _____

Statement of Requirement	Sources Document	Sources Section	Evaluation of Compliance
Requirement 1 The design of the underground facility, including the shaft collar area, ramp portals, and main pads should provide for control of water or gas intrusion. The shaft collars and ramp portals should be located to prevent water inflow from a probable maximum flood (PMF).	10 CFR 60 DAA DAA SDRD SDRD SDRD	60.133(d) 1.12.1.1 2.3.4.1 1.2.6.1 PC3c 1.2.6.1.1 PC1b 1.2.1.4 PC2	
Requirement 2 The ESF underground excavation shall be of adequate size to support current and future testing. The underground excavation shall be able to accommodate site specific conditions and be able to drift from the MTL up to 10,000 ft to other parts of the repository block	10 CFR 60 10 CFR 60 DAA SDRD	60.74(a) 60.133(b) 2.4.6.5 1.2.6.5 Constraint O.v	
Requirement 3 Two means of access (egress) shall be incorporated into the ESF.	30 CFR 57 SDRD	57.11050 1.2.60 Performance Criterion 4c	

Statement of Requirement	Sources Document	Sources Section	Evaluation of Compliance
Requirement 4 The openings required for rock handling and for support facilities (e.g. maintenance shops, electrical substations, pump stations, refuge chambers, lunch rooms, and storage facilities) shall be located away from in situ site characterization testing.	10 CFR 60 SDRD	60.133(b) 1.2.6.6.1 PC 1a	
Requirement 5 Long exploratory drifts extended laterally from the ESF on the MTL shall be constructed in locations that will permit them to be used to support repository operations.	SDRD	1.2.6.6 Constraint E.iv	
Requirement 6 The ESF shall be designed with a minimum of 75 feet between the centerlines of adjacent ESF and waste emplacement drifts.	10 CFR 60 DAA	60.130 1.10.6.1	

Evaluation of compliance will be either YES - the option being evaluated complies with the requirement; NO - the option being considered does not comply with the requirement; or UNCERTAIN - it cannot be determined whether the option complies with the requirement. A NO evaluation must be explained in the comments section below and will result in the option being eliminated from further consideration.

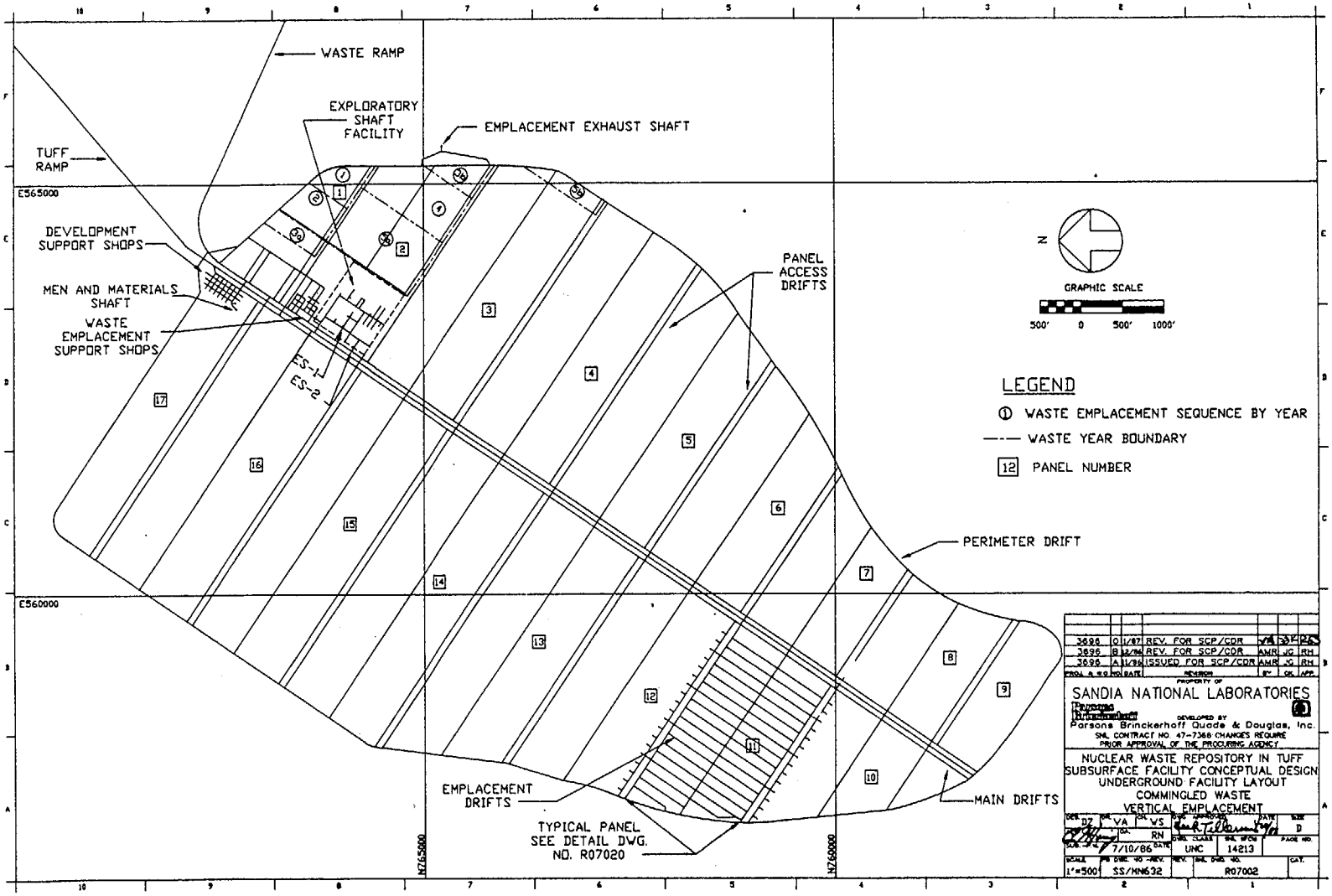
Comments on evaluation:

Evaluators:

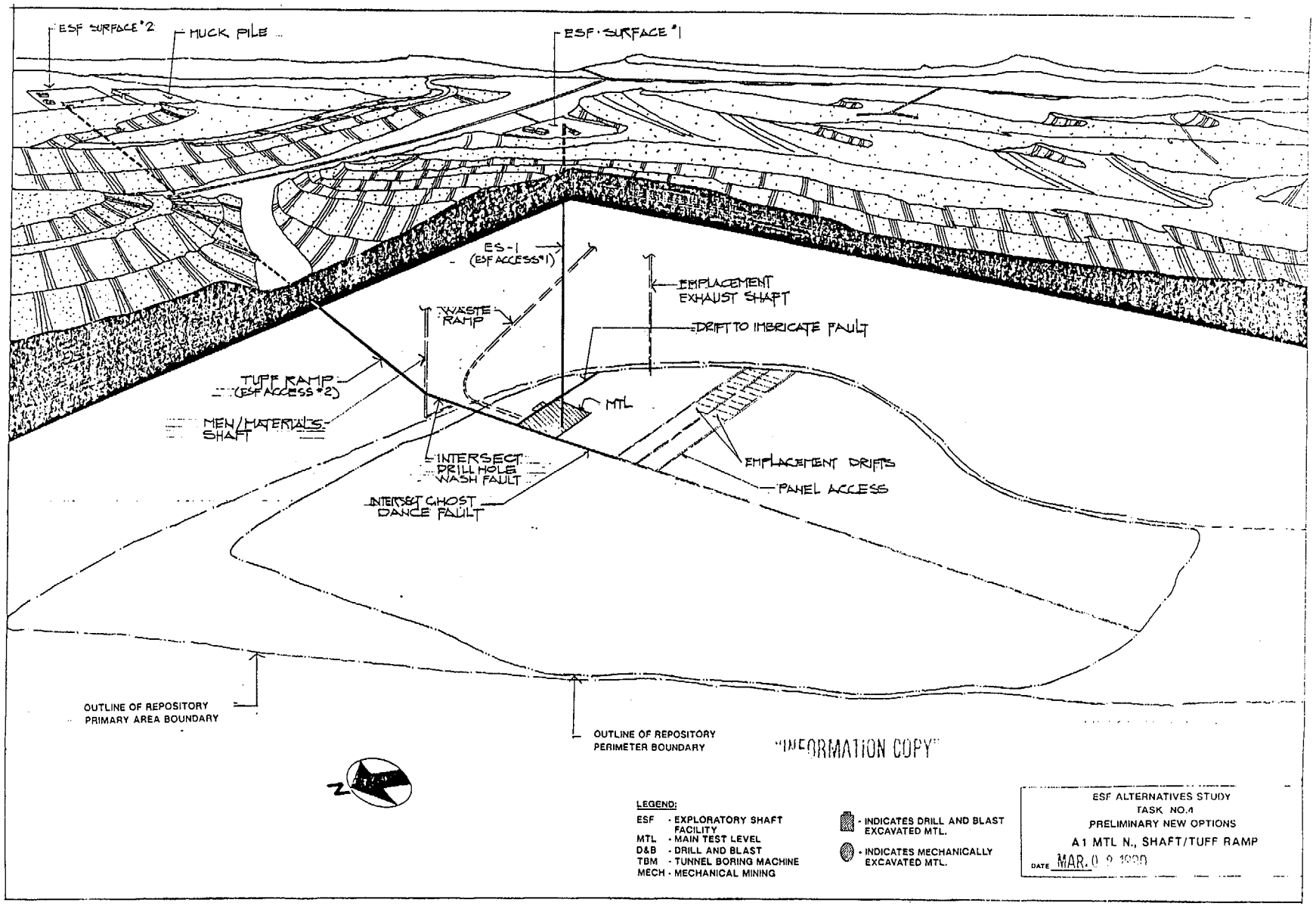
Name (Print)	Signature	Date

APPENDIX 4D

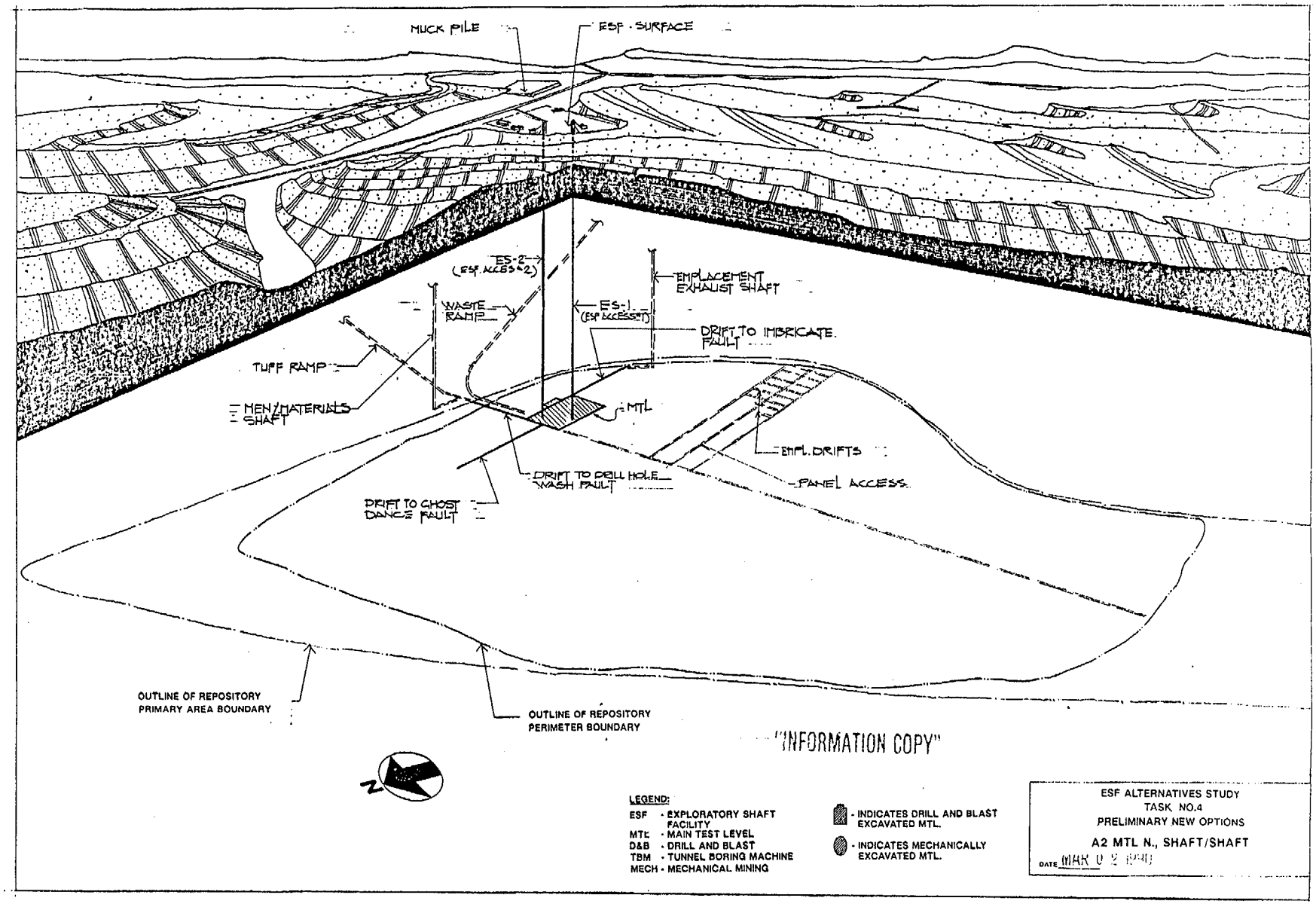
SKETCHES OF
INITIAL 17 OPTIONS



Option 1 (Base Case)


ESF SURFACE #2
MUCK PILE
ESF SURFACE #1
ES-1 (ESF ACCESS #1)
EMPLACEMENT EXHAUST SHAFT
WASTE RAMP
DRIFT TO IMBRICATE FAULT
TUFF RAMP (ESF ACCESS #2)
MTL
MEN/MATERIALS SHAFT
INTERSECT DRILL HOLE WASH FAULT
EMPLACEMENT DRIFTS
PANEL ACCESS
INTERSECT GHOST DANCE FAULT
OUTLINE OF REPOSITORY PRIMARY AREA BOUNDARY
OUTLINE OF REPOSITORY PERIMETER BOUNDARY
"INFORMATION COPY"
N
LEGEND:
ESF - EXPLORATORY SHAFT FACILITY
MTL - MAIN TEST LEVEL
D&B - DRILL AND BLAST
TBM - TUNNEL BORING MACHINE
MECH - MECHANICAL MINING
- INDICATES DRILL AND BLAST EXCAVATED MTL.
- INDICATES MECHANICALLY EXCAVATED MTL.
ESF ALTERNATIVES STUDY
TASK NO.1
PRELIMINARY NEW OPTIONS
A1 MTL N., SHAFT/TUFF RAMP
DATE MAR. 0 2 1990

Option 2 (A1)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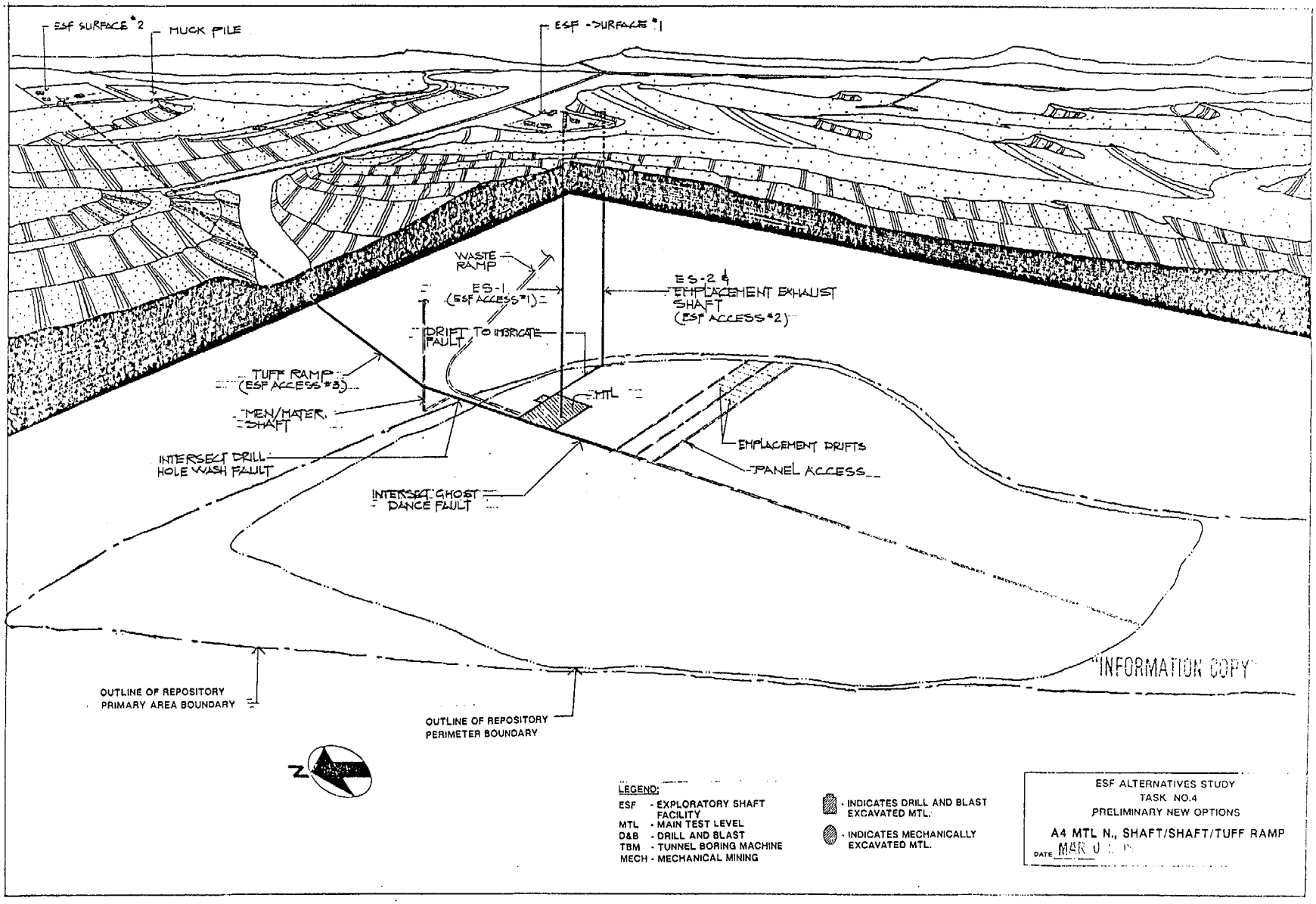
ESF - SURFACE
ES-2
(ESF ACCESS #2)
EMPLACEMENT EXHAUST SHAFT
WASTE RAMP
ES-1
(ESF ACCESS #1)
DRIFT TO IMBRICATE FAULT
TUFF RAMP
MEN/MATERIALS SHAFT
MTL
EMPL. DRIFTS
DRIFT TO DRILL HOLE WASH FAULT
PANEL ACCESS
DRIFT TO GHOST DANCE FAULT
OUTLINE OF REPOSITORY PRIMARY AREA BOUNDARY
OUTLINE OF REPOSITORY PERIMETER BOUNDARY
"INFORMATION COPY"
N
LEGEND:
ESF - EXPLORATORY SHAFT FACILITY
MTL - MAIN TEST LEVEL
D&B - DRILL AND BLAST
TBM - TUNNEL BORING MACHINE
MECH - MECHANICAL MINING
- INDICATES DRILL AND BLAST EXCAVATED MTL.
- INDICATES MECHANICALLY EXCAVATED MTL.
ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A2 MTL N., SHAFT/SHAFT
DATE MAR 0 2

Option 3 (A2)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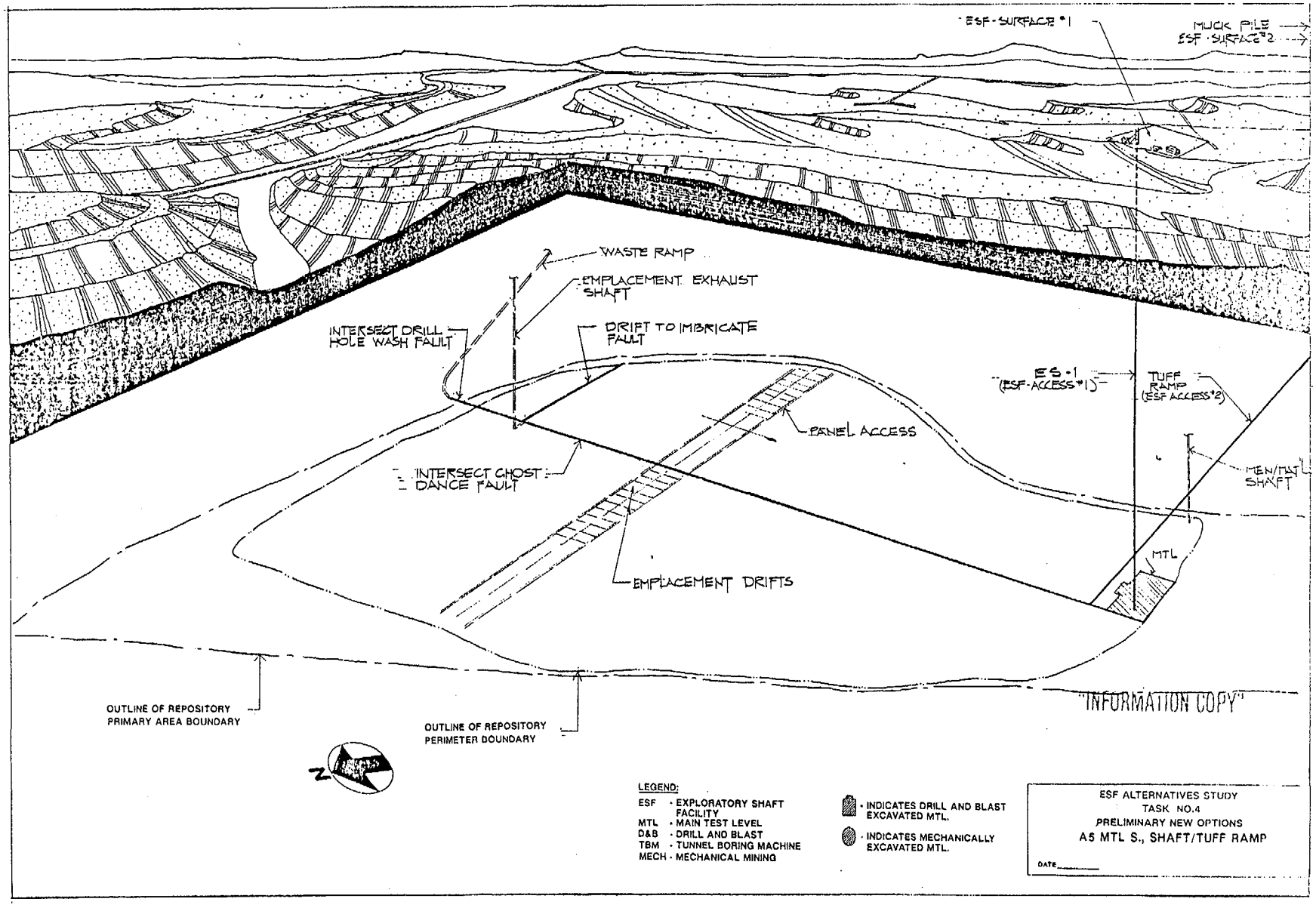
MUCK PILE
ESF SURFACE #1
WASTE RAMP
ES-1 (ESF ACCESS #1)
ES-2 & EMPLACEMENT EXHAUST SHAFT (ESF ACCESS #2)
DRIFT TO INTERCEPT FAULT
TUFF RAMP (ESF ACCESS #3)
MTL
MEN/MATER. SHAFT
EMPLACEMENT DRIFTS
INTERSECT DRILL HOLE WASH FAULT
PANEL ACCESS
INTERSECT GHOST DANCE FAULT
"INFORMATION COPY"
OUTLINE OF REPOSITORY PRIMARY AREA BOUNDARY
OUTLINE OF REPOSITORY PERIMETER BOUNDARY
N
LEGEND:
ESF - EXPLORATORY SHAFT FACILITY
MTL - MAIN TEST LEVEL
D&B - DRILL AND BLAST
TBM - TUNNEL BORING MACHINE
MECH - MECHANICAL MINING
- INDICATES DRILL AND BLAST EXCAVATED MTL.
- INDICATES MECHANICALLY EXCAVATED MTL.
ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A4 MTL N., SHAFT/SHAFT/TUFF RAMP
DATE MAR

Option 4 (A4)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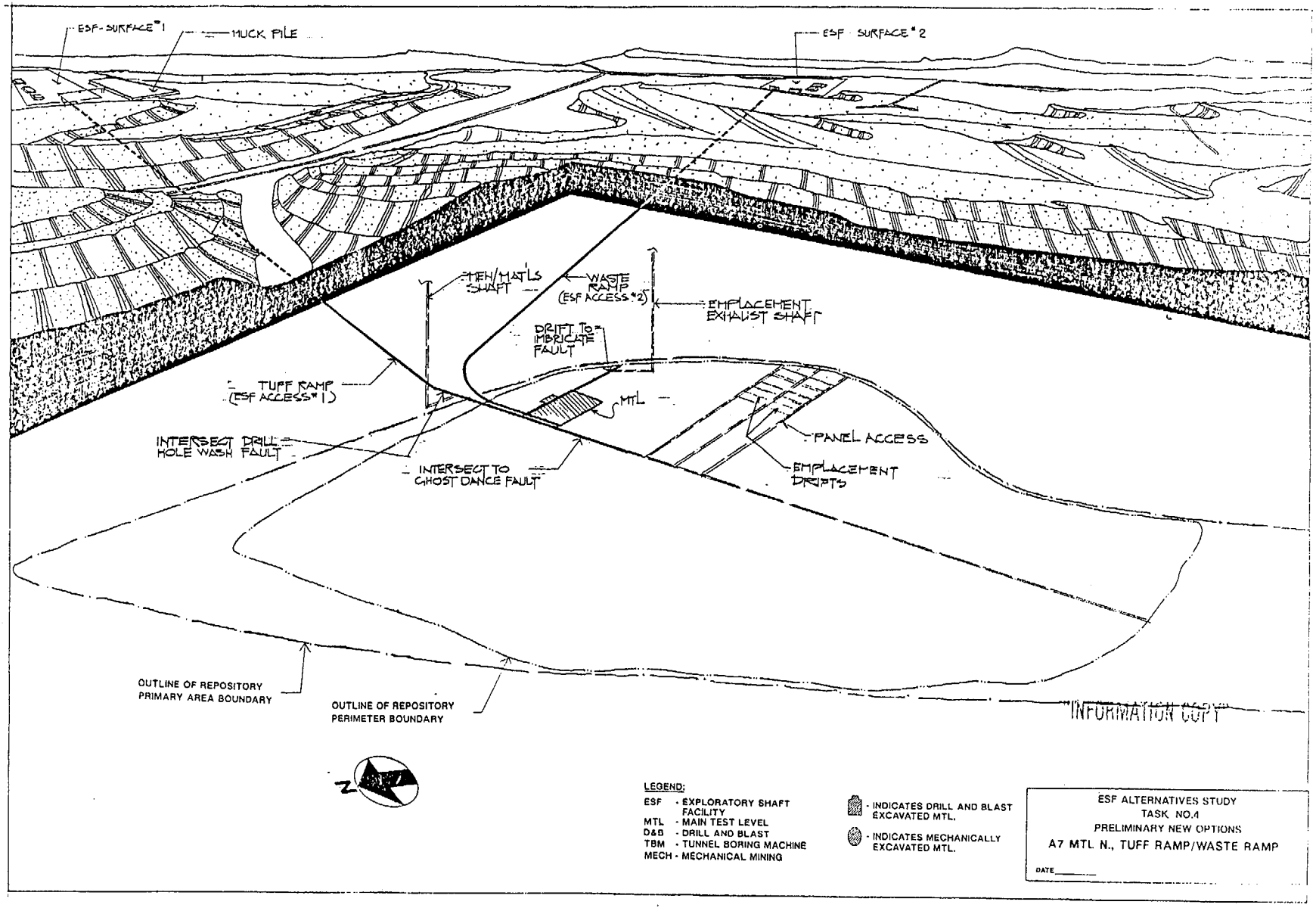
MUCK PILE
ESF-SURFACE #2
WASTE RAMP
EMPLACEMENT EXHAUST SHAFT
INTERSECT DRILL HOLE WASH FAULT
DRIFT TO IMBRICATE FAULT
ES-1 (ESF-ACCESS #1)
TUFF RAMP (ESF ACCESS #2)
PANEL ACCESS
INTERSECT GHOST DANCE FAULT
MEN/MAT SHAFT
MTL
EMPLACEMENT DRIFTS
OUTLINE OF REPOSITORY PRIMARY AREA BOUNDARY
OUTLINE OF REPOSITORY PERIMETER BOUNDARY
"INFORMATION COPY"
N
LEGEND:
ESF - EXPLORATORY SHAFT FACILITY
MTL - MAIN TEST LEVEL
D&B - DRILL AND BLAST
TBM - TUNNEL BORING MACHINE
MECH - MECHANICAL MINING
- INDICATES DRILL AND BLAST EXCAVATED MTL.
- INDICATES MECHANICALLY EXCAVATED MTL.
ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A5 MTL S., SHAFT/TUFF RAMP
DATE

Option 5 (A5)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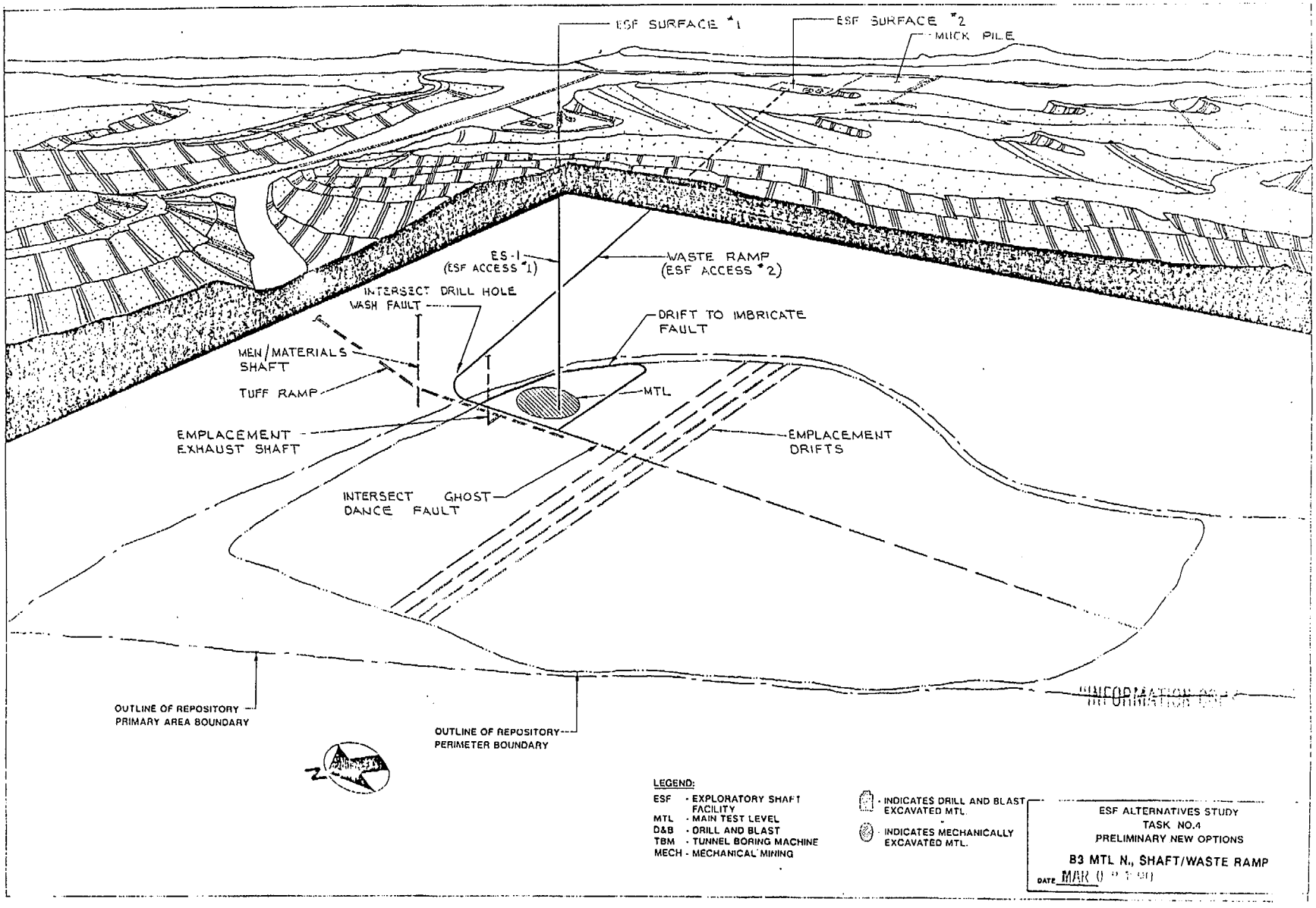
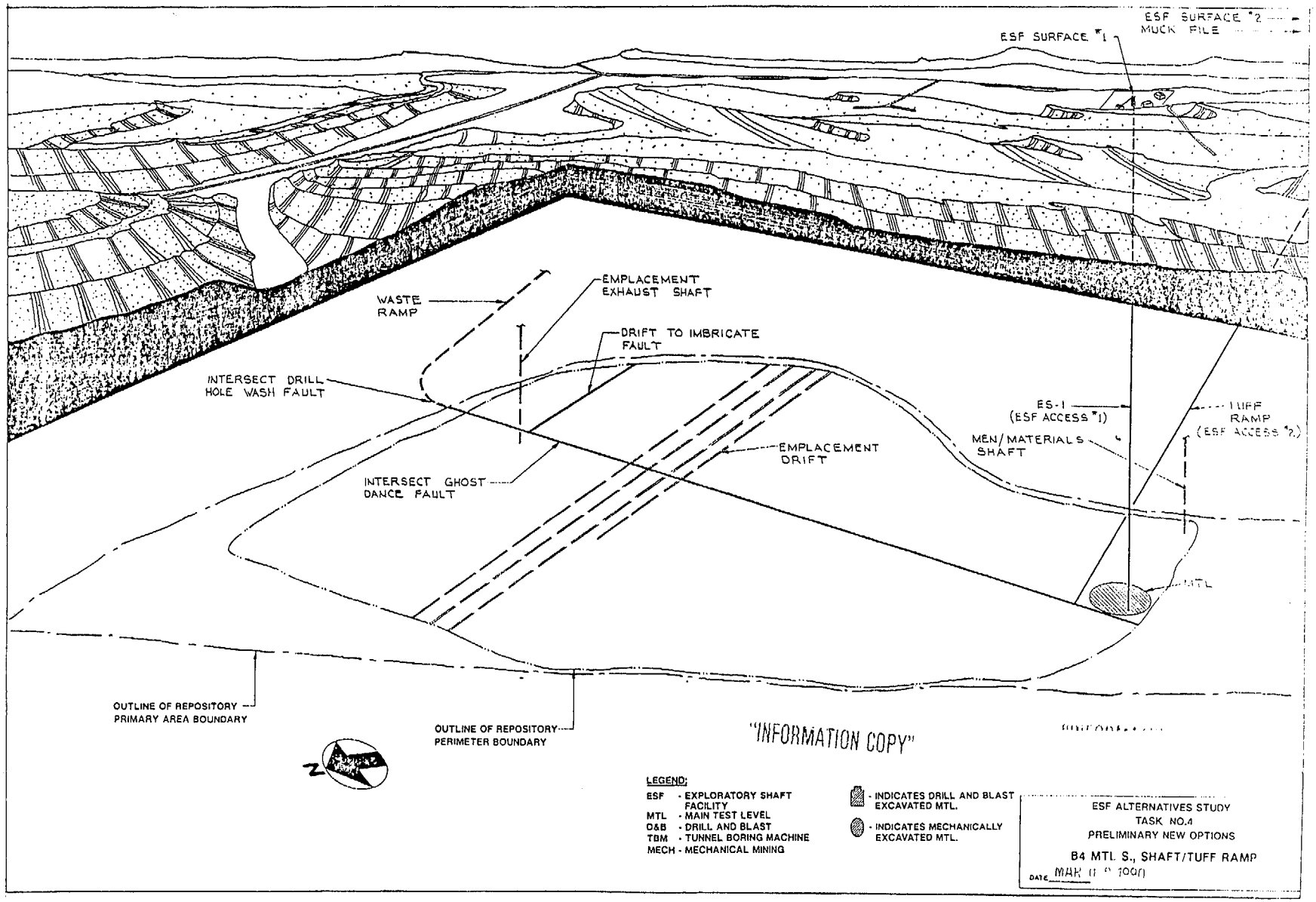
MUCK PILE
ESF SURFACE #2
MEN/MAT'LS SHAFT
WASTE RAMP (ESF ACCESS #2)
EMPLACEMENT EXHAUST SHAFT
DRIFT TO IMBRICATE FAULT
TUFF RAMP (ESF ACCESS #1)
MTL
INTERSECT DRILL HOLE WASH FAULT
INTERSECT TO GHOST DANCE FAULT
PANEL ACCESS
EMPLACEMENT DRIFTS
OUTLINE OF REPOSITORY PRIMARY AREA BOUNDARY
OUTLINE OF REPOSITORY PERIMETER BOUNDARY
INFORMATION COPY
N
LEGEND:
ESF - EXPLORATORY SHAFT FACILITY
MTL - MAIN TEST LEVEL
D&B - DRILL AND BLAST
TBM - TUNNEL BORING MACHINE
MECH - MECHANICAL MINING
- INDICATES DRILL AND BLAST EXCAVATED MTL.
- INDICATES MECHANICALLY EXCAVATED MTL.
ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
A7 MTL N., TUFF RAMP/WASTE RAMP
DATE

