U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: ESF ALTERNATIVES STUDY-OPTIONS AND SUPPORTING INFORMATION

PRESENTER: DR. ALDRED L. STEVENS

PRESENTER'S TITLE AND ORGANIZATION: DIVISION SUPERVISOR, REPOSITORY ENGINEERING DIVISION
SANDIA NATIONAL LABORATORIES

PRESENTER'S TELEPHONE NUMBER: (505) 844-1849

JULY 24-25, 1990

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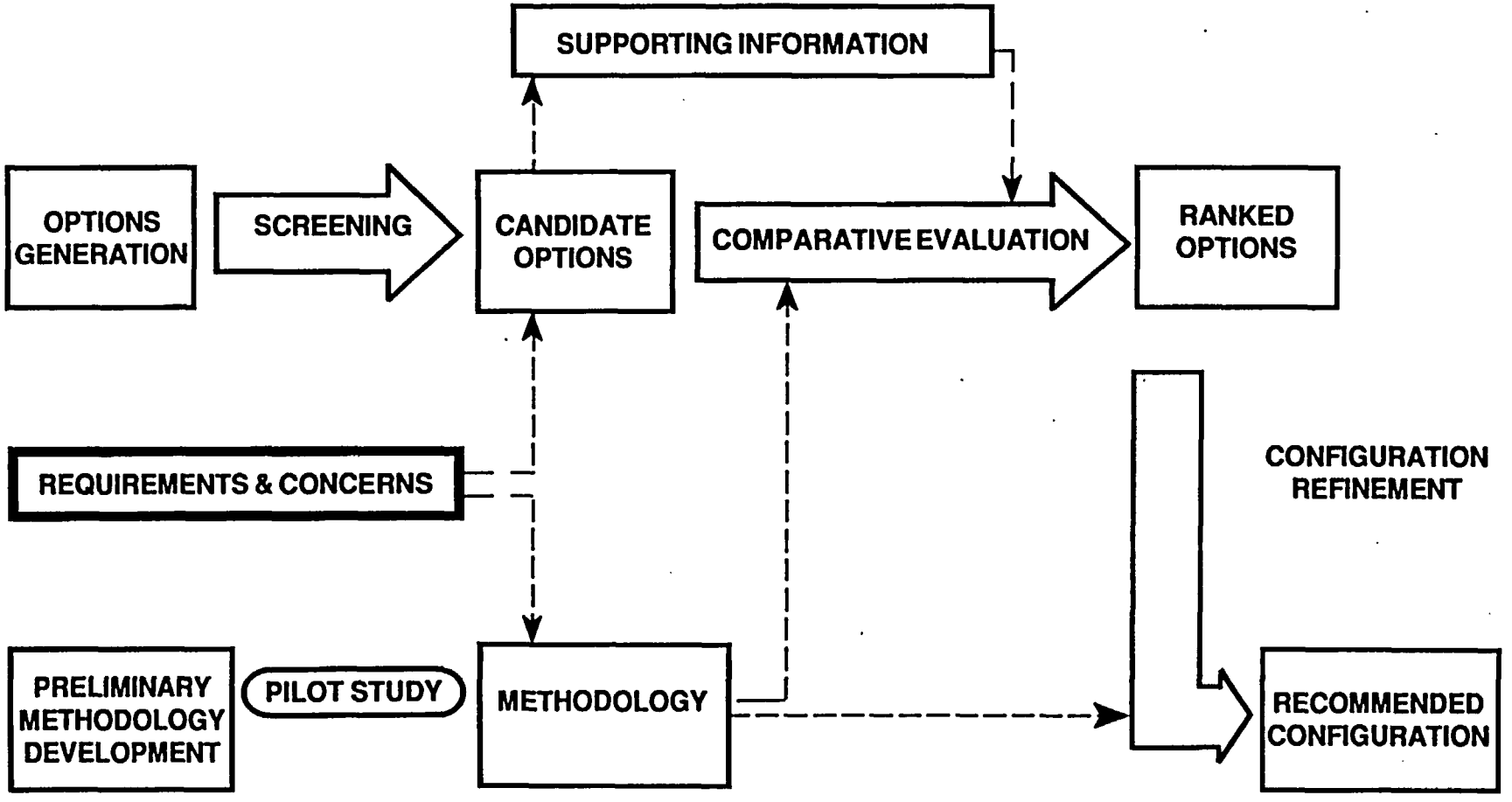
ESF ALTERNATIVES STUDY

REQUIREMENTS & CONCERNS



REQUIREMENTS AND CONCERNS

REQUIREMENTS DOCUMENTS REVIEWED INCLUDE:

- 10 CFR 20
- 10 CFR 60
- 10 CFR 960
- 30 CFR 57 (MSHA)
- 40 CFR 191
- 29 CFR 1910 (OSHA)
- DOE ORDERS
- MISCELLANEOUS REGULATIONS
- OCRWM AND PROJECT DOCUMENTS

ALL REQUIREMENTS HAVE BEEN IDENTIFIED FOR USE IN EVALUATION OF OPTIONS

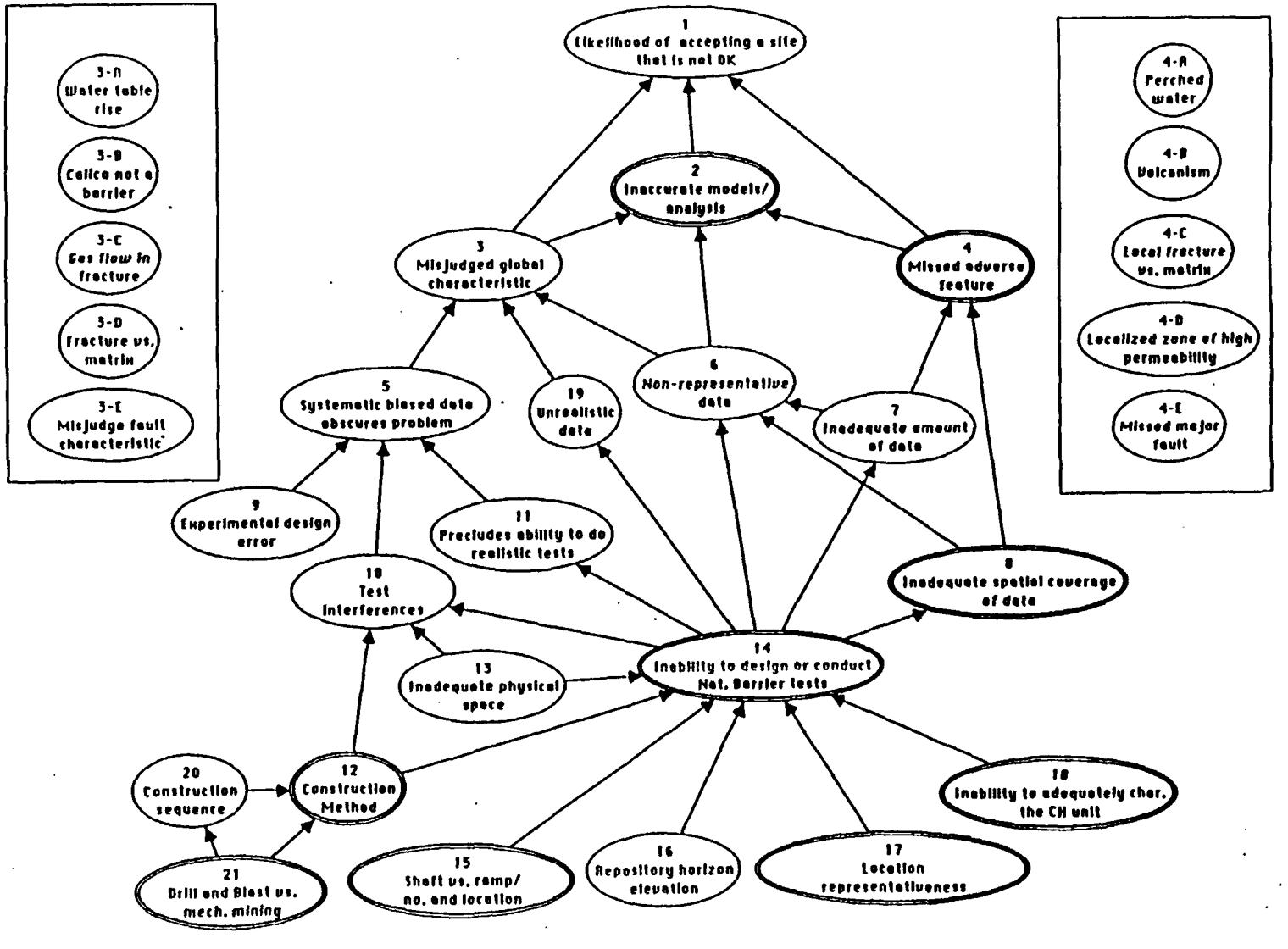
- APPROXIMATELY 2500 REQUIREMENTS (WHICH MAY IMPACT THE SELECTION OF THE PREFERRED OPTION) WERE IDENTIFIED

  NOTE: THIS NUMBER MAY APPEAR EXCESSIVE, AS THE ESF REQUIREMENTS DOCUMENT REPEATS MANY 10 CFR 60 REQUIREMENTS IN SEVERAL DIFFERENT SUB-SYSTEMS

- APPROXIMATELY 250 REQUIREMENTS WERE DETERMINED TO BE DISCRIMINATORY TO THE SELECTION OF RECOMMENDED CONFIGURATION

- THESE REQUIREMENTS ARE BEING CROSS-CORRELATED TO THE INFLUENCE DIAGRAMS

EXAMPLE INFLUENCE DIAGRAM



LIKELIHOOD OF INCORRECTLY ACCEPTING A SITE THAT IS NOT OK

EXAMPLE CORRELATION OF REQUIREMENT TO FACTOR ON INFLUENCE DIAGRAM

REQUIREMENT	INFLUENCE DIAGRAM NAME	FACTOR #	FACTOR STATEMENT
10 CFR 60.15(C) (3) EXPLORATORY BOREHOLES, SHAFTS IN GROA TO BE LOCATED WHERE OTHER SHAFTS/PILLARS ARE PLANNED	TESTING: LIKELIHOOD OF ACCEPTING NOT OK AT SITE	15	SHAFT/RAMP # AND LOCATION
		13	INADEQUATE PHYSICAL SPACE
	TESTING: LIKELIHOOD OF REJECTING OK SITE	22	SHAFT/RAMP # AND LOCATION
		28	INADEQUATE PHYSICAL SPACE FOR TEST FLEXIBILITY
	SCENARIO (POSTCLOSURE PERFORMANCE)	83	ESF ACCESS LOCATION

EXAMPLE CORRELATION OF REQUIREMENT TO FACTOR ON INFLUENCE DIAGRAM

(CONTINUED)

REQUIREMENT	INFLUENCE DIAGRAM NAME	FACTOR #	FACTOR STATEMENT
10 CFR 60.15(C) (3) EXPLORATORY BOREHOLES, SHAFTS IN GROA TO BE LOCATED WHERE OTHER SHAFTS/PILLARS ARE PLANNED	NON-RADIOLOGICAL WORKER SAFETY	43	# OF RAMPS/ SHAFTS
	RADIOLOGICAL PUBLIC HEALTH	26*	COMPLEXITY OF LAYOUT
	RADIOLOGICAL WORKER SAFETY	28	COMPLEXITY OF LAYOUT
	ESF COST (POSTCLOSURE PERFORMANCE)	44**	# AND LOCATION OF U/G ACCESSES

* ESF SHAFTS/RAMPS LATER USED FOR REPOSITORY OPERATIONS; SIMPLIFIES LAYOUT

** ESF SHAFTS/RAMPS LATER USED FOR REPOSITORY OPERATIONS; AFFECTS COSTS

EXAMPLE CORRELATION OF REQUIREMENT TO FACTOR ON INFLUENCE DIAGRAM

(CONTINUED)

REQUIREMENT	INFLUENCE DIAGRAM NAME	FACTOR #	FACTOR STATEMENT
10 CFR 60.133(E) (2) U/G OPENINGS DESIGNED TO REDUCE ROCK MOVEMENT AND FRACTURING	SCENARIO (POSTCLOSURE PERFORMANCE)	78	ESF CONSTRUCTION METHOD
		84	REPOSITORY CONSTRUCTION METHOD
	NON-RADIOLOGICAL WORKER SAFETY	39	CONSTRUCTION METHOD
	TESTING: LIKELIHOOD OF ACCEPTING BAD SITE	12	CONSTRUCTION METHOD

EXAMPLE CORRELATION OF REQUIREMENT TO FACTOR ON INFLUENCE DIAGRAM

(CONTINUED)

REQUIREMENT	INFLUENCE DIAGRAM NAME	FACTOR #	FACTOR STATEMENT
10 CFR 60.133(E) (2) U/G OPENINGS DESIGNED TO REDUCE ROCK MOVEMENT AND FRACTURING	TESTING: LIKELIHOOD OF REJECTING OK SITE	17	CONSTRUCTION METHOD
	ESF COST	54	CONSTRUCTION METHOD

PRESENT CONCERNS ABOUT ESF CONFIGURATION

- **NUCLEAR WASTE TECHNICAL REVIEW BOARD**
  - REEXAMINE THE PROPOSED ESF CONFIGURATION, INCORPORATING THE USE OF A SHAFT BORING MACHINE TO CONSTRUCT ES-1
  - REEXAMINE THE INCORPORATION OF A RAMP IN THE PROPOSED ESF CONFIGURATION, EXCAVATED BY THE USE OF THE TUNNEL BORING MACHINE
- **NWTRB COMMENTS AND RECOMMENDATIONS AS EXPRESSED IN THE REPORT TO CONGRESS**

PRESENT CONCERNS

(CONTINUED)

- **REMOVAL OF NRC OBJECTIONS**

  - NEED FOR DOE TO DEMONSTRATE THE ADEQUACY OF BOTH THE ESF DESIGN AND THE DESIGN CONTROL PROCESS

    RECOMMENDATION: "THE TITLE II DESIGN SHOULD ENSURE THAT...THE NUMBER OF SHAFTS AND THEIR LOCATIONS IN THE FINAL REPOSITORY CONTRIBUTE TO REDUCING UNCERTAINTY WITH RESPECT TO WASTE ISOLATION."