Option 6 (A7)



Option 7-11 (B3, Rev 2-6)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ESF SURFACE #1
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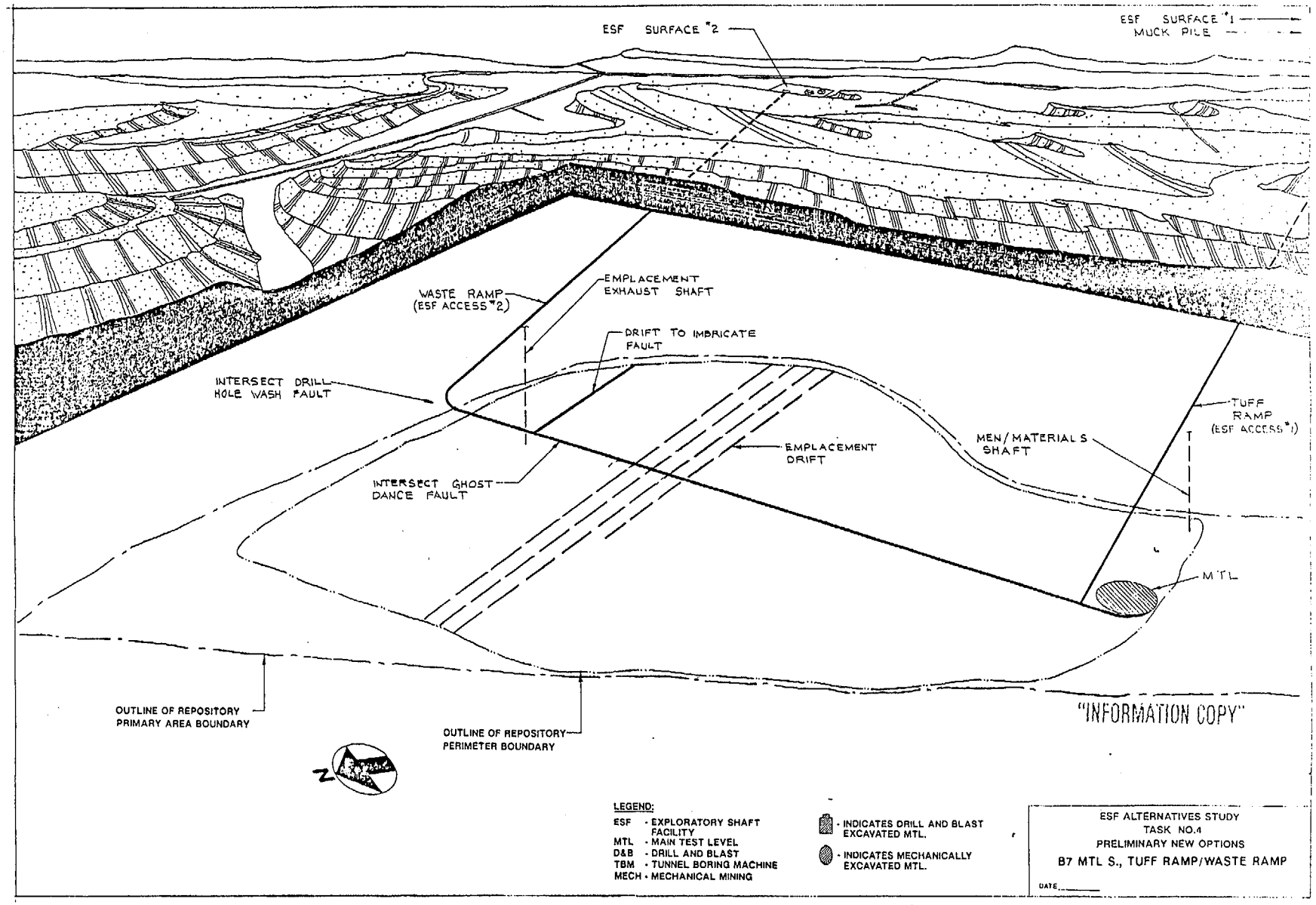
EMPLACEMENT EXHAUST SHAFT
DRIFT TO IMBRICATE FAULT
INTERSECT DRILL HOLE WASH FAULT
ES-1 (ESF ACCESS #1)
TUFF RAMP (ESF ACCESS #2)
MEN/MATERIALS SHAFT
EMPLACEMENT DRIFT
INTERSECT GHOST DANCE FAULT
MTL
OUTLINE OF REPOSITORY PRIMARY AREA BOUNDARY
OUTLINE OF REPOSITORY PERIMETER BOUNDARY
"INFORMATION COPY"
N
LEGEND:
ESF - EXPLORATORY SHAFT FACILITY
MTL - MAIN TEST LEVEL
D&B - DRILL AND BLAST
TBM - TUNNEL BORING MACHINE
MECH - MECHANICAL MINING
- INDICATES DRILL AND BLAST EXCAVATED MTL.
- INDICATES MECHANICALLY EXCAVATED MTL.
ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B4 MTL S., SHAFT/TUFF RAMP
DATE MAR

Option 12 (B4)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ESF SURFACE #1
MUCK PILE
WASTE RAMP
(ESF ACCESS #2)
EMPLACEMENT
EXHAUST SHAFT
DRIFT TO IMBRICATE
FAULT
INTERSECT DRILL
HOLE WASH FAULT
TUFF
RAMP
(ESF ACCESS #1)
MEN/MATERIALS
SHAFT
EMPLACEMENT
DRIFT
INTERSECT GHOST
DANCE FAULT
MTL
OUTLINE OF REPOSITORY
PRIMARY AREA BOUNDARY
OUTLINE OF REPOSITORY
PERIMETER BOUNDARY
"INFORMATION COPY"
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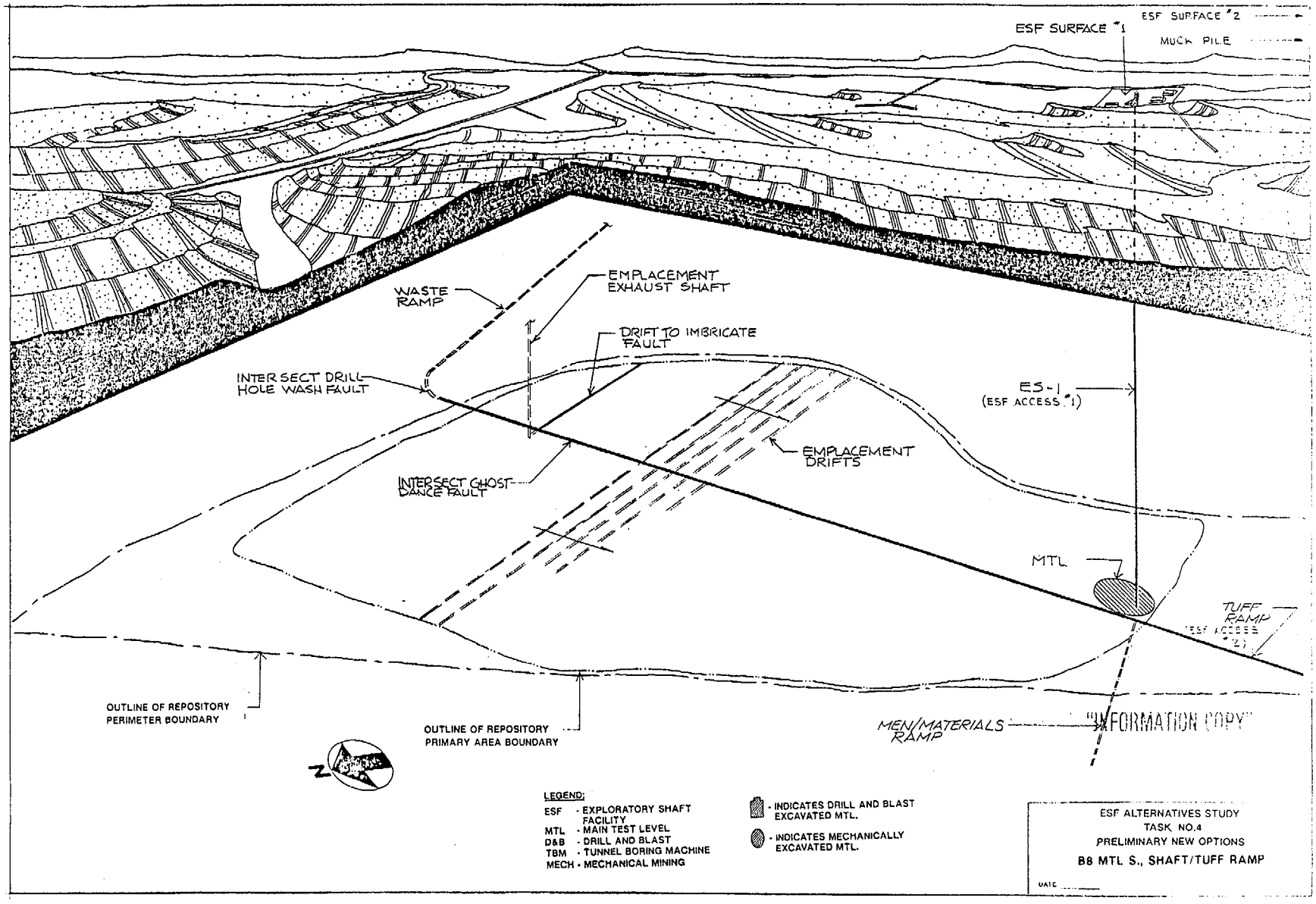
LEGEND:
ESF - EXPLORATORY SHAFT FACILITY
MTL - MAIN TEST LEVEL
D&B - DRILL AND BLAST
TBM - TUNNEL BORING MACHINE
MECH - MECHANICAL MINING
- INDICATES DRILL AND BLAST EXCAVATED MTL.
- INDICATES MECHANICALLY EXCAVATED MTL.
ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B7 MTL S., TUFF RAMP/WASTE RAMP
DATE

Option 13 (B7)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ESF SURFACE #1
MUCK PILE
WASTE RAMP
EMPLACEMENT EXHAUST SHAFT
DRIFT TO IMBRICATE FAULT
INTERSECT DRILL HOLE WASH FAULT
ES-1 (ESF ACCESS #1)
EMPLACEMENT DRIFTS
INTERSECT GHOST DANCE FAULT
MTL
TUFF RAMP (ESF ACCESS #2)
OUTLINE OF REPOSITORY PERIMETER BOUNDARY
OUTLINE OF REPOSITORY PRIMARY AREA BOUNDARY
MEN/MATERIALS RAMP
INFORMATION COPY
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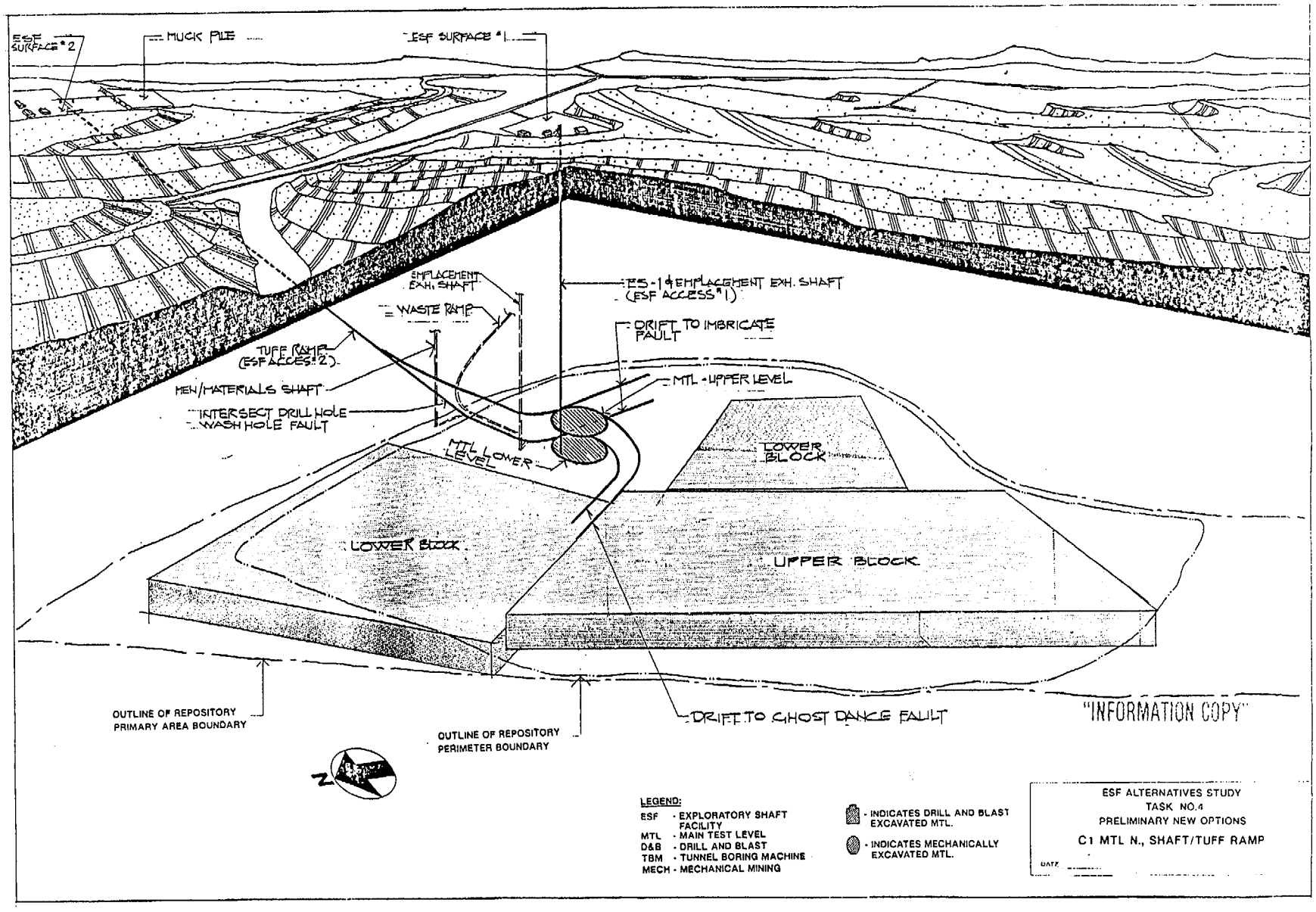
LEGEND:
ESF - EXPLORATORY SHAFT FACILITY
MTL - MAIN TEST LEVEL
D&B - DRILL AND BLAST
TBM - TUNNEL BORING MACHINE
MECH - MECHANICAL MINING
- INDICATES DRILL AND BLAST EXCAVATED MTL.
- INDICATES MECHANICALLY EXCAVATED MTL.
ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
B8 MTL S., SHAFT/TUFF RAMP
DATE

Option 14 (B8)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ESF SURFACE #1
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WASTE RAMP
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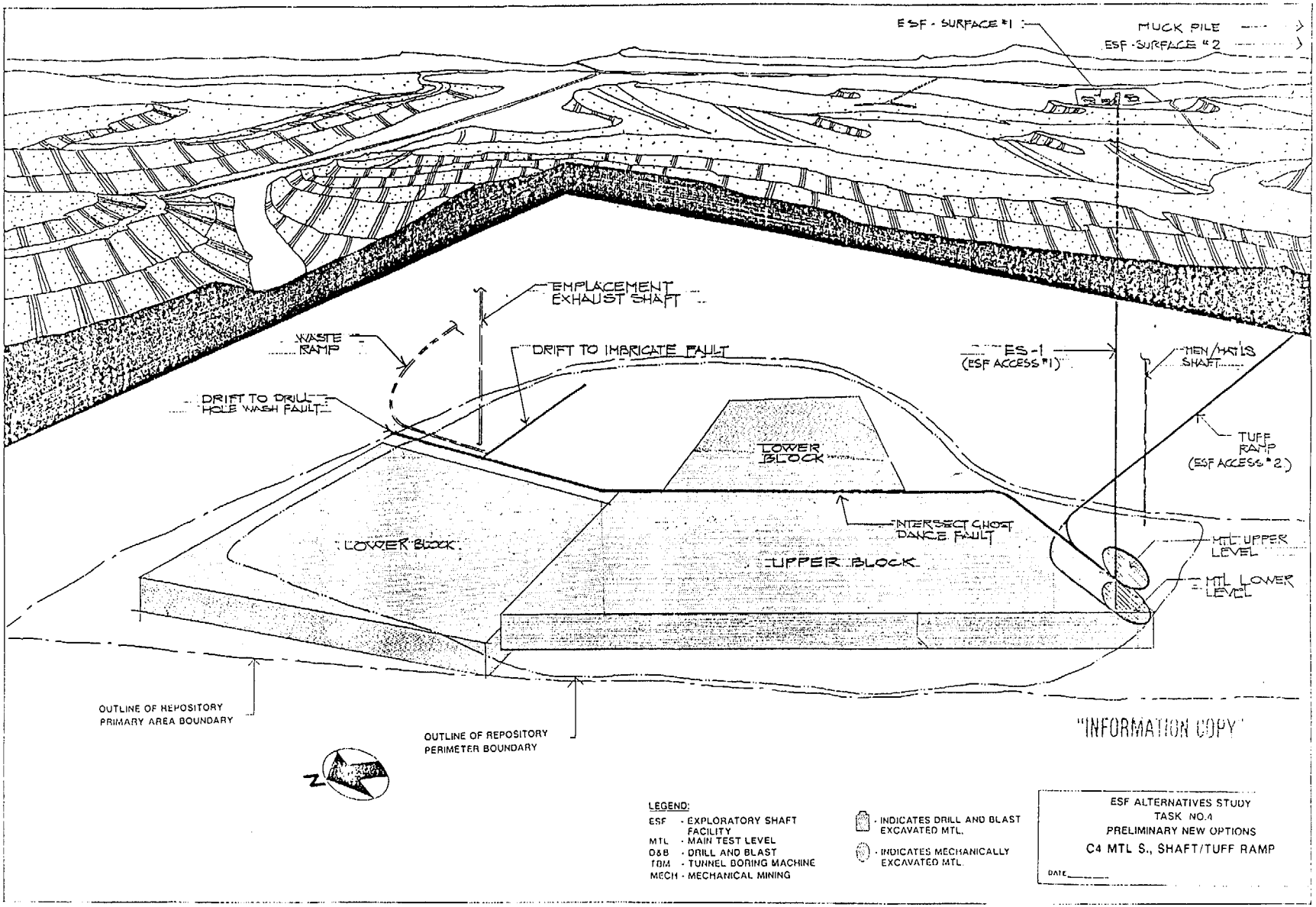
DRIFT TO IMBRICATE FAULT
TUFF RAMP (ESF ACCESS #2)
MEN/MATERIALS SHAFT
MTL - UPPER LEVEL
INTERSECT DRILL HOLE
WASH HOLE FAULT
MTL LOWER LEVEL
LOWER BLOCK
LOWER BLOCK
UPPER BLOCK
OUTLINE OF REPOSITORY PRIMARY AREA BOUNDARY
OUTLINE OF REPOSITORY PERIMETER BOUNDARY
DRIFT TO GHOST DANCE FAULT
"INFORMATION COPY"
N
LEGEND:
ESF - EXPLORATORY SHAFT FACILITY
MTL - MAIN TEST LEVEL
D&B - DRILL AND BLAST
TBM - TUNNEL BORING MACHINE
MECH - MECHANICAL MINING
- INDICATES DRILL AND BLAST EXCAVATED MTL.
- INDICATES MECHANICALLY EXCAVATED MTL.
ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
C1 MTL N., SHAFT/TUFF RAMP
DATE

Option 15 (C1)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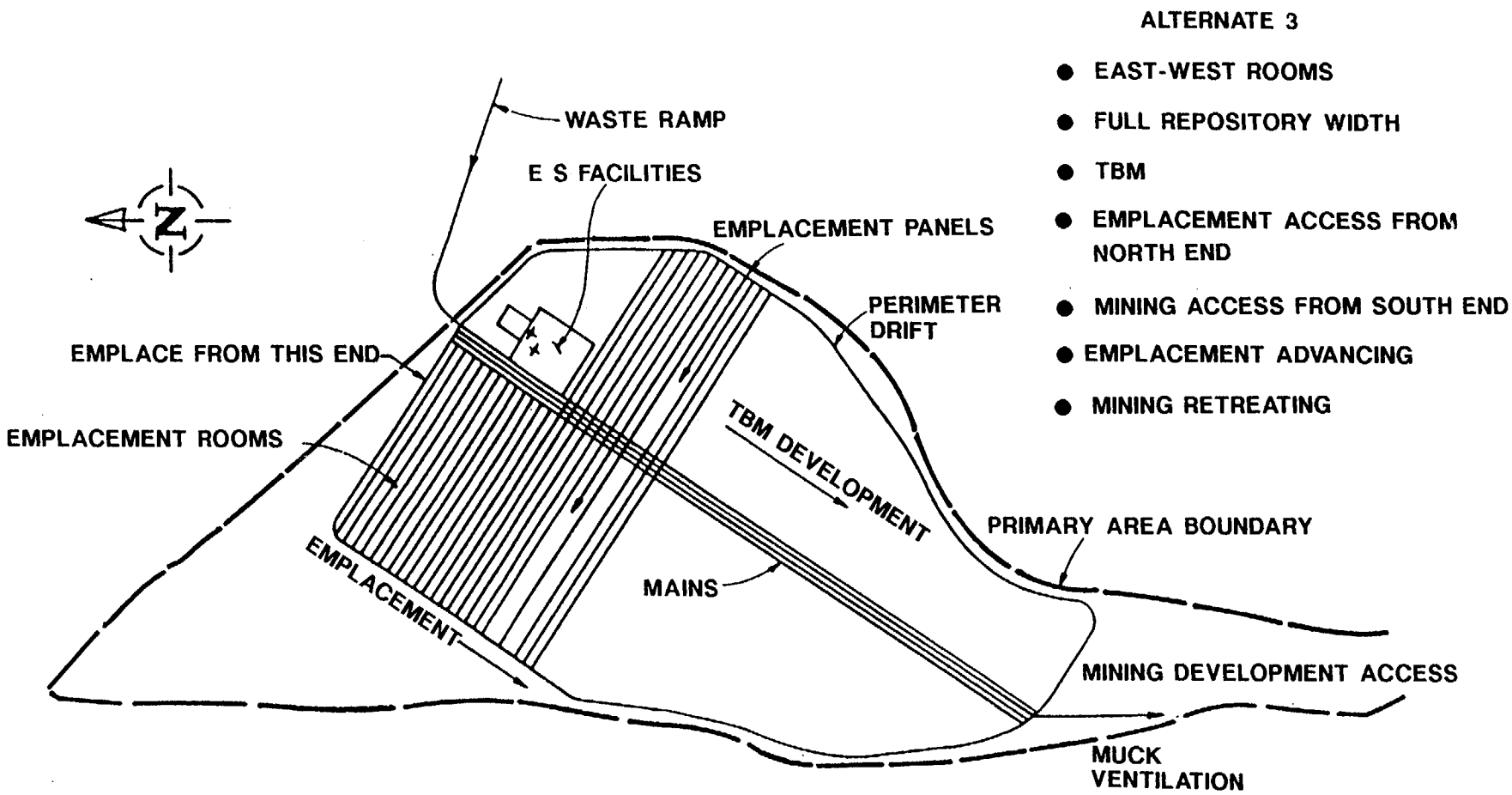
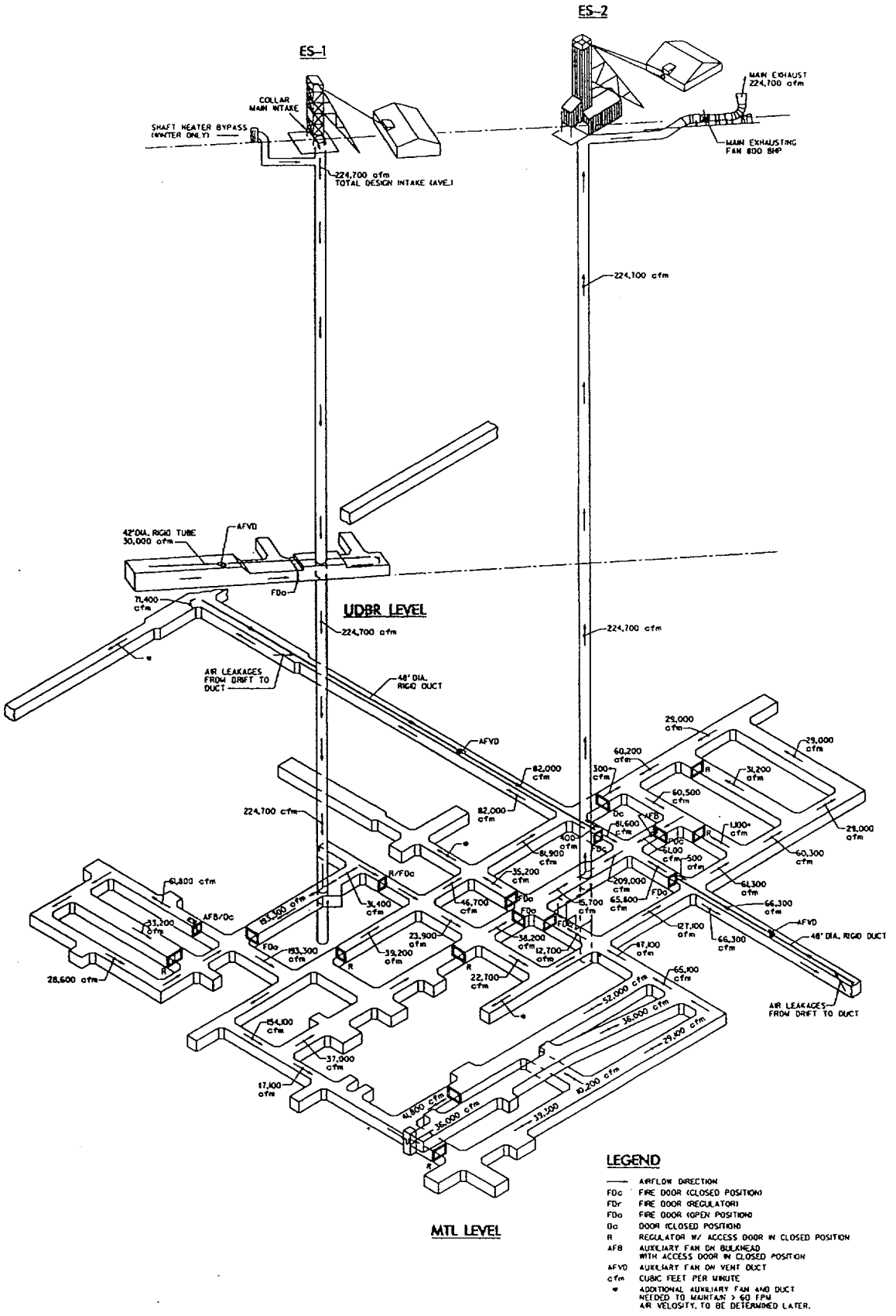
WASTE RAMP
DRIFT TO IMBRICATE FAULT
ES-1 (ESF ACCESS #1)
MEN/MATLS SHAFT
DRIFT TO DRILL HOLE WASH FAULT
LOWER BLOCK
TUFF RAMP (ESF ACCESS #2)
INTERSECT CHOST DANCE FAULT
LOWER BLOCK
UPPER BLOCK
MTL UPPER LEVEL
MTL LOWER LEVEL
OUTLINE OF REPOSITORY PRIMARY AREA BOUNDARY
OUTLINE OF REPOSITORY PERIMETER BOUNDARY
"INFORMATION COPY"
N
LEGEND:
ESF - EXPLORATORY SHAFT FACILITY
MTL - MAIN TEST LEVEL
D&B - DRILL AND BLAST
TBM - TUNNEL BORING MACHINE
MECH - MECHANICAL MINING
- INDICATES DRILL AND BLAST EXCAVATED MTL.
- INDICATES MECHANICALLY EXCAVATED MTL.
ESF ALTERNATIVES STUDY
TASK NO.4
PRELIMINARY NEW OPTIONS
C4 MTL S., SHAFT/TUFF RAMP
DATE

Option 16 (C4)



Option 17 (R11, page 1 of 2)



Option 17 (R11, page 2 of 2)

APPENDIX 5A

LIST OF DOCUMENTS AND RECORDS RELEVANT TO THE DEVELOPMENT OF THE 34 ESF-REPOSITORY OPTIONS

SUPPORTING DOCUMENTATION FOR SAND91-0025 - REFERENCES AND RECORDS PACKAGES, SECTION 5

Records Management System Number (RMS)	Title	Date	Source/ Org.	File Code
1. *017230	DIM-243 Rev. A	5/15/90	E.R. Gruer	60/12611/ DIM243/1.0/QA
2. *022646	Summary of the Aug. 8, 1990 Meeting of the Management Panel for the Exploratory Shaft Facility (ESF) Alternatives Study	8/15/90	L.S. Costin	60/12611/ DIM252/1.2/QA
3. *018829	Interface Control Input from Calico Hills Risk/ Benefit Analysis (CHRBA) to the Exploratory Shaft Facility (ESF) Alternatives Study	6/30/90	J.H. Nelson/ SAIC, A.L. Stevens	65/12611/ ITM010/1.1/QA
LIST OF DATA PACKAGES DEVELOPED FOR THE ESF-AS				
4. *016190	ESF Alternatives Study Task 4 Deliverable for Options Screening, DIM-243 Items I & II	3/9/90	E.R. Gruer	60/12611/ DIM243/1.4/QA
5. *016999	ESF Alternatives Study Task 4 Deliverable for Options Screening, DIM-243 Item III	5/2/90	E.R. Gruer	60/12611/ DIM243/1.4/QA
6. *017115	ESF Alternatives Study Task 4 Deliverable for Options Scoring, DIM-243 Item III Part 2	5/9/90	E.R. Gruer	60/12611/ DIM243/1.4/QA
7. *017319	Exploratory Shaft Facility Alternatives Study Testing Input Package Test 4 Deliverable	5/14/90	R.E. Finley	60/12611/ DIM243/1.3/QA

SUPPORTING DOCUMENTATION FOR SAND91-0025 - REFERENCES AND RECORDS PACKAGES, SECTION 5 (cont.)

Records Management System Number (RMS)	Title	Date	Source/ Org.	File Code
8. *0188849	Transmittal of Revised Section (Calico Hills) Exploratory Shaft Facility Alternatives Study Testing Input Package, Task 4 Deliverable	7/20/90	A. Kalia/ LANL, R.E. Finley	60/12611/ DIM243/1.4/QA
9. *026437	ESF-AS Task 4 Revised Deliverable Three (Final Data Package)	3/12/91	E.R. Gruer	60/12611/ DIM243/1.4/NQ

GUIDANCE FOR DEVELOPMENT OF SUPPORTING INFORMATION FOR OPTIONS

The guidance for developing the ESF-AS options can be found in the following record:

10. *025483	Call for Review of the ESF-AS Task-4 Revised Deliverable III	12/7/90	A.L. Stevens	60/12611/ DIM243/1.3/QA

APPENDIX 5B

INFORMATION SUPPORTING COST AND SCHEDULE

1. Description of cost and schedule information for ESF including cost and schedule assumptions.

2. Description of cost and schedule information for repository including cost and schedule assumptions.

3. Description of ESF-repository cash flow projections development.

January 25, 1991

Cost and Schedule Input to Sandia Alternative Studies Final Report.

ESF Cost and Schedule

The cost estimating and scheduling efforts of this report are of a caliber categorized by DOE as a "Planning Estimate." Further details about this type of estimate and its approved range of contingency allowances are provided by DOE in the "Cost Guide" DOE/MA-0063, Vol. 6 titled "Cost Estimating Methods and Techniques."

Cost

In general there was a concerted effort to apply cost data consistently from option to option, i.e., the cost of a ramp portal is the same for all ramps. Uncertainty adjustments have been made via the application of the "contingency allowance" as prescribed by DOE guidelines. Calculations were carried out with personal computers using custom spread sheets and Microsoft Excel.

Assumptions

Principal assumptions germane to all ESF options evaluated presume REECo to be the prime constructor and operator, equipment and material procurement will be done by REECo, REECo ESF cost adders are applicable, Nevada Test Site (NTS) union labor rates apply and constant dollars were adequate.

Development of Data

Costs were developed from the "bottoms up" on a lump sum or unit cost per foot basis for typical generic situations and reflected labor, materials and equipment components. Current pricing was used for all major equipment items, i.e., TBM's, roadheaders,

mobile miners, etc. This cost data was then applied to specific options with each option having about twenty (20) line item cost calculations, which include a contingency factor, to arrive at option specific "Total ESF Project Cost." Cash flow projections were then prepared based upon the option specific construction schedule time elements.

Testing costs for entries and the TS level were already calculated for the 1992 Work Authorization Schedule (WAS) based upon Appendix C of the SDRD and represent drilling cost for 35 tests. These costs were applied to all options as appropriate.

Operation and Support costs were extracted from 1992 WAS/ESF five (5) year projections as developed for the WAS Base Case. Further projections were then made to the year 2005, the end of the construction schedule. Adjustments were made to all other options by adding or subtracting peak operations and support costs, of about $34,000,000 per year, as the specific schedules varied from the Base Case.

Cashflow Projections

Expenditure projections were prepared by distributing the gross estimated cost in proportion to their corresponding activities as represented on a specific options construction bar chart schedule. The cost of major capital purchases such as transformers, TBM's, mobile miners and roadheaders were adjusted forward to the start of a given activity to allow for early commitment.

Schedule

A collective effort was made to apply productivity rates consistently from option to option, i.e., a tunnel bored ramp advances at 55 feet per day, a roadheader excavated drift at 24 feet per day etc. Contingency adjustments were not applied to construction activities. Scheduling was conducted on personal computers using Primavera Systems "Finest Hour" Project Management and Control Software.