  - NEED TO IMPLEMENT A BASELINED QUALITY ASSURANCE PROGRAM BEFORE STARTING SITE CHARACTERIZATION

PRESENT CONCERNS

(CONTINUED)

- RESPOND TO NRC COMMENTS --NUREG-1347, JULY 1989, NRC STAFF SITE CHARACTERIZATION ANALYSIS OF THE DEPARTMENT OF ENERGY'S SITE CHARACTERIZATION PLAN, YUCCA MOUNTAIN SITE, NEVADA

- STATE OF NEVADA COMMENTS--STATE OF NEVADA COMMENTS ON THE DOE SITE CHARACTERIZATION PLAN, YUCCA MOUNTAIN SITE, NEVADA; VOLUMES I-IV, SEPTEMBER 1989

COMPARISON OF FEATURE vs COMPARISON OF OPTIONS

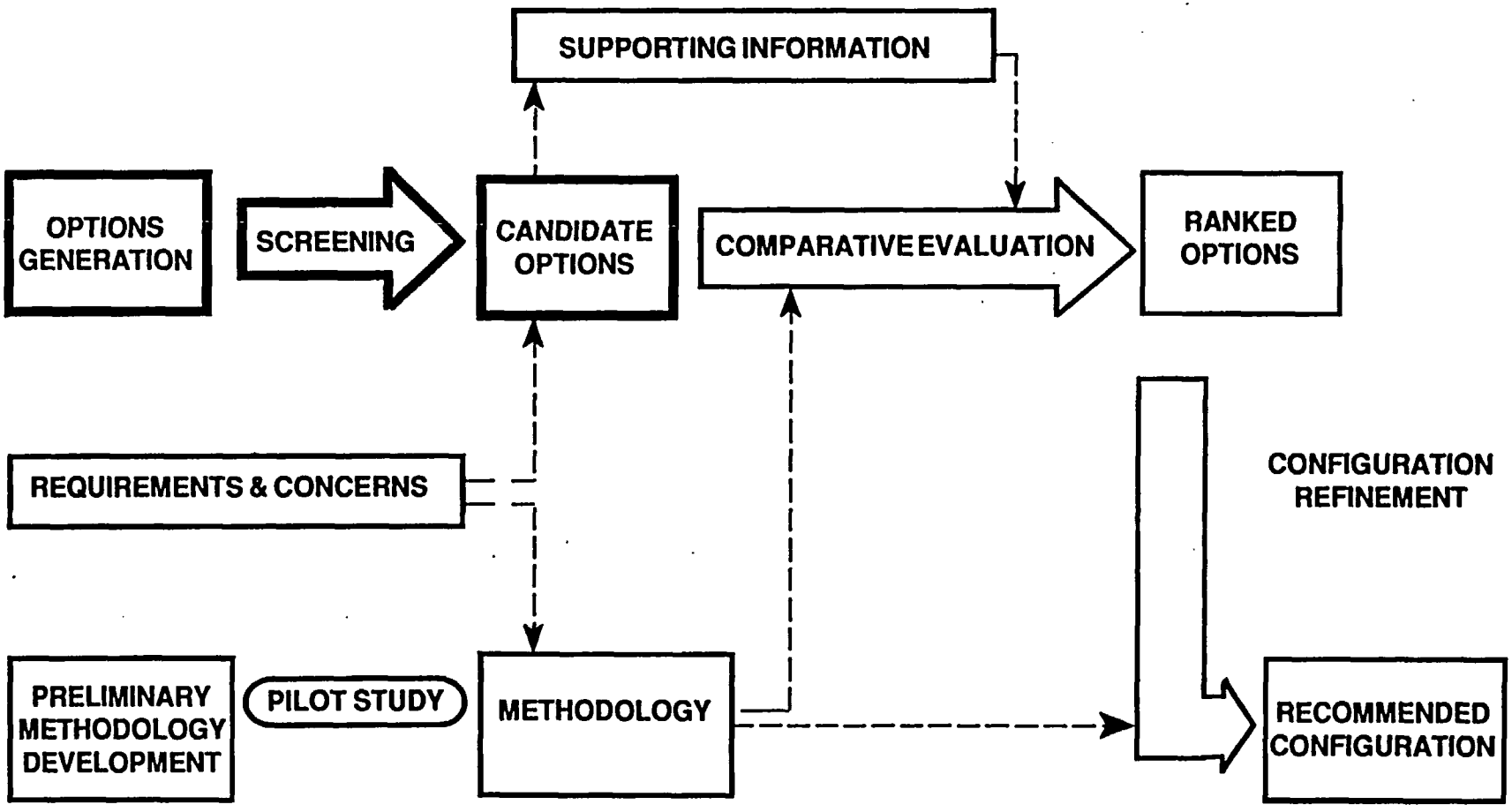
- IT HAS BEEN SUGGESTED THAT DOE COMPARE DESIGN FEATURES, SELECT THE BEST FEATURES, THEN CONSTRUCT AN ESF/REPOSITORY DESIGN COMPOSED OF THE BEST FEATURES

- SUCH AN APPROACH REQUIRES THAT THE IMPACTS OF EACH FEATURE ON THE EVALUATION FACTORS BE INDEPENDENT FROM THE IMPACTS OF OTHER FEATURES, IN ORDER FOR THE RESULTS TO BE ADDITIVE – THEY ARE NOT

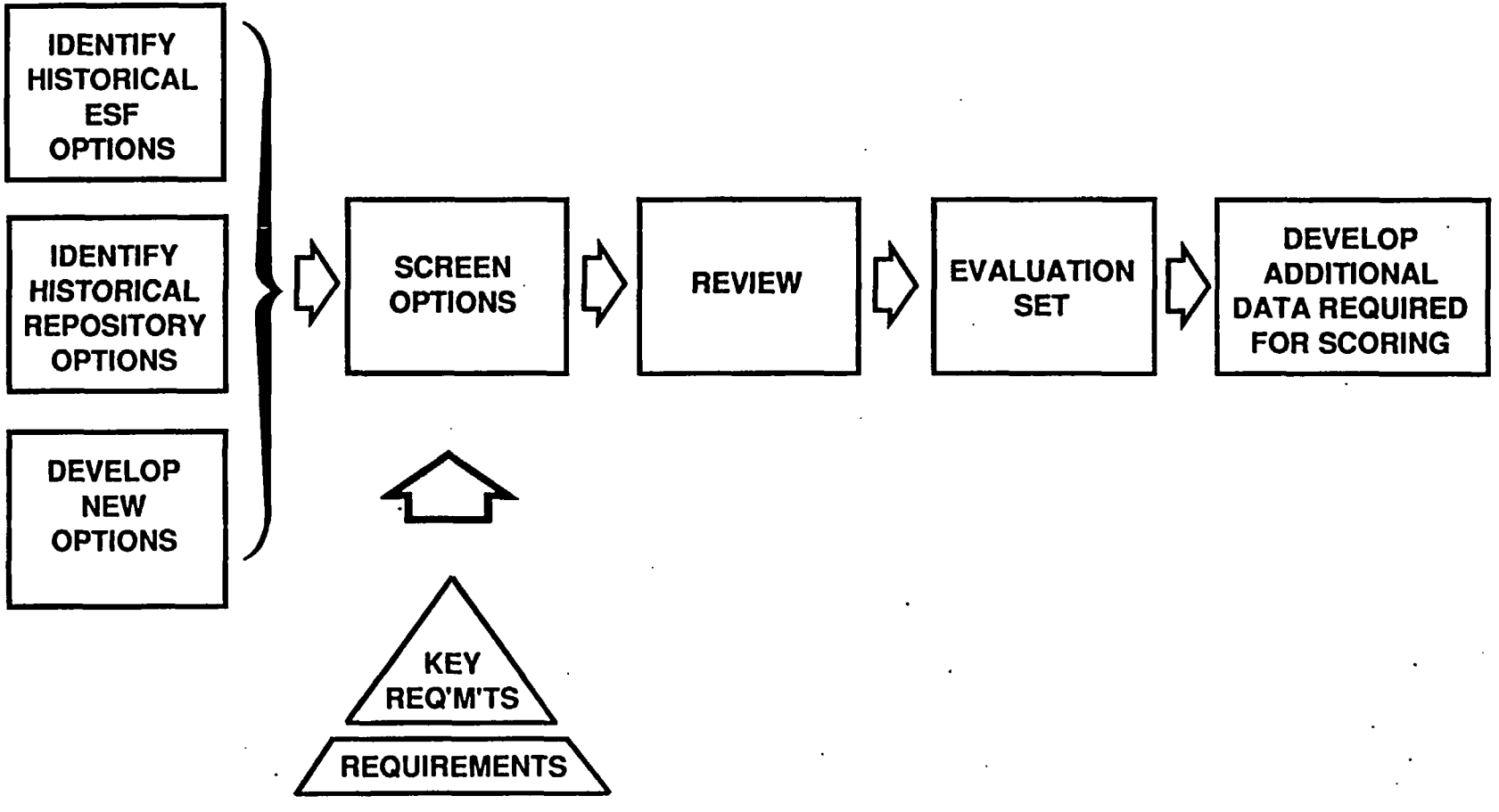
- THEREFORE, DOE ELECTED TO EVALUATE THE FEATURES AS THEY ARE EMBEDDED IN THE OPTIONS

ESF ALTERNATIVES STUDY

OPTIONS GENERATION, SCREENING, AND CANDIDATE OPTION



PROCESS FOR DEVELOPING ESF/REPOSITORY OPTIONS



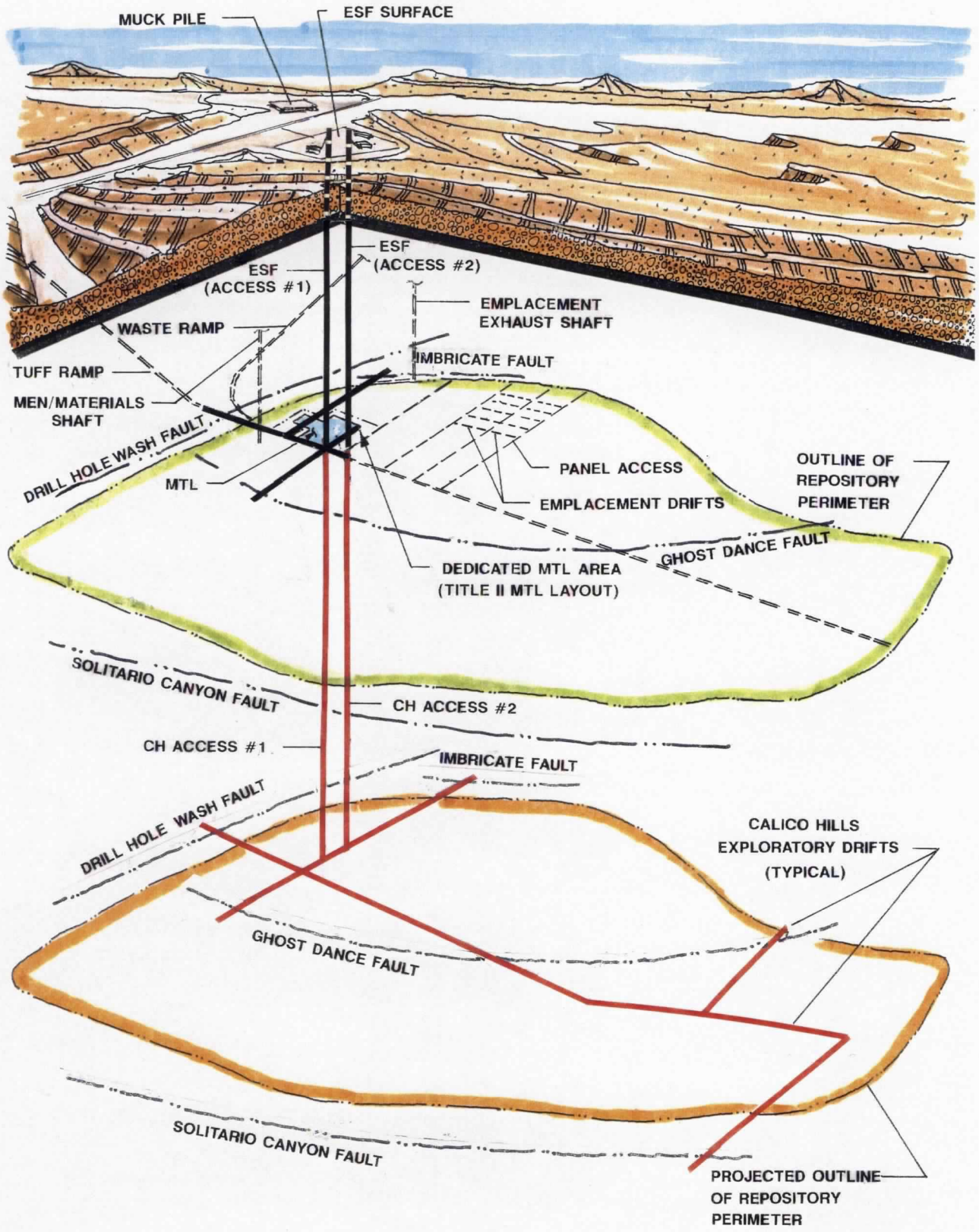
OPTIONS IDENTIFIED

- 52 OPTIONS IDENTIFIED FOR SCREENING
  - ADDRESS GOALS TO RESOLVE CONCERNS
  - SCREENING BASED ON REQUIREMENTS
  - CONSISTENT WITH OBJECTIVES
- 21 OPTIONS DID NOT PASS MINIMUM (8) SCREENING CRITERIA
- REMAINING 31 DIVIDED INTO 12 CLASSES
- 12 REPRESENTATIVE OPTIONS DEVELOPED IN ADDITION TO BASE CASE
- TOTAL OF 17 FINAL AFTER EXPANDING ONE TO FIVE
  - SPAN THE "SPACE" OF POSSIBLE FEATURES