Assumptions

Principal assumptions relevant to all ESF options evaluated presume REECo to be the prime constructor and operator and all raise boring will be subcontracted to a independent company. Surface construction is scheduled on a five (5) day week and all underground work is scheduled based on a seven (7) day week. All schedules commence "Design" March 1, 1991.

Development of Data

Schedules were developed from the "bottoms up" based upon engineering sketches and quantities; testing durations were supplied by LANL. Excavation and performance rates are based on engineering calculations, manufacturer's quotes or published articles and have been reviewed and accepted by the "Expert Panel on Cost & Schedule." A typical schedule contains 20 to 30 topics from "Design" thru "NRC Review," represents construction logic required by the specific mining equipment used and includes construction of both the Topopah Spring level and the Calico Hills level.

TASK 4
ESF ALTERNATIVE STUDIES

General statement of conditions:

This cost schedule effort is categorized as a "planning" document as defined by DOE/MA-0063 Vol. 6 Cost Guide May 1982. The applicable contingency for this category in general construction projects is 25% to 35%. In addition, 10% to 25% would be added for a technology development contingency associated with a pilot plant supported concept which most closely parallels this project. The total contingency could then be stated as 35% to 60%. This contingency if applied, is of sufficient size to obviate any of the apparent inconsistencies which might be observed in certain calculated values.

PART I - CONSTRUCTION SCHEDULING ASSUMPTIONS

1. Schedules assume a "Fast Track," phased design approach will be used.

2. Schedules for all options are "Success Oriented."

3. Schedules are based on the assumption that procurement will not constrain construction activities.

4. Underground development is allowed to proceed with a single access, prior to completion of a required second access.

5. Ventilation and muck removal constraints were considered in scheduling underground development.

6. Construction to be performed by REECo, except for raise boring which is subcontracted.

7. Construction management to be performed by REECo.

8. WORKWEEK:

- Design & surface construction - 5 days/week
- All work below ground-7 days/week
- Holidays = 10 days/year plus an adjustment for Christmas and New Years.

9. FIXED DATES/DURATIONS - ALL OPTIONS:

- Start of Design - 03/91
- Start of Site Preparation - 06/92
- Start of First Access/Early Testing - 06/93
- MTL Testing Period - 5 years
- NRC Review Period - 3 years
- REPOSITORY LIFE CYCLE:
  - Construction Phase
    1. Design: LAD = 30 months
       FPCD = 42 months
    2. Physical Construction = 5 years
  - Emplacement = 25 years
  - Caretaking = 25 years
  - Retrieval
    = 9 years for Design and Construction plus
    35 years for Retrieval
  - Closure and Decommissioning without Retrieval
    = Varies from 131 to 238 months
  - Closure and Decommissioning with Retrieval
    = 7-1/2 years

10. DESIGN:

- ESF DESIGN
  - Duration for Single Site (Based on WAS) = 480 days
  - Duration for Multiple Sites = 518 days
- CH LEVEL DESIGN
  - Duration = 155 days

11. SITE PREPARATION:

- Activity includes site preparation, buildings, utilities and roads
- Duration for single site = 249 days
- Duration for multiple sites:
  = 249 days each (Except Group "B" Options)
  = 281 days each (All Group "B" Options)
- Start of construction for multiple sites was staggered by 6 weeks.

12. ACCESS CONSTRUCTION:

- SHAFT:
  - Constructed to final depth prior to start of exploratory drifting
  - Construction duration includes time allowances* for the following non-current activities:
    - Surface Plant/Hoist Set-Up = 39 days
    - Collar Construction = 80 days
    - Shaft Excavation - Based on Advance Rate in Item 13
    - Shaft Internals = 70 days
    - Shaft Utilities = 100 days
    - Testing Activities (See Item 14)

    *Note: Time allowances may vary slightly from Option to Option.

- RAMP:
  - Conveyor and utilities installed concurrently with TBM excavation.
  - Construction duration includes time allowances for the following activities:
    - Surface Plant/Portal Construction = 118 days
    - Testing Activities (See Item 14)
    - Ramp Excavation - Based on Advance Rate in Item 13

13. EXCAVATION ADVANCE RATES:

- SHAFTS (Includes Lining except for Blind Drill)
  - D&B (Drill and blast): 12' DIA = 8.2 FT/DAY

	16' DIA = 8.4 FT/DAY
- SBM:	16' DIA = 40 FT/DAY
- V-MOLE:	16' DIA = 21 FT/DAY
- RAISE BORE:	16' DIA = 14 FT/DAY
- BLIND DRILL:	16' DIA = 16 FT/DAY

- RAMPS (Not lined, but includes wire mesh and bolts plus invert)

- TBM:	= 55 FT/DAY
- ROADHEADER:	= 24 FT/DAY

- DRIFTS

- D&B:	9' DAY/HEADING (Finished)
- TBM:	55' DAY/HEADING (Finished)
- ROADHEADER (CH):	24' DAY/HEADING (Finished)
- MOBILE MINER:	14' DAY/HEADING (Finished)

14. TESTING:

Access testing durations vary slightly (few days) option to option.

- ACCESS-SCENARIO 1 OPTIONS
  - SHAFT, Full Test Program:
    - 512 days from surface to MTL
    - 409 days from surface to MTL (SBM & V-Mole)
    - 184-189 days from MTL to Calico Hills
  - SHAFT, Minimal Test Program:
    - 32 days (mapping) surface to Calico Hills
  - RAMP, Full Test Program:
    - 497 days from surface to MTL. Documented guidance from TMO provided for 400 days in full tested ramp. Based on discussions between RSN and TMO, due to uncertainties associated with testing in TBM accesses, it was decided to use 497 days for testing in ramps for the purposes of these schedules only. (This difference includes construction support for vertical seismic profiling and long radial borehole tests - 97 days)
    - 172 days + 1 day per week of construction from MTL to Calico Hills
  - RAMP, Minimal Test Program:
    - Not applicable in Scenario 1

- ACCESS-SCENARIO 2 OPTIONS
  - SHAFT, Critical Test Program:
    - 200 days surface to MTL
    - 81-88 days MTL to Calico Hills
  - SHAFT, Minimal Test Program:
    - 32 days surface to Calico Hills (mapping)
  - RAMP, Critical Test Program:
    - 168 days + 1 day per week of construction to MTL
    - 69 days + 1 day per week of construction MTL to Calico Hills
  - RAMP, Minimal Testing Program:
    - 1 day per week of construction from surface to MTL
    - 1 day per week of ramp construction MTL to CH
- EXPLORATORY DRIFTING (CH&TS):
  - Advance rates are not impacted by testing.
- MTL AND DEFERRED ACCESS TESTING
  - 5 years except C Options
  - C Options = 5 years per MTL Level (Mainly concurrent)
  - Notes:
    a) Five years test period begins a minimum of 2 months after start of MTL test drilling.
    b) MTL test drilling begins a minimum of 6 months after start of MTL excavation.
    c) Beginning of 5 year test period does not occur without 2 methods of egress available.
- CALICO HILLS (TESTING):
  The duration of the testing was assumed to be not more than 5 years and never exceed the end of the 5 year MTL test period. Assumed uniform 120 day lag from start of CH exploratory drifting to start of CH testing.
- Definition of <u>Early Testing</u> is found in Table 1 of Stevens' guidelines, September 19, 1990.
- Definition of <u>Early Drifting</u> is that excavation needed to meet the requirements of early testing for the level which is not the primary target level.
- Reaching a target fault - No delay reflected in schedule.
- Crossing faults - No delay reflected in schedule.
- Perched Water Testing - No delay reflected in schedule.

PART II - BASIS FOR ESF COST ESTIMATES

METHODOLOGY:

1. Generic cases were developed which included estimated values for key components such as labor, equipment and consumables.

2. Generic cases were then factored and applied to specific options and engineers' data.

3. Specific activity costs estimated were as follows:

   a. Engineering Cost: Based on WAS '92 data as a lump sum.
   b. Site Cost: Estimated for one and two sites by RSN as a lump sum.
   c. Shaft Cost: Six generic cases were estimated and applied to specific options on a per foot basis.
   d. Ramp Portal and TBM: Estimated on a lump sum basis.
   e. Ramp Cost: Estimated and applied to specific options on a per foot basis.
   f. Testing Cost: Based on '92 WAS information and applied on a specific lump sum basis to 12' shafts, 16' shafts, ramps and the MTL.
   g. MTL Cost: Estimated for D&B and mobile miner (MM) excavation, then applied to specific options on a per foot basis.
   h. Exploration Cost: Calculated for TBM, MM and roadheader, then applied to specific options on a per foot basis.
   i. Construction Support: Taken from SAIC WAS '92 data through FY '96; from FY '97 on estimates were made based on WAS figures.
   j. REECo Operations: The same as above.
   k. Incremental Operation and Support Cost: Provided for at the rate of $34,800,000 per year. See the "Cost Estimating Flow Chart" attached.

ASSUMPTIONS:

1. REECo will be the primary constructor.
2. Equipment and material procurement, by REECo. (Adders included freight and handling, S.T., G&A).
3. Labor Rates: NTS union rates with REECo cost adders.

4. Work Shifts: As per schedule data.
5. Holidays: As per schedule data.
6. Subcontracted work: Raise bore only. Note: No TBM subcontracted.
7. Contingency: QA = 15%, construction uncertainties = 15%-45% based on professional judgment of equipment applications, ground conditions and known omissions.
8. Success Oriented Project: No labor problems
   No material supply problems
   No scope changes.
9. Design Costs: All - Above.
10. Operating Contractor will be REECo.
11. Operating Costs: Include energy, water supply, site maintenance and operation. See above.
12. Schedule - Duration of Activities: In general based on engineered quantities divided by performance rate. See attached "Schedule Data."
13. Constant dollars.
14. Raise boring work will be subcontracted.
15. It is presumed the blind shaft drill can be "loaned" from the NTS weapons program.

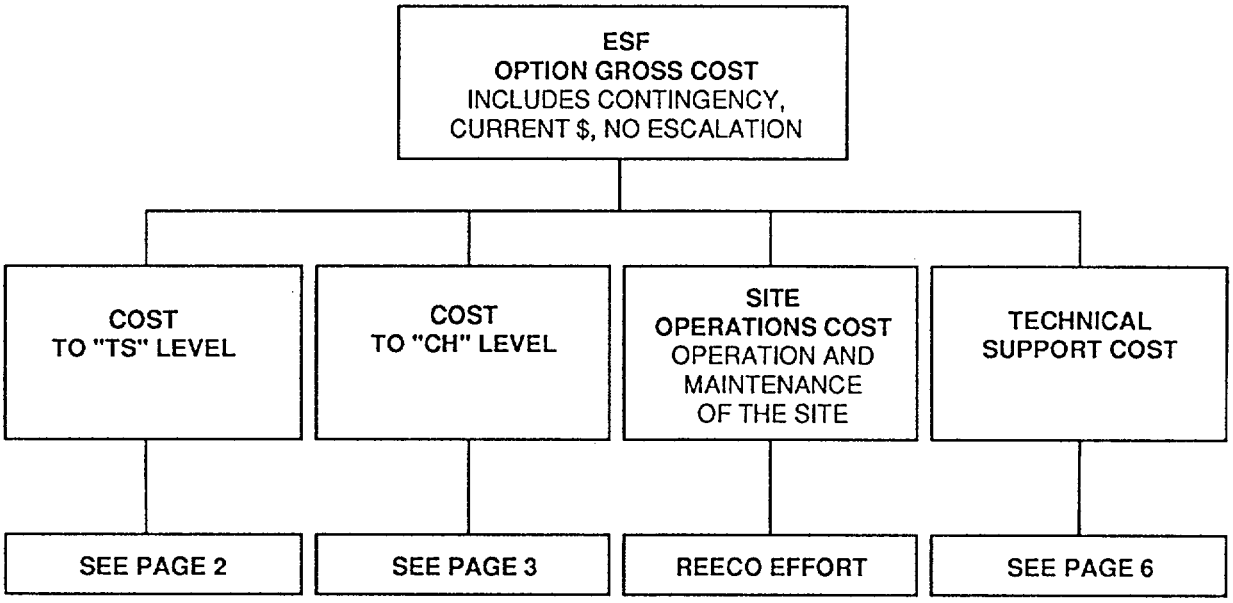
MISCELLANEOUS ITEMS:

1. Costs have been assembled by WBS accounts as per the attached "WBS Cross Reference."

ITEMS NOT INCLUDED:

1. Testers: (PIs) LANL, SNL, USES, etc.
2. DOE adders.
3. Escalation.

TASK #4 ALTERNATIVE STUDIES
COST ESTIMATING FLOW CHART



PAGE 1

COST TO TS LEVEL
CONSTRUCTION & TESTING

COST TO "TS"
EXPENDITURE TO REACH THE MTL

- **DESIGN**
  A/E COST TO DESIGN
  ESF AND TEST FACILITY
- **SITE**
  BUILDINGS, POWER, WATER, AND
  ROADS, ETC.
- **ACCESS**
  SHAFT/RAMP COLLAR, DR.
  ADVANTAGES, UTILITIES, ETC.
- **MTL AT TS**
  DRIFT/FACILITY EXCAVATION AND
  UTILITIES, SEE PAGE 4
- **TS EXPLORATION**
  ALL EXCAVATION TO FAULTS WITH
  UTILITIES
- **ACCESS TESTING**
  RBT, EET, SCT, MAPPING,
  SAMPLING, ETC.
- **MTL TESTING**
  SEQ.DR., DBR, ENGINEERED
  BARRIER, INTACT. FRACTURE, ETC.

COST TO CH LEVEL
CONSTRUCTION & TESTING

COST TO "CH"
EXPENDITURE TO REACH THE CALICO HILLS

- **DESIGN**
  A/E COST TO DESIGN CH AND TEST FACILITY
- **ACCESS**
  SHAFT/RAMP COLLAR, DR. ADVANTAGES, UTILITIES, ETC.
- **CH EXPLORATION**
  ALL EXCAVATION TO FAULTS WITH UTILITIES
- **ACCESS TESTING**
  RBT, EET, SCT, MAPPING, SAMPLING, ETC.
- **CH TESTING**
  SAMPLING, INTACT. FRACTURE, DIFFUSION, ETC.

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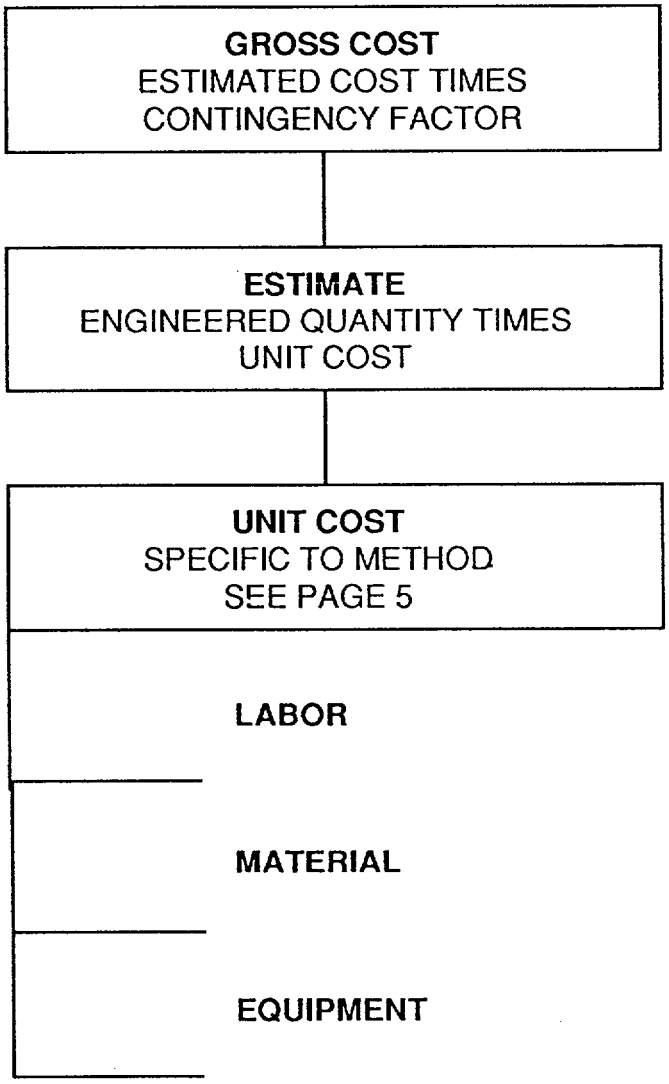
MTL AT TS
COSTING METHODOLOGY



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UNIT COST
TYPICAL EXAMPLE

MTL
UNIT COST
MINING METHODS ARE
D & B AND MOBILE MINER

LABOR

$/HOUR X TIME X ADDERS
$/HOUR = NTS UNION WAGES

- **$/HOUR**
  RANGE FROM $19.00 TO $29.00/HOUR
- **TIME**
  ENG. QUANTITY/RATE + ALLOW
  9, 55, 14, 24 FFT/DAY
- **ADDERS**
  GEN. AND ADMIN. AT 13%
  LABOR LOAD AT 65%

MATERIAL

UNIT $ X QUANTITY X ADDERS
EQUIPMENT, CONCRETE, ETC.

- **UNIT COST**
  $/FT. OR CAPITAL EQUIPMENT COST BASED ON QUOTES
- **QUANTITY**
  BASED ON DRAWINGS, SKETCHES OR EXPERIENCE
- **ADDERS**
  GEN. AND ADMIN. AT 13%, ST. AND FT. AT 11%, AND HANDLING AT 11%

EQUIPMENT

RENTAL RATE X TIME X ADDER

- **RENTAL RATE**
  BASED ON RENTAL RATE BOOK OR REECO ACCT. BOOK
- **TIME**
  QUANTITY/RATE OF WORK
  MEANS PUBLISHED DATA
- **ADDER**
  GEN. AND ADMIN. AT 13%

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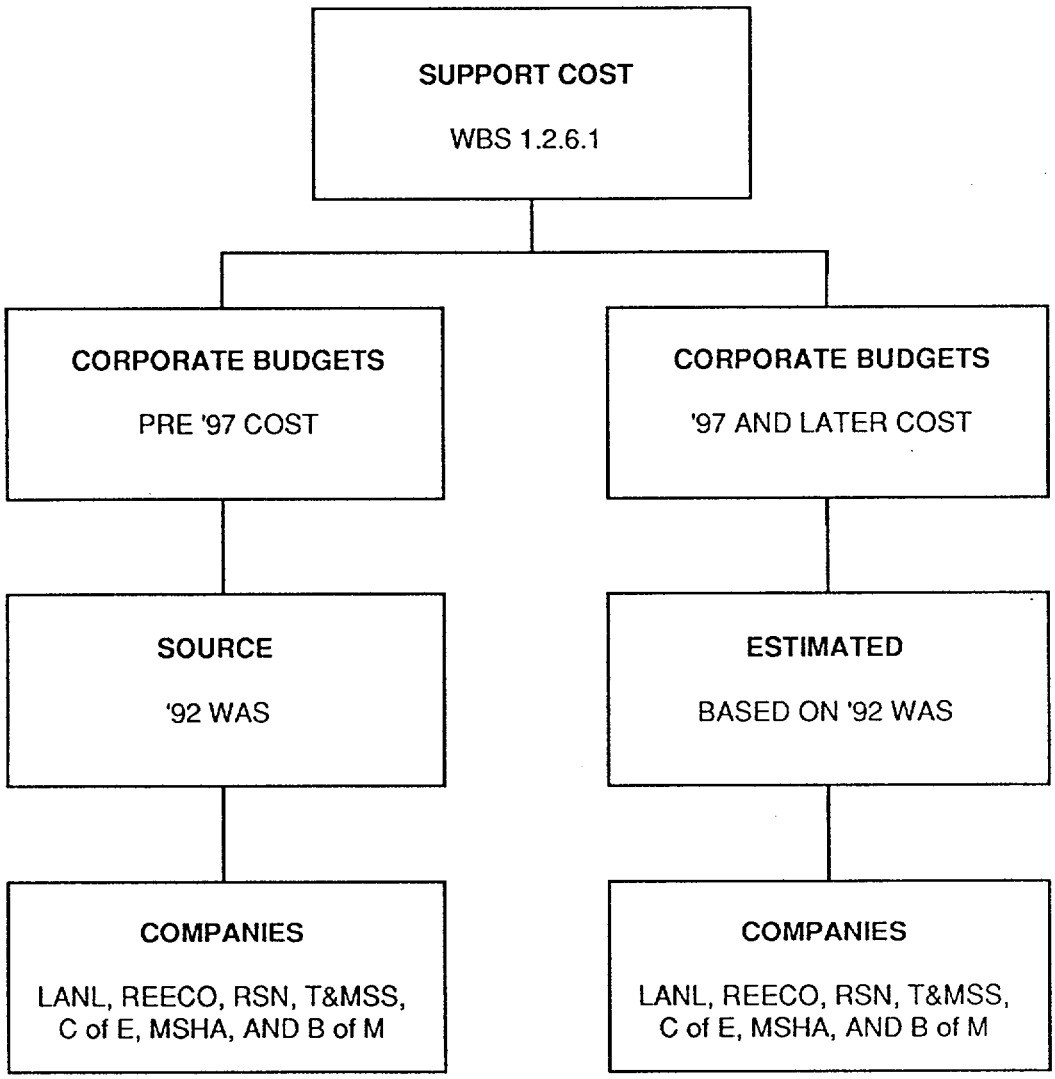
TECHNICAL SUPPORT
LABS & A/E's



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Repository Cost Estimates

General Estimating Assumptions

The repository surface and subsurface engineering and construction costs for the 34 repository options are based on estimates prepared by BNI and PBQ&D and reported in the Repository Life Cycle Cost Data for the 1990 TSLCC Estimate.

The repository subsurface construction estimates are derived from the Case 2T estimates with modifications to reflect the requirements of the 34 repository options. The repository surface construction costs were assumed constant for all options.

The cost estimates do not include allowances for change in scope or design criteria, changes in repository location, licensing delays, construction and/or operating labor problems, mandates related to total retrieval activities, or cost escalation through the life of the project. Any of these uncertainties could have a significant impact on cost and/or schedule.

Also, these estimates do not include management by government agencies, any offsite nuclear waste preparation and transport, costs for offsite railroad maintenance, or any costs that occur before license application design.

Repository Engineering Cost Estimates

A/E services are used to perform Title I, Title II and Title III design for the repository surface and subsurface facilities. It is assumed that the Title I and Title II costs comprise 95% of the total A/E costs and Title III the remaining 5%. It is also assumed that the Title I costs are half the Title II costs.

Title I preliminary design continues the design effort utilizing the Conceptual Design and the project Design Criteria as a basis for additional project development. Title I

design develops topographical and subsurface data and determines the requirements and criteria which will govern the definitive design. Tasks include the preparation of preliminary planning and engineering studies, preliminary drawings, outline specifications, life-cycle cost analysis, preliminary cost estimates, and scheduling for project completion. Preliminary design provides identification of long range lead procurement items and risks associated with continued project development.

Title II definitive design continues the development of the project based on the approved preliminary design (Title I). Definitive design includes any revisions required of the Title I design, preparation of final working drawings, equipment lists, specifications, bidding documents, cost estimates, and coordination with all parties which might affect the project, development of firm construction and procurement schedules and assistance in analyzing proposals or bids.

It is assumed that Title II costs are twice those for Title I.

Title III services are required to assure that the project is constructed in accordance with the plans and specifications (construction inspection), and that the quality of the materials and workmanship are consistent with the requirements of the project (materials testing).

Design phases for the Yucca Mountain Site Characterization Project are not organized by the traditionally singular Title I and Title II method. Because of the need to obtain NRC concurrence and design work relating to the nuclear waste path, this project has two separate design categories - license application design (LAD) and final procurement and construction design (FPCD).

LAD includes Title I and Title II design for all of the repository surface and subsurface nuclear materials handling facilities. It is assumed that LAD costs are 70% of the total Title I costs and 60% of the total Title II costs.

LAD = 70% Title I + 60% Title II
= [70% x 1/3 x 95% of total A/E] + [60% x (2/3 x 95% of total A/E)]
= 60% of total A/E costs (20% Title I; 40% Title II)

FPCD includes Title I and Title II design for all the repository surface and subsurface support facilities. The FPCD is estimated to be 35% of the total A/E costs. It is assumed that FPCD costs are 30% of the total Title I costs and 40% of the total Title II costs.

FPCD = 30% Title I + 40% Title II
= [30% x (1/3 x 95% of total A/E)] + [40% x (2/3 x 95% of total A/E)]
= 35% of total A/E costs (12% Title I; 23% Title II)

Repository Construction Cost Estimates

Repository construction costs include sinking and outfitting the men and materials shaft, and exhaust ventilation shaft, mining and outfitting the waste and tuff accesses, and mining and outfitting the underground service facilities. Sufficient underground emplacements panels are developed to accommodate emplacement of waste simultaneous with continuing construction. Standard equipment required for initial operation of both surface and underground facilities plus construction management costs are also included. The cost of construction is based on the following assumptions:

- Construction contracts based on competitive bids and fixed-priced contract,
- Design and QA procedures similar to those applied to current commercial nuclear projects,
- Equipment and material from U.S. sources,
- Availability of craft and professional personnel in the general project area, including Las Vegas,

- Craft wages that comply with the Davis-Bacon wage rates (DOL, 1986),

- An uninterrupted schedule (no major funding, labor, or supply problems), and

- A project that proceeds according to the schedule in the June 1988 Draft Mission Plan Amendment.

Cost Estimate Summaries

Total costs for the repository surface and subsurface facilities are spread across the design and construction phases using a straight-line method based on the number of months for each phase. The following schedule assumption are used as the basis for spreading the total costs.

- LAD has a duration of 30 months with completion to coincide with the milestone for the start of the NRC review.

- FPCD starts at the completion of LAD and has a duration of 42 months.

- Title III (physical construction) has a duration of 60 months and starts at the completion of FPCD.

The annualized repository cost estimates are included in the cash flow estimates as "Repository Construction" costs.

Annualized ESF-Repository Life Cycle Cost Estimates

General Assumptions

The annualized cost estimates are based on the total project costs for each option as reported in the Task 4 Cash Flow calculations described in Appendix A.

The start dates and durations for all phases of the ESF-Repository life cycle are as identified in this Appendix and are used as the basis for spreading total costs and calculating annualized costs.

Repository cost estimates are divided into four phases. Phase 1 is the initial 5-year construction period during which a sufficient portion of the underground facilities is completed to begin emplacement. This phase includes the engineering costs for the repository surface and subsurface facilities. Phase 2 represents the emplacement operations period and lasts 25 years. Phase 3 is the caretaker period and lasts 25 years. Phase 4 is the decommissioning and closure phase. The duration of Phase 4 activities is dependent upon the option and the assumption of a normal or off-normal repository life cycle.

The repository normal life cycle is defined as the start of construction through the end of closure and decommissioning without retrieval. Table 5B-1 shows the schedule durations, which are rounded to the nearest year, for the normal life cycle.

TABLE 5B-1

ESF-REPOSITORY NORMAL LIFE CYCLE SCHEDULE DURATIONS*

Option	Duration (Years)
1, 18 - Base	11
2, 19 - A1	12
3, 20 - A2	12
4, 21 - A4R1	12
5, 22 - A5	11
6, 23 - A7	12
7, 24 - B3R2	13
8, 25 - B3R3	13
9, 26 - B3R4	13
10, 27 - B3R5	13
11, 28 - B3R6	13
12, 29 - B4	13
13, 30 - B7	13
14, 31 - B8	12
15, 32 - C1	18
16, 33 - C4	20
17, 34 - R11	12

*Start of repository construction through closure and decommissioning.

The off-normal life cycle is defined as the start of construction through the end of closure and decommissioning with retrieval. It is assumed that the schedule duration for Phase 4 activities which includes retrieval are identical for all options and are comprised of 9 years for design and construction, 25 years for retrieval, and 7 1/2 years for closure and decommissioning. The closure and decommissioning period was rounded to 7 years for the purpose of calculating annualized costs.

Cost Components

The cost components contained in the project total cost reported in the Task 4 Cash Flow calculations are:

Project total = ESF construction total + ESF operations total + Calico Hills total + repository total

The repository total comprises the following cost components:

Repository total = construction + surface facilities + disposal containers + emplacement operations + caretaker operations + decommissioning

The construction cost estimate includes engineering costs for the repository subsurface and surface facilities and the cost of construction for repository subsurface facility. The surface facilities cost component contains only the cost of construction.

The total cost of surface facilities and disposal containers is assumed to be the same for all options. Construction of subsurface facilities, emplacement operations, and caretaker operations varies among the options.

The decommissioning cost reported in the cash flow estimates refers to the cost of closure and decommissioning for the ESF-repository normal life cycle. For the normal life cycle, the annual and total decommissioning costs vary among the options.

Phase 4 activities which include retrieval (off-normal life cycle) are not in the cash flow cost estimates. The off-normal life cycle assumes that the total cost of Phase 4 activities is identical among all options.

Calculations

Annualized costs estimates for the ESF-repository life cycle include a "high," "best," and "low" cost for the normal life cycle and the off-normal life cycle of the repository.

The total project cost from the cash flow cost estimates is considered to be the "best" cost estimate for the normal life cycle. The high and low estimates are derived by applying percentages to each of the components of best estimate.

It is assumed that the uncertainty of the cost estimates is the same for all 34 options with regard to ESF construction, ESF operations, and Calico Hills costs. The percentages applied for these components are:

	High	Low
ESF construction	120%	95%
ESF operations	120%	95%
Calico Hills	124%	95%

The cost components which comprise the repository total not only vary among the options, but also with each phase of the repository life-cycle. A summary of the high/low uncertainty ranges which apply to each phase of the options is provided in Table 5B-2.

TABLE 5B-2

SUMMARY OF HIGH/LOW UNCERTAINTY RANGES FOR THE REPOSITORY COST ESTIMATE

Option	Const. Phase 1		Emp. Op. Phase 2		Care Ops. Phase 3		Close & Decom. Phase 4	
	H	L	H	L	H	L	H	L
1, 18 - Base	1.20	0.90	1.25	0.90	1.15	0.95	1.25	0.95
2, 19 - A1	1.22	0.88	1.27	0.88	1.17	0.93	1.27	0.93
3, 20 - A2	1.22	0.88	1.27	0.88	1.17	0.93	1.27	0.93
4, 21 - A4R1	1.22	0.88	1.27	0.88	1.17	0.93	1.27	0.93
5, 22 - A5	1.22	0.88	1.27	0.88	1.17	0.93	1.27	0.93
6, 23 - A7	1.22	0.88	1.27	0.88	1.17	0.93	1.27	0.93
7, 24 - B3R2	1.23	0.87	1.28	0.87	1.15	0.95	1.25	0.95
8, 25 - B3R3	1.23	0.87	1.28	0.87	1.15	0.95	1.25	0.95
9, 26 - B3R4	1.23	0.87	1.28	0.87	1.15	0.95	1.25	0.95
10, 27 - B3R5	1.23	0.87	1.28	0.87	1.15	0.95	1.25	0.95
11, 28 - B3R6	1.23	0.87	1.28	0.87	1.15	0.95	1.25	0.95
12, 29 - B4	1.25	0.85	1.30	0.85	1.17	0.93	1.27	0.93
13, 30 - B7	1.25	0.85	1.30	0.85	1.17	0.93	1.27	0.93
14, 31 - B8	1.25	0.85	1.30	0.85	1.17	0.93	1.27	0.93
15, 32 - C1	1.22	0.88	1.27	0.88	1.17	0.93	1.27	0.93
16, 33 - C4	1.22	0.88	1.27	0.88	1.17	0.93	1.27	0.93
17, 34 - R11	1.25	0.85	1.30	0.85	1.17	0.93	1.27	0.93

The uncertainty associated with the cost estimate for the surface facilities and the disposal containers is assumed to be the same for all options. The high value for these cost components is assumed to be 125% of the best estimate, while the low value is assumed to be 90% of the best estimate.

The ESF-repository normal life cycle cost estimates, therefore, are calculated as follows:

Best estimate	= project total from cash flow
High estimate	= (ESF construction total * 1.20) + (ESF operations total * 1.20) + (Calico Hills * 1.24) + repository high
Repository high	= (construction * construction high %) + (emplacement operations * emplacement high %) + (caretaker operations * caretaker high%) + (decommissioning * decommissioning high %) + (surface facilities + disposal containers) * 1.25
Low estimate	= (ESF construction total * 0.95) + (ESF operations total * 0.95) + (Calico Hills * 0.95) + repository low
Repository low	= (construction * construction low %) + (emplacement operations * emplacement low %) + (caretaker operations * caretaker low %) + (decommissioning * decommissioning low %) + (surface facilities + disposal containers) * 0.90

The best, high, and low annualized cost estimates for the off-normal life cycle are identical to the normal life cycle costs with the exception of those costs incurred during Phase 4 activities. The off-normal life cycle assumes retrieval, the cost of which is not included in the Phase 4 cost estimates reported in the cash flow. It is assumed that the total costs of design and construction, retrieval, and decommissioning and closure activities which occur during Phase 4 are identical among all options. The high and low annualized cost estimates are obtained by multiplying the best estimate by 1.25 and 0.95, respectively.

Input to Sensitivity Analyses

The annualized costs are summed for each of the following decision scenarios as an input into the sensitivity analyses used by the management review board to facilitate the scoring process:

Scenario F - total thru beginning of early testing
Scenario E - total thru end of early testing
Scenario D - total thru end of late testing
Scenario C - total thru NRC decision
Scenario B - total thru end of closure and decommissioning with retrieval
Scenario A - total thru end of closure and decommissioning without retrieval

The schedule dates for end of early testing, end of late testing, and NRC review were taken from the "Finest Hour" Schedule described in ESF Schedule Section in this Appendix. Completion of Topopah Springs early testing was used for Options 1 through 17, while Completion of Calico Hills early testing was used for Options 18 through 34. It is assumed that late testing is completed at the start of NRC review and the NRC decision has a duration of 42 months.

APPENDIX 5C

COMPLETE DATA PACKAGE
FOR OPTION 30 (B7)

WBS 126111
NA

OPTION 30
B7 (Scenario 2)
CONTENTS

SKETCHES

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OPTION 30
B7 (Scenario 2)
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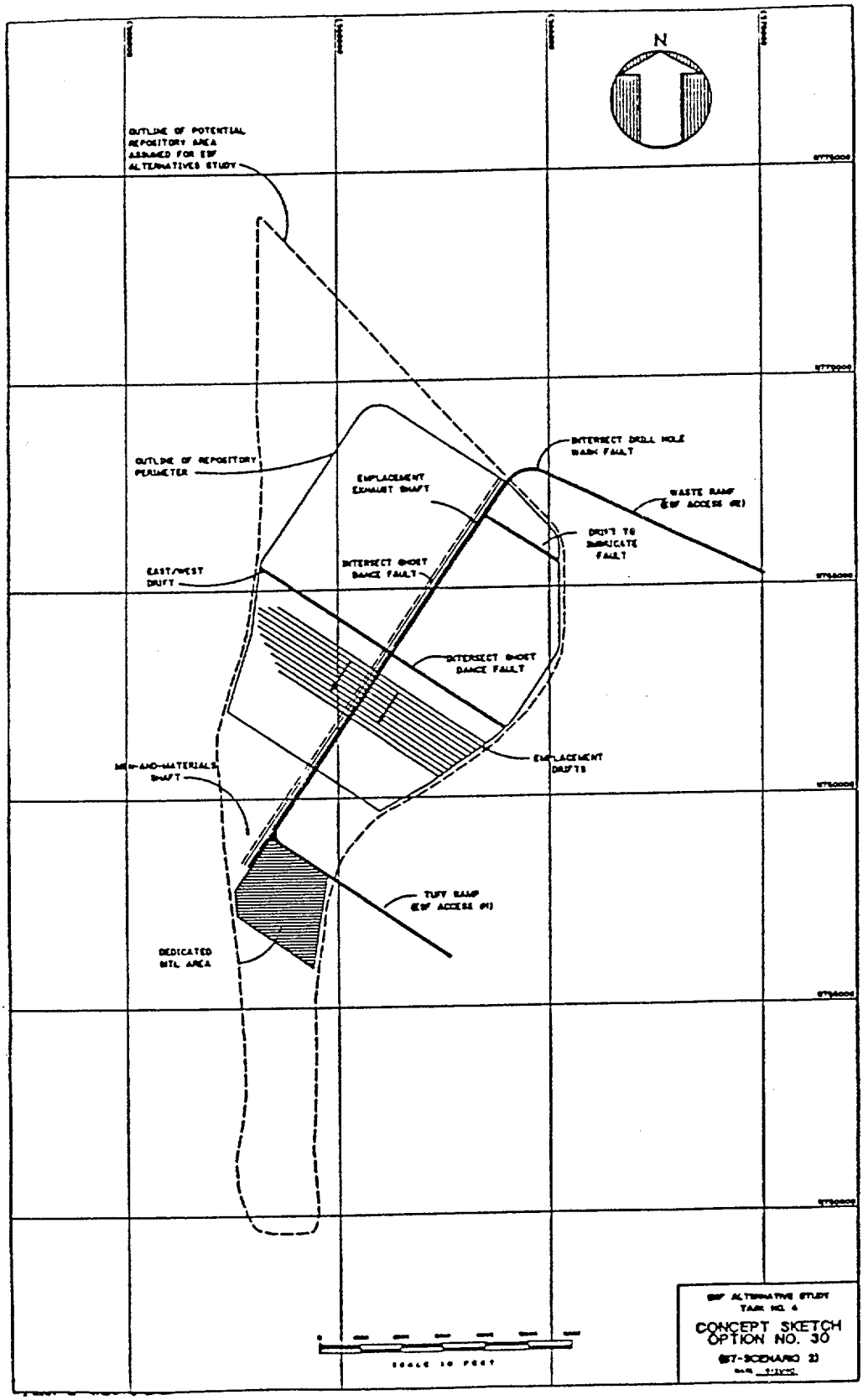
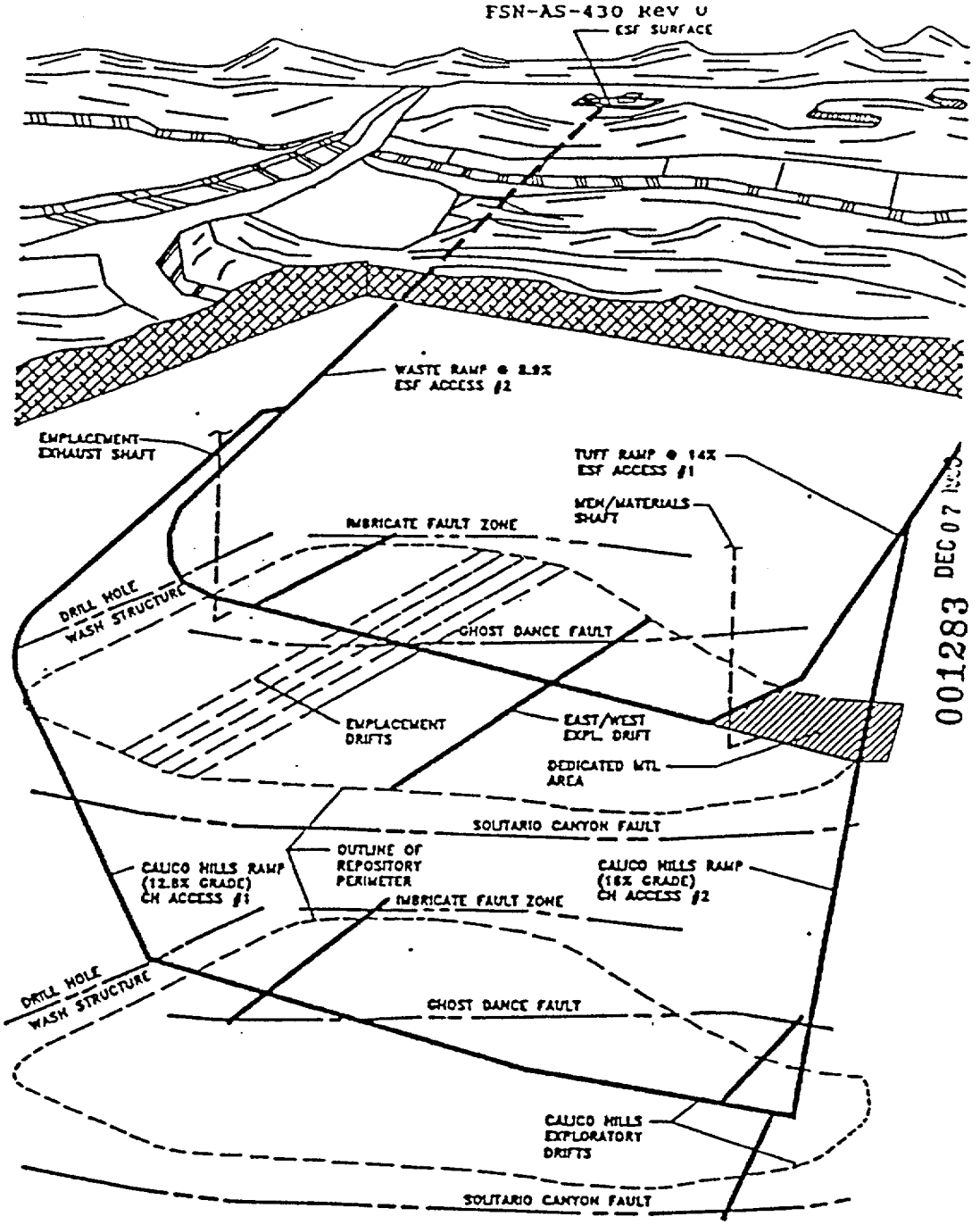
2) Schedule	5C-43

ESF ALTERNATIVES STUDY DATA SHEETS FOR TESTING INPUT OPTIONS 13 (B7) AND 30 (B7) 5C-44


N
OUTLINE OF POTENTIAL REPOSITORY AREA ASSUMED FOR ESF ALTERNATIVES STUDY
OUTLINE OF REPOSITORY PERIMETER
EMPLACEMENT EXHAUST SHAFT
INTERSECT DRILL HOLE WASH FAULT
WASTE RAMP (ESF ACCESS #2)
DRIFT TO BARRICADE FAULT
EAST/WEST DRIFT
INTERSECT GHOST DANCE FAULT
INTERSECT GHOST DANCE FAULT
EMPLACEMENT DRIFTS
MEN-AND-MATERIALS SHAFT
TUFF RAMP (ESF ACCESS #1)
DEDICATED MTL AREA
SCALE IN FEET
ESF ALTERNATIVE STUDY
TASK NO. 4
CONCEPT SKETCH
OPTION NO. 30
EST-SCENARIO 23

FSN-AS-430 Rev 0



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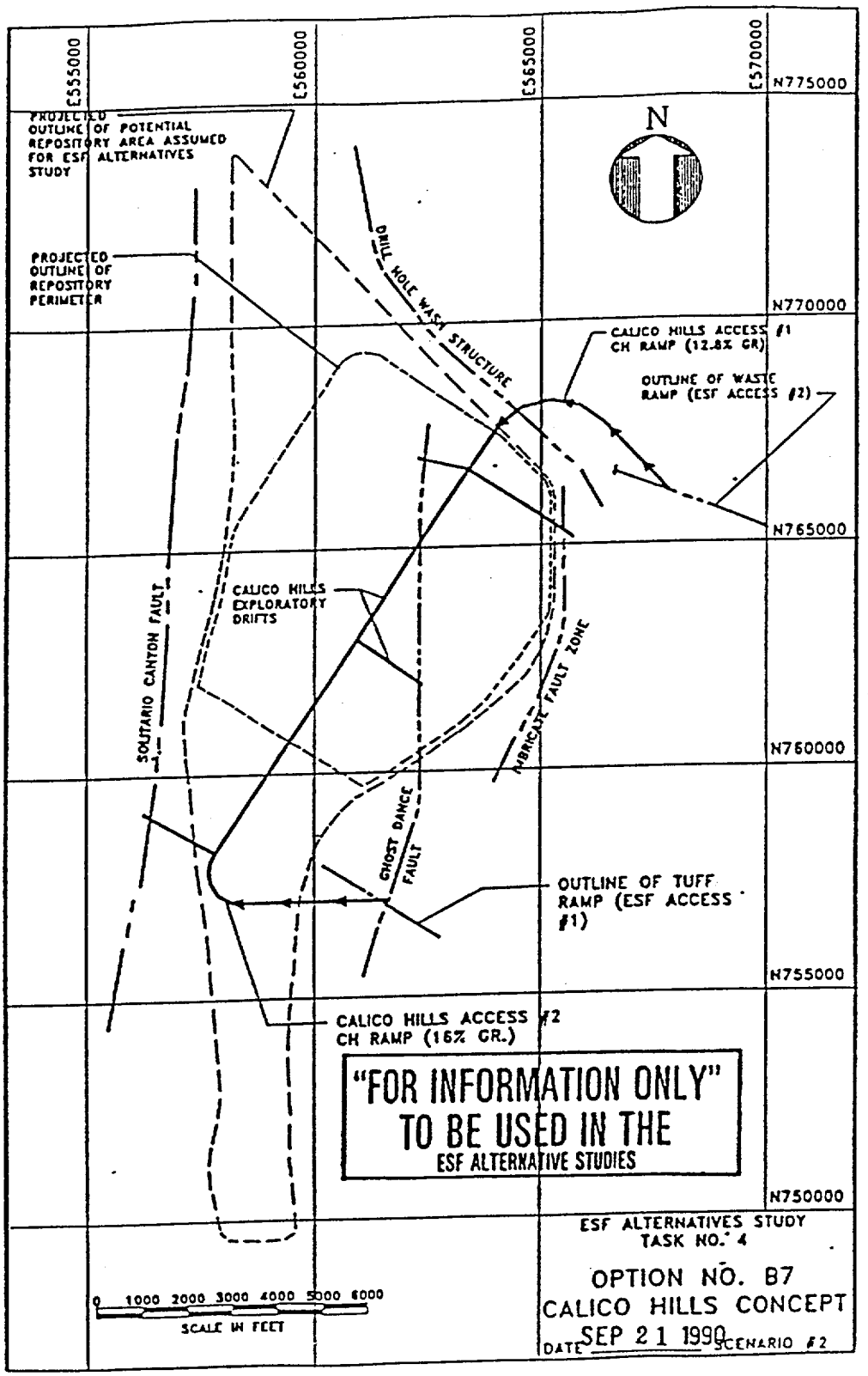
ESF ALTERNATIVES STUDY
TASK NO. 4
OPTION NO. B7
ISOMETRIC SCENARIO #2
DATE



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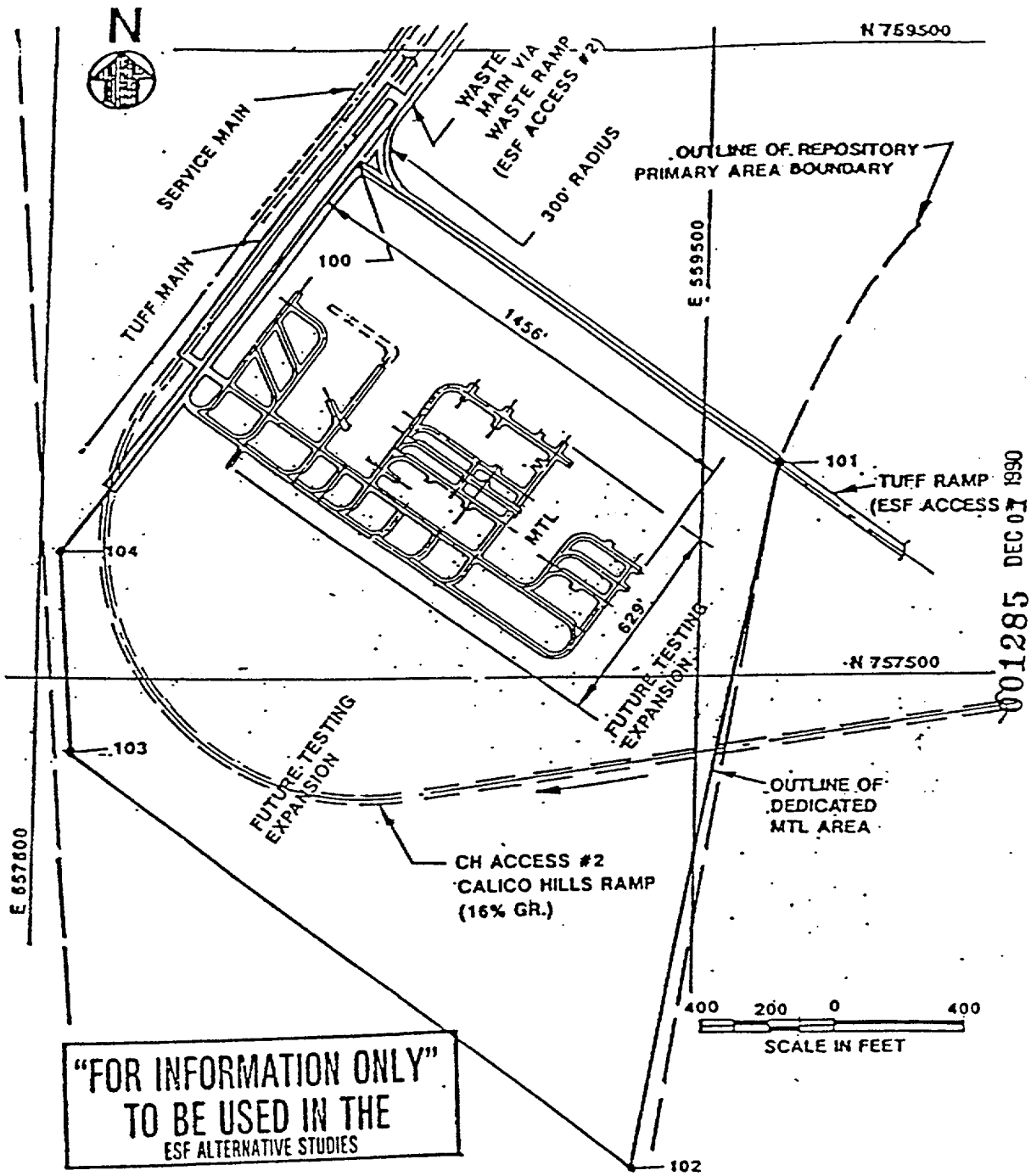

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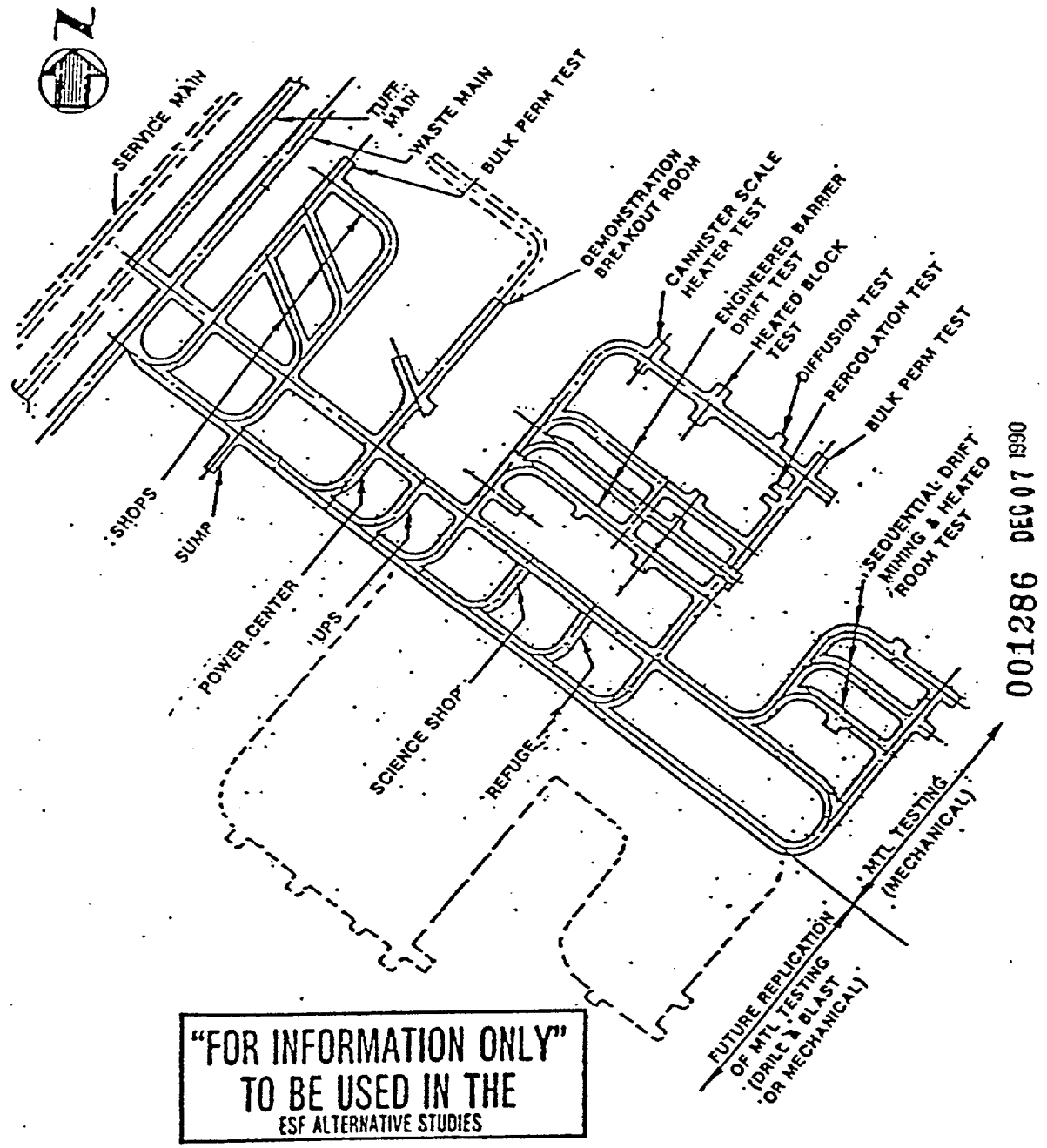
DEDICATED MTL AREA = 4,194,054 SQ. FT.
MTL LAYOUT AREA = 915,824 SQ. FT.

ESF ALTERNATIVES STUDY
TASK NO. 4
OPTION NO. B7
ESF/REPOSITORY INTERFACE
DATE SEP 21 1990 SCENARIO #2

001285 DEC 07 1990



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001286 DEC 07 1990

200 100 0 200
SCALE IN FEET

ESF ALTERNATIVES STUDY
TASK NO. 4
OPTION NO. B7
MTL LAYOUT
DATE SEP 21 1990 SCENARIO #2

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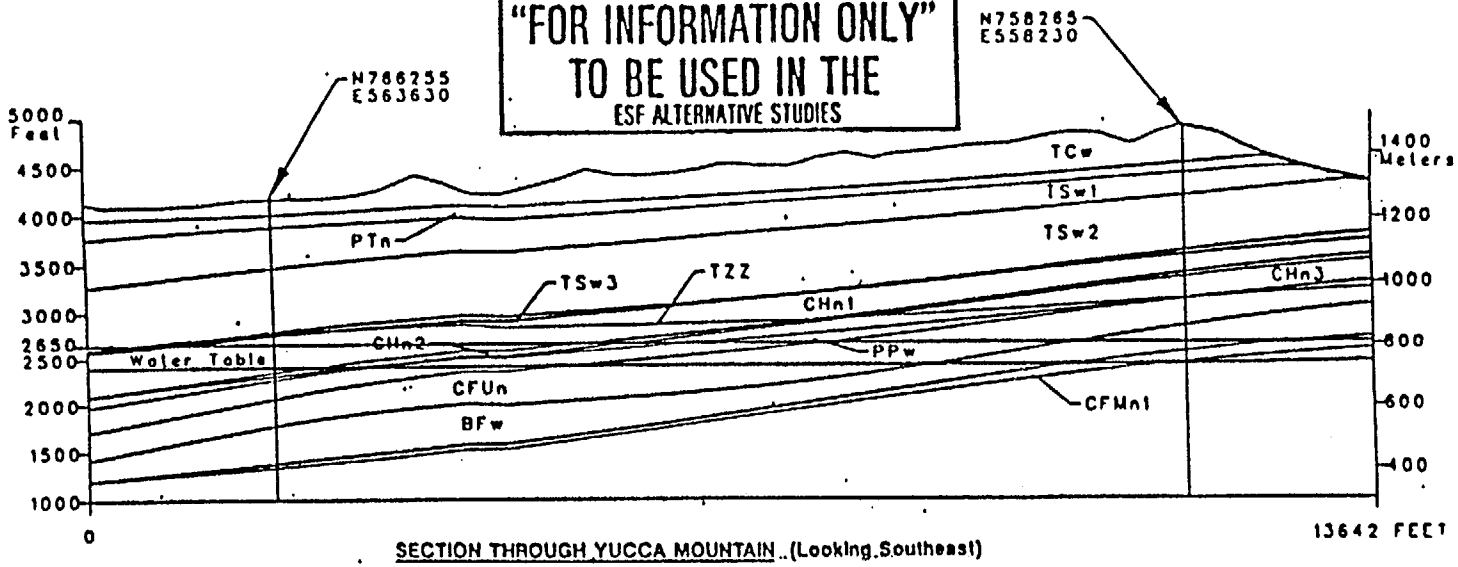
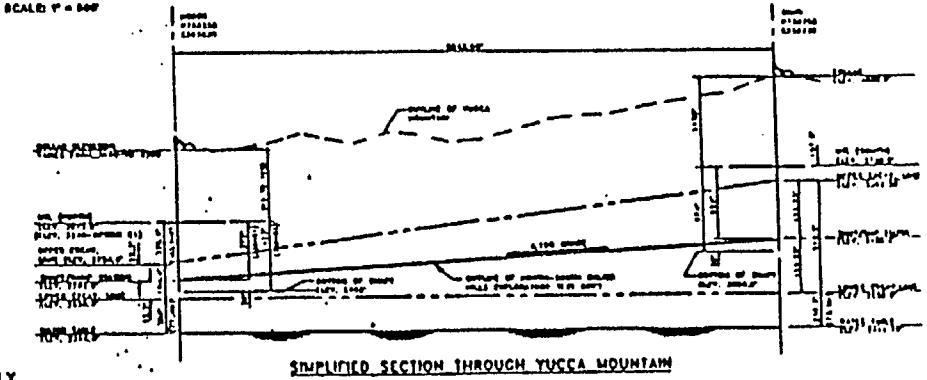


SECTION THROUGH YUCCA MOUNTAIN (Looking Southeast)

(TOPOGRAPHY = REF0001)

TCw = TIVA CANYON WELDED (REF0221)
PTn = PAINTBRUSH TUFF NONWELDED (REF0222)
TSw1 = TOPOPAH SPRING WELDED #1 (REF0272)
TSw2 = TOPOPAH SPRING WELDED #2 (REF0005)
TSw3 = TOPOPAH SPRING WELDED #3 (REF0202)
CHn1 = CALICO HILLS/PAINTBRUSH NONWELDED #1 (REF0007)
CHn2 = CALICO HILLS/PAINTBRUSH NONWELDED #2 (REF0203)
CHn3 = CALICO HILLS/PAINTBRUSH NONWELDED #3 (REF0204)
PPw = PROW PASS WELDED (REF0205)
CFUn = UPPER CRATER FLAT NONWELDED (REF0011)
BFw = BULLFROG WELDED (REF0012)
CFMn1 = MIDDLE CRATER FLAT NONWELDED (REF0206)
TZZ = ZEOLITIZED ZONE (REF0017)
(WATER TABLE = REF0018)

NOTE: CALICO HILLS EXPLORATORY DRIFTING IS LOCATED APPROXIMATELY MIDWAY BETWEEN THE TOPOPAH SPRING/CALICO HILLS CONTACT (UPPER EXCAVATION LIMIT) AND 2650 FEET ELEVATION (LOWER EXCAVATION LIMIT).



SIMPLIFIED SECTION THROUGH YUCCA MOUNTAIN

CAI.0408

ESF ALTERNATIVE STUDY
TASK NO. 4

SECTIONS
CALICO HILLS CONCEPT
SCENARIO #2

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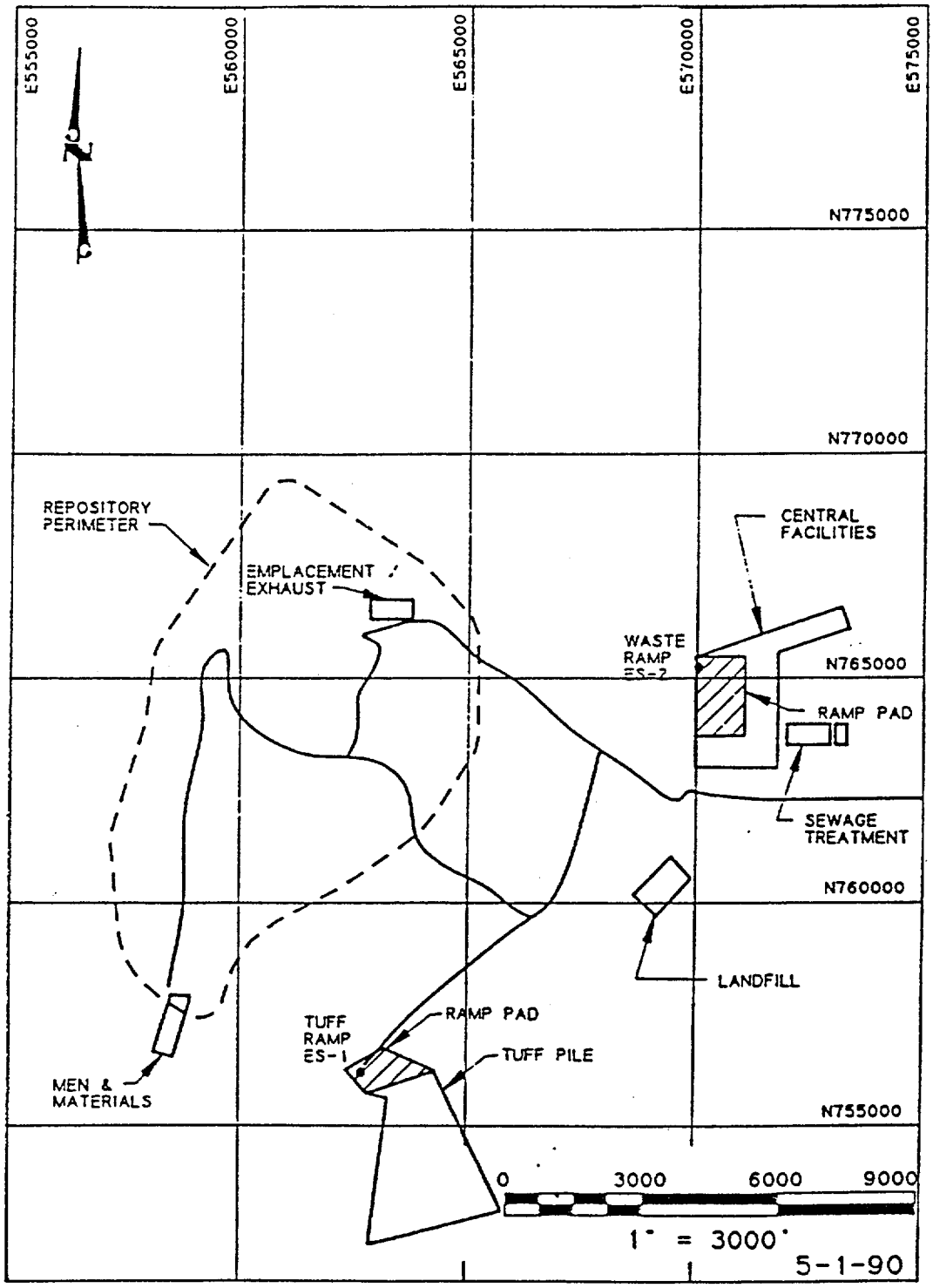

001288 DEC 07 1990

ESF - ALTERNATIVE STUDY - TASK #4

SURFACE FACILITIES-SCENARIO #2 B7

SUMMARY OF SELECTED ESF/REPOSITORY DATA

SELECTED OPTION No. 87-SCENARIO #2

OPTION DESCRIPTION MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS AND TWO RAMPS, NORTH AND SOUTH ACCESS
MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE), MTL AT SOUTH END OF REPOSITORY,
CH ACCESS BY INTERNAL RAMPS FROM TUFF AND WASTE RAMPS AT NORTH AND SOUTH.

ACCESS SUMMARY	EXPLORATORY SHAFT FACILITY			CALICO HILLS		REPOSITORY			
	ESF ACCESS #1	ESF ACCESS #2	ESF ACCESS #3	CH ACCESS #1	CH ACCESS #2	MEN & MATERIAL	EMPL. EXH.	TUFF	WASTE
TYPE	RAMP	RAMP		INTERNAL RAMP	INTERNAL RAMP	SHAFT	SHAFT	SEE ESF ACCESS #1	SEE ESF ACCESS #2
FINISHED DIM. (FT.)	25' DIA.	25' DIA.		18' DIA.	18' DIA.	25' DIA.	25' DIA.		
CONSTRUCTION METHOD	TBM	TBM		TBM	TBM	MECH. V-HOLE	MECH. V-HOLE		
LOCATION SURFACE	N. 756196	N. 765251				N. 759200	N. 766590		
	E. 562698	E. 570034				E. 557860	E. 563280		
LOCATION UNDER-GROUND	N. 758188	N. 767500		TBD	TBD				
	E. 559745	E. 564053		TBD	TBD				
				TBD	TBD				
				TBD	TBD				

MTL LAYOUT FEATURES	
MTL LOCATION	SOUTH
MTL ELEVATION	3730'
MINING METHODS	
MTL	MECH. (MOBILE MINER)
EXPL. DRIFTS	MECH. (TBM & MOBILE MINER)

CH LAYOUT FEATURES	
TOTAL DRIFTING (LF)	19000
MINING METHOD	ROADHEADER & TBM

REPOSITORY LAYOUT FEATURES	
EMPLACEMENT DRIFT ORIENTATION	N 56 W
REPOSITORY ELEVATION	2938-3700
MINING METHODS	
MAINS	TBM
PERIMETER DRIFTS	TBM
PANEL ACCESS DRIFTS	NOT USED
EMPLACEMENT DRIFTS	TBM

TEST PROGRAM IMPLICATIONS

The Yucca Mountain Project testing program's participants have evaluated the impacts and implications of each of the 17 ESF alternative design options on the 35 individual tests, including Calico Hills as defined by the YMP Calico Hills Study, and Integrated Data System, to be conducted in the ESF. The individual test data sheets may be found in PART II of this option data.

The TESTING SUMMARY MATRIX may be found in ITEM 1.

DISTURBED SURFACE AREA (ACRES)			PEAK MANPOWER			ESTIMATED ESF, CH, AND U/G REPOSITORY COSTS (X1,000)		
	ESF	120		ESF			ESF	
	REPOSITORY	528		REPOSITORY			CH	
							REPOSITORY	
	TOTAL	648					TOTAL	

NOTE: ALL VALUES SHOWN ARE APPROXIMATE AND SUBJECT TO CHANGE DURING DESIGN

DATE 9/21/90

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MTL/CH DATA SHEET

SELECTED OPTION No. B7-SCENARIO #2

OPTION DESCRIPTION MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS AND TWO RAMPS, NORTH AND SOUTH ACCESS MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE), MTL AT SOUTH END OF REPOSITORY, CH ACCESS INTERNAL RAMPS FROM TUFF AND WASTE RAMPS AT NORTH AND SOUTH.

ACCESS FEATURES		ESF ACCESS #1	ESF ACCESS #2	ESF ACCESS #3	CH ACCESS #1	CH ACCESS #2
TYPE		RAMP	RAMP		INT. RAMP	INT. RAMP
APPROX. DIM. (FT.)		25' DIA.	25' DIA.		18' DIA.	18' DIA.
CROSS-SECTIONAL AREA (SQ. FT.)		491	491		254	254
CONSTRUCTION METHOD		TBM	TBM		TBM	TBM
LOCATION (APPROX.)	SURFACE	N. 756196	N. 765251			
		E. 562698	E. 570034			
	UNDER-GROUND	N. 758188	N. 767500		TBD	TBD
		E. 559745	E. 564053		TBD	TBD
					TBD	
					TBD	
ELEVATION (APPROX.)	SURFACE	4125	3687			
	MTL	3625	3100		3509 (WYE)	3915
	CH				2702	3106
GRADE		DEC. @ 14.0%	DEC. @ 8.9%		DEC @ 12.8%	DEC @ 16%
BEARING		S 56 E	N 65 W		TBD	TBD
**LENGTH (FT.)		3597	6548		6300	5000
UNITS TRANSECTED		Not Available	Not Available		See Stratigraphic Section	See Stratigraphic Section
ESF FUNCTION		Science Vent. Exhaust Emerg. Egress Muck Handling	Science Vent. Intake Emerg. Egress Men & Material		Science Vent. Intake Emerg. Egress Men & Material Vent. exh. Tube	Vent. Exhaust during test phase Emerg. Egress

NOTE: ALL VALUES SHOWN ARE APPROXIMATE AND SUBJECT TO CHANGE DURING DESIGN

** LENGTH SHOWN FOR ESF ACCESSES IS TO MTL/REPOSITORY HORIZON. LENGTH SHOWN FOR CH ACCESSES IS INCREMENTAL FROM MTL/REPOSITORY HORIZON TO CH HORIZON.

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DEC 07 1990
001290

DATE 9/21/90

MTL/CH DATA SHEET

SELECTED OPTION No. B7-SCENARIO #2

OPTION DESCRIPTION MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS AND TWO RAMPS, NORTH AND SOUTH ACCESS MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE), MTL AT SOUTH END OF REPOSITORY, CH ACCESS BY INTERNAL RAMPS FROM TUFF AND WASTE RAMPS AT NORTH AND SOUTH

CONCEPT FEATURES		MTL	CH
LOCATION		SOUTH	N/A
ELEVATION - SHAFT/RAMP STATION		3730	3106
APPX. DISTANCE TO WATER TABLE (FT.)		1318	644
MTL LAYOUT AREA (SQ. FT.)		915834	N/A
DEDICATED MTL AREA (SQ. FT.)		4194055	N/A
EXPANSION AREA AVAIL. (SQ. FT.)		3278221	N/A
* MINING METHODS	EXPL. DRIFTS	MECH. (TBM & MOBILE MINER)	TBM
	MTL	MECH. (MOBILE MINER)	ROADHEADER
EXTENT OF EXPLORATORY DRIFTING		INTERSECT DRILL HOLE WASH AND GHOST DANCE FAULTS WITH LONG DRIFT TO NORTH, DRIFT TO IMBRICATE FAULT OFF OF LONG DRIFT	LONG NORTH/SOUTH DRIFT INTERSECTING DRILL HOLE WASH AND GHOST DANCE FAULTS, DRIFT TO IMBRICATE, GHOST DANCE (TWICE), AND SOLITARIO CANYON FAULTS

MATERIALS	WATER (GALS.)	CONCRETE (CU. YDS.)	STEEL (TONS)
ESF ACCESS #1	900535		
ESF ACCESS #2	1584576		
ESF ACCESS #3			
MTL/EXPL. DRIFTS	4361436		
CH ACCESS #1	774900		
CH ACCESS #2	738000		
CH ACCESS #3			
CH EXPL. DRIFTS	2239140		
**TOTAL	10598587	32776	740

NOTE: ALL VALUES SHOWN ARE APPROXIMATE AND SUBJECT TO CHANGE DURING DESIGN

**TOTALS FOR CONCRETE AND STEEL DO NOT INCLUDE CH QUANTITIES.

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DATE 10/10/90

001291 DEC 07 1990

MTL/CH DATA SHEET

SELECTED OPTION No. B7-SCENARIO #2

OPTION DESCRIPTION MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS AND TWO RAMPS, NORTH AND SOUTH ACCESS MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE), MTL AT SOUTH END OF REPOSITORY, CH ACCESS BY INTERNAL RAMPS FROM TUFF AND WASTE RAMPS AT NORTH AND SOUTH

CONCEPT FEATURES (CONTINUED)

OPERABILITY COMMENTS

Provides better operational efficiency and flexibility than Base Case. Larger access openings provide additional ESF ventilation capacity. The additional air could be used to support expansion of MTL testing, additional exploratory drifting, and testing of the Calico Hills. Revised MTL configuration enhances ventilation efficiency. Larger dedicated MTL area and new configuration facilitate MTL expansion by reducing the potential for interference between MTL construction and on-going testing activities.