PRESENTATION OF OPTIONS (WITHOUT CALICO HILLS)

PROCESS FOR INCORPORATING CALICO HILLS TESTING STRATEGY INTO 17 OPTIONS

PRESENTATION OF OPTIONS (WITH CALICO HILLS)

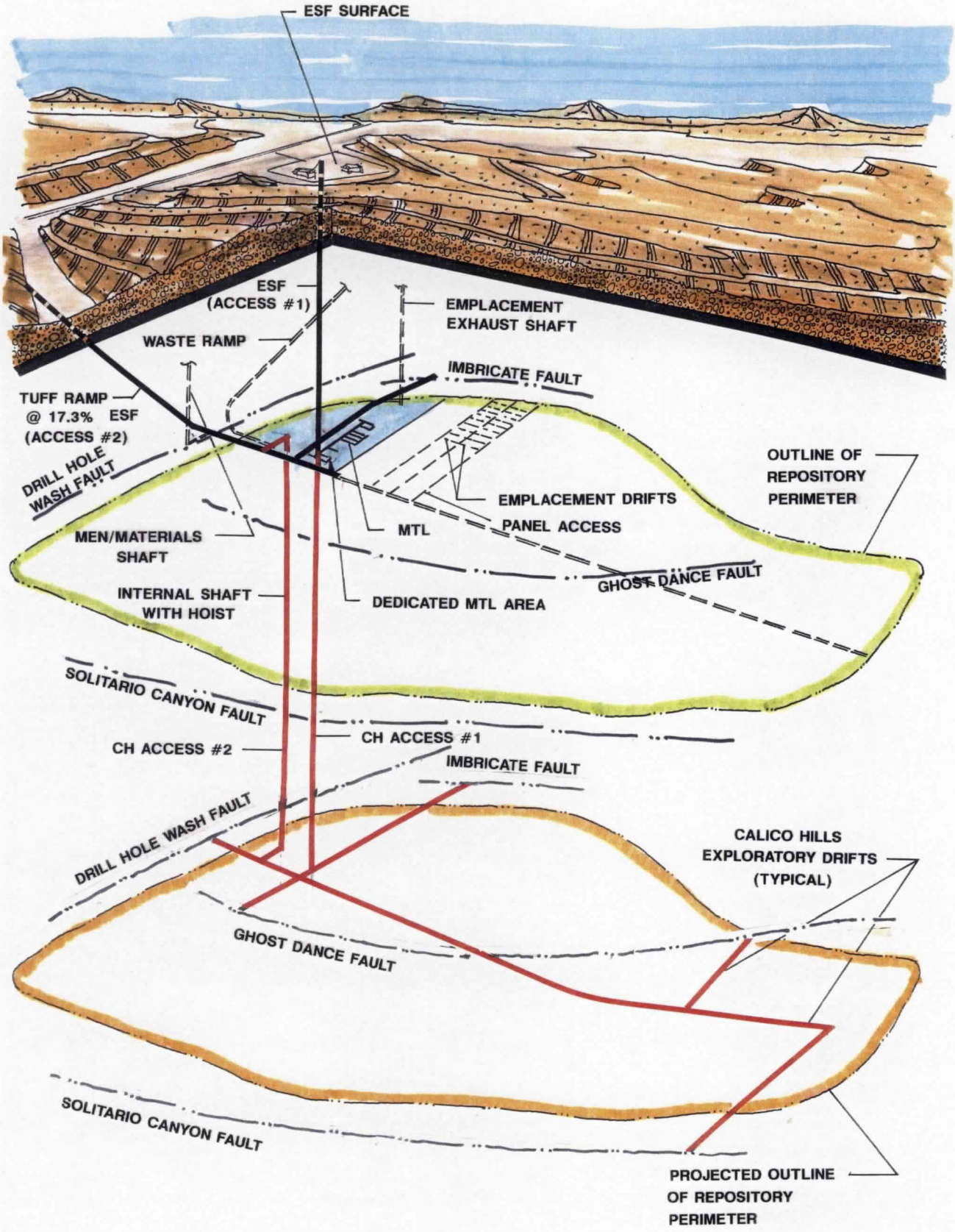


ESF ALTERNATIVES STUDY
TASK NO. 4

BASE CASE

ISOMETRIC

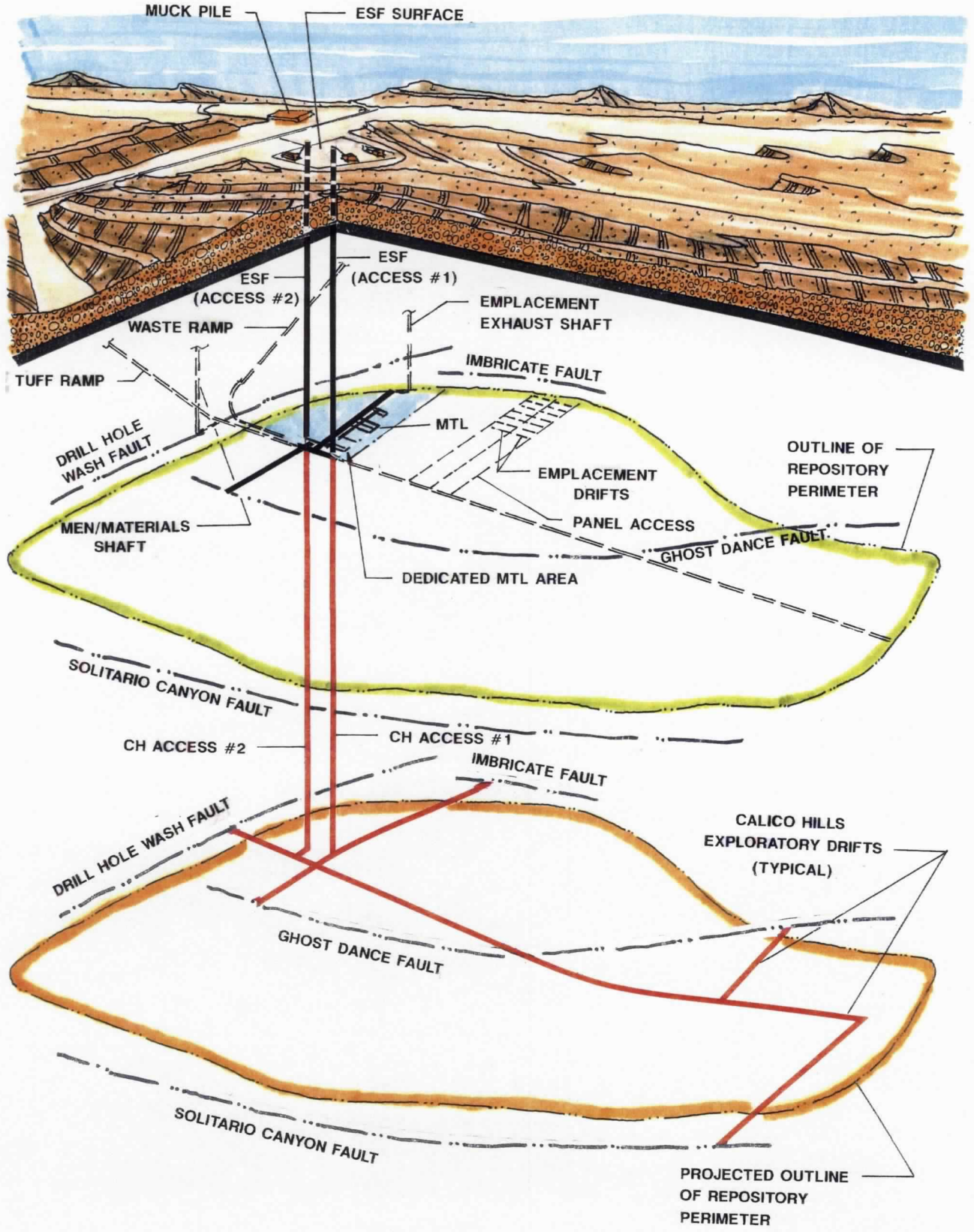
DATE: _____



ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. A1
ISOMETRIC

DATE: _____

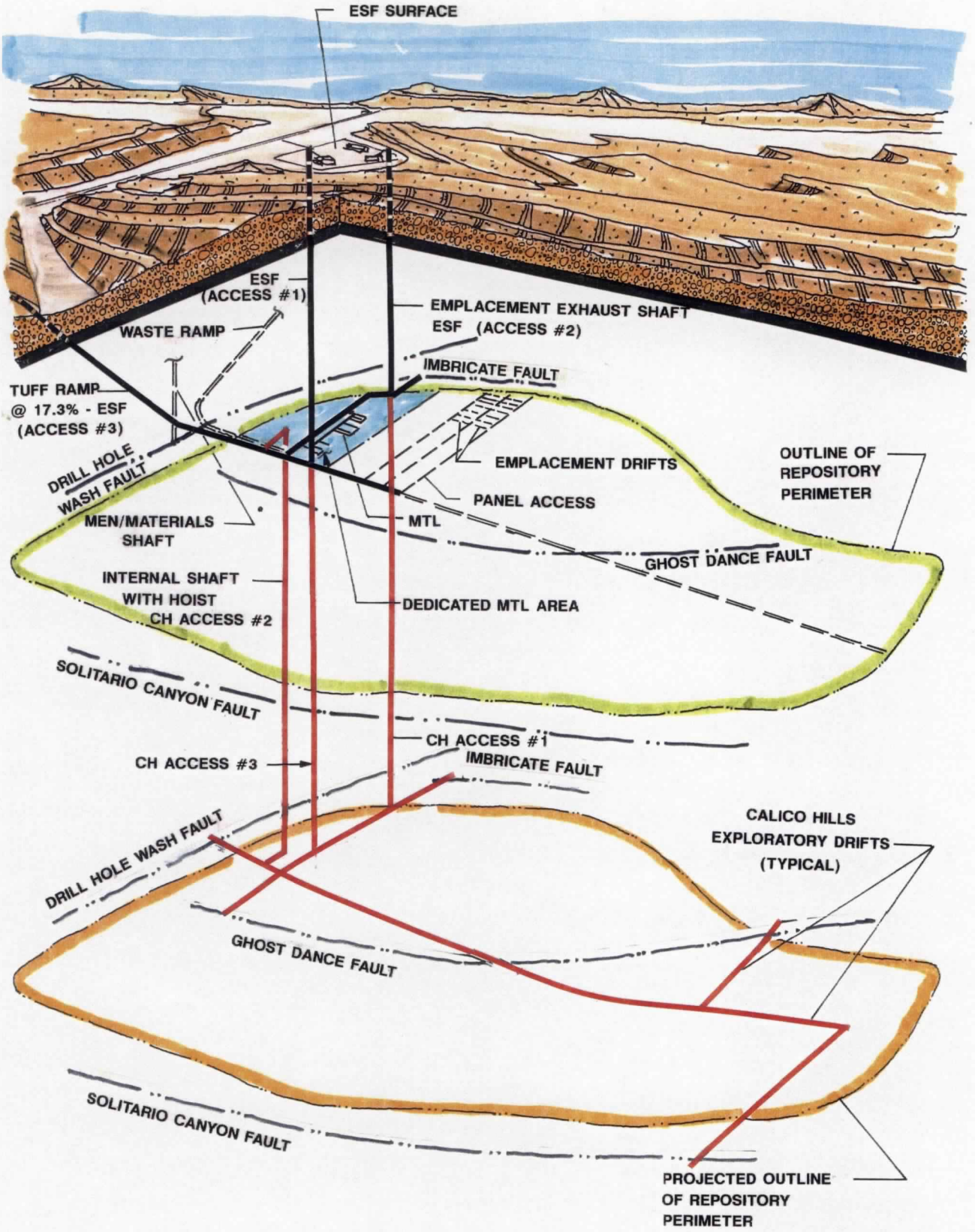


ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. A2

ISOMETRIC

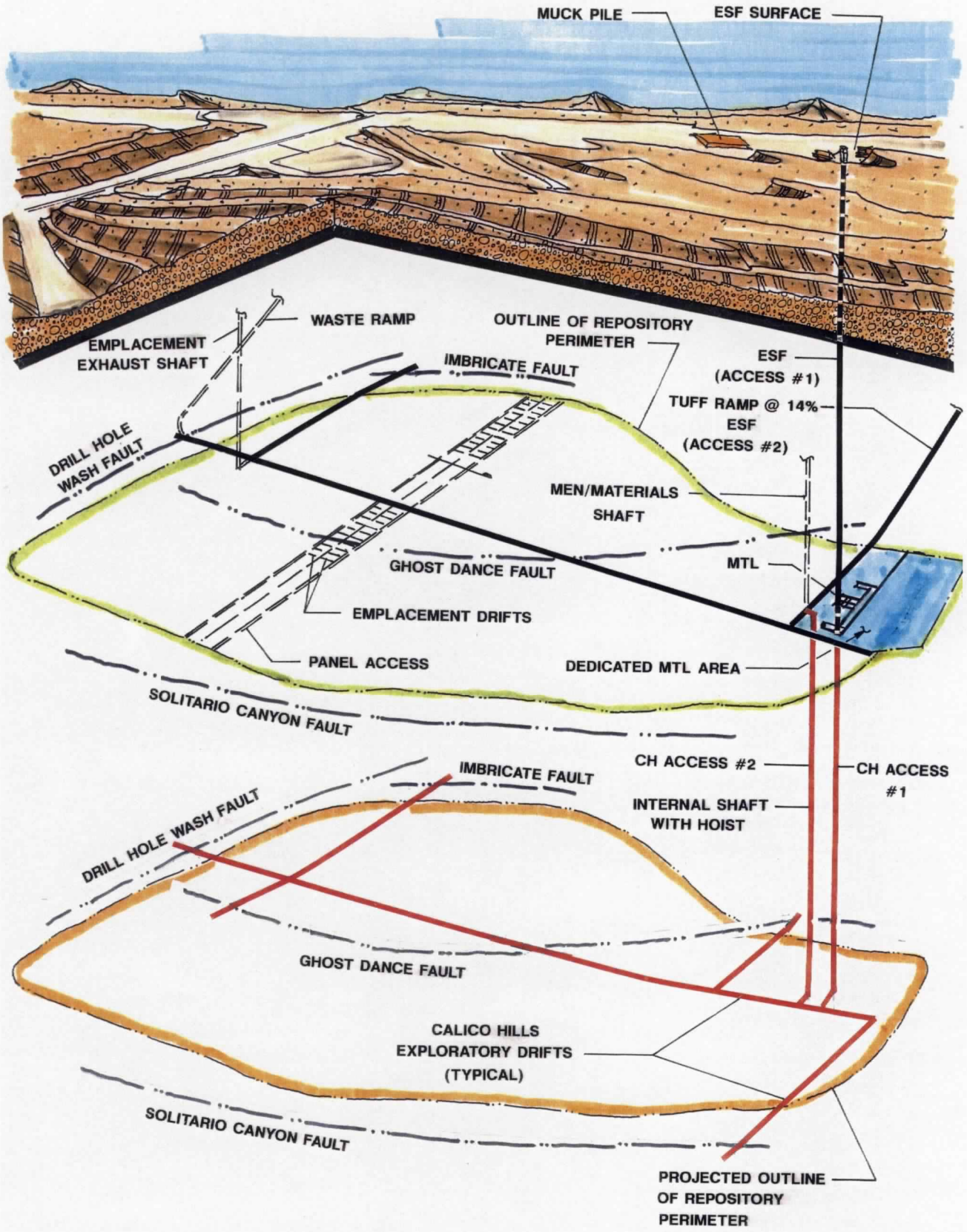
DATE: _____



ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. A4 REV. 1
ISOMETRIC

DATE: _____

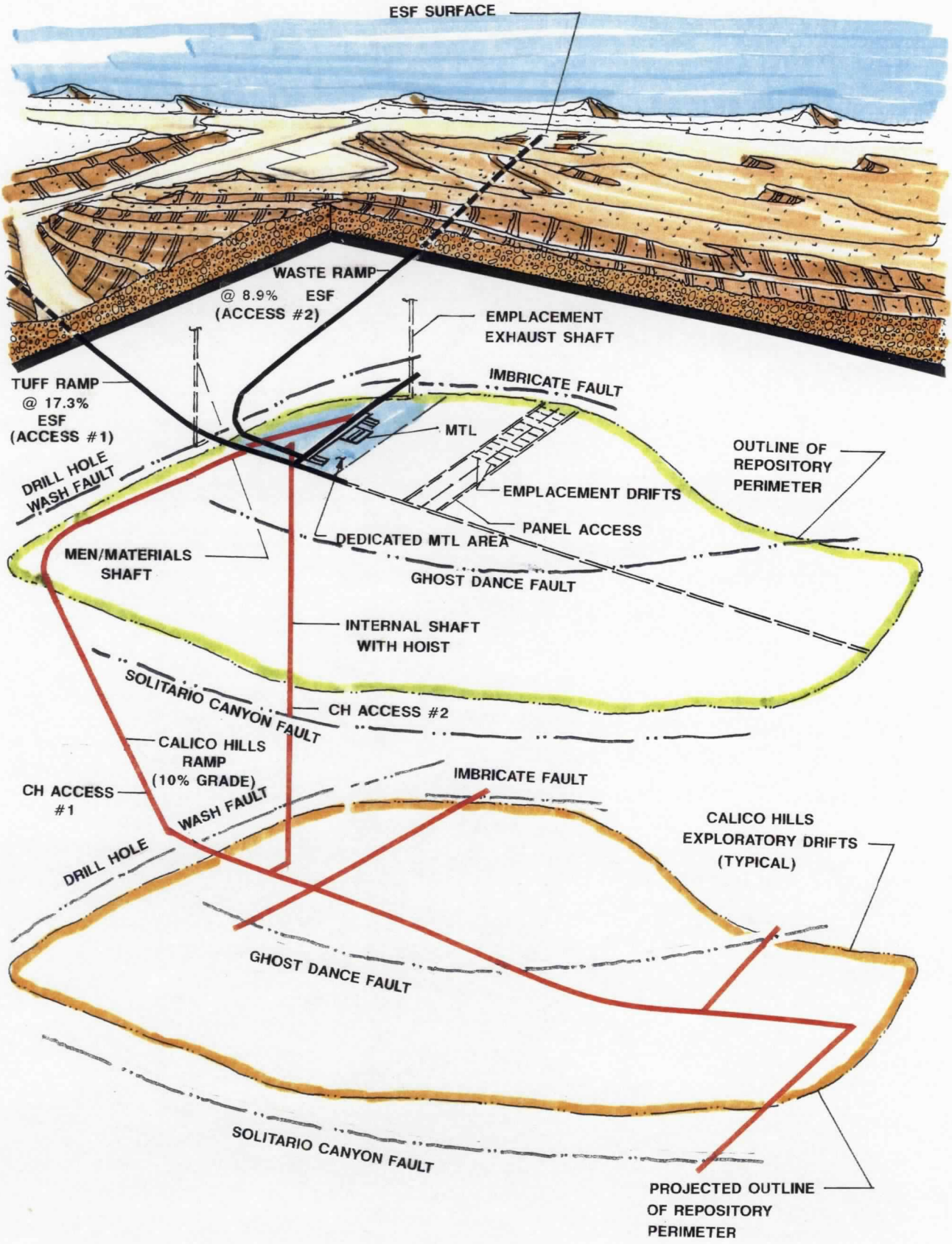


ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. A5

ISOMETRIC

DATE: _____

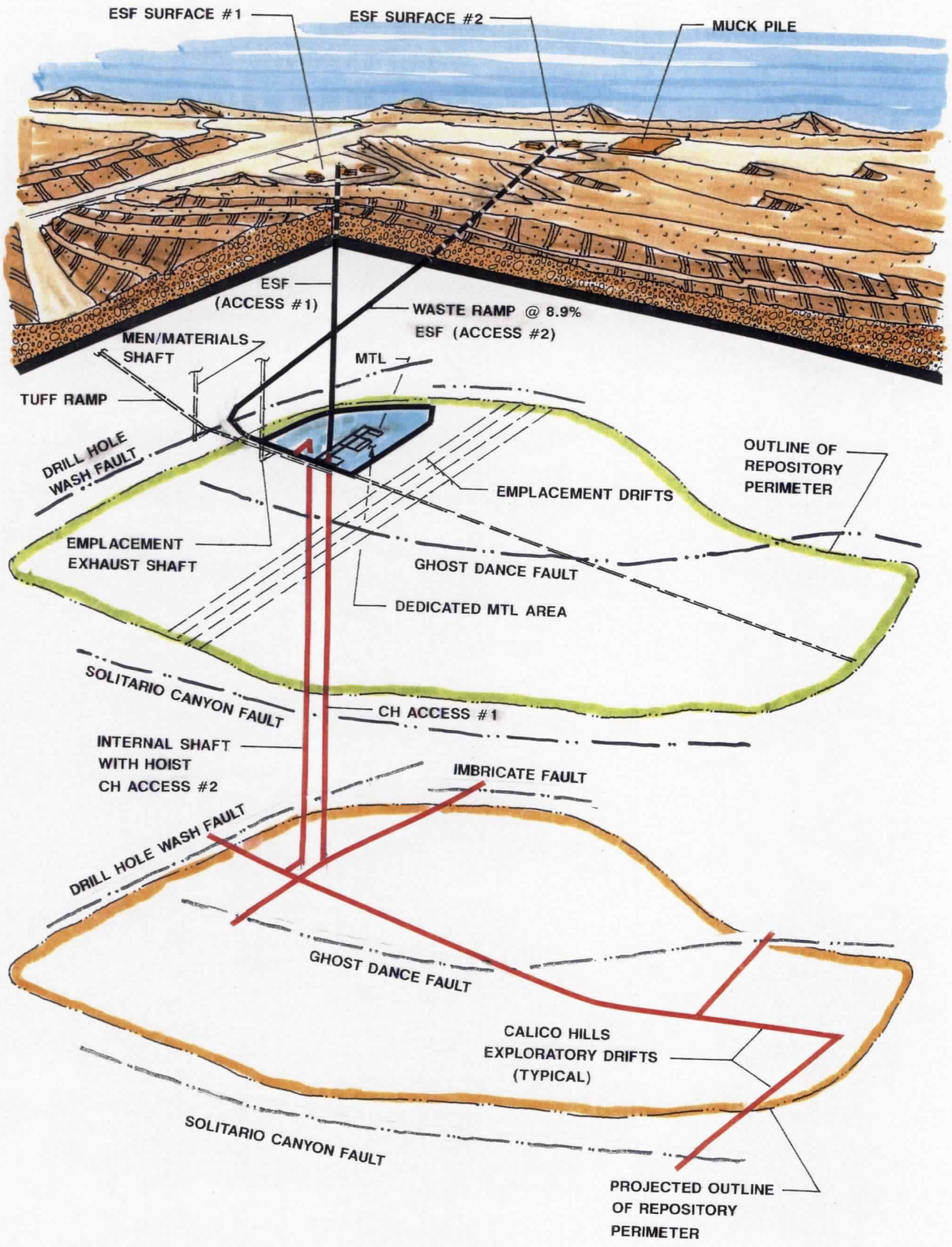


ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. A7

ISOMETRIC

DATE:

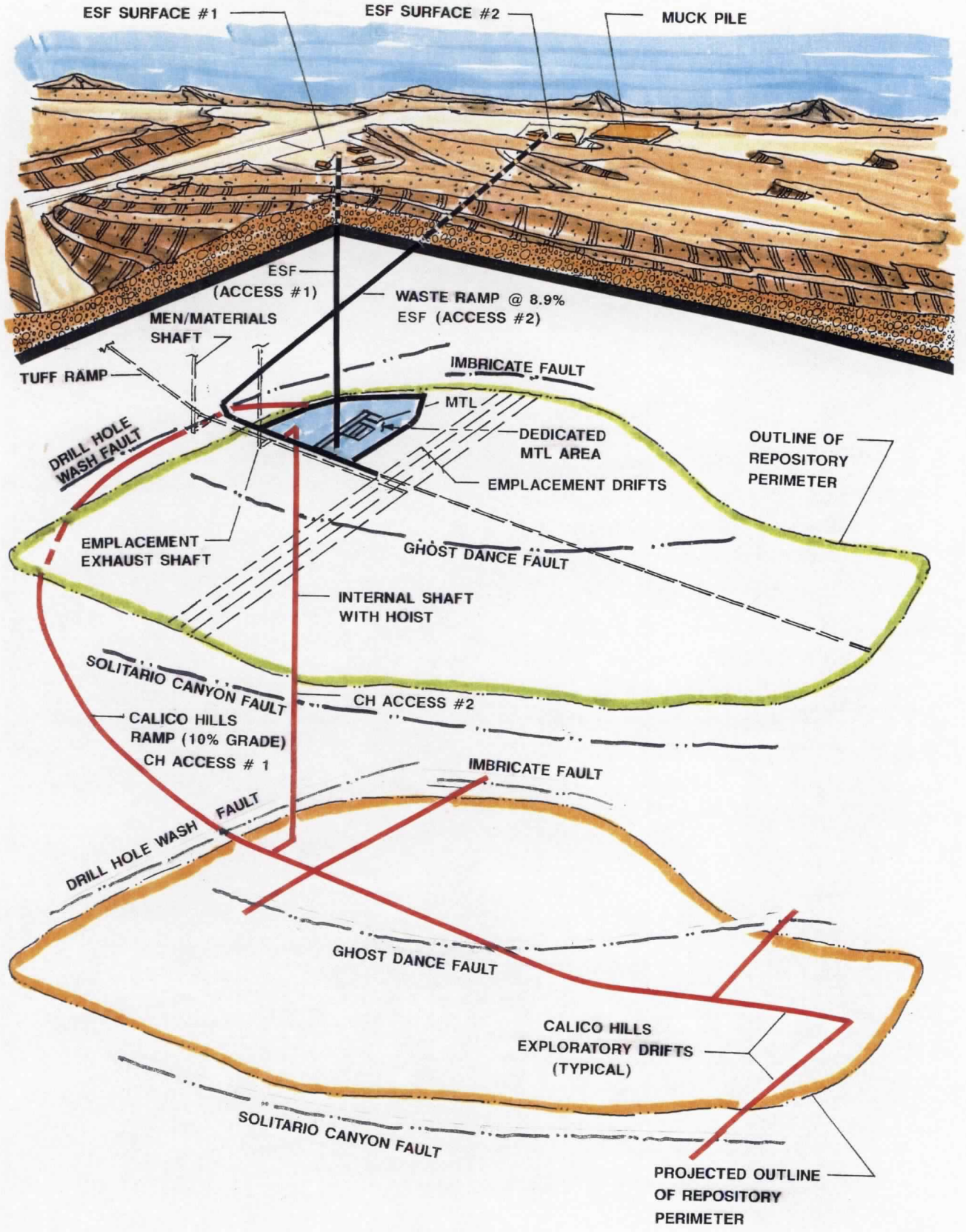


ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. B3 REV. 2

ISOMETRIC

DATE: _____

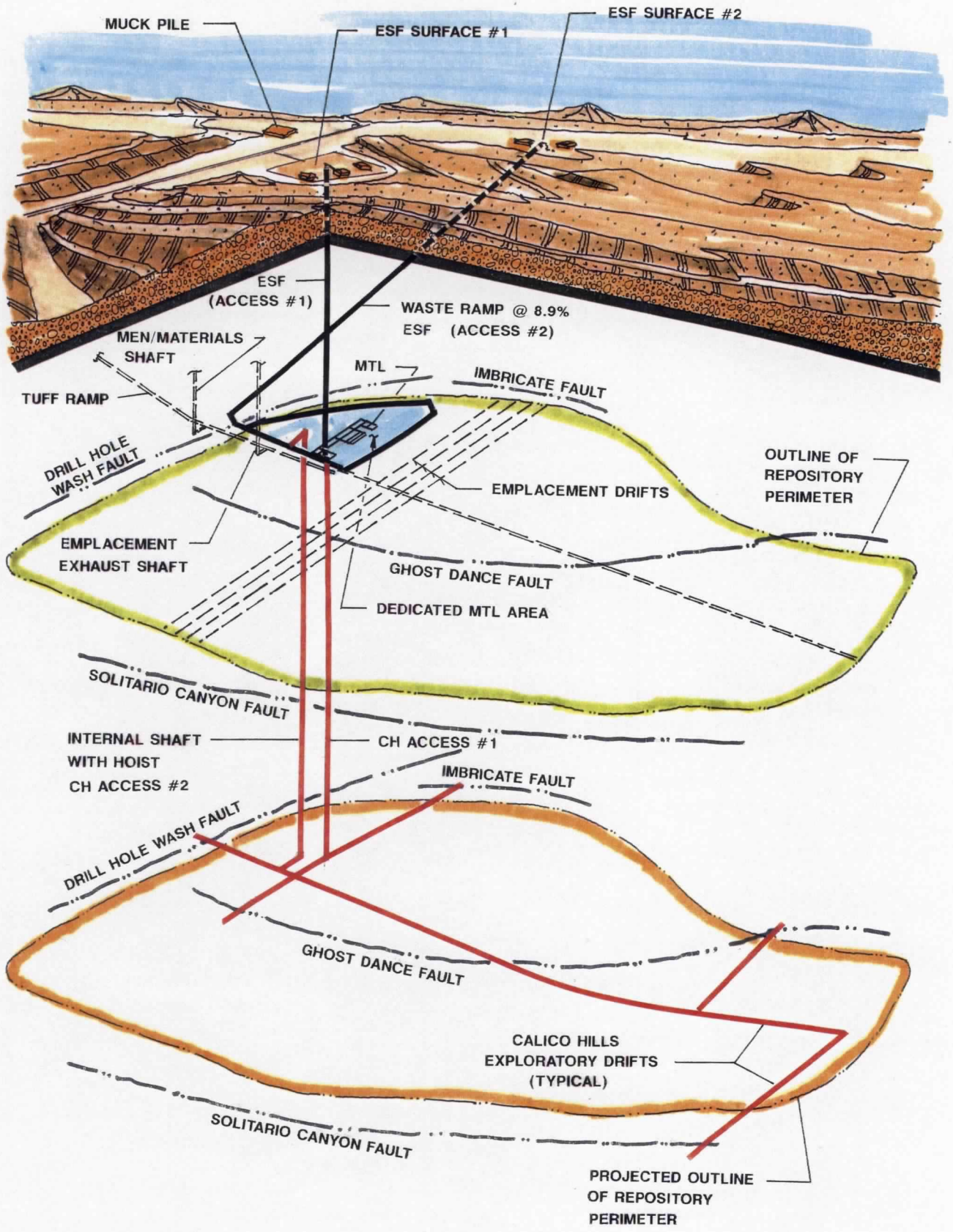


ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. B3 REV. 3

ISOMETRIC

DATE: _____

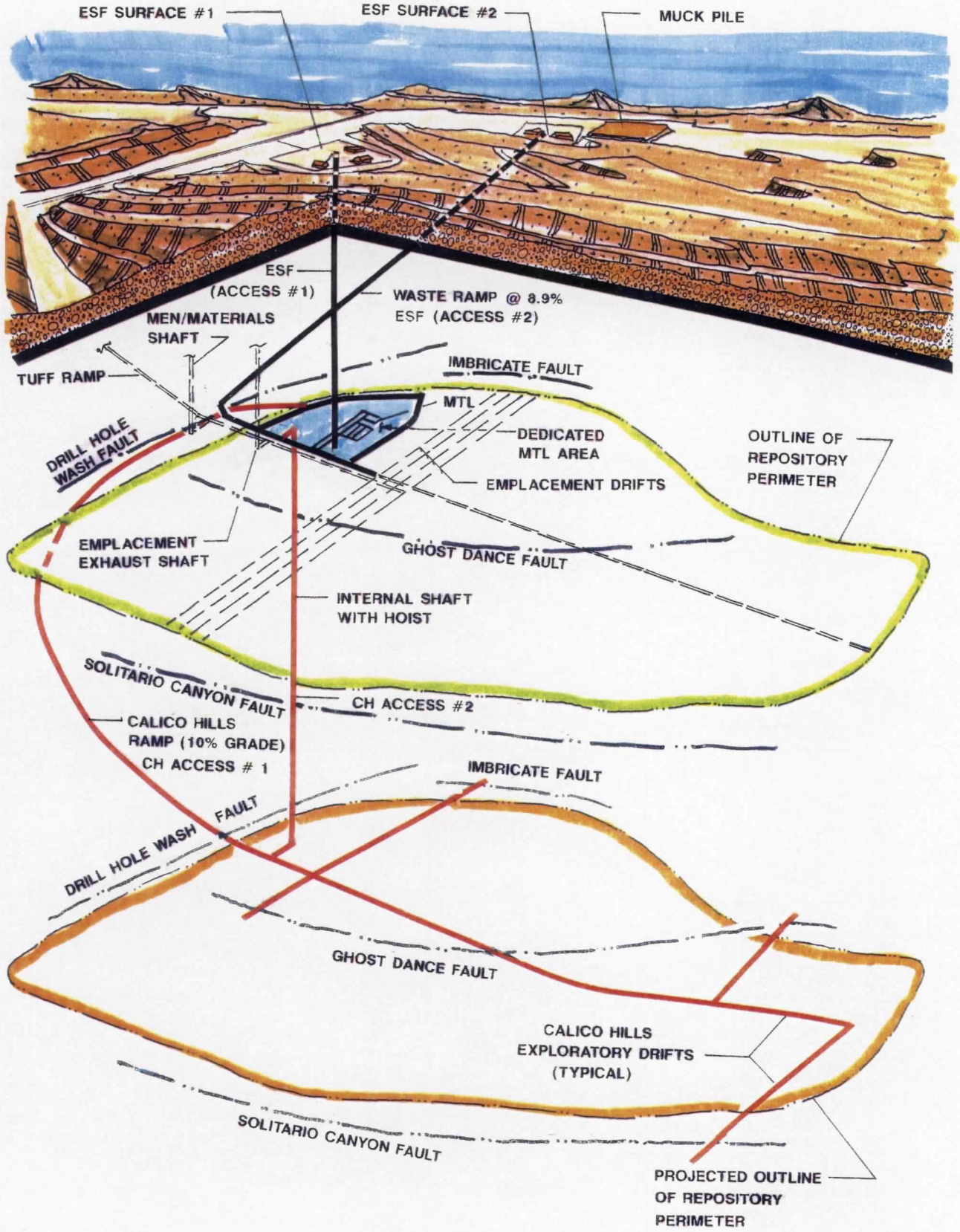


ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. B3 REV. 4

ISOMETRIC

DATE: _____

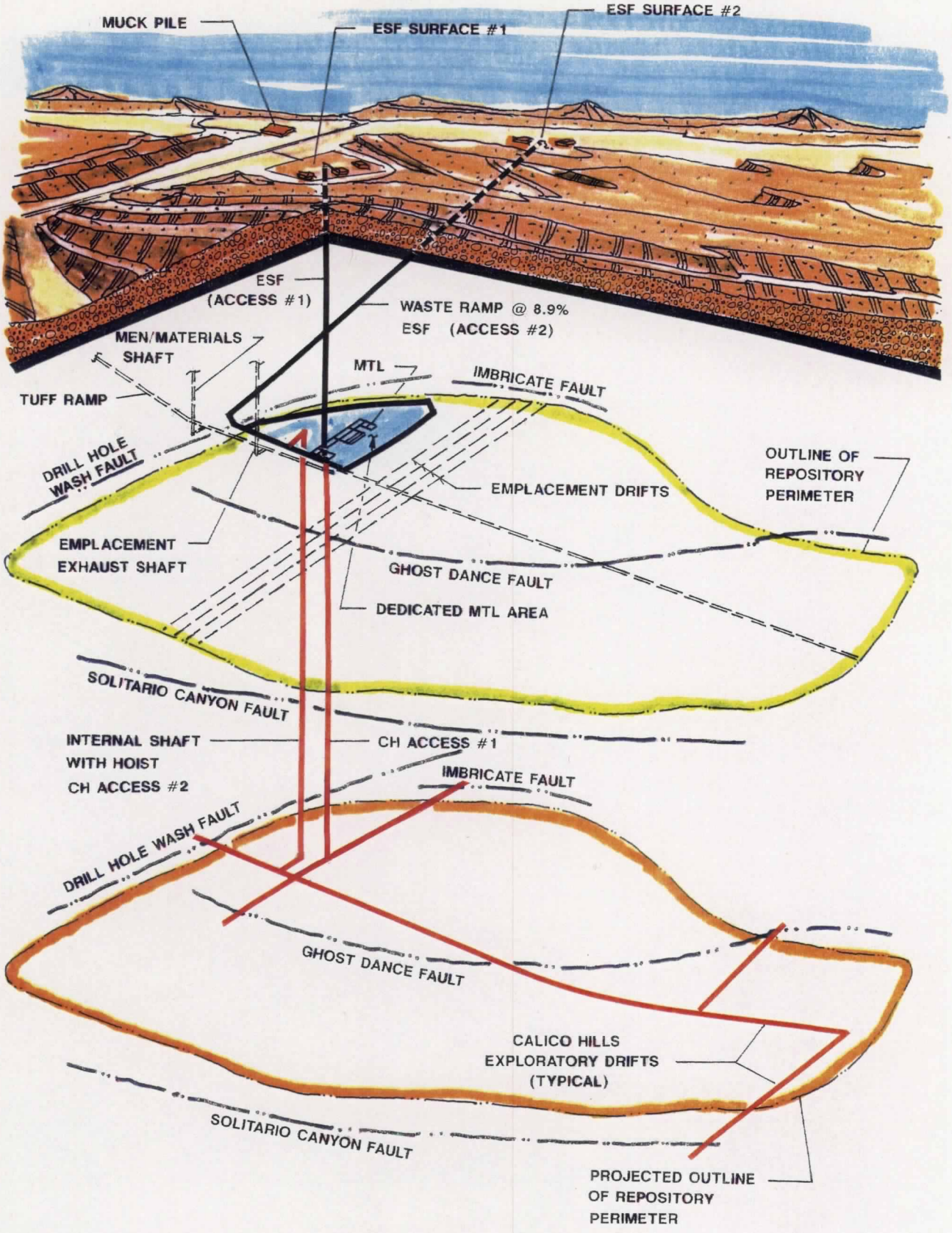


ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. B3 REV. 5

ISOMETRIC

DATE: _____

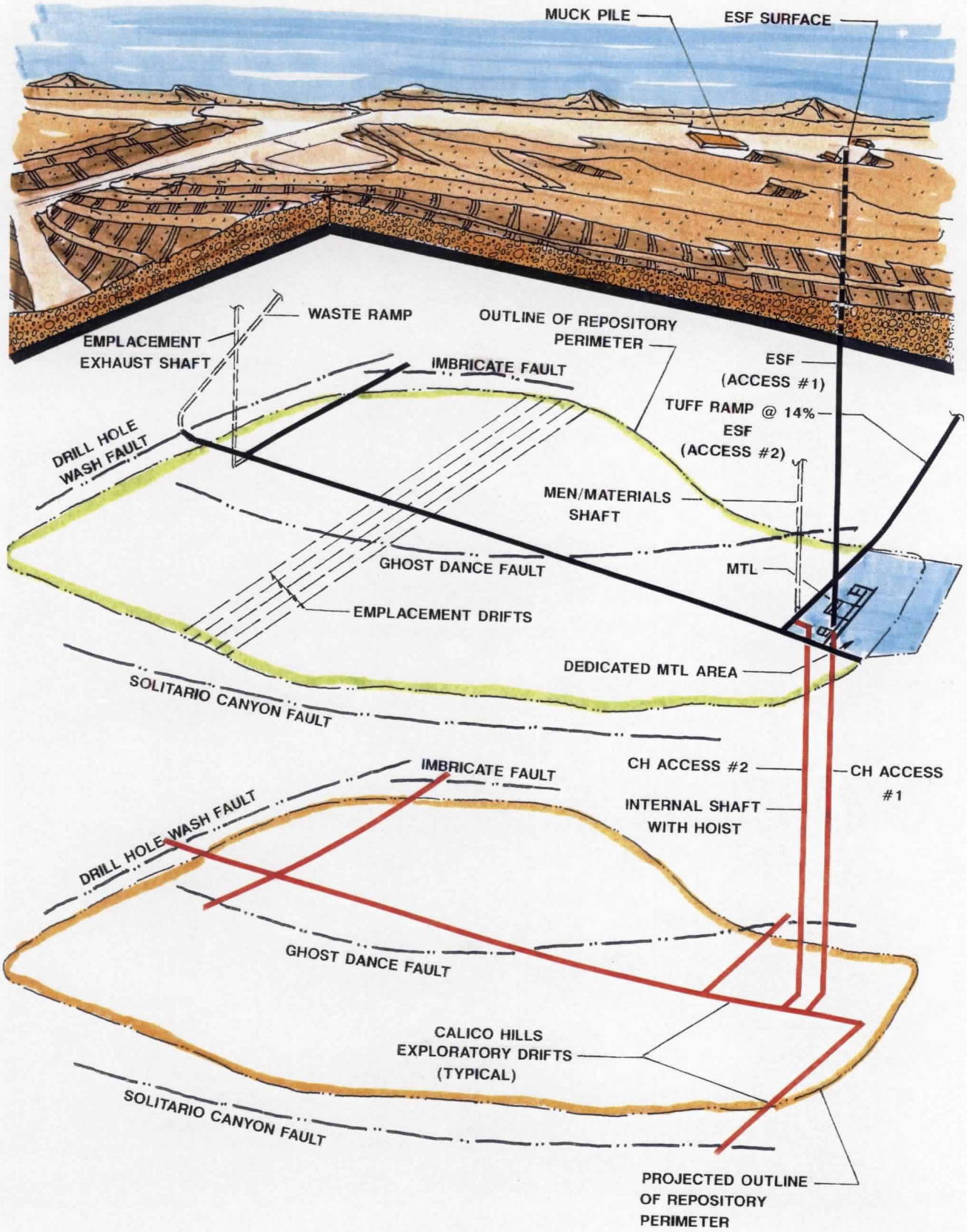


ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. B3 REV. 6

ISOMETRIC

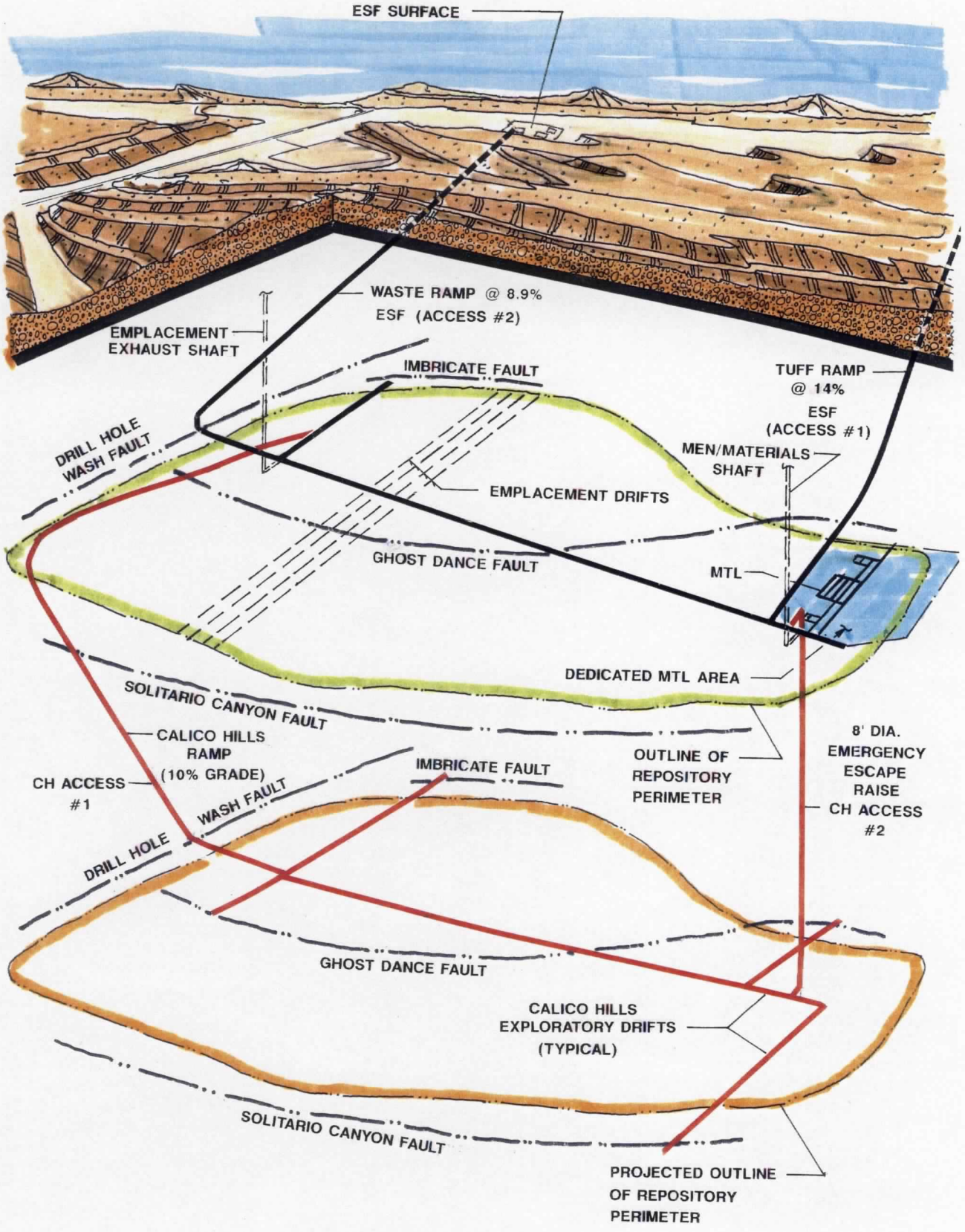
DATE: _____



ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. B4
ISOMETRIC

DATE: _____

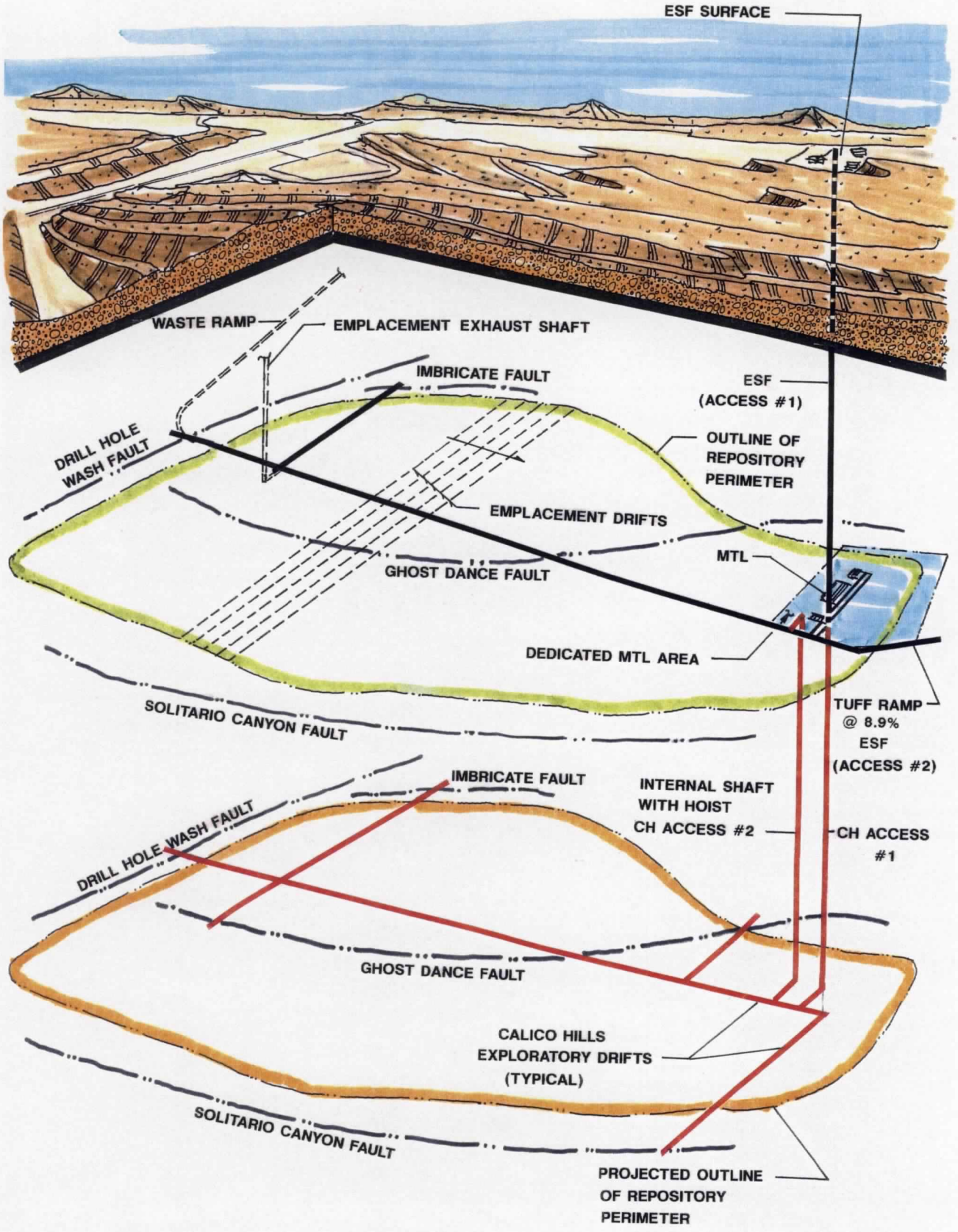


ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. B7

ISOMETRIC

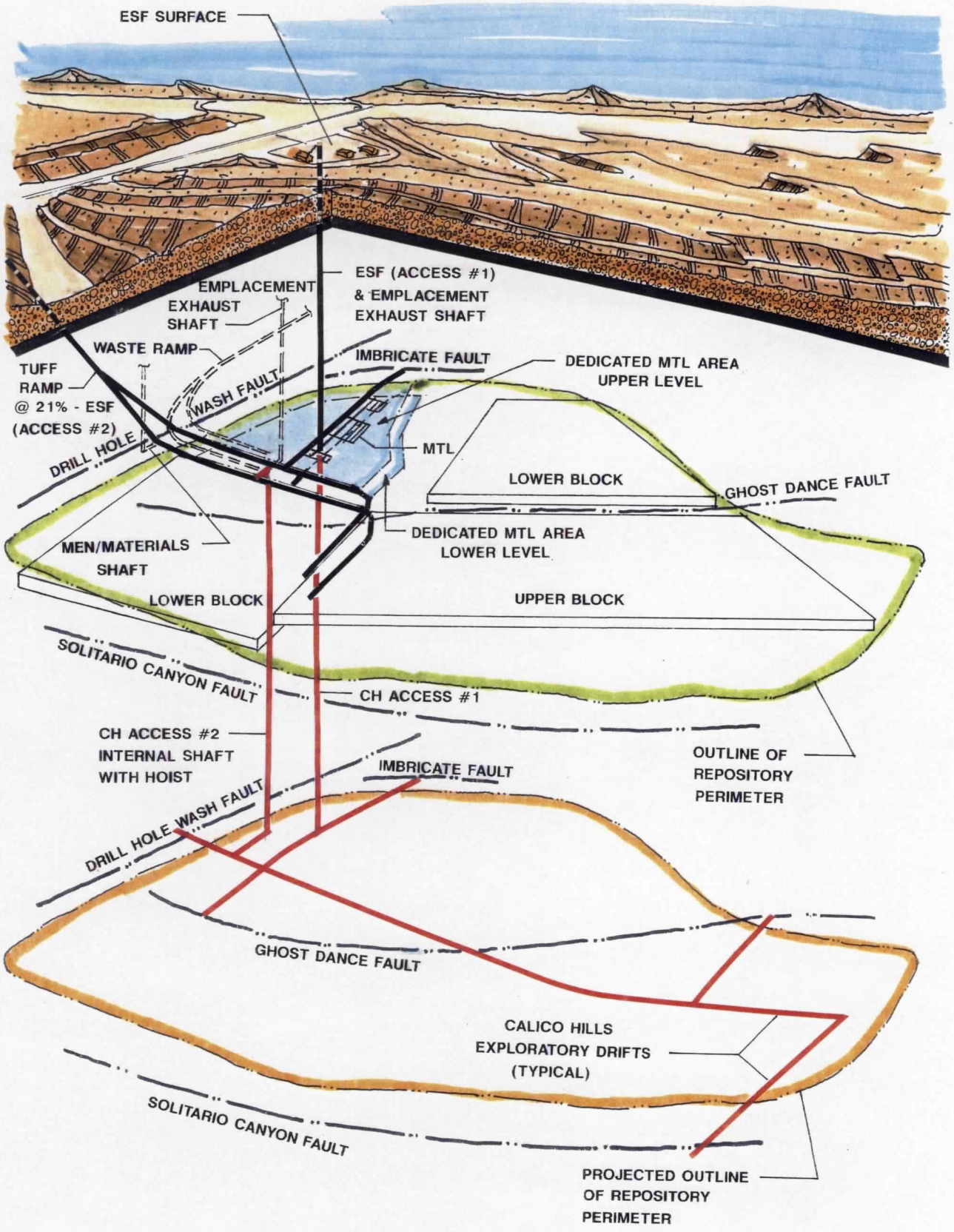
DATE: _____



ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. B8
ISOMETRIC

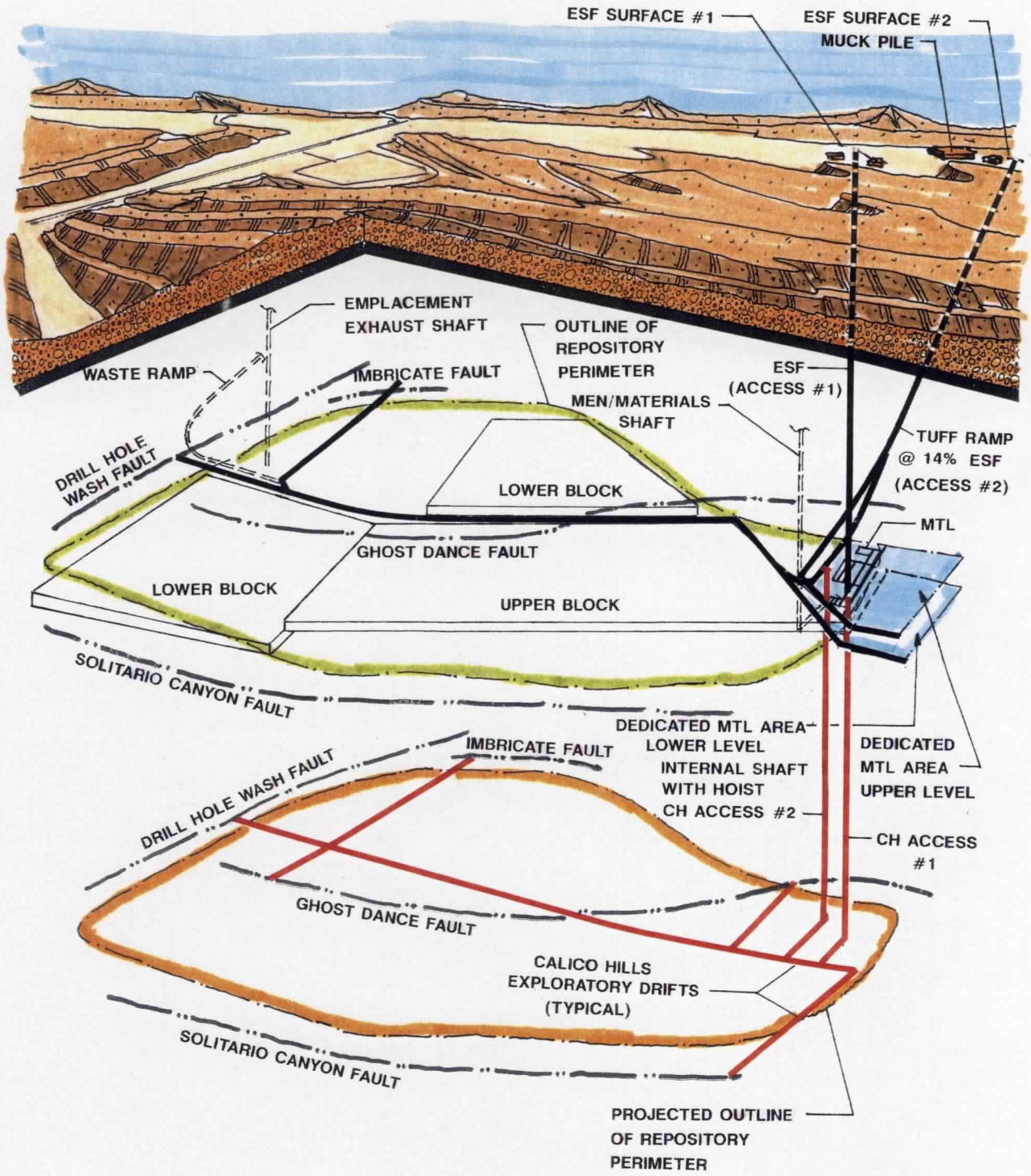
DATE: _____



ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. C1
ISOMETRIC

DATE: _____



ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. C4
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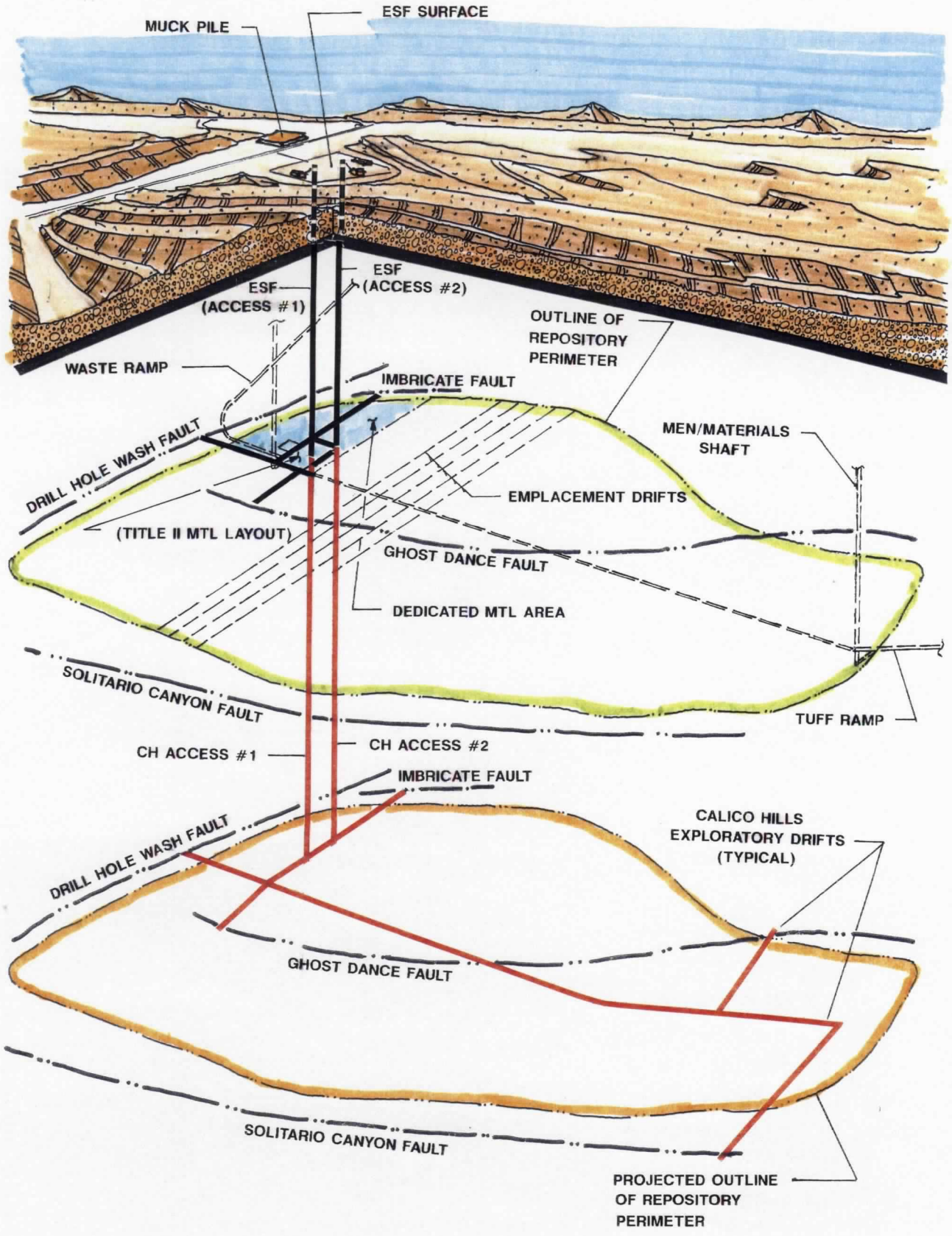
DATE: _____



ESF ALTERNATIVES STUDY
TASK NO. 4

OPTION NO. R-11

ISOMETRIC

DATE: _____

SUPPORTING DATA FOR EACH OPTION

PART I DESIGN FEATURES

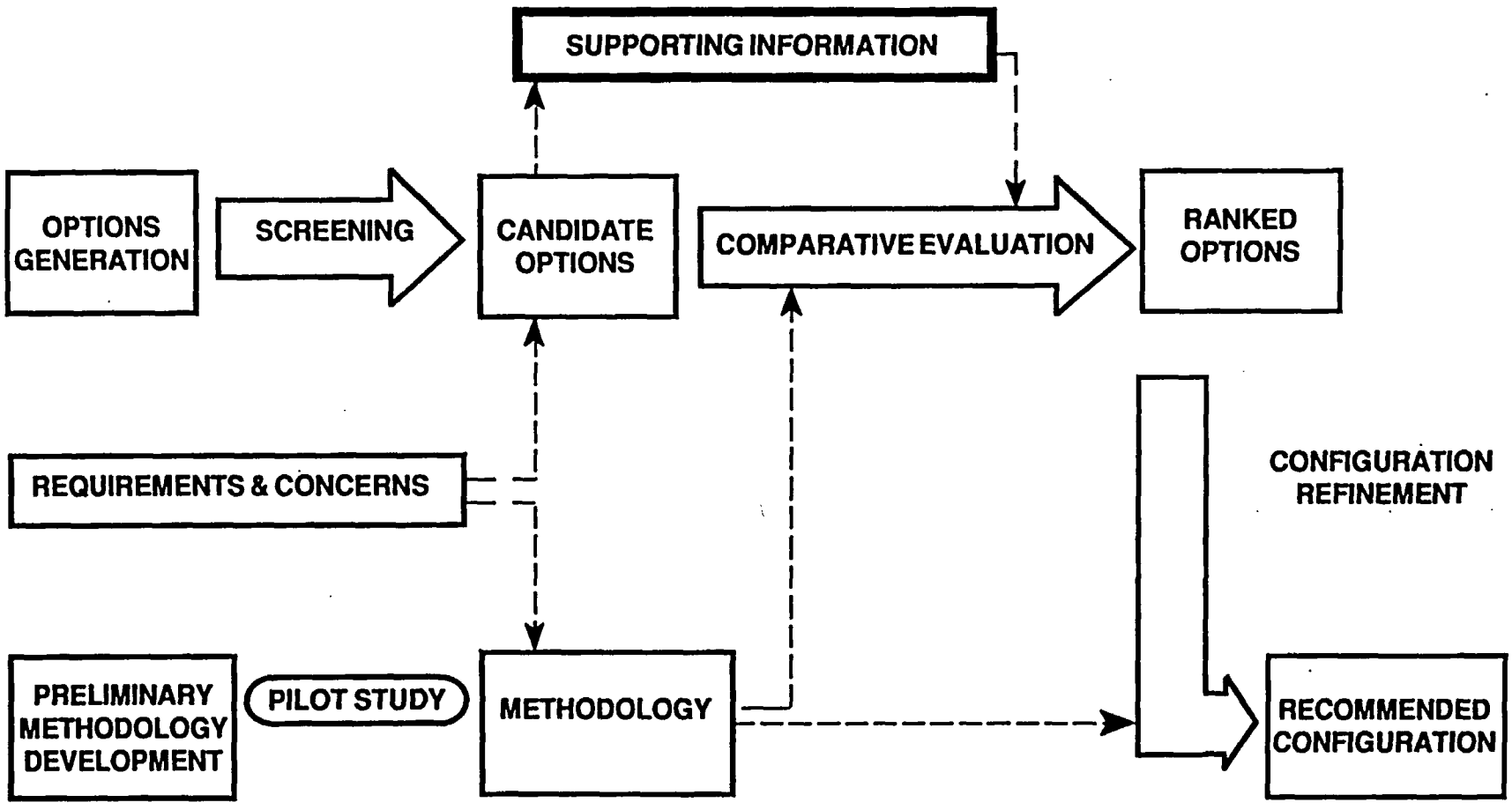
- **SKETCHES:**
  - CONCEPT – PLAN VIEW
  - CONCEPT – ISOMETRIC VIEW
  - ESF/REPOSITORY INTERFACE
  - MAIN TEST LEVEL LAYOUT
  - STRATIGRAPHY COLUMNS
  - SURFACE DISTURBANCES
- **DATA SHEETS:**
  - SUMMARY OF SELECTED ESF/REPOSITORY DATA
  - ESF DATA:
    * CONCEPT DESCRIPTION, FEATURES, ACCESSES, CONSTRUCTABILITY, OPERABILITY, AND SELECTED QUANTITIES
  - REPOSITORY DATA:
    * CONCEPT DESCRIPTION, FEATURES, ACCESSES, CONSTRUCTABILITY, OPERABILITY, AND SELECTED QUANTITIES

SUMMARY OF ESF/REPOSITORY OPTIONS

OPTION #		E.S.F.								REPOSITORY				
		ACCESS 1		ACCESS-2		MAIN TEST LEVEL				ACCESSES		CONSTRUCTION METHOD		
		SIZE	CONST. METHOD	SIZE	CONST. METHOD	LAYOUT	CONST. METHOD	LOCATION	ELEVATION	SHAFTS	RAMPS (TBM)	RAMPS & DRIFTS	EMPL. AREA	TOTAL ACCESSES
1	BASE CASE	12' SHAFT	DRILL & BLAST	12' SHAFT	DRILL & BLAST	TITLE II G.A.	DRILL & BLAST	NE	SAME AS REPOS.	2-20'	1-25' 1-23'	TBM	DRILL & BLAST	6