SEQUENCE OF CONSTRUCTION

1 ESF Access #1 (25 ft. dia. ramp)
- Bore decline @ 14% with 25 ft. dia. TBM, install temporary utilities and ground support as required. Remove muck with conveyor.
- Conduct all scheduled tests at designated locations interrupting boring as required.
- Cut stations and transfer points as required at MTL and at an intermediate location to facilitate driving of ramp to CH Level.

2 ESF Access #2 (25 ft. dia. ramp)
- Bore decline @ 8.9% with 25 ft. dia. TBM, install temporary utilities and ground support as required. Remove muck with conveyor.
- Conduct all scheduled tests at designated locations interrupting boring as required.
- Cut stations and transfer points as required at MTL and at an intermediate location to facilitate driving of ramp to CH Level.

3 Calico Hills
- Excavate exploratory drifts with a TBMs from the bottom of CH Accesses #1 and #2. Additional drifting may be done with a roadheader.
- Handle muck with conveyor supplemented by rubber tired equipment.
- Calico Hills development will be done on a first priority basis with MTL activity.

4 MTL
- Drift from the bottom of both ramps towards the center of repository block with TBMs until a connection is made.
- Excavate the remaining exploratory drifts and testing facility with a mobile miner, use rubber tired muck haulage to a conveyor transfer.

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001292 DEC 07 1990

NOTE: ALL VALUES SHOWN ARE APPROXIMATE AND SUBJECT TO CHANGE DURING DESIGN

MTL/CH DATA SHEET

SELECTED OPTION No. B7-SCENARIO #2

OPTION DESCRIPTION MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS AND TWO RAMPS, NORTH AND SOUTH ACCESS MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE), MTL AT SOUTH END OF REPOSITORY, CH ACCESS BY INTERNAL RAMPS FROM TUFF AND WASTE RAMPS AT NORTH AND SOUTH

CONCEPT FEATURES (CONTINUED)

CONSTRUCTIBILITY COMMENTS

TBM methods have proven to be effective in a variety of conditions and situations, and permit construction schedules to be predicted with reasonable accuracy. Uncertainty exists with respect to the feasibility of some scientific investigations of the rock surface during excavation operations. The TBM method inflicts less rock damage and uses less water per unit excavated than does drill and blast methods. This may be a benefit to the Site Characterization activity. TBM boring of the Waste Ramp combination horizontal and vertical curve will advance at a slower rate than would flat curve or straight decline driving.

The mechanical method (mobile miner) which may be employed for MTL excavation utilizes proven disc cutter technology. This method offers some degree of orientation flexibility and free access to excavated surfaces for scientific investigation. Uncertainty exists with respect to water usage and production rates since the mobile miner is a prototype excavating machine.

Use of a roadheader for Calico Hills exploratory drift excavation utilizes proven technology and is applicable to the softer nonwelded tuff of the Calico Hills formation. A roadheader has the advantages of less rock damage and water use compared to drill and blast methods, high shape and orientational flexibility, and relatively good test accessibility and safety.

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001293 DEC 07 1990

NOTE: ALL VALUES SHOWN ARE APPROXIMATE AND SUBJECT TO CHANGE DURING DESIGN

ESF SURFACE FACILITIES DATA SHEET
SELECTED OPTION NUMBER: Scenario #2, B7
OPTION DESCRIPTION: Two Ramps (One N and One S)

FACILITY	LOCATION (ESF ACCESS)	SIZE (ACRES)	DISTURBED AREA (ACRES)
RAMP PAD HOIST HOUSE SURFACE DATA BLDG. OPERATIONS BLDG. SHOP CONTRACTOR AREA COMMUNICATIONS TOWER MPBH AREA	#2	1.9	2.57
RAMP PAD Walker/Shop Change House Muck Pile Contractor Area Warehouse Equip./Scientific Trailers	#1	16.79	22.67
TOPSOIL STORAGE PAD	J-13	6.10	8.24
BORROW AREA	#2	14.3	14.3
AUXILLIARY PADS TEST SUPPORT FAC. CHANGE HOUSE WAREHOUSE BATCH PLANT EXPLOSIVES STORAGE EQUIP./SCIENTIFIC TRAILERS VEHICLE MAINT./FUEL PARKING SECURITY FACILITY	#1	22.11	29.85
ROADS	-	5.61 mi.	25.53
DRAINAGE MANAGEMENT	-	1.62	2.19
SUB TOTAL			105.35

UTILITIES	LOCATION	SIZE/QTY.	DISTURBED AREA
WASTE WATER	#1 and #2	1.53	2.06
SANITARY FACILITIES	#1 and #2	2.53	3.42
SURFACE FACILITIES	#1 and #2	4.82	6.51
WATER TANKS BOOSTER PUMP USAGE (GALLONS X 1000)	#1 and #2	2.75	3.71
ESF CONST.	70,700		
ESF OPER.	109,500		
TOTAL	179,700		
SUB TOTAL			15.70
TOTAL			121.05

001291 DEC 07 1990

REPOSITORY DATA SHEET		REPOSITORY DESCRIPTIONS
OPTION NUMBER 30	-	(B7 SCENARIO 2)
OPTION DESCRIPTION:		MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS AND TWO RAMPS; NORTH AND SOUTH ACCESS MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE RAMP) MTL AT SOUTH END OF REPOSITORY

Repository Description

Accesses to the repository include the tuff ramp and the men-and-materials shaft in the southern end, and the waste ramp and the emplacement exhaust shaft (close to the central mains) in the north end. The ramps are developed by TBM. Emplacement drifts are perpendicular to a group of four mains, and are developed by TBM across the full width of the repository to intersect the single, continuous perimeter drift. Development proceeds north to south, with emplacement following in the same direction.

Repository Surface Facilities Description

The central surface facilities, located in Midway Valley close to the portal of the waste ramp, consist of three functional areas--the waste receiving and inspection area; the waste operations area, which includes all buildings in which radioactive material is handled or stored; and the general support facilities, such as, administration buildings, security stations, and warehouses. The tuff ramp surface facilities consist of tuff-handling conveyors and stockpiles for the mined rock disposal system. Facilities at the emplacement exhaust shaft consist of a filter building and ventilation structure. Facilities at the men-and-materials shaft area consist of a headframe, hoist house, changehouse, fans, and offices to support underground development operations.

001295 DEC 07 1990

REPOSITORY DATA SHEET		REPOSITORY CONSTRUCTIBILITY AND OPERABILITY COMMENTS
OPTION NUMBER 30	-	(B7 SCENARIO 2)
OPTION DESCRIPTION:		MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS AND TWO RAMPS; NORTH AND SOUTH ACCESS MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE RAMPS) MTL AT SOUTH END OF REPOSITORY

- TBMs are proven technology and are mainly used in single-entry projects. TBMs have never been used as the primary mining method in a large-scale hard-rock mining operation.
- TBM technology and equipment continue to improve at an accelerated rate.
- TBMs require a well-designed, totally integrated support system to function effectively.
- The use of multiple TBMs, combined with the large number of openings to be developed, requires a high level of technical TBM expertise.
- Optimal use of TBMs permits a simpler layout with longer emplacement drifts that results in fewer active headings and simplifies operational planning.
- TBM methods use few machines for production and are susceptible to significant delays caused by major equipment breakdown.
- In long emplacement drifts, it is more difficult to isolate unexpected geologic problem areas than in panel layouts with shorter emplacement drifts.
- TBMs have less flexibility to respond to unforseen geologic conditions than conventional mining.
- This layout has less drift footage and fewer intersections requiring less ground control monitoring and maintenance throughout the repository life.

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OPTION NUMBER 30 - (B7 SCENARIO 2) (Cont'd)

- Long emplacement drifts result in fewer available working locations.
- Long emplacement drifts will likely require alternate cooldown techniques for inspection or maintenance and will take longer than shorter drifts to cool down.
- TBM layouts have lower ventilation requirements than conventional mining.
- Operational flexibility and ventilation margins may be enhanced with additional or relocated ventilation shafts.
- Uniform drift cross sections allow for consistent ground support methods.
- Repository grades for this layout preclude the use of conventional rail transport.
- Initial construction of the repository is enhanced by having the tuff ramp and main completed as part of the ESF.
- Ramp and shaft openings located at both the north and south ends of the repository provide separate accesses for emplacement and mining personnel and equipment. This results in good separation of these operations and enhances safety.

001297 DEC 07 1990

REPOSITORY DATA SHEET		THE ROLE OF THE ESF OPENINGS IN REPOSITORY CONSTRUCTION AND OPERATIONS
OPTION NUMBER 30	-	(B7 SCENARIO 2)
OPTION DESCRIPTION:		MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS AND TWO RAMPS; NORTH AND SOUTH ACCESS MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE RAMP) MTL AT SOUTH END OF REPOSITORY

The ESF openings are:

- o Future repository tuff ramp
- o Future repository waste ramp.

Repository Construction Phase

The tuff ramp is the main route for muck haulage from the repository development areas to the surface muck disposal area. After repository construction authorization is received, the ramp will be equipped with the permanent conveying system. It will then be used to haul muck from the shops and the men-and-materials mechanical shaft-sinking operation and other subsequent development.

Fresh air will be provided via the waste ramp until the men-and-materials shaft is connected to the repository. Exhaust air will be routed to the surface via the tuff ramp.

Men, materials, and supplies will be transported via the waste ramp until the men-and-materials shaft is commissioned. Mining equipment may be taken underground on either ramp.

The ESF shops will be used to support initial development until the permanent repository shops are commissioned. Utility systems used for MTL development will be used for initial repository development until the permanent repository utilities are installed.

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OPTION NUMBER 30 - (B7 SCENARIO 2) (Cont'd)

Repository Operations Phase

During repository operations, the functions of the tuff ramp remain the same as during the repository construction period. The waste ramp will be used as an emplacement ventilation intake and will be designated as a main route for transportation of waste for underground emplacement. The dedicated MTL area will be designed to provide space for:

- Training area for waste emplacement activities
- Emergency and mine rescue activities.

Unrestricted access from the repository to these facilities will be maintained.

001299 DEC 07 1990

REPOSITORY DATA SHEET		IMPACT OF MTL MOVEMENT
OPTION NUMBER 30	-	(B7 SCENARIO 2)
OPTION DESCRIPTION:		MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS AND TWO RAMPS; NORTH AND SOUTH ACCESS MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE RAMP) MTL AT SOUTH END OF REPOSITORY

Impact of Moving the MTL on Repository Design

The conceptual underground layout has the flexibility to accommodate any relocation of the MTL. A continued ESF/MTL/repository interface can mitigate repository design, construction, and operating complications resulting from the relocation of the MTL. At this phase in the design process, an MTL location adjacent to the central mains or the perimeter would have the least impact. Specific effects to be considered are the following:

- regional temperature distribution;
- utilization of available emplacement area;
- isolation of ventilation systems;
- ease of development and operations;
- availability of ESF accesses for repository construction and operations; and
- schedule for repository development.

In this option, the tuff ramp and the waste ramp are part of the ESF and would not be affected by lateral movement of the MTL. If the MTL moves off the main corridor, lateral drifting on the repository level will be extended to connect the MTL with the other openings. If the MTL horizon is changed, connecting drifts off the ramps at the proper elevations will be necessary, and other connections to the repository level will have to be reexamined.

001300 DEC 07 1990

REPOSITORY DATA SHEET		BASE CASE DESIGN DEFICIENCY COMMENTS
OPTION NUMBER 30	-	(B7 SCENARIO 2)
OPTION DESCRIPTION:		MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS AND TWO RAMPS; NORTH AND SOUTH ACCESS MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE RAMP) MTL AT SOUTH END OF REPOSITORY

Perceived Deficiencies of the Base Case Repository Design are:

1. Surface entrance locations for the men-and-materials shaft and tuff ramp are adjacent to the potential regional maximum flood area and so may be subject to flooding.

2. Present layout of ESF facility does not allow for potential expansion beyond the existing boundaries.

3. Repository access openings and main drifts have limited flexibility to accommodate increased ventilation requirements resulting from operational changes or development rate increases.

001301 DEC 07 1990

In response to perceived deficiencies in the Base Case Design, the following changes were made for this option:

1. Portals of both the men-and-materials shaft and tuff ramp were moved to eliminate potential flooding problem.

2. Repository emplacement area was redesigned to provide additional area for potential ESF expansion.

3. The number of main drifts was increased from three to four. Diameters of access openings and mains were increased to 25 feet. Repository access drifts were eliminated and emplacement drift sizes increased to 25-foot diameter.

jbc/09-21-90

REPOSITORY DATA SHEET — REPOSITORY ACCESSES - PHYSICAL FEATURES

OPTION NUMBER 30 — B7, SCENARIO 2

OPTION DESCRIPTION: MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS & TWO RAMPS; NORTH AND SOUTH ACCESS
MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE RAMP)
MTL AT SOUTH END OF REPOSITORY

FEATURES		MEN & MATERIALS	EMPLACEMENT EXHAUST	TUFF	WASTE
TYPE		SHAFT	SHAFT	RAMP	RAMP
APPROX DIA (FT) *FINISHED]		25*	25*	25	25
LINING TYPE		CONCRETE	CONCRETE	NOT DETERMINED	NOT DETERMINED
CROSS SECTIONAL AREA (SQ FT)		491	491	491	491
CONSTRUCTION METHOD (**)		MECHANICAL VMOLE/ RAISEBORE	MECHANICAL VMOLE/ RAISEBORE	MECHANICAL TBM	MECHANICAL TBM
LENGTH (FT) TO REP. LEVEL		1176	1170	3597	6548
HORIZONTAL DISTANCE (FT)		N/A	N/A	3562	6390
GRADE		VERTICAL	VERTICAL	14.0%	8.9%
BEARING		NOT APPLICABLE	NOT APPLICABLE	S 56 E	N 65 W
LOCATION (APPROX)					
SURFACE	N	759200	766590	756196	765251
	E	557860	563280	562696	570034
	EL	4890	4300	4125	3687
UNDERGR	N	-	-	758188	767500
	E	-	-	559745	564253
	EL	3714	3130	3625	3100
OPENING FUNCTION IN REPOSITORY		TRANSPORTATION OF PERSONNEL, MATERIALS AND SUPPLIES VENTILATION	WASTE EMPLACEMENT EXHAUST AIR VENTILATION	MUCK HAULAGE UNDERGROUND TO SURFACE VENTILATION	ROUTE FOR ALL TRANSPORTED WASTE FROM SURFACE TO UNDERGROUND VENTILATION
OPENING FUNCTION IN ESF		NONE	NONE	ACCESS # 1	ACCESS # 2

(**) MECHANICAL EXCAVATION USES FULL FACE TUNNEL BORING MACHINES (TBM'S). THESE TBM'S WILL USE A DOMED HEAD WITH RECESSED CUTTERS.

VMOLE EXCAVATION FOR SHAFT CONSTRUCTION CONSISTS OF MECHANICALLY ENLARGING AN EXISTING PILOT HOLE WITH A VERTICAL SELF CONTAINED BORING MACHINE, WHOSE CUTTERHEAD HAS A V CONFIGURATION. THE PILOT HOLE IS CONSTRUCTED BY RAISE BORING.

SOURCE: [B7_ACC.WK1] 27-Sep-90

001302 DEC 07 1990

REPOSITORY DATA SHEET — REPOSITORY LAYOUT -- PHYSICAL FEATURES

OPTION NUMBER 30 — B7, SCENARIO 2

OPTION DESCRIPTION: MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS & TWO RAMPS; NORTH AND SOUTH ACCESS
MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE)
MTL AT SOUTH END OF REPOSITORY

FEATURES	EMPLACEMENT DRIFTS	WASTE	MAIN DRIFTS TUFF	MAIN DRIFTS SERVICE	MAIN DRIFTS VENT	PERIMETER DRIFT
APPROX DIA/SIZE (FT)-EXCAVATED	25	25	25	25	25	25
LINING TYPE	SHOTCRETE	SHOTCRETE	SHOTCRETE	SHOTCRETE	SHOTCRETE	SHOTCRETE
CROSS SECTIONAL AREA (SQ FT)	491	491	491	491	491	491
CONSTRUCTION METHOD (*)	MECHANICAL TBM	MECHANICAL TBM	MECHANICAL TBM	MECHANICAL TBM	MECHANICAL TBM	MECHANICAL TBM
TYPICAL LENGTH (FT)	800-3500	8300	10100	10300	10300	26600
GRADE - %	4-8.5	2.5-8	2.5-8	2.5-8	2.5-8	0.7-9.7
ORIENTATION (BEARING)	S 56 E	N 34 E	N 34 E	N 34 E	N 34 E	VARIABLE
VERTICAL POSITION IN REPOSITORY HORIZON	STANDARD REFER.(**)	STANDARD REFER.(**)	STANDARD REFER.(**)	STANDARD REFER.(**)	STANDARD REFER.(**)	STANDARD REFER.(**)
ELEVATIONS (FT)	2938-3610	3100-3500	3100-3700	3100-3700	3100-3675	2938-3615
DISTANCE FROM WASTE CANISTER EMPLACE DRIFT TO WATER TABLE	558-1180	—	—	—	—	—

* MECHANICAL EXCAVATION USES FULL FACE TUNNEL BORING MACHINES (TBM'S) FOR THE MAJORITY OF OPENINGS. THESE TBM'S WILL USE A DOMED HEAD WITH RECESSED CUTTERS. LIMITED USE OF A MOBILE MECHANICAL MINER IS PLANNED FOR SELECTED OPENINGS (SHOPS, CROSSCUTS, ETC.).

** PRIOR INTERPRETATION OF TSw1/TSw2 CONTACT

SOURCE: [B7_LAY.WK1] 27-Sep-90

001303 DEC 07 1990

REPOSITORY DATA SHEET — SURFACE DISTURBANCE

SELECTED OPTION NUMBER: B7 - *Scenario 2*

OPTION DESCRIPTION: MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS AND TWO RAMPS; NORTH AND SOUTH ACCESS
MECHANICALLY MINED ESP WITH TWO RAMPS (TUFF AND WASTE RAMP)
MTL AT SOUTH END OF REPOSITORY

		DISTURBED AREA (acres)
1.0 Central Surface Facilities	(EAST OF EXILE HILL)	
1.1	Waste Handling Area (inc. Waste Ramp Portal)	120
1.2	Sewage Disposal Lagoon	22
1.3	Land Disposal Area	30
1.4	Drainage Diversion Dike	30
1.5	Railroad and Access Roads (to 40 Mile Wash)	86
1.6	Utilities (Power, Water, Sewer)	14
		302
2.0 Men and Materials Shaft or Ramp	(YUCCA CREST AT HIGHWAY RIDGE)	
2.1	Main Facility (bldgs, prking, whse, laydown)	20
2.2	Access Roads	37
2.3	Utilities (Power, Water)	16
		73
3.0 Emplacement Exhaust Shaft	(TOP OF DEAD YUCCA RIDGE)	
3.1	Main Facility (fan bldgs, prking, laydown)	9
3.2	Access Roads	6
3.3	Utilities (Power, Water)	1
		16
4.0 Tuff Ramp	(GHOST DANCE WASH)	
4.1	Portal and Muck Pile (misc bldgs, prking, conveyors, laydown)	137
4.2	Access Roads	ESP 0
4.3	Utilities (Power, Water)	ESP 0
		137
	TOTAL AREA	528

SOURCE: (B7_SDIS.WK1) 26-Apr-90

001304 DEC 07 1990

REPOSITORY DATA SHEET — REPOSITORY MATERIALS AND WATER USAGE

OPTION NUMBER 30 — B7, SCENARIO 2

OPTION DESCRIPTION: MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS & TWO RAMPS, NORTH AND SOUTH ACCESS
MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE)
MTL AT SOUTH END OF REPOSITORY

TYPE OF MATERIAL	Units	PHASE 1 Construction	PHASE 2 Operations	PHASE 3 Caretaker	PHASE 4 Closure	TOTAL
STEEL *	Tons	5,119	78,293	1,829	12,437	97,678
CONCRETE **	CY	53,769	342,997	60,575	12,205	469,546
REPOSITORY WATER USAGE (TOTAL)						
UNDERGROUND	Gal	32,403,000	417,728,000	85,410,000	819,936,000	1,355,477,000
SURFACE	Gal	114,364,000	475,336,000	74,925,000	344,900,000	1,009,545,000
TOTAL	Gal	146,767,000	893,064,000	160,335,000	1,164,836,000	2,365,022,000

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* INCLUDES ROCKBOLTS, DOORS, PIPE, WIREMESH, LINING PLATE & PLUG

** INCLUDES CEMENT, SHOTCRETE, GROUT

SOURCE: [B7_MTL.WK1] 27-Sep-90

REPOSITORY DATA SHEET — REPOSITORY QUANTITIES - EXCAVATION LENGTHS AND AREAS

OPTION NUMBER 30 — B7, SCENARIO 2

OPTION DESCRIPTION: MECHANICALLY MINED REPOSITORY WITH TWO SHAFTS & TWO RAMPS; NORTH AND SOUTH ACCESS
MECHANICALLY MINED ESF WITH TWO RAMPS (TUFF AND WASTE RAMP) MTL AT SOUTH END OF REPOSITORY

EXCAVATION LENGTHS	ACCESS OPENINGS	LINEAL FEET
	SHAFTS	2,346
	(1) RAMPS	0
	(1) MAIN DRIFTS	28,900
	EMPLACEMENT MANIFOLDS	49,192
	(1) EMPLACEMENT DRIFTS	363,757
	EMPLACEMENT HOLES	537,930
	PERIMETER DRIFTS	26,565
	SHOPS, OFFICES AND DRIFTS	8,400
	(2) TOTAL	462,160

REPOSITORY AREA		ACRES
	(3) WITHIN ESF ALTERNATIVES STUDY BOUNDARY	2,150
	FOR EMPLACEMENT	1,032
	FOR LAYOUT LOSSES (SHOPS, MAINS, STANDOFF, ETC.)	161
	PROVIDED FOR ESF TESTING	96
	(4) NET REMAINING	861

NOTES:

(1) THESE QUANTITIES REPRESENT THE TOTAL LENGTHS EXCAVATED MINUS THE ESF LENGTHS

(2) TOTAL DOES NOT INCLUDE THE LENGTH OF THE EMPLACEMENT HOLES

(3) BASED ON OUTLINE OF POTENTIAL REPOSITORY AREA ASSUMED FOR ESF ALTERNATIVES STUDY.

(4) NOT MEANT TO IMPLY THAT THIS AREA IS AVAILABLE FOR WASTE EMPLACEMENT. UTILIZATION OF THIS REMAINING AREA FOR THE PURPOSE OF EMPLACING WASTE WILL DEPEND PRIMARILY ON DESIGN ESF LOCATION, REPOSITORY DEVELOPMENT SEQUENCE SCHEME AND OVERALL LAYOUT CONFIGURATION. FOR SOME OF THE OPTIONS IT IS LIKELY THAT ONLY SMALL PORTIONS OF THE "NET REMAINING" CAN BE SUCCESSFULLY USED TO EMPLACE WASTE.

QUANTITIES DO NOT INCLUDE IMPACTS OF EAST/WEST EXPLORATION DRIFTING.

SOURCE: [B7_QNT.WK1] 27-Sep-90

FSN-SD-AS-476

TASK 4 STUDIES SCENARIO #2
COST AND SCHEDULE
PERFORMANCE PROJECTIONS

ESF OPTION: B7

10/17/90

ITEM	COST HIGH [+]	COST ESTIMATE	COST LOW [-]	SCHEDULE DURATION HIGH [+]	SCHEDULE DURATION MONTHS	SCHEDULE DURATION LOW [-]	FACE MAN-HRS
							441000
ES CONSTRUCTION	22%	619,530	5%	22%	67	0%	
CH CONSTRUCTION	24%	154,884	0%	24%	42	0%	
							PEAK STAFF
TOTAL	22%	$774,414	4%	37%	67	0%	400

REPOSITORY ITEM	COST HIGH [+]	COST ESTIMATE	COST LOW [-]	SCHEDULE DURATION HIGH [+]	SCHEDULE DURATION MONTHS	SCHEDULE DURATION LOW [-]	
CONSTRUCTION	15%	470,000	15%	0%	** 60	23%	
EMPLACEMENT OPS	30%	2,210,000	15%	0%	300	9%	
CARETAKER OPS	17%	340,000	7%	0%	300	0%	
DECOMMISSIONING	27%	480,000	7%	100%	149	0%	PEAK STAFF
SUBTOTAL	26%	$3,500,000	13%	18%	809	5%	688
SURFACE FACIL.	-	3,120,000	-	-	57	-	
DISPOSAL CONT.	-	3,300,000	-	-	NA	-	
REPOSIT. TOTAL	NA	$9,920,000	NA	NA	809	NA	
GRAND TOTAL	NA	$10,694,414	NA				
TOTAL ESF & U/G REPOSITORY COST	26%	$4,274,414	11%				

$X1000

*****NOTE*****

"+" & "-" PERCENTAGES ARE SUBJECTIVE & NOT RELATED TO STATISTICAL ESTIMATING METHODS

** - DURATION [60 MONTHS] IS TIME TO CONSTRUCT MINIMUM FUNCTIONAL EMPLACEMENT AREA

*** - DURATION OF ES CONSTRUCTION IS START OF "SITE PREP" TO COMPLETION OF "EXPLORATION DRIFTING"[ED]; CH IS FROM START OF IT'S "ENTRY" TO COMPLETION OF "ED".TOTAL TIME IS THE SCHEDULE DURATION FROM START OF "SITE PREP" TO END OF LAST THE "ED".

001307 DEC 07 1990

28-Nov-90
18:13:42

COST & SCHEDULE Scoring Data Sheets for OPTION # 30 B7

Annualized Costs by Calendar Year:

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
	|-Note 1				|-Note 2						|-Note 3			|-Note 4									
High Est.	24	56	170	196	232	136	37	36	92	88	60	41	41	82	270	270	270	270	287	378	378	378	378
Best Est.	20	47	142	163	190	114	31	29	74	71	48	33	33	66	218	218	218	218	230	297	297	297	297
Low Est.	19	44	133	148	173	106	29	27	66	62	42	29	29	57	184	184	184	184	197	263	263	263	263

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
High Est.	378	378	378	378	378	378	378	378	378	378	378	378	378	378	378	378	378	378	378	378	318	30	30
Best Est.	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	252	25	25
Low Est.	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	223	23	23

Scenarios F, E, D, C & A

	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
High Est.	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	36
Best Est.	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	29
Low Est.	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	27

	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082
High Est.	65	65	65	65	65	65	65	65	65	65	65	65	54										
Best Est.	52	52	52	52	52	52	52	52	52	52	52	52	43										
Low Est.	48	48	48	48	48	48	48	48	48	48	48	48	40										

Scenario B

	2050	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081
High Est.	10	58	58	58	58	58	58	58	58	66	109	109	109	109	109	109	109	109	109	109	109	109	109
Best Est.	8	48	48	48	48	48	48	48	48	53	84	84	84	84	84	84	84	84	84	84	84	84	84
Low Est.	7	44	44	44	44	44	44	44	44	50	80	80	80	80	80	80	80	80	80	80	80	80	80

	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104
																			|-Note 5				
High Est.	109	109	109	109	109	109	109	109	109	109	109	100	53	53	53	53	53	53	44				
Best Est.	84	84	84	84	84	84	84	84	84	84	84	77	41	41	41	41	41	41	34				
Low Est.	80	80	80	80	80	80	80	80	80	80	80	73	39	39	39	39	39	39	32				

Scenario Code	Description		Total Cost-Note 6 %	Total Cost-Note 6 $M	Restoration Cost %	Restoration Cost $M	Duration (Months)
F	TOTAL THRU BEGINNING OF EARLY TESTING (Note 1)	High	120	165	36	54	
		Best	100	137	29	27	28
		Low	95	130	10	13	
E	TOTAL THRU END OF EARLY TESTING (Note 2)	High	121	842	38	228	
		Best	100	629	20	106	54
		Low	92	489	10	49	
D	TOTAL THRU END OF LATE TESTING (Note 3)	High	122	1092	E+10M	236	
		Best	100	897	E+10M	118	122
		Low	91	820	E+10M	59	

Scenario Code	Description		Total Cost-Note 6 %	Total Cost-Note 6 $M	Restoration Cost	Restoration Cost $M	Duration (Months)
C	TOTAL THRU NRC DECISION (Note 4)	High	122	1282	Same	236	
		Best	100	1060	as	118	184
		Low	91	964	D	59	
B	TOTAL THRU END OF RETRIEVAL, DECOM., & CLOSURE (Note 5)	High	120	16401	(Included		
		Best	100	12966	In Total)		1318
		Low	90	11984			
A	TOTAL THRU END OF DECOM., BACKFILL, & CLOSURE	High	120	13586	(Included		
		Best	100	10827	In Total)		960
		Low	88	9616			

NOTES:
1) START OF CONSTRUCTION, 24 JUN 1993 (START OF EARLY TESTING).
2) END OF EARLY TESTING, 1 NOV 1995.
3) END OF LATE TESTING, 9 MAY 2001.
4) NRC DECISION, 7 NOV 2004 (42 MONTHS AFTER END OF LATE TESTING).
5) END OF RETRIEVAL, 7 NOV 2100.
6) TOTAL COST EXCLUDES RESTORATION COST UNLESS OTHERWISE STATED.

001308 DEC 07 1990

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TASK 4 ALTERNATIVES STUDY

CASH FLOW

OPTION: B7-SCENARIO 2 (No.30)

	ITEM	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	CONST. SUPPORT	5,300	6,634	8,306	20,600	17,172	11,472	11,000	11,000	11,000	11,000	11,000	7,000	7,000	7,000
	REECO OPERATION	0	1,558	7,078	8,255	14,204	12,222	10,200	8,200	6,200	2,866	2,866	2,866	2,866	2,866
E	LAB TEST SUPPORT	NA	0	0	0	0	0	0	0	0	0	0	0	0	0
	FSN/H&N DESIGN	14,458	19,277	6,426	0	0	0	0	0	0	0	0	0	0	0
S	SITE CONST.	0	19,268	24,401	0	0	0	0	0	0	0	0	0	0	0
	FIRST ENTRY	0	0	38,899	30,565	0	0	0	0	0	0	0	0	0	0
F	ENTRY TEST	0	0	4,065	0	0	0	0	0	0	0	0	0	0	0
	SECOND ENTRY	0	0	40,937	28,527	0	0	0	0	0	0	0	0	0	0
	ENTRY TEST	0	0	363	0	0	0	0	0	0	0	0	0	0	0
	THIRD ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MTL	0	0	0	0	22,590	14,725	7,363	0	0	0	0	0	0	0
	EXPLORATION	0	0	0	9,947	59,684	29,842	0	0	0	0	0	0	0	0
	MTL TEST DRILLING	0	0	0	0	0	15,995	1,599	0	0	0	0	0	0	0
	DESIGN	0	0	11,056	0	0	0	0	0	0	0	0	0	0	0
C	FIRST ENTRY	0	0	0	38,541	18,832	0	0	0	0	0	0	0	0	0
	ENTRY TESTING	0	0		1,756	0	0	0	0	0	0	0	0	0	0
H	SECOND ENTRY	0	0	0	24,416	32,957	0	0	0	0	0	0	0	0	0
	EXPLORATION DRIFTING	0	0	0	0	24,764	28,892	0	0	0	0	0	0	0	0
	TESTING	0	0	0	0	118	710	710	710	710	533	0	0	0	0
	SURFACE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R	DISPOSAL CONTAINERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	CONSTRUCTION	0	0	0	0	0	0	0	9,430	56,560	56,560	34,440	23,390	23,390	56,000
P	EMPLACEMENT OPERATIONS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O	CARETAKER OPERATIONS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S.	DECOMMISSIONING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ESF CONSTRUCTION TOTAL	14,458	38,545	115,091	69,040	82,274	60,562	8,962	0	0	0	0	0	0	0
	ESF OPERATIONS TOTAL	5,300	8,192	15,384	28,855	31,376	23,694	21,200	19,200	17,200	13,866	13,866	9,866	9,866	9,866
	CALICO HILLS TOTAL	0	0	11,056	64,713	76,672	29,602	710	710	710	533	0	0	0	0
	REPOSITORY TOTAL	0	0	0	0	0	0	0	9,430	56,560	56,560	34,440	23,390	23,390	56,000
	PROJECT TOTAL	19,758	46,737	141,531	162,608	190,322	113,858	30,872	29,340	74,470	70,959	48,306	33,256	33,256	65,866

COMPLETION OF EARLY TESTING

TOTAL PROJECT COST AS OF 11/1/1995 529,235

COMPLETION OF LATE TESTING

TOTAL PROJECT COST AS OF 5/1/2001 896,557

COMPLETION OF ESF	OCT.2004
ESF CONSTRUCTION TOTAL	388,932
ESF OPERATIONS TOTAL	227,731
CALICO HILLS TOTAL	184,706
REPOSITORY TOTAL	259,770
PROJECT TOTAL	1061139

001309 DATE 12/6/90 DEC 07 1990

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TASK 4 ALTERNATIVES STUDY

CASH FLOW

OPTION: B7-SCENARIO 2 (No.30)

	ITEM	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	CONST. SUPPORT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REECO OPERATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	LAB TEST SUPPORT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FSN/H&N DESIGN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	SITE CONST.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FIRST ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SECOND ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	THIRD ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MTL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EXPLORATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MTL TEST DRILLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DESIGN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	FIRST ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TESTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H	SECOND ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EXPLORATION DRIFTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TESTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SURFACE FACILITIES	0	0	0	0	13,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000
R	DISPOSAL CONTAINERS	0	0	0	0	21,833	131,000	131,000	131,000	131,000	131,000	131,000	131,000	131,000	131,000
E	CONSTRUCTION	216,350	216,350	216,350	216,350	180,000	0	0	0	0	0	0	0	0	0
P	EMPLACEMENT OPERATIONS	0	0	0	0	14,733	88,400	88,400	88,400	88,400	88,400	88,400	88,400	88,400	88,400
O	CARETAKER OPERATIONS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S.	DECOMMISSIONING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ESF CONSTRUCTION TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ESF OPERATIONS TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CALICO HILLS TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REPOSITORY TOTAL	216,350	216,350	216,350	216,350	229,567	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400
	PROJECT TOTAL	216,350	216,350	216,350	216,350	229,567	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400

001310 DATE 12/6/90 DEC 07 1990

FSN-SD-AS-476 Rev. 4

TASK 4 ALTERNATIVES STUDY

CASH FLOW

OPTION: 87-SCENARIO 2 (No.30)

	ITEM	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
	CONST. SUPPORT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REECO OPERATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	LAB TEST SUPPORT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FSN/H&N DESIGN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	SITE CONST.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FIRST ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SECOND ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	THIRD ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MTL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EXPLORATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MTL TEST DRILLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DESIGN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	FIRST ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TESTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H	SECOND ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EXPLORATION DRIFTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TESTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SURFACE FACILITIES	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000
R	DISPOSAL CONTAINERS	131,000	131,000	131,000	131,000	131,000	131,000	131,000	131,000	131,000	131,000	131,000	131,000	131,000	131,000
E	CONSTRUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P	EMPLACEMENT OPERATIONS	88,400	88,400	88,400	88,400	88,400	88,400	88,400	88,400	88,400	88,400	88,400	88,400	88,400	88,400
O	CARETAKER OPERATIONS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S.	DECOMMISSIONING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ESF CONSTRUCTION TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ESF OPERATIONS TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CALICO HILLS TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REPOSITORY TOTAL	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400
	PROJECT TOTAL	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400	297,400