2	A1	16' SHAFT	-"-	25' RAMP	TBM	MODIFIED T II G.A.	-"-	-"-	-"-	2-25'	1-25' +ESF	-"-	-"-	5
3	A2	16' SHAFT	-"-	16' SHAFT	DRILL & BLAST	-"-	-"-	-"-	-"-	-"-	2-25'	-"-	-"-	6
4	A4 REV.1	16' SHAFT	-"-	12' SHAFT 25' RAMP	D&B TBM	-"-	-"-	-"-	-"-	1-25' ENLARGE ES-2 25'	1-25' +ESF	-"-	-"-	5
5	A5	16' SHAFT	-"-	25' RAMP	TBM	-"-	-"-	S	-"-	2-25'		-"-	-"-	5
6	A7	25' RAMP	TBM	25' RAMP	-"-	-"-	-"-	NE	-"-	-"-	IN ESF	-"-	-"-	4
7	B3, REV. 2-	16' SHAFT	SBM	-"-	-"-	-"-	MECH.	-"-	-"-	-"-	1-25' +ESF	-"-	TBM	5
8	B3,REV.3-		V-MOLE											
9	B3,REV. 4-		BLIND BORE											
10	B3,REV. 5-		RAISE BORE											
11	B3, REV. 6-		DRILL & BLAST											
12	B4	16' SHAFT	DRILL & BLAST	-"-	-"-	-"-	-"-	S	-"-	-"-	-"-	-"-	-"-	5
13	B7	25' RAMP	TBM	-"-	-"-	-"-	-"-	-"-	-"-	-"-	IN ESF	-"-	-"-	4
14	B8	16' SHAFT	DRILL & BLAST	-"-	-"-	-"-	-"-	-"-	-"-	1-25'	2-25' +ESF	-"-	-"-	5
15	C1	16' SHAFT	-"-	-"-	-"-	TWO LEVEL	-"-	NE	TWO LEVELS SAME AS REPOS.	2-25' ENLARGE ES-1-25'	1-25' +ESF	-"-	-"-	4
16	C4	16' SHAFT	-"-	-"-	-"-	-"-	-"-	S	-"-	2-25'	-"-	-"-	-"-	5
17	R11	12' SHAFT	-"-	12' SHAFT	DRILL & BLAST	TITLE II G.A.	DRILL & BLAST	NE	SAME AS REPOS.	2-25'	2-25'	-"-	-"-	6