001311 DATE 12/6/90 DEC 07 1990

FSN-SD-AS-476 Rev. 4

TASK 4 ALTERNATIVES STUDY

CASH FLOW

OPTION: B7-SCENARIO 2 (No.30)

	ITEM	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
	CONST. SUPPORT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REECO OPERATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	LAB TEST SUPPORT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FSN/H&N DESIGN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	SITE CONST.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FIRST ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SECOND ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	THIRD ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MTL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EXPLORATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MTL TEST DRILLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DESIGN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	FIRST ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TESTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H	SECOND ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EXPLORATION DRIFTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TESTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SURFACE FACILITIES	78,000	66,667	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
R	DISPOSAL CONTAINERS	131,000	109,333	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
E	CONSTRUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P	EMPLACEMENT OPERATIONS	88,400	73,667	0	0	0	0	0	0	0	0	0	0	0	0
O	CARETAKER OPERATIONS	0	2,267	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600
S.	DECOMMISSIONING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ESF CONSTRUCTION TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ESF OPERATIONS TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CALICO HILLS TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REPOSITORY TOTAL	297,400	251,933	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600
	PROJECT TOTAL	297,400	251,933	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600

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FSN-SD-AS-476 Rev. 4

TASK 4 ALTERNATIVES STUDY
CASH FLOW

OPTION: B7-SCENARIO 2 (No.30)

	ITEM	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
	CONST. SUPPORT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REECO OPERATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	LAB TEST SUPPORT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FSN/H&N DESIGN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	SITE CONST.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FIRST ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SECOND ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	THIRD ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MTL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EXPLORATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MTL TEST DRILLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DESIGN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	FIRST ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TESTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H	SECOND ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EXPLORATION DRIFTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TESTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SURFACE FACILITIES	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,167	11,000
R	DISPOSAL CONTAINERS	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	833	0
E	CONSTRUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P	EMPLACEMENT OPERATIONS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O	CARETAKER OPERATIONS	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	11,333	0
S.	DECOMMISSIONING	0	0	0	0	0	0	0	0	0	0	0	0	6,761	40,563
	ESF CONSTRUCTION TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ESF OPERATIONS TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CALICO HILLS TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	REPOSITORY TOTAL	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	29,094	51,563
	PROJECT TOTAL	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	24,600	29,094	51,563

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FSM-SD-AS-476 Rev. 4

TASK 4 ALTERNATIVES STUDY
CASH FLOW

OPTION: B7-SCENARIO 2 (No.30)

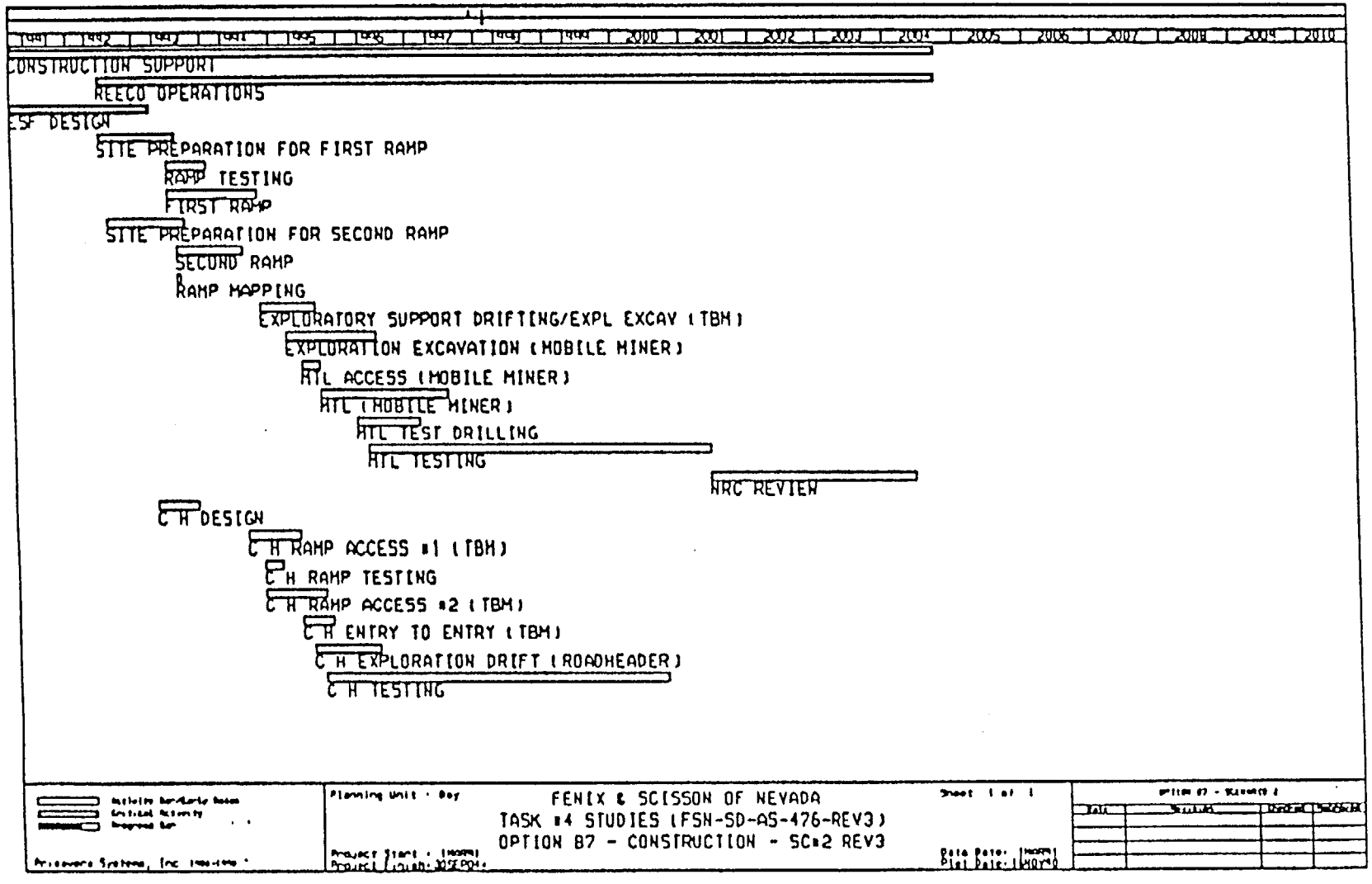
	ITEM	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	TOTALS
	CONST. SUPPORT	0	0	0	0	0	0	0	0	0	0	0	0	145,484
	REECO OPERATION	0	0	0	0	0	0	0	0	0	0	0	0	82,247
E	LAB TEST SUPPORT	0	0	0	0	0	0	0	0	0	0	0	0	0
	FSM/H&N DESIGN	0	0	0	0	0	0	0	0	0	0	0	0	40,161
S	SITE CONST.	0	0	0	0	0	0	0	0	0	0	0	0	43,669
	FIRST ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	69,464
F	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	4,065
	SECOND ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	69,464
	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	363
	THIRD ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	0
	ENTRY TEST	0	0	0	0	0	0	0	0	0	0	0	0	0
	MTL	0	0	0	0	0	0	0	0	0	0	0	0	44,678
	EXPLORATION	0	0	0	0	0	0	0	0	0	0	0	0	99,474
	MTL TEST DRILLING	0	0	0	0	0	0	0	0	0	0	0	0	17,594
	DESIGN	0	0	0	0	0	0	0	0	0	0	0	0	11,056
C	FIRST ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	57,373
	ENTRY TESTING	0	0	0	0	0	0	0	0	0	0	0	0	1,756
H	SECOND ENTRY	0	0	0	0	0	0	0	0	0	0	0	0	57,373
	EXPLORATION DRIFTING	0	0	0	0	0	0	0	0	0	0	0	0	53,656
	TESTING	0	0	0	0	0	0	0	0	0	0	0	0	3,492
	SURFACE FACILITIES	11,000	11,000	11,000	11,000	11,000	11,000	11,000	11,000	11,000	11,000	11,000	9,167	2,343,000
R	DISPOSAL CONTAINERS	0	0	0	0	0	0	0	0	0	0	0	0	3,300,000
E	CONSTRUCTION	0	0	0	0	0	0	0	0	0	0	0	0	1,305,170
P	EMPLACEMENT OPERATIONS	0	0	0	0	0	0	0	0	0	0	0	0	2,210,000
O	CARETAKER OPERATIONS	0	0	0	0	0	0	0	0	0	0	0	0	340,000
S.	DECOMMISSIONING	40,563	40,563	40,563	40,563	40,563	40,563	40,563	40,563	40,563	40,563	40,563	33,803	527,324
	ESF CONSTRUCTION TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	388,932
	ESF OPERATIONS TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	227,731
	CALICO HILLS TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	184,706
	REPOSITORY TOTAL	51,563	51,563	51,563	51,563	51,563	51,563	51,563	51,563	51,563	51,563	51,563	42,969	10,025,494
	PROJECT TOTAL	51,563	51,563	51,563	51,563	51,563	51,563	51,563	51,563	51,563	51,563	51,563	42,969	10,826,863

001314

DATE 12/6/90

DEC 07 1990

CLOSURE OF REPOSITORY
NOV. 2072



001315 DEC 07 1990

EARLY START	EARLY FINISH	
18APR96		COMPLETION OF C H EARLY TESTING
	25JUN96	COMPLETION OF TS EARLY DRIFTING
9MAY01		START OF NRC REVIEW

1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

Activity Bar/Critical Dates
Critical Activity
Progress Bar

Primavera Systems, Inc. 1990-1990

Planning Unit - Day

Project Start : 18APR91
Project Finish: 30SEP04

FENIX & SCISSON OF NEVADA
TASK #4 STUDIES (FSN-SD-AS-476-REV1)
OPTION B7 -MILESTONES- SC#2 REV 1

Sheet 1 of 1

Data Date: 18APR91
Plot Date: 9NOV90

OPTION B7 - MILESTONES 2

Date	Revision	Checked	Approved

001316 DEC 07 1990

EARLY START	EARLY FINISH	
1MAR91	1DEC91	TRANSFORMERS PROCUREMENT
16FEB92	23JUN93	TBM PROCUREMENT
2APR92	8AUG93	TBM PROCUREMENT
21MAR93	27JUL94	C H TBM PROCUREMENT
12JUN93	18OCT94	C H TBM PROCUREMENT
12OCT93	1MAR95	MOBILE MINER PROCUREMENT
12JAN94	20MAY95	SECOND MOBILE MINER PROCUREMENT
12APR94	18AUG95	C H ROADHEADER PROCUREMENT

1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

Activity Bar/Early Bars
Critical Activity
Progress Bar

Primavera Systems, Inc. 1990-1991

Planning Unit - Day

FENIX & SCISSON OF NEVADA
TASK #4 STUDIES (FSN-SD-AS-476-REV1)
OPTION B7 -PROCUREMENT- SC#2 REV 1

Sheet 1 of 1

Project Start : 1MAR91
Project Finish: 30SEP94

Data Date: 1MAR91
Plot Date: 6NOV90

OPTION B7 - SCENARIO 2

DATE	REVISED	DRAWN	CHECKED

001317 DEC 07 1990

MIX & SCISSON OF NEVADA — FINEST HOUR — TASK #4 STUDIES (FSN-SD-AS-476-REV3)

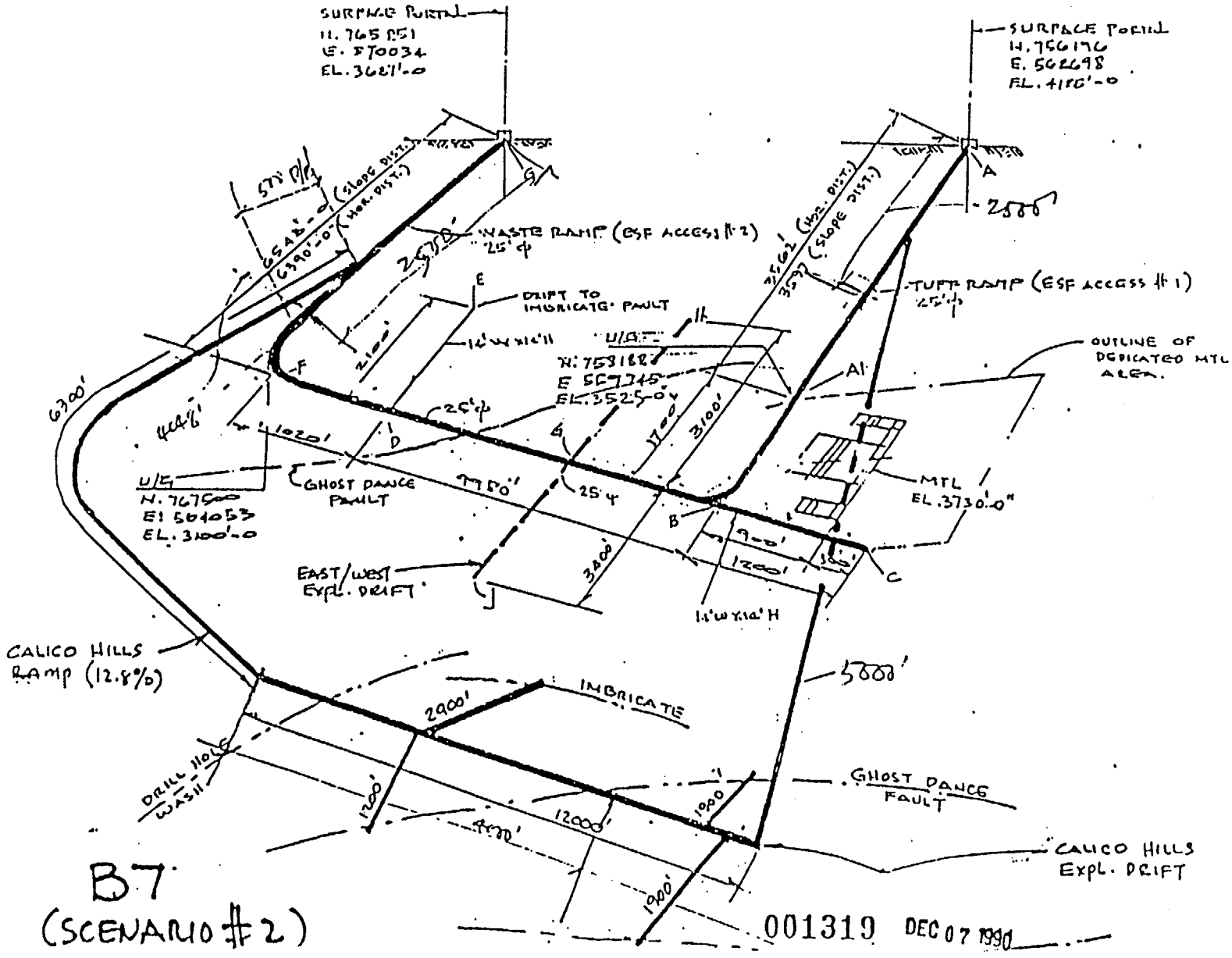
REPORT DATE 16NOV90 RUN NO. 19 — OPTION 87 - SCENARIO 2 — START DATE 1MAR91 FIN DATE 30SEP04*

9:28

ACTIVITY REPORT — DATA DATE 1MAR91 PAGE NO. 1

ACTIVITY ID	ORIG DUR	REM DUR	CAL	%	ACTIVITY DESCRIPTION	SCHEDULED START	SCHEDULED FINISH
OPERATIONS AND TESTING							
1	3356	3356	1	0	CONSTRUCTION SUPPORT	1MAR91	30SEP04
2	4278	4278	2	0	REECO OPERATIONS	22JUN92	30SEP04
PROCUREMENT							
3	270	270	2	0	TRANSFORMERS PROCUREMENT	1MAR91	10DEC91
4	475	475	2	0	TBM PROCUREMENT	16FEB92*	23JUN93
5	475	475	2	0	TBM PROCUREMENT	2APR92*	8AUG93
42	475	475	2	0	C N TBM PROCUREMENT	21MAR93*	27JUL94
43	475	475	2	0	C N TBM PROCUREMENT	12JUN93*	18OCT94
6	475	475	2	0	MOBILE MINER PROCUREMENT	12OCT93*	1MAR95
26	475	475	2	0	SECOND MOBILE MINER PROCUREMENT	12JAN94*	20MAY95
25	475	475	2	0	C N ROADHEADER PROCUREMENT	25FEB94*	2JUL95
DESIGN							
7	518	518	1	0	ESF DESIGN	1MAR91	2APR93
1ST RAMP							
8	281	281	1	0	SITE PREPARATION FOR FIRST RAMP	22JUN92	9AUG93
9	200	200	2	0	RAMP TESTING	24JUN93	24JAN94
10	463	463	2	0	FIRST RAMP	24JUN93	18OCT94
SECOND RAMP							
11	281	281	1	0	SITE PREPARATION FOR SECOND RAMP	4AUG92	21SEP93
12	336	336	2	0	SECOND RAMP	9AUG93	27JUL94
13	19	19	2	0	RAMP MAPPING	9AUG93	27AUG93
UNDERGROUND FACILITY							
14	274	274	2	0	EXPLORATORY SUPPORT DRIFTING/EXPL EXCAV (TBM)	19OCT94	4AUG95
17	464	464	2	0	EXPLORATION EXCAVATION (MOBILE MINER)	2MAR95	25JUN96
31	96	96	2	0	MTL ACCESS (MOBILE MINER)	21MAY95	26AUG95
15	650	650	2	0	MTL (MOBILE MINER)	27AUG95	10JUL97
18	320	320	2	0	MTL TEST DRILLING	9MAR96	7FEB97
19	1742	1742	2	0	MTL TESTING	8MAY96	8MAY01
20	1046	1046	2	0	NRC REVIEW	9MAY01	9MAY04
PROJECT MILESTONES							
40	0	0	2	0	COMPLETION OF C N EARLY TESTING	1NOV95	
37	0	0	2	0	COMPLETION OF TS EARLY DRIFTING		25JUN96
41	0	0	2	0	START OF NRC REVIEW	9MAY01	
CALICO HILLS							
27	155	155	1	0	C N DESIGN	5APR93	10NOV93
33	263	263	2	0	C N RAMP ACCESS #1 (TBM)	28JUL94	1MAY95
24	81	81	2	0	C N RAMP TESTING	19OCT94	20JAN95
28	309	309	2	0	C N RAMP ACCESS #2 (TBM)	19OCT94	9SEP95
29	167	167	2	0	C N ENTRY TO ENTRY (TBM)	2MAY95	18OCT95
32	339	339	2	0	C N EXPLORATION DRIFT (ROADHEADER)	3JUL95	22JUN96
30	1742	1742	2	0	C N TESTING	1SEP95	31AUG00

001318 DEC 07 1990



B7
(SCENARIO #2)

001319 DEC 07 1990

08-Nov-90
erg

DATA: OPTION 30 B7

REPOSITORY ENGINEERING COST
(A/E plus Support Contractor)

CONSTANT 1989 $ (millions)

Cal Yr	Escal %	Escal factor	Title I and Title II LAD Mos dur	LAD % of task	LAD Cost est.	FPCO Mos dur	FPCO % of task	FPCO Cost est.	Title III Mos dur	Title III % of task	Title III Cost est.	ENGR TOTAL	GRAND TOTAL
1989	BASE	1.000	30	100	$141.39	42	100	$81.86	60	100	$11.75	$235.00	
1990	0.0%	1.000	0	0	$0.00	0	0	$0.00	0	0	$0.00	$0.00	$0
1991	0.0%	1.000	0	0	$0.00	0	0	$0.00	0	0	$0.00	$0.00	$0
---	0.0%	1.000	0	0	$0.00	0	0	$0.00	0	0	$0.00	$0.00	$0
Nov-98	0.0%	1.000	2	6.66	$9.43	0	0	$0.00	0	0	$0.00	$9.43	$9
Jan-99	0.0%	1.000	12	40	$56.56	0	0	$0.00	0	0	$0.00	$56.56	$57
Jan-2000	0.0%	1.000	12	40	$56.56	0	0	$0.00	0	0	$0.00	$56.56	$57
Jan-2001	0.0%	1.000	4	13.3	$18.85	8	19.0	$15.59	0	0	$0.00	$34.44	$34
Jan-2002	0.0%	1.000	0	0	$0.00	12	28.5	$23.39	0	0	$0.00	$23.39	$23
Jan-2003	0.0%	1.000	0	0	$0.00	12	28.5	$23.39	0	0	$0.00	$23.39	$23
Jan-2004	0.0%	1.000	0	0	$0.00	10	23.8	$19.49	2	3.33	$0.39	$19.88	$56
Jan-2005	0.0%	1.000	0	0	$0.00	0	0	$0.00	12	20	$2.35	$2.35	$216
Jan-2006	0.0%	1.000	0	0	$0.00	0	0	$0.00	12	20	$2.35	$2.35	$216
Jan-2007	0.0%	1.000	0	0	$0.00	0	0	$0.00	12	20	$2.35	$2.35	$216
Jan-2008	0.0%	1.000	0	0	$0.00	0	0	$0.00	12	20	$2.35	$2.35	$216
Nov-2009	0.0%	1.000	0	0	$0.00	0	0	$0.00	10	16.6	$1.96	$1.96	$180
TOTAL					$141.39			$81.86			$11.75	$235.00	-

DEC 07 1990

001320

REPOSITORY DATA SHEET

COST AND STAFFING DATA

OPTION NUMBER: 30
B7, SCENARIO 2

		COST (Millions 1989 Constant $) High Cost	Estimated Cost	Low Cost	STAFFING Total Man-Hours (Note 1)	Mechanical Excavation (Note 2)	Drill and Blast Excavation (Note 3)	Peak Workforce (Note 4)
Repository Underground Facilities	Phase 1 Initial Construction 5 yrs	25%	$470	-15%	4,058,500	47%	4%	487 1.2 x avg
	Phase 2 Emplacement Operations 25 yrs	30%	$2,210	-15%	34,385,500	33%	0.4%	688 1.0 x avg
	Phase 3 Caretaker Operations 25 yrs	17%	$340	-7%	6,355,300	0%	0%	127 1.0 x avg
	Phase 4 Backfill and Closure 12 yrs	27%	$480	-7%	7,920,500	0%	0%	383 1.2 x avg
	Total	28%	$3,500	-13%	52,719,800	25%	1%	
Repository Surface Facilities	Total	$3,120 (Source: 1990 TSLCC Case 2T)						
Repository Disposal Containers	Total	$3,300 (Source: 1990 TSLCC Case 2T)						
Repository Grand Total		$9,920						

Notes:

(1) Total manhours represents all underground workers, direct supervisors, and technical support personnel and includes a contingency percentage equal to what is applied to the costs.

(2) Mechanical excavation includes TBMs, shaft drills, raise boring, and emplacement borehole drilling. Reported proportion refers to all personnel that participate in the excavation effort (e.g., supervisors, nippers, and those present in the heading).

(3) Drill and blast excavation includes shafts and drift excavation. Comment in note 2 about included persons also applies.

(4) Staffing numbers are based on 2000 hours per full time equivalent. Peak staffing values are estimated as a percentage of the average staffing over the entire period.

All numbers are rounded to the nearest $10 million.

Repository related Calico Hills costs are not included.

SOURCE: [CSUM-B7.WO1] 05-Oct-90

001321 DEC 07 1990

SCHEDULE

Option Number: 30 B7, Scenario 2		Expected Construction Duration (Months) High	Projected	Low
Repository Underground Facilities	Phase 1 Initial Construction 5 yrs	55 (4)	54 (1)	46 (5)
	Phase 2 Emplacement Operations 25 yrs	288	282 (2)	274
	Phase 3 Caretaker Operations 25 yrs	300	300	300
	Phase 4 Backfill & Closure variable (7)	298	149	149 (6)
Repository Surface Facilities	Total (3)	N/A	57	N/A

Notes:

(1) Duration refers to the time required to construct and prepare the Minimum Functional Emplacement Area.
(2) Duration refers to the time required to complete mining and drilling of the repository to its full capacity of 70,000 MTU.
(3) Reported value applies to the time required to complete surface facilities and begin receiving waste.
(4) Reported values take into account unforeseen interruptions and delays in the construction of the critical openings.
(5) Reported values include additional work shifts and better performance in the construction of the critical openings.
(6) Backfill and closure duration is restricted by ventilation capabilities.
(7) Repository related Calico Hills backfill requirements are not included.

001322 DEC 07 1990

SOURCE: [B7_SCH.WK1] 05-Oct-90

ESF Alternatives Study

Data Sheets

for

Testing Input

Options 13 (B7) and 30 (B7)[1]

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1. The testing program for the initial 17 options (Options 1 through 17) was evaluated prior to the addition of Options 18 through 34. This evaluation, the evaluation for Options 1 through 17, was assumed to apply equally to both the early Topopah Spring testing strategy and the early Calico Hills testing strategy. Therefore, the testing evaluation for Option 17 is presented as part of the Option 30 data set.

OPTION B7

INCLUDED:

PART II TESTING

TEST 1.	Geologic Mapping of the Exploratory Shaft and Drifts
TEST 2.	Mineralogy and Petrology of Candidate Host Rock
TEST 3.	Seismic Tomography/Vertical Seismic Profiling
TEST 4.	Shaft Convergence
TEST 5.	Demonstration Breakout Rooms
TEST 6.	Sequential Drift Mining
TEST 7.	Heater Experiment in Unit TSw1
TEST 8.	Canister -Scale Heater Experiment
TEST 9.	Yucca Mountain Heated Block
TEST 10.	Thermal Stress Measurements
TEST 11.	Heated Room Experiment
TEST 12.	Development and Demonstration of Required Equipment.
TEST 13.	Plate Loading Tests
TEST 14.	Rock-Mass Strength Experiment
TEST 15.	Evaluation of Mining Methods
TEST 16.	Monitoring of Ground Support Systems
TEST 17.	Monitoring Drift Stability
TEST 18.	Air Quality and Ventilation Experiment
TEST 19.	In-situ Testing of Seal Components

INCLUDED:

TEST 20.	Overcore Stress Experiments in the Exploratory Shaft Facility
TEST 21.	Matrix Hydrologic Properties Testing
TEST 22.	Intact-Fracture Test in the Exploratory Shaft Facility
TEST 23.	Percolation Tests in the Exploratory Shaft Facility
TEST 24.	Bulk-Permeability Test in the Exploratory Shaft Facility
TEST 25.	Radial Borehole Tests in the Exploratory Shaft Facility
TEST 26.	Excavation Effects Test in the Exploratory Shaft Facility
TEST 27.	Calico Hills Test in the Exploratory Shaft Facility
TEST 28.	Perched-Water Test in the Exploratory Shaft Test Facility
TEST 29.	Hydrochemistry Tests in the Exploratory Shaft Test Facility
TEST 30.	Diffusion Tests in the Exploratory Shaft Test Facility
TEST 31.	Chloride and Chlorine-36 Measurements of Percolation at Yucca Mountain
TEST 32.	Engineered Barrier System Field Tests
TEST 33.	Laboratory Tests)Thermal and Mechanical) Using Samples Obtained from the ESF
TEST 34.	Multipurpose-Borehole Testing Near the ESF
TEST 35.	Hydrologic Properties of Major Faults Encountered in Main Test Level of the Exploratory Shaft Facility
IDS	Integrated Data System

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE MAY 8, 1990

ESF TEST GEOLOGIC MAPPING OF EXPLORATORY SHAFTS AND DRIFTS

PREPARERS:

ESF Test Organization (USGS/USBR) Steven C. Beason
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
MARK McLEOWN	Mark McLeown	USGS/USBR	May 8, 1990

TEST REFERENCE (Regulatory): 10 CFR 60.21, 10 CFR 60.113, INFO NEEDS 1.6.1 through 1.6

TEST SUPPORTS (Check) Repository Design (X) Site Suitability (X) (Characterization) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.4.2.2.4

SDRD Rev 1 Section B-GEO-1 (Attached)

Other Characterization of Structural Features in the Site Area (Study Plan)

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (x)

Exploratory Drifts (x)

TEST EVALUATION RATIONALE AND DISCUSSION
TEST NAME: UNDERGROUND GEOLOGIC MAPPING
OPTION NUMBER: B7

1) PURPOSE OF THE TEST: To gather specific geologic information from the walls of the various ESF excavations by detailed geologic mapping by photogrammetry and detail line surveys. Information needs: Analyses of the geology and hydrogeology, hydrogeologic properties and conditions, including the orientation, distribution, aperture infilling and origin of fractures, discontinuities, and heterogeneities is necessary for site characterization, and are specifically required by 10 CFR 60.21 for license applications. More specifically, information obtained helps satisfy performance issue 1.6: "Will the site meet the performance objectives for pre-waste-emplacement ground-water travel time as required by 10 CFR 60.113?," and information needs 1.6.1. through 1.6.4. The data to meet the information needs were derived by applying performance allocation to the performance and design issues described in the SCP.

2) Mapping will be performed on all excavation surfaces (except floors) in the ESF. In machine excavated ramps, mapping will probably be done immediately behind the tunnel boring machine. For complete photographic coverage of the excavation mapping must be done in an area free of obstructions of the tunnel periphery. Mapping will require that the installation of chain-link fabric and/or shotcrete be delayed until the walls of the drifts are stereophotographed.

3) The quality of geologic data in this option will be inferior to the base case as no shafts are planned. A shaft within the proposed repository block is important to characterization of the fractures from the surface down.While a machine excavated shaft will allow collection of large-scale fracture data, the small-scale data may be difficult and/or time consuming to obtain. Small-scale fractures will also be difficult to obtain in machine excavated drifts. Small-scale fractures will also be difficult to obtain in machine excavated drifts. The excavation of the ramps will however, allow mapping of the structural regime east of the proposed repository block.

4) All excavations will be fully mapped throughout the ESF.

5) Mapping in machine bored excavations will take considerably longer than drill-blast excavations because of the difficulty of collecting small scale fracture data in machine excavations. We estimate approximately 1 shift (8 hours) per 6-8 lineal feet of drift. Because of of access to heading of the inclined drift, travel time will become a consideration in scheduling as the length of the drift increases.

6) This option is inferior to the base case because of the absence of shafts. Since the waste ramp is fairly steep, travel time to the heading will become a consideration as the ramp lengthens. The option does, however, allow examination of the structural regime southeast of the proposed repository block, and through the length of the center of the block. Note drawing shows three accesses (1 shaft).

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/7/90

ESF TEST MINERALOGY AND PETROLOGY OF CANDIDATE HOST ROCK

PREPARERS:

ESF Test Organization (Los Alamos) DAVID BROXTON
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
David Vaniman	David Vaniman	LANL	5/9/90

TEST REFERENCE (Regulatory): 10CFR 60.15, .21, .122

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (x) Both ( )
(Characterization)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.3.2.1.1, 8.3.1.3.2.1.3, 8.3.1.3.2.2.1

SDRD Rev 1 Section B-GEO-2 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (Includes Calico Hills Test) (x)

Exploratory Drifts (x)

Attachment to Testing Data Sheet

DATE: 5/2/90

TEST EVALUATION RATIONALE AND DISCUSSION

TEST NAME: Mineralogy-Petrology

OPTION NUMBER: B7

For this option, provide information supporting the evaluation of test feasibility and data quality. This information must include specific references to the following items:

1) Purpose of the Test (Tie to issues and critical information needs, major parameters.)
2) The ability to install and conduct the test relative to BASE CASE.
3) The quality of data obtained, relative to BASE CASE.
4) Location(s) of the test relative to BASE CASE.
5) Estimate of time (Schedule) for the test, including
   a) Installation
   b) Initial testing
   c) Longer - term test monitoring
5) Preliminary assessment of the option's flexibility, regarding the test, to allow expansion of the test confirmation or additional testing. This assessment should be made relative to the BASE CASE.

This option is superior to the base case because the two inclined ramps provide better opportunities to characterize fault and fracture mineralogy at the site. This option is the preferred option of Mineralogy-Petrology studies. Because vertical variations in the Topopah Spring Member will be addressed by drill holes of the surface-based drilling program, we want to maximize our characterization of lateral features and of vertical features (eg. faults and fractures) poorly sampled by vertical drill holes and shafts. For these reasons, we favor use of inclined ramps, particularly from an easterly direction, to examine vertical and lateral variations in bulk rock and fault/fracture mineralogy. Another advantage of this option is that it allows much greater characterization of the repository horizon (particularly away from the MTL area) than many of the other options.

This option would be improved by adding: 1) a drift to intersect the Ghost Dance fault at a second location, 2) a drift to intersect Solitario Canyon fault and 3) a drift NE-SW in the tuff of Calico Hill unit (should extend Southwestwards at least until the transition from zeolitic to vitric tuffs is penetrated). The Characterization of the Calico Hills barrier should a be major goal of the ESF. The present option description is vague about how far workings will penetrate the Calico Hills. We believe that ramps should not only reach the Calico Hills, but should extend laterally as far as possible to allow examination of as much of the unit as possible.

Test schedule has minimal impact relative to Base Case.

Additional Comments about Mineralogy-Petrology Studies in the Exploratory Shaft Facility (ESF)

The purpose of Mineralogy-Petrology studies in the ESF is to:
1. determine the vertical and lateral mineralogic, chemical, and textural variability of the candidate host rock,
2. evaluate the alteration history of the candidate host rock and the underlying tuff of Calico Hills, and
3. determine the distribution, origin, and retardation potential of fault- and fracture-lining minerals in the candidate host rock and tuff of Calico Hills.
Mineralogy-Petrology studies in the ESF will complement similar studies based on the characterization of core samples from the surface-based drilling program and of samples from surface exposures.

We offer the following observations about the general features of the 17 ESF design options now under review. These observations supplement the review sheets for the ES options and summarize our preferences for layouts for Mineralogy-Petrology studies. We recognize the final ES layout must satisfy the competing needs of many program participants and appreciate the opportunity to express our needs for this facility. To briefly summarize and prioritize the more detailed discussion below, we support 1) options with ramp access from the east, 2) options that include ramp access and increased spatial access to increase sample representativeness and 3) excavation of ramps using tunnel boring machines and excavation of vertical shafts using drilling and blasting techniques.

Vertical shafts in the ESF provide an opportunity to characterize vertical variations in bulk rock and fracture mineralogy in the tuff of Calico Hills. For studies of bulk rock mineralogy, chemistry, and textures, the vertical shafts provide information that is similar in quality and usefulness to that provided by drill holes in the surface-based drill program. Vertical shafts can provide access to long vertical sections of dominantly vertical fractures, enabling us to examine vertical variations in mineralogy and percent coverage in individual fractures. However, based on our present knowledge of fracture-mineralogy heterogeneities, it is unlikely that information about fracture mineralogy in the shafts can be extrapolated laterally to other parts of the exploratory block. Should a vertical shaft(s) be a component of the ESF, we are certainly interested in complementing the data we expect to collect from the surface-based drilling program by examining shaft samples. Our characterization activities will benefit most from the continuous lateral exposures provided by inclined ramps, particularly those that approach the potential repository horizon from the east. These ramps will cross the complex system of faults that bound the eastern side of the exploration block and provide a more continuous exposure of the bedded tuffs that may form a capillarity barrier on top of the Topopah Spring Member. We are particularly interested in the opportunity to compare the mineralogy and chemistry of hydrogenic deposits in the Bow Ridge fault at depth with the results of similar studies conducted in Trench 14. Characterization of the Bow Ridge fault could include construction of a drift along the fault strike and drilling of the fault at depth. These studies will support activities attempting

to distinguish between deep ground-water and surface-water as the transporting medium in these deposits. Inclined ramps from the east also provide an excellent opportunity to examine the imbricate fault zone for evidence of ground water movement in fractures; evidence of fracture flow can include direct detection of water or gels in fractures, or dating of secondary minerals that line faults and fractures. Thorough characterization of these largely vertical structures is best accomplished in the subhorizontal workings of inclined ramps.

In general, we support the use of tunnel boring machines (TBM) over drilling and blasting (DB) methods for the excavation of inclined ramps and of lateral drifts at the repository level. The TBM will preserve the geologic features and their interrelationships in a natural state better than the DB methods. The DB methods will disturb the drift walls and complicate interpretation of primary features. We need access to drift walls to conduct our studies and collect samples whether the excavation is done by TBM or DB.

If the ESF design includes a vertical shaft(s), the DB excavation method is preferred to the TBM methods because access to shaft walls is limited before a liner is emplaced; thus our studies will rely on the use of muck samples for characterization. The elevation from which the muck samples are derived must be well known if the shaft is to be useful for characterizing vertical variations in rock properties. In addition, the DB methods will result in the excavation of large blocks for characterization activities. TBM methods will generally produce small chips that are less satisfactory for testing.

Of the 17 ES layouts proposed, we are most interested in those that incorporate a NE-SW drift that traverses the length of the exploration block. We believe these layouts will allow a more thorough characterization of lateral variability of the candidate host rock and a better understanding of faults and fractures at the repository level. We agree with the NWTRB's recommendation to intersect the Ghost Dance fault in two locations; as mentioned above, there may be significant variations in the mineralogy of the fault-lining minerals. In addition, we suggest that at least one lateral drift be constructed to the Solitario Canyon fault which bounds the west side of the exploration block. Characterization of faults at Yucca Mountain is important because mineral veinlets in these faults provide a record of past ground water transport and information about the history of fault movement.

Finally, we believe the ESF design should include a provision for characterization of the tuff of Calico Hills. This unit is one of the primary physical and geochemical barriers to radionuclide migration and should be as thoroughly characterized as the candidate host rock for the repository. From a Mineralogy-Petrology perspective, the most complete characterization can be accomplished by a drift that extends from NE to SW; this drift would provide access for characterization of the zeolitic tuffs, their fracture mineralogy, and the transition zone separating the vitric and zeolitic facies of the Calico Hills. Access ramps or shafts to the Calico Hills would provide opportunities to examine major lithologic boundaries beneath the repository, including the top and base of the vitrophyre.

Based on the discussion above, we believe option B7 is the layout that provides Mineralogy-Petrology researchers the best opportunity for completing comprehensive site characterization of the candidate host rock. Possible variants of option B7, including multilevel layouts and MTL areas located in the central or northern part of the exploration block, are also acceptable as long as the inclined ramps from the east and long NE-SW repository-level drift are included in the design. We recognize the final ES layout must satisfy the competing needs of many program participants.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/2/90

ESF TEST SEISMIC TOMOGRAPHY AND VERTICAL SEISMIC PROFILING

PREPARERS:

ESF Test Organization (USGS/Lawrence Berkeley Laboratory) Robert W. Craig
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
MERRICK S. WHITFIELD	Merrick S. Whitfield	USGS-WRD	5/4/90

TEST REFERENCE (Regulatory): 10 CFR 60.21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) (x) Both ( )

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.4.2.2.5

SDRD Rev 1 Section B-GEO-3 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (x)

Exploratory Drifts (x)

TEST EVALUATION RATIONALE AND DISCUSSION

Date: May 3, 1990

TEST NAME: Seismic Tomography and Vertical Seismic Profiling
OPTION NUMBER: 13 (B7)

1) Purpose of test: Provide information relative to the following issues: Issue 4.4, fracture distribution, seismic properties, relation to fracture properties; seismic shear-wave amplitudes; seismic shear-wave polarizations; seismic shear-wave travel times; seismic-wave propagation characteristics. Issue 4.4, geologic model synthesis, relationships among geochemical test results, VSP fracture data, and lithologic data; relationships among geomechanical test results, VSP fracture data, and lithologic data.

2) Ability to conduct test: Better with two ramps over two shafts.

3) Quality of data obtained: Better without blast damage.

4) Location(s) of the test: Provides additional data.

5) Estimate of time for test:

a) Installation: 14 days (equivalent to 7 tests).

b) Initial Testing: Five to ten hours per each test.

c) Longer-term monitoring: None

6) Preliminary assessment of flexibility: No significant difference from base case.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST SHAFT CONVERGENCE

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

James T. George	James T. George	SNL 6314	05/04/90
Name	Signature	Organization	Date

TEST REFERENCE (Regulatory): 10CFR60.21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.5.1

SDRD Rev 1 Section B-MECH-1 (Attached)

Other Excavation Investigations (Study Plan)

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level ( )

Exploratory Drifts ( )

OPTION 13 (B7)

TEST 4: SHAFT CONVERGENCE DATE: 5-4-90

Ability in Base Case	Ability of Option With Respect to the Base Case
Provides verification of shaft design assumptions and early data for model evaluation. Convergence measurements are planned at 3 locations incl. PTn, TSw1, and TSw2 horizons. Provides continuous data (MPBX) and cross-shaft measurements at regular time intervals. Test also includes overcore stress measurements and shaft liner pressure measurements.	Option is inferior to the Base Case. The use of two ramps as ESF accesses does not allow the Shaft Convergence Experiment to be conducted. However, convergence measurements will be made in each of the ramps as part of the drift stability monitoring experiment. Similar types of measurements will be made in this test, however, both ramps are off the repository block. The location of the shaft, MTL, and ramp in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

Option 13 (B7)

Test 4 Shaft Convergence

Schedule Impact:

Installation and Initial Testing:

Shaft convergence tests will not be performed. Therefore, there is no schedule impact.

Longer Term Test Monitoring:

Shaft convergence tests will not be performed. Therefore, there is no schedule impact.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST DEMONSTRATION BREAKOUT ROOMS

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A Blankenship		6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.21, 10CFR60.133

TEST SUPPORTS (Check): Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.5.2

SDRD Rev 1 Section B-MECH-2 (Attached)

Other Excavation Investigations (Study Plan)

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (x)

Exploratory Drifts ( )

OPTION 13 (B7) DATE: 5-4-90

TEST 5: DEMONSTRATION BREAKOUT ROOMS

Ability in Base Case	Ability of Option With Respect to the Base Case
Provides verification of design assumptions and early data for repository drift alignment. Data will be used to validate numerical models used to predict preclosure performance. Requires installation of MPBXs and tape extensometers at the working face as the DBR is excavated. The DBRs will be conducted in both TSw1 and TSw2 at the MTL.	Option is inferior to the Base Case. Upper DBR could not be conducted as described in the Base Case. Flexibility exists to construct the upper DBR in either ramp at TSw1, however, the data obtained may be of lesser quality because the ramp is off the repository block. The location of the shaft, MTL, and ramp in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-15-90

OPTION 13 (B7)

TEST 5: DEMONSTRATION BREAKOUT ROOMS

Schedule Impact:

See SDRD for DBR construction schedule

If Demonstration Breakout Rooms are constructed from the ramp, there is potential, yet unknown impact on ramp construction.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST SEQUENTIAL DRIFT MINING

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Douglas A. Blankenship — Name
Signature — Organization 6314 — Date 5/4/90

TEST REFERENCE (Regulatory): 10CFR Part 60.21, 10CFR60.133

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.5.3

SDRD Rev 1 Section B-MECH-3 (Attached)

Other Excavation Investigations (Study Plan)

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (x)

Exploratory Drifts ( )

OPTION 13 (B7) DATE: 5-15-90

TEST 6: SEQUENTIAL DRIFT MINING

Ability in Base Case	Ability of Option With Respect to the Base Case
Provides verification of design assumptions and estimates of rock mass relaxation. Data will be used to validate numerical models used to predict preclosure performance. Requires installation of MPBXs and tape extensometer anchors at the working face and from adjacent drifts.	Option is equivalent to the Base Case. Test is conducted at the MTL. Larger test expansion area allows the flexibility to conduct additional Sequential Drift Mining Experiments at the MTL or in alcoves off the main. The location of the MTL in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094).

DATE: 5-4-90

OPTION 13 (B7)

TEST 6: SEQUENTIAL DRIFT MINING

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST HEATER EXPERIMENT IN UNIT TSw1

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins)

CHECKED BY:

James T. George	James T. George	SNL 6314	05/04/90
Name	Signature	Organization	Date

TEST REFERENCE (Regulatory): 10 CFR Part 60.21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.6.1

SDRD Rev 1 Section B-MECH-4 (Attached)

Other _____

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level ( )

Exploratory Drifts ( )

OPTION 13 (B7) DATE: 5-15-90

TEST 7: HEATER EXPERIMENT IN UNIT TSw1

Ability in Base Case	Ability of Option With Respect to the Base Case
Provides information on the thermomechanical response of high-lithophysal tuff (TSw1) to elevated temperatures. Data will be used to validate the numerical models used to predict preclosure performance. Test to be conducted in the upper DBR after construction is complete. No requirement for instrument installation prior to or during construction.	Option inferior to the Base Case. Shaft accessed upper DBR will not exist. This option allows for conducting heater experiments in a DBR from either ramp or in an alcove off the ramps. The information obtained from such tests may be of lesser quality because the ramps are off the repository block. The location of the MTL, and ramp in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094).

DATE: 5-4-90

OPTION 13 (B7)

TEST 7: HEATER EXPERIMENT IN UNIT TSw1

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST CANISTER-SCALE HEATER EXPERIMENT

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A. Blankenship	[signature]	6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.6.2

SDRD Rev 1 Section B-Mech-5 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (x)

Exploratory Drifts ( )

OPTION 13 (B7) DATE: 5-15-90

TEST 8: CANISTER-SCALE HEATER EXPERIMENT

Ability in Base Case	Ability of Option With Respect to the Base Case
Provides information on the thermomechanical response of TSw2 to elevated temperatures at the waste emplacement canister scale. Data will be used to validate the numerical models used to predict preclosure performance. Test to be conducted in an alcove in the MTL. No requirement for instrument installation prior to or during construction	Option is equivalent to the Base Case. Test is conducted at the MTL. Larger test expansion areaallows the flexibility to conduct additional Canister Scale Heater Experiments at the MTL or in alcoves off the main. The location of the MTL, in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094).

DATE: 5-4-90

OPTION 13 (B7)

TEST 8: CANISTER-SCALE HEATER EXPERIMENT

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST HEATED BLOCK

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A. Blankenship	[signature]	6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.6.3

SDRD Rev 1 Section B-MECH-6 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (x)

Exploratory Drifts ( )

OPTION 13 (B7) DATE: 5-15-90

TEST 9: YUCCA MOUNTAIN HEATED BLOCK

Ability in Base Case	Ability of Option With Respect to the Base Case
Provides information on the thermomechanical response of TSw2 to elevated temperatures under controlled boundary conditions. Data will be used to validate the numerical models used to predict preclosure performance. Test to be conducted in alcove in the MTL. No requirement for instrument installation prior to or during construction.	Option is equivalent to the Base Case. Test is conducted at the MTL. Larger test expansion area allows the flexibility to conduct additional Heated Block Experiments at the MTL or alcove off the main. The location of the MTL in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

OPTION 13 (B7)

TEST 9: YUCCA MOUNTAIN HEATED BLOCK

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST THERMAL STRESS MEASUREMENTS

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A. Blankenship	[signature]	6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.21

TEST SUPPORTS (Check) Repository Design (x) Site Suitability ( ) Both ( )
(Characterization)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.6.4

SDRD Rev 1 Section B-MECH-7 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (x)

Exploratory Drifts ( )

OPTION 13 (B7) DATE: 5-15-90

TEST 10: THERMAL STRESS MEASUREMENTS

Ability in Base Case	Ability of Option With Respect to the Base Case
Provides information on the thermomechanical response of a the significant volume of the repository host rock around a the repository sized drift subjected high thermal stresses. Data will be used to validate the drifts numerical models used to the predict preclosure performance. Data will also be used to evaluate drift design and ground support assumptions. Test is to conducted in the lower DBR at fracture the MTL. No requirement for instrument installation prior to during construction.	Option equivalent to the Base Case. Test is conducted in lower DBR at the MTL. Larger test expansion area allows flexibility to conduct to additional Thermal Stress Experiments in excavated at the MTL. The location of the MTL in the south may not provide as representative data as the NE location owing to the be possibility of higher frequencies as can be interpreted from surface or maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

OPTION 13 (B7)

TEST 10: THERMAL STRESS MEASUREMENTS

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST HEATED ROOM EXPERIMENT

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A. Blankenship	[signature]	6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.6.5

SDRD Rev 1 Section B-MECH-8 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (x)

Exploratory Drifts ( )

OPTION 13 (B7) DATE: 5-15-90

TEST 11: HEATED ROOM EXPERIMENT

Ability in Base Case	Ability of Option With Respect to the Base Case
Provides information on the long-term thermomechanical the response of a repository-size drift to thermal conditions simulating those expected in the repository during waste emplacement. Data will be used to validate the numerical models used to predict preclosure performance. Data will also be used to evaluate drift design and ground support assumptions. Test is to be conducted in the Sequential Drift Mining drifts following completion of that experiment. There is no requirement for instrument installation prior to or during construction.	Option equivalent to the Base Case. Test is conducted in Sequential Drift Mining drifts following completion of that experiment at the MTL. The larger test expansion area allows the flexibility to conduct additional Heated Room Experiments in specially excavated drifts at the MTL. The location of the MTL in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

OPTION 13 (B7)

TEST 11: HEATED ROOM EXPERIMENT

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST DEVELOPMENT AND DEMONSTRATION OF REQUIRED EQUIPMENT

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A. Blankenship	[signature]	6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.122

TEST SUPPORTS (Check) Repository Design (x) Site Suitability (Characterization) ( ) Both ( )

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.2.5.6

SDRD Rev 1 Section B-MECH-9 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (x)

Exploratory Drifts ( )

TEST 12: DEVELOPMENT AND DEMONSTRATION OF REQUIRED EQUIPMENT

Ability in Base Case	Ability of Option With Respect to the Base Case
Prototypes of equipment expected to be used during repository operations will be demonstrated at the MTL. No specific locations or space requirements are defined for this test in the base case. It is expected that some of the contingency space defined for the base case will be used for this test. The base case does not allow for testing and demonstration of TBMs.	Option is superior to the Base Case. The test is to be conducted at the MTL. This option allows greater flexibility with regard to equipment testing owing to the greater test expansion area. This option allows for TBM evaluations at the repository horizon prior to repository development. The location of the MTL and ramp in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

OPTION 13 (B7)

TEST 12: DEVELOPMENT AND DEMONSTRATION OF REQUIRED EQUIPMENT

Schedule Impact:

This experiment has no impact on schedule for this option.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST PLATE LOADING TEST

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A. Blankenship	[signature]	63rd	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.7.1

SDRD Rev 1 Section B-MECH-10 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

REF 5/4/90

ESF Access ~~(Shafts)~~ Ramp only (x)

Main Test Level (x)

Exploratory Drifts (x)

OPTION 13 (B7) DATE: 5-15-90

TEST 13: PLATE LOADING TESTS

Ability in Base Case	Ability of Option With Respect to the Base Case
Provides information on the rock mass modulus for use in numerical models. Test is intended to be conducted in the DBrs and at other locations in the MTL. There is no requirement for instrument installation prior to or during construction, however, small alcoves must be provided for fielding these tests.	Option is superior to the Base Case. This test will be conducted in the upper DBR, alcoves at the MTL, in the long exploratory drifts, and in alcoves off the ramps and main. The larger test expansion area and the presence of the ramps and main allow the flexibility to conduct additional plate loading tests. The additional testing could provide information on the regional variability and and representativeness of MTL rock mass mechanical properties. However, plate loading tests conducted in alcoves off the ramps may provide information of lesser quality because the ramps are off the repository block. The location of the MTL and ramp in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

Option 13 (B7)

Test 13, Plate Loading Test

Schedule Impact:

Installation and Initial Testing:

The 15 plate loading tests described in the SDRD are assumed to have no impact on facility construction. The use of a ramp increases the amount of drifting and offers the opportunity to test additional ground in areas adjacent to the two large diameter TBM ramps and long exploratory drifts. To accommodate additional testing it is necessary that alcoves be created off the main drifts and ramps. It is anticipated that this option will require an addition of 24 test alcoves in the ramps and 12 test alcoves off the large diameter exploratory drift. The alcoves shall be 30 ft deep and are expected to take 3 days to complete. The test alcoves should be cut as soon as practical after the TBM has passed a designated test location. The impact of alcove excavation on ramp construction is expected to be minimal, however the time involved in alcove construction is 3 x (24 + 12) = 108 days.

Longer Term Test Monitoring:

This is a short duration test and will not have a long term monitoring impact.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST ROCK-MASS RESPONSE EXPERIMENT

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A Blankenship		6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.7.2

SDRD Rev 1 Section B-MECH-11 (Attached)

Other _____

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (x)

Exploratory Drifts ( )

OPTION 13 (B7) DATE: 5-15-90

TEST 14: ROCK-MASS STRENGTH EXPERIMENT

Ability in Base Case	Ability of Option With Respect to the Base Case
Provides information on the rock mass strength and deformability and the normal and shear behavior of individual intact joints. This information will be used to evaluate empirical and numerical rock mass models and to evaluate factors of scale. No requirement for installation of instruments prior to or during construction. Test is to be conducted in the lower DBR and other locations in the MTL.	Option is equivalent to the Base Case. Test is to be conducted in and the lower DBR and alcoves at the MTL. The larger test expansion area allows the flexibility to conduct additional Rock Mass Response experiments at the MTL. The location of the MTL in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

OPTION 13 (B7)

TEST 14: ROCK-MASS STRENGTH EXPERIMENT

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST EVALUATION OF MINING METHODS

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A Blankenship		6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.21

TEST SUPPORTS (Check) Repository Design (x) Site Suitability (Characterization) ( ) Both ( )

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.8.1

SDRD Rev 1 Section B-MECH-12 (Attached)

Other _____

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (Including Testing in Calico Hills) (x)

Exploratory Drifts (x)

OPTION 13 (B7) DATE: 5-15-90

TEST 15: EVALUATION OF MINING METHODS

Ability in Base Case	Ability of Option With Respect to the Base Case
Mining methods (eg drilling rates, water useage, drill & blast advance rates, etc) will be documented during ESF construction. Information will be used by repository designers to evaluate design assumptions. Information will be collected during construction of all ESF openings and will be done without impacting construction.	Option is equivalent to the Base Case. Test is to be conducted in all ESF openings. The larger test expansion area allows the flexibility to monitor mining methods in a greater amount of drifts thereby providing a more representative estimate for repository construction. No comparison of mechanical versus drill and blast excavation methods is possible. The location of the MTL and ramp in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

OPTION 13 (B7)

TEST 15: EVALUATION OF MINING METHODS

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST EVALUATION OF GROUND SUPPORT SYSTEMS

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Roy E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A. Blankenship	[signature]	6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.2

TEST SUPPORTS (Check) Repository Design (x) Site Suitability ( ) Both ( )
(Characterization)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.8.2

SDRD Rev 1 Section B-MECH-13 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (Including Testing in Alico Hills) (x)

Exploratory Drifts (x)

OPTION 13 (B7) DATE: 5-15-90

TEST 16: MONITORING OF GROUND SUPPPORT SYSTEMS

Ability in Base Case	Ability of Option With Respect to the Base Case
The performance of ground support systems will be monitored throughout all ESF openings. Loads and displacements in support elements will be monitored. There is a limited impact on construction to perform these measurements.	Option is superior to the Base Case. Test is to be conducted throughout the MTL, exploratory drifts, upper DBR, and in the ramps and main. This option does not allow a comparison of support requirements between drill & blast and TBM excavated openings. This option does provide the opportunity to make rock mass measurements in and around the faults that the ramps and main may pass through. In addition, the greater number of measurements possible in this option would enhance the assessment of ground support requirements for the repository. The location of the MTL and ramp in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

OPTION 13 (B7)

TEST 16: MONITORING OF GROUND SUPPPORT SYSTEMS

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST MONITORING DRIFT STABILITY

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Douglas A. Blankenship — Name
Signature — Signature
6314 — Organization
DAB 5/4/90 — Date

TEST REFERENCE (Regulatory): 10 CFR Part 60.21

TEST SUPPORTS (Check) Repository Design (x) Site Suitability (Characterization) ( ) Both ( )

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.8.3

SDRD Rev 1 Section B-MECH-14 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (Includes Testing in Calico Hills) (X)

Exploratory Drifts (x)

OPTION 13 (B7) DATE: 5-15-90

TEST 17: MONITORING DRIFT STABILITY

Ability in Base Case	Ability of Option With Respect to the Base Case
The performance of the underground openings themselves will be monitored using MPBXs and tape extensometer closure pins. Data will be used to evaluate design assumptions. Requires installation of some of the instruments at the working face both in the MTL and in the long exploratory drifts.	Option is superior to the Base Case. Test is to be conducted in the MTL, upper DBR, long exploratory drifts, and in the ramps and main. This option does not allow a comparison of the performance of underground openings excavated using drill and blast and mechanical excavation methods. This option does provide the opportunity to make rock mass measurements in and around the faults that the ramps and main may pass through. In addition, the greater number of measurements possible in this option would enhance the assessment of drift stability for the repository. The location of the MTL and ramp in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

Option 13 (B7)

Test 17, Monitoring Drift Stability

Schedule Impact:

Installation and Initial Testing:

The base case called for approximately 50 TE stations and the 50 MPBX's at the main test level. The use of two access ramps and a long exploratory drift increases the amount of drifting that must be instrumented. It is anticipated that an additional 90 TE stations and 48 MPBX's must be installed, yielding a total of 140 TE stations and 98 MPBX's. 2.0 hours are needed to install and obtain the initial reading at each TE station. 12 hours are needed to drill and install each extensometer. The total schedule impact is 2.0 x 140 + 12 x 98 = 1456 hours.

Longer Term Test Monitoring:

Each of the installed closure stations must be monitored daily for the first 25 days after construction, and weekly thereafter. It is likely that the TE readings during the 25 days following installation will impact construction. The weekly readings that follow will not impact the construction schedule. The time required to read each station is 0.25 hours. With 110 stations, the total construction impact is 0.25 x 25 x 140 = 875 hours.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST AIR QUALITY AND VENTILATION

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
DAB Douglas A. Blankenship		6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.74, 10CFR60.133

TEST SUPPORTS (Check) Repository Design (x) Site Suitability (Characterization) ( ) Both ( )

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.8.4

SDRD Rev 1 Section B-MECH-15 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (Includes Testing in Calico Hills) (x)

Exploratory Drifts (x)

OPTION 13 (B7) DATE: 5-4-90

TEST 18: AIR QUALITY AND VENTILATION EXPERIMENT

Ability in Base Case	Ability of Option With Respect to the Base Case
Measurements of dust generation, radon concentrations, air temperatures, air velocities, and air humidities will be made throughout the ESF to evaluate ventilation design assumptions. Measurements will be made without impacting construction.	Option equivalent to the Base Case. Test is to be conducted at the MTL and in the long exploratory drifts. The location of the MTL in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

OPTION 13 (B7)

TEST 18: AIR QUALITY AND VENTILATION EXPERIMENT

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST IN-SITU TESTING OF SEAL COMPONENTS

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A. Blankenship	[signature]	6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.134

TEST SUPPORTS (Check) Repository Design (x) Site Suitability (Characterization) ( ) Both ( )

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.3.2.2.3

SDRD Rev 1 Section B-SEAL-1 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (x)

Exploratory Drifts ( )

OPTION 13 (B7) DATE: 5-15-90

TEST 19: IN SITU TESTING OF SEAL COMPONENTS

Ability in Base Case	Ability of Option With Respect to the Base Case
Large-scale seal tests are planned for the MTL. Specific locations are not defined, but plans are to perform these tests in the contingency space. Specifics of the test are not defined at this time. No impacts on construction are expected.	Option is superior to the Base Case. Test is to be conducted at the MTL. Larger test expansion area allows the flexibility to conduct additional seal tests at the MTL. The presence of the TBM ramp allows for the flexibility to conduct seal tests in TBM excavated drifts at the base of the ramp or the main which could provide information on sealing requirements for repository ramps. The location of the MTL and ramp in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

OPTION 13 (B7)

TEST 19: IN SITU TESTING OF SEAL COMPONENTS

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/2/90

ESF TEST OVERCORE STRESS TESTS IN THE ESF

PREPARERS:

ESF Test Organization (USGS) F.T. Lee
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
HENRI S. SWOLES	[signature]	U.S.G.S.	5/2/90

TEST REFERENCE (Regulatory): 10CFR60-21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.2.1.2

SDRD Rev 1 Section B-MECH-16 (Attached)

Other Characterization of the Site Ambient Stress Conditions (Study Plan)

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (x)

Exploratory Drifts ( )

Option 13
B7

The purpose of the Overcore Stress Test is to determine the complete in situ state of stress above, within ,and below the repository host rock. This is in response to information needed for Issue 1.3.

Time required for this test is estimated as 2 days per test site (location) in addition to time required for drilling the borehole.

United States Department of the Interior

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BOX 25046 M.S. 966
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DENVER, COLORADO 80225

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

Option 13
B7

May 3, 1990

QA: n/a
WBS: 1.2.3.2.7.2.1

Memorandum

To: Robert W. Craig
USGS/YMP Coordinator
Mail Stop 421

From: F.T. Lee
PI/Overcore Stress Test, YMP

Subject: Review of ESF Alternatives Study

I have reviewed the following conceptual ESF excavation alternatives: Base Case, A1, A2, A4, A5, A7, B3, B4, B7, B8, C1, C4, and R11. Based on my review of these conceptual schemes and on a consideration of the overcore stress test method, it would appear that all the options presented can satisfactorily accommodate this test. At the level of detail presented, there is no obvious advantage or disadvantage of any option relative to the "Base Case."

Sincerely,

Fitzhugh T. Lee
Principal Investigator

Enclosures

United States Department of the Interior

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TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

option 13
B7

May 10, 1990

QA: n/a
WBS: 1.2.3.2.7.2.1

Memorandum

To: Robert W. Craig
USGS/YMP Coordinator
101 Convention Center Drive, Suite 860
Las Vegas, Nevada 89109

From: F.T. Lee
PI/Overcore Stress Test, YMP

Subject: Additional comments on the ESF Alternatives Study

In response to our phone conversation on May 7, 1990, concerning the excavation alternatives for the ESF, those ramp and long drift options that expose more of the test block than other excavation options might provide more attractive in situ stress measurement opportunities. This would become a viable consideration if the present study plan was expanded to allow additional stress-measurement locations.

bcc: ACCRF
GRA (3)
Keefer
Jibson
Chron
FTLee:bg

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/2/90

ESF TEST MATRIX HYDROLOGIC PROPERTIES TESTING

PREPARERS:

ESF Test Organization (USGS) Robert W. Craig
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
MERRICK S. WHITFIELD	Merrick S. Whitfield	USGS-WRD	5/4/90

TEST REFERENCE (Regulatory): 10 CFR 60.113

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) (x) Both ( )

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.3.1

SDRD Rev 1 Section B-HYD-1 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (x)

Exploratory Drifts (x)

TEST EVALUATION RATIONALE AND DISCUSSION

Date: May 2, 1990

TEST NAME: Matrix Hydrologic Properties Testing
OPTION NUMBER: 13 (B7)

1) Purpose of test: Provide information relative to the following issues: Issue 4.4, unsaturated-zone transmissive properties, permeability, effective, hydraulic, matrix (subsurface geologic properties); permeability, relative, hydraulic, matrix (subsurface geologic properties). Issue 1.6, unsaturated-zone storage properties, matrix pore-size distribution (subsurface geologic samples); porosity (subsurface geologic samples). Issue 1.6, unsaturated-zone fluid potential, matric potential (subsurface geologic samples); water potential (total) (subsurface geologic samples). Issue 4.4, unsaturated-zone moisture conditions, moisture content (volumetric) (subsurface geologic samples); water content (gravimetric) (subsurface geologic samples). Issue 4.4, unsaturated-zone fluid flux, vapor flux; water flux.

2) Ability to conduct test: Provides opportunity for a large quantity of samples in the vertical and lateral directions.

3) Quality of data obtained: Data quality is similar to base case.

4) Location(s) of the test: Collection is conducted in all excavations.

5) Estimate of time for test:

a) Installation: Estimate two hours drilling time at each sampling location in ramp and TBM drifts. Estimate a corehole every 25 ft. in ramp and TBM drifts.

b) Initial Testing: NA

c) Longer-term monitoring: NA

6) Preliminary assessment of flexibility: Ability to collect additional samples is very good.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5-3-90

ESF TEST INTACT-FRACTURE TEST IN THE ESF

PREPARERS:

ESF Test Organization (USGS) Gary R. Severson
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Carol J. Boughton	Carol J. Boughton	USGS/WRD/NHP	5/4/90

TEST REFERENCE (Regulatory): 10CFR 60.113

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (x) Both ( )
(Characterization)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.4.1

SDRD Rev 1 Section B-HYD-2 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (x)

Exploratory Drifts ( )

DATE: 3 MAY 1990

TEST EVALUATION RATIONALE AND DISCUSSION

TEST NAME: Intact-Fracture Test in the Exploratory Shaft Facility

OPTION NUMBER: B7

Purpose of Test

Rock core samples are to be collected of naturally occurring fractures in the ESF, MTL, and drifts for laboratory tests. Core samples of axial (fracture parallel to core axis) and radial (fracture perpendicular to core axis) fractures will be collected from the Tiva Canyon, Pah Canyon, and Topopah Spring members of the Paintbrush Tuff stratigaphic unit and from the Calico Hills stratigraphic unit (if penetrated). Twelve samples of each orientation will be collected from the four different rock types.

Rationale and Discussion

Not familiar enough with sampling fractures from rock surfaces excavated with TBM.

Schedule

Prototype Sampling Methods Test which supports above test has not been completed to the satisfaction of the test Co-Investigators. Prior to sampling the fractures, the area would be mapped and fracture planes evaluated as to their potential for sampling. Actual fracture sampling could take approximately four hours per core sample.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE May 7, 1990

ESF TEST PERCOLATION TEST IN THE ESF

PREPARERS:

ESF Test Organization (USGS) Edward Kwicklis
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Carol J. Boughton	Carol J. Boughton	USGS/WRD/NHP	5/7/90

TEST REFERENCE (Regulatory): 10CFR60.113

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) (x) Both ( )

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.4.2

SDRD Rev 1 Section B-HYD-3 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (x)

Exploratory Drifts ( )

TEST EVALUATION RATIONALE AND DISCUSSION

TEST NAME: PERCOLATION TEST IN THE ESF DATE: May 7, 1990

OPTION NUMBER: B7

1. Purpose of the test (tie to issues and critical information needs, major parameters).

The objective of this activity is to provide experimental data against which the validity of numerical and conceptual models dealing with flow and transport in unsaturated fractured rock can be tested.

2. The ability to install and conduct the test relative to BASE CASE

The ability to install and conduct the test relative to the base case is unchanged

3. The quality of data obtained, relative to BASE CASE.

The quality of data relative to the base case may be improved, because this option avoids drilling and blasting at the main test level, and so blast-induced fracturing of the experimental block will not be a concern. For instance, with mechanically excavated drifts, we are not introducing unmineralized fractures into a block in which all natural fractures contain mineral coatings or clays.

4. Location(s) of the test relative to BASE CASE.

The location is qualitatively equivalent to that of the base case.

5. Estimate of time (Schedule) for the test, including
(a) Installation

Unchanged relative to the base case.

(b) Initial testing

Unchanged relative to the base case.

(c) Longer term test monitoring

Unchanged relative to the base case.

6. Preliminary assessment of the option's flexibility, regarding the test, to allow expansion of the test confirmation or additional testing. This assessment should be made relative to the BASE CASE.

Unchanged relative to the base case.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/2/90

ESF TEST BULK-PERMEABILITY TEST IN THE ESF

PREPARERS:

ESF Test Organization (USGS) Carol J. Boughton
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
MERRICK S. WHITFIELD	Merrick S. Whitfield	USGS WRD	5/4/90

TEST REFERENCE (Regulatory): 10 CFR 60.113

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (x) Both ( )
(Characterization)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.4.3

SDRD Rev 1 Section B-HYD-4 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (x)

Exploratory Drifts (x)

Attachment to Testing Data Sheet

DATE: 5/2/90

TEST EVALUATION RATIONALE AND DISCUSSION

TEST NAME: Bulk-Permeability Test in the ESF

OPTION NUMBER: B7

For this option, provide information supporting the evaluation of test feasibility and data quality. This information must include specific references to the following items:

1) Purpose of the Test (Tie to issues and critical information needs, major parameters.)
2) The ability to install and conduct the test relative to BASE CASE.
3) The quality of data obtained, relative to BASE CASE.
4) Location(s) of the test relative to BASE CASE.
5) Estimate of time (Schedule) for the test, including
   a) Installation
   b) Initial testing
   c) Longer-term test monitoring
6) Preliminary assessment of the option's flexibility, regarding the test, to allow expansion of the test confirmation or additional testing. This assessment should be made relative to the BASE CASE.

1. To conduct air permeability testing for determination of scale at which fractured, welded tuff acts as a representative elementary volume (REV). This information will be used in conjunction with SCP Study 8.3.1.2.2.8, Conceptual and Numerical Modeling of Unsaturated Fractured Rock Hydrology, and SCP Study 8.3.1.2.2.9, Site Scale Unsaturated Zone Modeling, The result of all of these studies will be incorporated into Performance Assessment Ground Water Travel Time Issues.
2. The ability to map fractures on the machine bored face is questionable and will reduce the ability of investigator to gain best possible understanding of the three dimensionality of the test site.
3. Data quality reduced because of less detailed fracture data.
4. Locations of similar quality.
5. a) Six months per test times four sequential tests.
   b) Included in a) above.
   c) No long-term tests are currently planned.
6. Less flexibility because of reduced fracture data..

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

7 Rec

DATE 5/3/90

ESF TEST RADIAL BOREHOLE TESTS IN THE ESF

PREPARERS:

ESF Test Organization (USGS) Robert W. Craig
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
MERRICK S. WHITFIELD	Merrick S. Whitfield	USGS-WRD	5/8/90

TEST REFERENCE (Regulatory): 10 CFR 60.113

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (x) Both ( )
(Characterization)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.4.4

SDRD Rev 1 Section B-HYD-5 (Attached)

Other Characterization of the Yucca Mountain Unsaturated Zone (Study Plan)

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level ( )

Exploratory Drifts ( )

TEST EVALUATION RATIONALE AND DISCUSSION

Date: May 7, 1990

TEST NAME: Radial Boreholes Tests in the ESF
OPTION NUMBER: 13 (B7)

1) Purpose of test: Provide information relative to the following issues: Issue 4.4, unsaturated-zone transmissive properties, bulk permeability; bulk permeability, pneumatic; bulk porosity, fracture permeability; gas permeability, excavation effects;permeability (pneumatic) bulk, fractured rock; permeability (relative), gas (rock matrix); permeability (relative), water (rock matrix); permeability (saturated), gas (rock matrix). Issue 1.6, unsaturated-zone storage properties, moisture retention, rock matrix; porosity pore-size distribution, matrix; porosity, bulk, fractured rock; porosity, matrix. Issue 1.10, unsaturated-zone dispersive properties, diffusive tortuosity, fractured rock and rock mass. Issue 1.6, unsaturated-zone fluid potential, matric potential, fractured rock and rock mass;pneumatic potential, distribution; water potential (rock matrix), total fractured rock. Issue 4.4, unsaturated-zone fluid chemistry, temperature, and age, pore gas, composition; radioactive isotopes; stable isotopes; temperature, fractured rock. Issue 4.4, unsaturated-zone moisture conditions, water content (gravimetric), rock mass; water content (volumetric), rock mass.

2) Ability to conduct test: Ramps would require redesign of borehole configuration and would incorporate part of the excavation effects testing presently being conducted under the Excavation Effects Test. Tests would be conducted off the block because of ramp locations. Representativeness may be in question.

3) Quality of data obtained: Representativeness may be questionable, other data quality about the same as base case.

4) Location(s) of the test: Locations would be off the block.

5) Estimate of time for test:

a) Installation: One shift for each initial air-permeability test; three shifts for long term monitoring instrumentation.

b) Initial Testing: Air-permeability testing estimated to take one shift each test.

c) Longer-term monitoring: Monitoring for at least two-to-three years.

6) Preliminary assessment of flexibility: Ramps are probably more flexible in terms of conducting the test, but location off the block is a potential problem.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 04 May 1990

ESF TEST EXCAVATION EFFECTS TEST IN THE ESF

PREPARERS:

ESF Test Organization (USGS) Falah Thamir
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Carol J. Boughton	Carol J. Boughton	USGS/WRD/NHP	5/7/90

TEST REFERENCE (Regulatory): 10 CFR 60.21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.4.5

SDRD Rev 1 Section B-HYD-6 (Attached)

Other Characterization of the Yucca Mountain Unsaturated Zone (Study Plan)

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (x)

Exploratory Drifts ( )

DATE: 04 May 1990

TEST EVALUATION RATIONALE AND DISCUSSION

TEST NAME: *EXCAVATION EFFECTS TEST IN THE ESF*
OPTION NUMBER: *B7*

1. purpose of test

To estimate changes in fractured rock permeability that could be attributed to measurable changes in ground stress around the shaft due to excavation and lining (if applicable). The measured data will be used to calibrate a coupled hydrologic-mechanical model to predict changes in fractured rock permeability around different openings within the repository area.

2. ability to conduct test relative to BASE CASE

Test can be conducted around either ESF access no. 1 or 2.

3. quality of data relative to BASE CASE

Blast damage won't have to be assessed, and variability in the data will, most likely, be minimized (which is an advantage).

4. location of test relative to BASE CASE

Two different locations, at two different depths in the Topopah Spring welded unit will be required. Space as described in the BASE CASE will have to be provided for drilling boreholes.

5. estimate of time

(a) *installation: one month*

(b) *initial testing: one month at each level (location) or after the excavation is past the deepest monitoring zone.*

(c) *long-term testing and monitoring: Monitoring will continue until the lining (if applicable) is past the deepest monitoring zone.*

6. assessment of option flexibility relative to BASE CASE

This option is more flexible than the BASE CASE since two ESF access openings are made available for scientific investigations.

FROM USGS H.R.F. 05/07/90 11:45 P.19

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/2/90

ESF TEST CALICO HILLS TEST IN THE ESF

PREPARERS:

ESF Test Organization (USGS) Robert W. Craig
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
MERRICK S. WHITFIELD	Merrick S. Whitfield	USGS, WRD	5/4/90

TEST REFERENCE (Regulatory): 10 CFR 60.113

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (x) Both ( )
(Characterization)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.4.6

SDRD Rev 1 Section B-HYD-7 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (x)

Exploratory Drifts ( )

TEST EVALUATION RATIONALE AND DISCUSSION
Date: July 17, 1990

TEST NAME: Calico Hills Test in the ESF

OPTION NUMBER: B7

1) Purpose of test: Provide information relative to the following objectives: 1) determine the hydrogeologic properties and conditions of layers and fractures within the Calico Hills nonwelded unit; 2) determine if perched water exists at or near the contact between the Topopah Spring welded unit and the Calico Hills nonwelded unit,; and 3) investigate the permeability and flow conditions of the Ghost Dance fault where it transects the Calico Hills unit.

2) Ability to conduct test: Same as base case.

3) Quality of data obtained: Same as base case.

4) Location(s) of the test: Test locations are adequate to meet the objectives of the test.

5A) Estimate of time for test at each intersection of a major fault:

a) Installation: Time required to drill a 200-ft long near-horizontal borehole for temperature measurements. At later date, four 50-ft long inclined coreholes will be drilled for air-permeability testing and long-term monitoring. In total, five boreholes will be drilled at each intersection of a major fault.

b) Initial Testing: Time required for temperature logging is estimated at 4 hrs. per log. The first temperature log will be run soon after drilling, further logs will be run at intervals of one or two days initially, and weekly thereafter until effects of drilling have subsided and effects of ventilation of the drift are detected. Air-permeability testing, including cross-hole tests, will require approximately two to four weeks. None of these tests should require any stoppage in construction if reasonable access is provided.

c) Longer-term monitoring: Long-term monitoring will be conducted for a minimum of two years. Periodic access is required for equipment maintenance.

5B) Estimate of time for test at the transition zone of welded and nonwelded units:

a) Installation: Time required to drill two 30-ft long horizontal boreholes for cross-hole testing. One day for installation of initial instruments.

b) Initial Testing: Time required is estimated to be 15 days.

c) Longer-term monitoring: Long-term monitoring will be conducted for a minimum of two years. Periodic access is required for equipment maintenance.

6) Preliminary assessment of flexibility: Option has adequate flexibility for additional testing if required.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5-7-90

ESF TEST PERCHED WATER TEST IN THE ESF

PREPARERS:

ESF Test Organization (USGS) Michael P. CHORNACK
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
MERRICK WHITFIELD	Merrick Whitfield	USGS WRD	5/7/90

TEST REFERENCE (Regulatory): 10CFR60.113

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (x) Both ( )
(Characterization)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.4.7

SDRD Rev 1 Section B-HYD-8 (Attached)

Other Characterization of the Yucca Mountain Unsaturated Zone (Study Plan)

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (x)

Exploratory Drifts (x)

TEST EVALUATION RATIONALE AND DISCUSSION

TEST NAME: Perched Water Test in the ESF DATE: May 7, 1990
OPTION NUMBER: 13 (B7)

For this option, provide information supporting the evaluation of test feasibility and data quality. This information must include specific references to the following items:

1) Purpose of the Test (Tie to issues and critical information needs, major parameters.)

Detect the occurrence of any perched-water zones.

Estimate the hydraulic properties of the zones (transmissivity, hydraulic conductivity, and hydraulic head and storage coefficient).

Determine the implication of the existence of such zones on flux, flow paths, and travel times.

2) The ability to install and conduct the test relative to BASE CASE.

Equivalent to BASE CASE

3) The quality of data obtained, relative to BASE CASE.

Inferior to the BASE CASE since the 2 ramps will not penetrate much of the volcanic section directly overlying the ESF. The occurrence of perched water and the implications on flux, flow paths, and travel times at the ESF site could be overlooked. The use of TBM could delay the recognition of any perched-water zones encountered.

4) Location(s) of the test relative to BASE CASE.

To the north and east of BASE CASE locations.

5) Estimate of time (Schedule) for the test, including
a) Installation Depends on character of perched water encountered.
b) Initial Testing Depends on character of perched water encountered.
c) Longer - term test monitoring Depends on character of perched water encountered.

6) Preliminary assessment of the option's flexibility, regarding the test, to allow expansion of the test confirmation or additional testing. This assessment should be made relative to the BASE CASE.

Inferior to BASE CASE

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5-4-90

ESF TEST HYDROCHEMISTRY TESTS IN THE ESF

PREPARERS:

ESF Test Organization (USGS) Charles A. Peters
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
In Che Yang	[signature]	USGS	May 7, 1990

TEST REFERENCE (Regulatory): 10CFR 60.113

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (x) Both ( )
(Characterization)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.4.8

SDRD Rev 1 Section B-HYD-9 (Attached)

Other Characteization of the Yucca Mountain Unsaturated Zone (Study Plan)

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts)	(x)
Main Test Level	(x)
Exploratory Drifts	(x)

UNITED STATES GOVERNMENT

MEMORANDUM

DATE: MAY 7, 1990

REPLY TO
ATTN OF: C. A. Peters, Hydrologist

SUBJECT: UZ Hydrochemistry Test Input for ESF Alternatives

TO: Hemi Kalia

THROUGH: Al Yang

I believe that any of the proposed 17 options could provide the test locations required for the UZ Hydrochemistry tests. In making this determination I am assuming that any of the ramps mentioned in the 17 options will penetrate all of the geologic units that the base case shafts penetrate, and that all options will allow future penetration of the Calico Hills for study.

I have evaluated each of the options based on: (1) the ability to provide gas samples from all geologic units; (2) the ability to obtain rock core samples from three mutually perpendicular directions; (3) the ability to provide pre-construction effect gas samples; (4) the ability to provide core samples from the wettest zones encountered; (5) the ability to sample gases and pore water from near major faults; (6) the ability to provide adequate vertical and horizontal control for gas and pore water samples; (7) whether or not the prototype tests being presently done would be needed; and (8) the ability to utilize formerly drafted and approved study plans, procedures and design criteria. I have also attempted to weight the importance of these evaluation criteria.

The evaluation below reflects the ability of the option to conduct the test, the quality of the data obtained, and the flexibility of the test in regards to additional testing relative to the base case. The location of the test and the estimate of time for conduct of the test are summarily addressed below the ranking for each option.

Scores have been assigned to all 17 of the options, which also serves to rank the options relative to the base case. The 17 options are evaluated below. The weighting factor that was applied to each criteria are contained in the parentheses. A weight of three is a very important criteria, whereas a weight of one is least important. The options ability to supply each criteria is then ranked between 1 and 3, three being the best. The weight and the ability to achieve for each criteria are multiplied and summed to obtain a numerical rank for each option. The shorthand notion for the criteria is defined at the end of this memo.

#	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)	
1	3	3	3	1	1	3	1	3	3	→ Ranking (3, 2, 1) ..
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)	→ Weight Factor (3, 2, 1) ..
	9	9	6	2	2	9	2	6	3	→ Total Score = ① x ②

Total score = 48 out of a possible 60

The base case would allow work as previously planned and documented in the SCP and Study Plan 8.3.1.2.2.4, R0. The prototype tests in progress would still be relavent, as well as the present schedule. Many foreseen possible problems have already been worked out. However, many of the NWTRB's concerns are not well addressed.

#	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
2	3	3	3	2	3	3	2	2	3
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	9	6	4	6	9	4	4	3

Total score = 54

Option 2 (a1) would still allow the work to proceed as previously planned in the above mentioned documents. Additionally, this option would (with the required planning) also allow other work to proceed in the tuff ramp that would satisfy more of the NWTRB's concerns. This additional testing would require additional time and perhaps make the tests longer term.

	All (3)	Pre (3)	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
	Units	Const							
3	3	3	3	2	3	2	1	2	3
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	9	6	4	6	6	2	4	3

Total score = 49

Very similar to option 2, however the lack of the tuff ramp would reduce the amount of horizontal control sampled in the repository horizon and probably also reduce the amount of wet zones available for sampling.

#	All (3)	Pre (3)	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
	Units	Const							
4	3	3	3	2	3	3	2	2	3
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	9	6	4	6	9	4	4	3

Total score = 54

Similar to option 2 with the addition of a second shaft, which adds nothing to our testing program plans.

#	All (3)	Pre (3)	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
	Units	Const							
5	3	3	3	2	3	3	3	1	3
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	9	6	4	6	9	6	2	3

Total score = 54

The fact that the MTL is in the south adds nothing to nor takes anything away from the testing program. The drift from the south to the north end of the repository block adds additional horizontal control of the Topopah Spring welded unit. This would require additional testing locations and longer term monitoring.

#	All (3)	Pre (3)	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
	Units	Const							
6	3	2	3	2	3	0	2	0	0
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	6	6	4	6	0	4	0	0

Total score = 35

Not having a shaft makes the prior planning obsolete. Additionally, it removes the vertical control that a shaft allows. The locations and schedule for testing would change significantly.

	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
7	3	1	3	1	2	2	2	1	0
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	3	6	2	4	6	4	2	0

Total score = 36

The mechanically excavated shaft makes prototype studies irrelevant and reduces the relevance of the study plan. Additionally the drifting is not as extensive as some other options. The locations and schedule of testing would change.

	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
8	3	3	3	2	2	2	2	1	0
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	9	6	4	4	4	4	2	0

Total score = 42

Similar to option 7, except that the v-mole excavation method uses a pilot hole which would allow us to collect pre-construction gas samples.

#	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
9	3	1	3	1	2	2	2	1	0
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	3	6	2	4	6	4	2	0

Total score = 36

Similar to option 7 in regards to testing possibilities.

#	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
10	3	1	3	2	2	2	2	1	0
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	3	6	4	4	6	4	2	0

Total score = 38

Similar to option 7.

	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
11	3	3	3	2	2	3	2	3	3
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	9	6	4	4	6	4	6	3

Total score = 51

Similar to option 7, except that drilling and blasting the shaft will allow us to use the study plan and prototype tests already in progress. Schedule and location of tests would remain similar to the base case.

#	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
12	3	3	3	3	2	3	3	2	3
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	9	6	6	4	9	6	4	3

Total score = 56

The MTL at the south end of the repository block causes no problems. The drill and blast shaft allows use of prototype tests and prior plans. The drift the entire length of the repository block allows good horizontal control. There would be additional test locations and probable long term moniitoring.

	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
13	3	1	3	3	2	0	3	0	0
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	3	6	6	4	0	6	0	0

Total score = 34

The abscence of a shaft eliminates our vertical control and also changes our plans significantly and eliminates the usefulness of prototype work. The test locations and schedule would change significantly.

#	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
14	3	3	3	3	2	3	3	2	3
	(3)	(3)	(2)	(2)	(2)	(3)	(2)	(2)	(1)
	9	9	6	6	4	9	6	4	3

Total score = 56

The drill and blast shaft allows use of present plans and prototype work. The long drift gives good horizontal control. There would be additional test locations and probable long term monitoring.

	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
15	3 (3) 9	3 (3) 9	3 (2) 6	2 (2) 4	2 (2) 4	3 (3) 9	2 (2) 4	2 (2) 4	3 (1) 3

Total score = 52

The drill and blast shaft allows the present plans to be useable. The ramp and drifts allow some horizontal control. There would be additional test locations and probable long term monitoring

#	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
16	3 (3) 9	3 (3) 9	3 (2) 6	3 (2) 6	3 (2) 6	3 (3) 9	3 (2) 6	2 (2) 4	3 (1) 3

Total score = 58

The access to the ghost dance fault is very good and the drill and blast shaft allows use of prior plans. Addition of test locations and long term monitoring.

#	All (3) Units	Pre (3) Const	3D (2)	Wet (2)	Fault (2)	V (3)	H (2)	Plan (2)	Prot (1)
17	3 (3) 9	3 (3) 9	3 (2) 6	1 (2) 2	1 (2) 2	3 (3) 9	1 (2) 2	2 (2) 4	3 (1) 3

Total score = 46

The drill and blast shaft allows use of former plans. The limited drift reduces horizontal control. Similar in location and schedule to base case.

All Units - Gas and core/rock samples can be obtained from all lithologic/ stratigraphic units.

Pre Const - Gas samples of uncontaminated pre construction phase rock gas can be obtained.

3D - Rock/core samples can be obtained which represent 3 mutually perpindicular fabric directions.

Wet - Rock/core samples can be collected from wettest rareas of rock units.

Fault - Samples of gas and rock/core can be collected from near faults.

V - A complete vertical section can be sampled for gas and rock/core.

H - Allows for collection of many rock/core and gas samples from a large area of specific lithologic units.

Plan - The approved study plan, design criteria, etc. are applicable.

Proto - The prototype tests bieng currently performed are applicable.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/8/90

ESF TEST DIFFUSION TESTS IN THE ESF

PREPARERS:

ESF Test Organization (Los Alamos) June Fabryka-Martin
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Clarence J. Duffy — Name
Clarence J. Duffy — Signature
INC-7 — Organization
8 May 1990 — Date

TEST REFERENCE (Regulatory): 10CFR60.15, .21, .122

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (x) Both ( )
(Characterization)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.5

SDRD Rev 1 Section B-HYD-10 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (Include Testing in Calico Hills) (x)

Exploratory Drifts ( )

TEST EVALUATION RATIONALE AND DISCUSSION

Test Name: Diffusion tests in the ESF

Option number: All

1) Purpose of test. To determine effective diffusion coefficients under field conditions in unsaturated tuff; to compare field results to laboratory measurements in order to assess the general validity of extrapolating laboratory measurements to field conditions.

2) Ability to conduct the test relative to the base case is evaluated on the basis of:
   - test site: ability to locate test in alcoves in Topopah Springs and Calico Hills units. No discriminating advantage or disadvantage is apparent for any option, relative to the base case.

3) Quality of data obtained, relative to base case, is evaluated based on:
   - ability to dry-core diffusion-test boreholes beyond zone of stress relief induced by excavation activities (about 2 tunnel diameters, or 30 feet)
   - ability to locate fracture-free region of tuff
   - ability to be site test at sufficient distance to prevent interference from other activities (heater, ground motion, water) No discriminating advantage or disadvantage is apparent for any option, relative to the base case.

4) Locations of the tests are same (MTL) for all options

5) Test schedule:
   a) Installation: within a year after completion of MTL
   b) Initial testing - within two years after completion of MTL
   c) Longer-term test monitoring. Not applicable

6) Assessment of option's flexibility to allow expansion of the test, relative to base case. No advantage in expanding test beyond base case.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/8/90

ESF TEST CHLORIDE AND CHLORINE-36 MEASUREMENTS OF PERCOLATION AT YUCCA MOUNTAIN

PREPARERS:

ESF Test Organization (Los Alamos) June Fabryka-Martin
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Clarence J. Duffy	Clarence J. Duffy	INC-7	8 May 1990

TEST REFERENCE (Regulatory): 10 CFR 60.15, .21, .122

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (x) Both ( )
(Characterization)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.2.1

SDRD Rev 1 Section B-HYD-11 (Attached)

Other Water Movement Tests (Study Plan)

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (Includes Calico Hills Testing) (x)

Exploratory Drifts (x)

TEST EVALUATION RATIONALE AND DISCUSSION

Test Name: Chloride and chlorine-36 measurements of percolation at Yucca Mountain
Option number: 13 (B7)
Overall evaluation relative to base case: Inferior

2) Ability to conduct the test: Inferior to base case.
   - Ability to sample all lithologic sub-units. Not possible without shafts or vertical dry-cored holes
   - Ability to sample features of interest, e.g. fracture zones, lithologic contacts. Not possible to sample lithologic contacts.
   - Ability to obtain vertical profiles of chloride and chlorine-36. Not possible without shafts or vertical dry-cored holes.
   - Ability to obtain horizontal profiles of chloride and chlorine-36. Superior due to ability to collect samples from ramp excavations as well as MTL and exploratory drifts.

3) Quality of data obtained, relative to base case: equivalent to base case.
   - Minimization of Cl contamination. Probably superior to base case.
   - Rubble size: Inferior to base case because of small rubble size, unless samples could be collected all by dry-coring.
   - Depth resolution. Equivalent to base case.
   - Control of sample location with respect to lithologic unit. Equivalent to base case.
   - Precise control of sample location relative to lithologic contact, fracture, fault or other linear hydrogeologic feature. Equivalent to base case.

4) Locations of the test relative to base case: inferior to base case
   - Vertical profiles of chloride and chlorine-36: none
   - Horizontal profiles of chloride and chlorine-36: 2 ramps, MTL and exploratory drifts

5) Test schedule: equivalent to base case

6) Assessment of option's flexibility to allow expansion of the test, relative to base case. Inferior to base case unless vertical dry-cored boreholes can be drilled from the surface to the MTL.

TEST EVALUATION RATIONALE AND DISCUSSION

Test Name: Chloride and chlorine-36 measurements of percolation at Yucca Mountain
Option number: All (general discussion of criteria used for evaluation)

1) Purpose of test. To evaluate rates and paths of water movement in the unsaturated zone at Yucca Mountain. Vertical and horizontal profiles of chloride and chlorine-36 may be interpreted in terms of rates of water movement by matrix flow, may provide evidence for water movement by fracture flow, and may indicate the extent of non-homogeneity of matrix flow rates.

List of criteria used to evaluate and compare ESF options

2) Ability to conduct the test relative to the base case is evaluated on the basis of:
   - Ability to sample all lithologic sub-units
   - Ability to sample features of interest, e.g. fracture zones, lithologic contacts
   - Ability to obtain vertical profiles of chloride and chlorine-36
   - Ability to obtain horizontal profiles of chloride and chlorine-36

3) Quality of data obtained, relative to base case, is evaluated based on:
   - Minimization of Cl contamination
   - Rubble size; ability to step-leach samples so as to distinguish between meteoric and rock Cl
   - Depth resolution
   - Control of sample location with respect to lithologic unit
   - Precise control of sample location relative to lithologic contact, fracture, fault or other linear hydrogeologic feature

4) Locations of the test relative to base case involves assessment of ability to obtain:
   - Vertical profiles of chloride and chlorine-36
   - Horizontal profiles of chloride and chlorine-36

5) Test schedule
   a) Installation is interpreted to mean collection of samples as excavation proceeds
   b) Initial testing - not applicable
   c) Longer-term test monitoring. Applicable to sample collection from ramps and Main Test Level.

6) Assessment of option's flexibility to allow expansion of the test, relative to base case. To be discussed under item 4 for each option.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5-11-90

ESF TEST ENGINEERED BARRIER SYSTEM FIELD TESTS

PREPARERS:

ESF Test Organization (LAWRENCE LIVERMORE LABORATORY) DALE WILDER (SEE ATTACHMENT)
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins Jr.

CHECKED BY:

JAMES BLINK	SEE ATTACHMENT	LLNL	5-10-90
Name	Signature	Organization	Date

TEST REFERENCE (Regulatory): 10 CFR 60.113

TEST SUPPORTS (Check) Repository Design (x) Site Suitability (Characterization) ( ) Both ( )

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.4.2.4.4

SDRD Rev 1 Section B-WP-1 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level (x)

Exploratory Drifts ( )

Lawrence Livermore National Laboratory

LLYMP9005065
May 10 , 1990

WBS 1.2.6
QA: N/A

Hemi Kalia
Yucca Mountain Project
Los Alamos National Laboratory
P. O. Box 0
Mercury, NV 89023

REFERENCE: LLYMP9005037

SUBJECT: Assessment of ESF Alternatives Options vs ESF Tests

Dear Hemi:

I have ranked the options under consideration. Most alternatives are really engineering options and are not fundamentally different in regards to the scientific efforts. Therefore, it is difficult to make a distinction between the options based on scientific criteria. The exceptions are in the access central block area and the option that allows flexibility of handling high-level waste. Attached is my ranking sheet.

If you have any further questions, please call me at 415-422-6908.

Dale G. Wilder
Technical Area Leader
Near Field Environment
Modeling and Testing
Yucca Mountain Project

I have reviewed the document and concur with the conclusions.

James Blink
Deputy Project Leader
Yucca Mountain Project

DW/ec

cc:
M. Cloninger

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ESF ALTERNATIVE RANKING

	A	B	C	D	E	F	G	H	I
1	Option	SF	Cntr blk	Samples	Schedule	Confirm	REp Loc	Test Area	Total score
2									
3	A7	5	3	5	5	5	4	4	31
4	A4-1	5	3	4	4	5	4	4	29
5	C1	4	3	3	4	5	4	4	27
6	B3-2	4	4	4	4	0	4	4	24
7	B3-3	4	4	4	4	0	4	4	24
8	B3-4	4	4	4	4	0	4	4	24
9	B3-5	4	4	4	4	0	4	4	24
10	B7	4	5	4	4	0	2	4	23
11	A1	4	0	4	3	4	3	4	22
12	A5	4	5	3	3	1	2	4	22
13	B3-6	4	4	3	3	0	4	4	22
14	B4	4	5	3	3	1	2	4	22
15	C4	4	5	3	3	1	2	4	22
16	B8	4	5	2	4	0	2	4	21
17	B11	0	2	2	2	4	3	4	17
18	A2	0	0	2	2	4	3	4	15
19	BC	0	2	2	2	4	3	0	13

Description of evaluated option characteristics (from table)

SF - Ability of the option to handle high-level sources

Cntr Blk - Flexibility of option to easily allow access to central part of the repository block

Samples - Ability of option to allow obtaining block samples (from ESF accesses) for laboratory testing

Schedule - Ability of option to allow most immediate start of test

Confirm - Ability of option (flexibility) to allow performance confirmation testing immediately upon completion of initial testing

Rep Loc - Can test location in the option supported as representative or repository block

Test Area- Flexibility of option to expand testing area for initial or confirmation testing

Ranking Criteria

Recorded by J. Blink after a conversation with D. Wilder

Values range from 0 (not acceptable) to 5 (best) for each criterion.

Spent Fuel Experiment Feasibility

0 = two shafts (difficult to move SF w/o interfering with other activities)
4 = one shaft and one ramp (ramp can serve double duty)
5 = two ramps or three total access points

Access to Central Block

0 = no central drift
2 = some drift beyond the MTL
3 = drift toward center, but not thru full repository
5 = central drift crosses entire repository

Representative Location for Experiments

1,2 = South area MTL (which is farther from center)
3,4 = North area MTL
Score shifted upward if a central drift exists
Score shifted downward for multi-level repositories w/o access to each level

Early Sample Feasibility

2 = two blasted shafts (blasting is slower than mechanical)
3 = mechanical shaft or long mechanical ramp
4 = one mechanical ramp or one long mechanical ramp plus a mechanical shaft
5 = two mechanical ramps

Early EBSFT

2 = blasted shafts with mapping
3 = mechanical shaft
4 = a long mechanical ramp or one long mechanical ramp plus a mechanical shaft
5 = a short mechanical ramp or two mechanical ramps

EBSFT Confirmation Testing

0 = not enough space
1 = very little experimental flexibility
4 = good area but not well linked to the EBSFT
5 = good area with good linkage to the EBSFT

Size of Test Area

0 = small
4 = adequate

ENGINEERED BARRIER TEST

The following information supports the initial evaluation of options against the Engineered Barrier Test. This information is provided by the Los Alamos Test Manager's Office and was developed after discussion, and with the permission of, Dale Wilder, Lawrence Livermore National Laboratory.

Purpose of Test -
The primary purpose of the Waste-Package Environment (Engineered Barrier) tests is to provide information about the near-field hydrologic, thermal, and mechanical environment of the waste package for use in assessing the expected performance of the waste package sub system. The rationale for the tests is constrained by measurement capabilities that can be applied in situ and by the ability of analytical and numerical models to use the data obtained with the measurements. A secondary purpose of the tests is to provide the option of testing certain components that may be part of the Engineered Barrier System, such as packing materials. The tests include an accelerated thermal cycle to examine the cooling side of the thermal pulse. The parameters to be measured or derived include temperature, moisture content, pore pressure (matric potential), rock-mass deformation, and rock-mass stress changes.

Ability to Install and Conduct Test -
No discriminator between options. All options should be capable of fielding and supporting the test. The Base Case is least flexible, however, due to its much smaller test area (MTL) and area for test expansion.

Quality of Data Obtained -
No discriminator between options, but same concern regarding Base Case's inflexibility due to minimal test area and expansion capability.

Location of Test -
Any option which allows the test location to be placed in a more central repository block position was evaluated superior (see table).

Schedule Consideration -
The time required to install and conduct the test should not vary between the options relative to the Base Case. Options which allow the start of testing earlier in the overall ESF schedule were evaluated as superior (see table).

Flexibility -
Options which allow more test area available for test expansion and confirmation testing (all but Base Case) were evaluated as superior. Options which allow test relocation along the main running the length of the block were rated superior from the standpoint of testing flexibility and ability to obtain most representative data.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/4/90

ESF TEST LABORATORY TESTS

PREPARERS:

ESF Test Organization (SANDIA National Laboratories) Ray E. Finley
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Douglas A Blankenship	[signature]	6314	5/4/90

TEST REFERENCE (Regulatory): 10 CFR Part 60.21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.15.1.1.4

SDRD Rev 1 Section B-MECH-17 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts)	(x)
Main Test Level	(x)
Exploratory Drifts	(x)

OPTION 13 (B7) DATE: 5-15-90

TEST 33: LABORATORY TESTS (THERMAL AND MECHANICAL) USING SAMPLES OBTAINED FROM THE ESF

Ability in Base Case	Ability of Option With Respect to the Base Case
Laboratory tests (thermal and mechanical) are planned to be conducted to support the ESF in situ tests. Samples will be obtained from cored instrumentation holes associated with in situ tests. These samples will be obtained from throughout the MTL, long drifts, and in the Shaft.	Option is superior to the Base Case. Laboratory samples will be taken from MTL, upper DBR, long exploratory drifts, the ramps, and the main. The testing of samples from the ramp and main may provide information on the regional variability of rock mechanical and thermal properties. However, testing of samples from the ramp may provide data of lesser quality because the ramp is off the repository block. The location of the MTL and ramp in the south may not provide as representative data as the NE location owing to the possibility of higher fracture frequencies as can be interpreted from surface maps of the region (e.g. Scott and Bonk, 1984, USGS OFR 84-094)

DATE: 5-4-90

OPTION 13 (B7)

TEST 33: LABORATORY TESTS (THERMAL AND MECHANICAL) USING SAMPLES OBTAINED FROM THE ESF

Schedule Impact:

See SDRD

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5-7-90

ESF TEST MULTIPURPOSE BOREHOLES TESTING NEAR THE ESF

PREPARERS:

ESF Test Organization (USGS) Michael P. CHORNACK
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
MERRICK S. WHITFIELD	Merrick S. Whitfield	USGS-WRD	5/4/90

TEST REFERENCE (Regulatory): 10CFR 60.

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) (x) Both ( )

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.4.9

SDRD Rev 1 Section B-MPBH-1 (Attached)

Other Characterization of the Yucca Mountain Unsaturated Zone (Study Plan)

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level ( )

Exploratory Drifts ( )

TEST EVALUATION RATIONALE AND DISCUSSION

TEST NAME: Multipurpose Boreholes DATE: May 4, 1990
OPTION NUMBER: 13 (B7)

For this option, provide information supporting the evaluation of test feasibility and data quality. This information must include specific references to the following items:

1) Purpose of the Test (Tie to issues and critical information needs, major parameters.)

To monitor and evaluate potential hydrologic and engineering interference effects from exploratory shaft (ES) construction on ES tests and interference effects between ES tests.

To identify possible occurrence of perched water and, if present, sample and test.

To confirm engineering and hydrogeologic properties on which the ESF design is based and identify anomalous conditions in the vicinity of the ESF.

2) The ability to install and conduct the test relative to BASE CASE.

If drilling of the MPBH's are directly linked to shaft construction, Option 13 which has no shafts would eliminate the MPBH's. No tests would be installed or conducted under this option.

3) The quality of data obtained, relative to BASE CASE.

No data would be collected

4) Location(s) of the test relative to BASE CASE.

None

5) Estimate of time (Schedule) for the test, including
   a) Installation None
   b) Initial testing None
   c) Longer - term test monitoring None

6) Preliminary assessment of the option's flexibility, regarding the test, to allow expansion of the test confirmation or additional testing. This assessment should be made relative to the BASE CASE.

No testing will be conducted

North and South Ramps

Dual ramps each with testing, particularly with one in the south and one in the north, will increase the total distance between tests and between the ramps and the IDS Surface Facility, over which the IDS must communicate. This will require special more expensive data communication techniques. Data quality will not be impacted.

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/2/90

ESF TEST HYDROLOGIC PROPERTIES OF MAJOR FAULTS ENCOUNTERED IN THE MTL OF THE ESF

PREPARERS:

ESF Test Organization (USGS) Robert W. Craig
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
MERRICK S. WHITFIELD	Merrick S. Whitfield	USGS-WRD	5/4/90

TEST REFERENCE (Regulatory): 10 CFR 60.113

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) (x) Both ( )

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.3.1.2.2.4.10

SDRD Rev 1 Section B-HYD-10 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) ( )

Main Test Level ( )

Exploratory Drifts (x)

TEST EVALUATION RATIONALE AND DISCUSSION

Date: May 2, 1990

TEST NAME: Hydrologic Properties of Major Faults Encountered in the MTL of the ESF

OPTION NUMBER: 13 (B7)

1) Purpose of test: Provide information relative to the following issues: Issue 4.4, unsaturated-zone transmissive properties, provide air permeability, matrix; and water permeability, matrix. Issue 1.1, unsaturated-zone fault hydrologic characteristics, provide air permeability, rock mass. Issue 1.6, unsaturated-zone fault hydrologic characteristics, provide hydraulic potential, rock mass. Issue 1.11, unsaturated-zone fault hydrologic characteristics, provide pneumatic potential, rock mass. Issue 1.12, unsaturated-zone fault hydrologic characteristics, provide water content, rock mass. Issue 4.4, unsaturated-zone fault hydrologic characteristics, provide water permeability, rock mass. Issue 4.4, unsaturated-zone fluid chemistry, temperature, and age, provide carbon-14 activity; composition of formation gases; composition of formation water; stable-isotope composition (oxygen-18, deuterium); thermal potential, rock mass; tritium activity. Issue 4.4, unsaturated-zone moisture conditions, water content, matrix.

2) Ability to conduct test: Option is almost identical to base case.

3) Quality of data obtained: Same quality of data provided by almost identical access.

4) Location(s) of the test: Option is almost identical to base case.

5) Estimate of time for test:

a) Installation: Same as base case.

b) Initial Testing: Same as base case.

c) Longer-term monitoring: Same as base case.

6) Preliminary assessment of flexibility: This option provides superior flexibility in that access to the Ghost Dance fault a second time in the central or southern portion of the block is possible via an additional "east-west drift".

ESF ALTERNATIVES STUDY DATA SHEET FOR TESTING INPUT

DATE 5/9/90

ESF TEST INTEGRATED DATA SYSTEM

PREPARERS:

ESF Test Organization (Los Alamos) Z. Ross Dobald
Preparer's Name

Los Alamos Test Manager's Office Ned Z. Elkins

CHECKED BY:

Name	Signature	Organization	Date
Ronald Oliver	Ronald Oliver	LANL	5-10-90

TEST REFERENCE (Regulatory): 10CFR60.122 and .141 and .21

TEST SUPPORTS (Check) Repository Design ( ) Site Suitability (Characterization) ( ) Both (x)

TEST REQUIREMENTS/CONSTRAINTS:

SCP Section 8.4.2.3.2.2 Dec 1988

SDRD Rev 1 Section B-IS-1 (Attached)

Other

CURRENT TEST LOCATION(S) (Check)

ESF Access (Shafts) (x)

Main Test Level (Includes Testing in the Calico Hills) (x)

Exploratory Drifts (x)

APPENDIX 5D

BIBLIOGRAPHY OF REFERENCE MATERIAL USED FOR PANEL EVALUATIONS

SNL (Sandia National Laboratories), "Yucca Mountain Project Exploratory Shaft Facility Alternatives Study Implementation Plan," Rev. O, Albuquerque, NM, November 30, 1989.

Barrett, L. H., Memo to Carl Gertz, Subject: "Guidance for Evaluating Reasonable Alternatives for the Exploratory Shaft Facility," U.S. Department of Energy, Yucca Mountain Project Office, Las Vegas, NV, October 30, 1989.

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PANEL 8. MANAGEMENT

General references only.

PANEL 9. PROGRAMMATIC VIABILITY

General references only.

APPENDIX 6A

RECORDS PACKAGE LIST OF DOCUMENTS FOR EVALUATION OF FEATURES TO DETERMINE WHETHER THE FEATURES ARE DISCRIMINATORS FOR PERFORMANCE

SUPPORTING DOCUMENTATION FOR SAND91-0025 - RECORDS PACKAGES, SECTION 6

Records Management System Number (RMS)	Title	Date	Source/ Org.	File Code
1. 016974	Design Investigation Memo (DIM) 251, Evaluation of Repository/ ESF-Feature Performance Discriminators	4/26/90	T.E. Blejwas	60/12611/ DIM251/1.0
2. 018381	Memo from T. E. Blejwas to A. L. Stevens and L. S. Costin, Subj: Summary of Evaluations for DIM 251 (with all attachments): Dated July 3, 1990	7/3/90	T.E. Blejwas	60/12611/ DIM251/1.3 60/12611/ DIM251/1.4

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