ESFSUM6P.A01/7-24,25-90

ESF ALTERNATIVES STUDY
SUPPORTING INFORMATION



SUPPORTING DATA FOR EACH OPTION

PART I DESIGN FEATURES

- SKETCHES:
  - CONCEPT – PLAN VIEW
  - CONCEPT – ISOMETRIC VIEW
  - ESF/REPOSITORY INTERFACE
  - MAIN TEST LEVEL LAYOUT
  - STRATIGRAPHY COLUMNS
  - SURFACE DISTURBANCES
- DATA SHEETS:
  - SUMMARY OF SELECTED ESF/REPOSITORY DATA
  - ESF DATA:
    * CONCEPT DESCRIPTION, FEATURES, ACCESSES, CONSTRUCTABILITY, OPERABILITY, AND SELECTED QUANTITIES
  - REPOSITORY DATA:
    * CONCEPT DESCRIPTION, FEATURES, ACCESSES, CONSTRUCTABILITY, OPERABILITY, AND SELECTED QUANTITIES

SUPPORTING DATA FOR EACH OPTION

(CONTINUED)

PART II COST/SCHEDULE/STAFFING

- DATA SUMMARY SHEETS(S)
  - COST IMPACTS OF CONSTRUCTABILITY AND OPERABILITY
- SCHEDULE
  - ESF
    - * CONSTRUCTION
    - * TESTING
  - REPOSITORY (LIFE CYCLE)

ESF DATA SHEET

SELECTED OPTION No. A1

OPTION DESCRIPTION CONVENTIONALLY MINED REPOSITORY WITH TWO SHAFTS & TWO RAMPS, NORTH ACCESS ONLY
CONVENTIONALLY MINED ESF WITH ONE ES SHAFT & ONE RAMP (TUFF RAMP)
MTL AT NORTHEAST REPOSITORY CORNER

ESF ACCESS FEATURES		ESF ACCESS #1	ESF ACCESS #2	ESF ACCESS #3
TYPE		SHAFT	RAMP	
APPROX. DIA. (FT.)		16	25	
CROSS-SECTIONAL AREA (SQ. FT.)		201	491	
* CONSTRUCTION METHOD		D&B	TBM	
LOCATION (APPROX.)	SURFACE	N. 766375 E. 563690	N. 772730 E. 566100	
	UNDERGRND.		N. 767535 E. 564001	
ELEVATION (APPROX.)	SURFACE	4160	4070	
	UNDERGRND.	3075	3100	
GRADE		VERT.	DEC. @ 17.3%	
BEARING		VERT.	N 22 E	
**LENGTH (FT.)		1085	5686	
UNITS TRANSECTED		See Stratigraphic column	Not available	
ESF FUNCTION		Science Ventilation Intake Emergency Egress Men & Material	Science Ventilation Exhaust Emergency Egress Muck Handling	

* DRILL AND BLAST EXCAVATION USES SMOOTH WALL, CONTROLLED BLASTING TECHNIQUES, IN WHICH CLOSELY SPACED, LIGHT, PERIMETER CHARGES ARE DETONATED LAST IN THE BLAST SEQUENCE.

** LENGTH SHOWN IS TO MTL (FOR SHAFT), OR REPOSITORY LEVEL (FOR RAMP)

DATE 7/19/90

ESF DATA SHEET

SELECTED OPTION No. A1

OPTION DESCRIPTION CONVENTIONALLY MINED REPOSITORY WITH TWO SHAFTS & TWO RAMPS, NORTH ACCESS ONLY
CONVENTIONALLY MINED ESF WITH ONE ES SHAFT & ONE RAMP (TUFF RAMP)
MTL AT NORTHEAST REPOSITORY CORNER

ESF DESIGN FEATURES

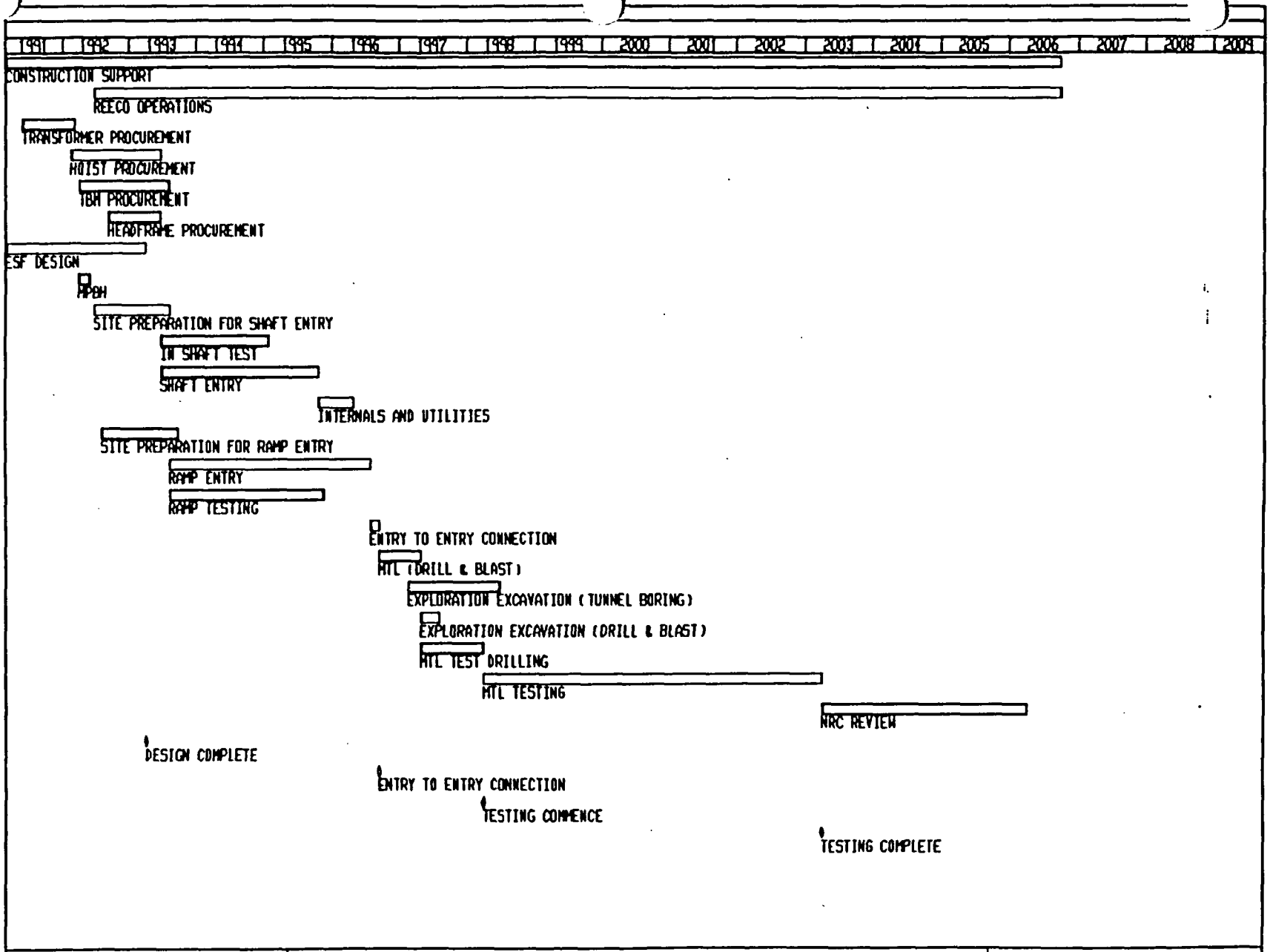
MTL LOCATION		NORTHEAST
MTL ELEVATION (APPROX.)		3075
APPX. DISTANCE- MTL TO WATER TABLE (FT.)		650
MTL LAYOUT AREA (SQ. FT.)		853760
DEDICATED MTL AREA (SQ. FT.)		4010149
EXPANSION AREA AVAIL. (SQ. FT.)		3156389
* MINING METHODS	EXPL. DRIFTS	D&B AND TBM
	MTL	D&B
EXTENT OF EXPLORATORY DRIFTING		INTERSECT DRILL HOLE WASH FAULT DRIFT TO GHOST DANCE FAULT DRIFT TO IMBRICATE FAULT

MATERIALS	WATER (GALS.)	CONCRETE (CU. YDS.)	STEEL (TONS)
ESF ACCESS #1	523000		
ESF ACCESS #2	1238000		
ESF ACCESS #3			
MTL/EXPL. DRIFTS	3009000		
TOTAL	4770000	18096	985

ACCESS TO CALICO HILLS	Access from north end of repository. Shaft, ramp, or both initially constructed to CH horizon, or extended at a later date. Extension of finished accesses could interfere with ongoing ESF construction/testing activities. CH development flexibility increased relative to BASE CASE due to larger access openings.
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, or 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.

* DRILL AND BLAST EXCAVATION USES SMOOTH WALL, CONTROLLED BLASTING TECHNIQUES, IN WHICH CLOSELY SPACED, LIGHT, PERIMETER CHARGES ARE DETONATED LAST IN THE BLAST SEQUENCE.

DATE 7/19/90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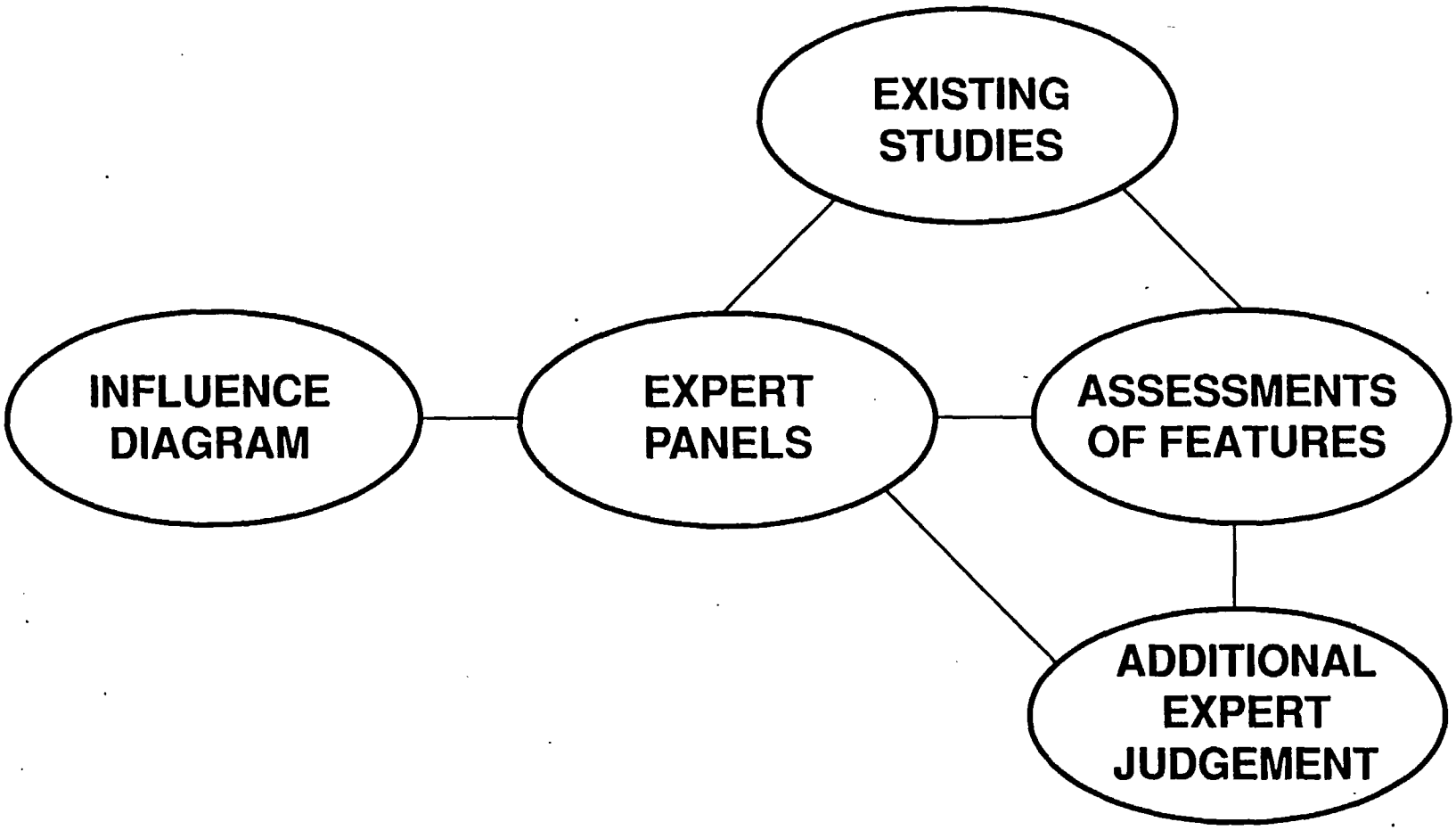
CONSTRUCTION SUPPORT
REECO OPERATIONS
TRANSFORMER PROCUREMENT
HOIST PROCUREMENT
TBM PROCUREMENT
HEADFRAME PROCUREMENT
ESF DESIGN
APSH
SITE PREPARATION FOR SHAFT ENTRY
IN SHAFT TEST
SHAFT ENTRY
INTERNALS AND UTILITIES
SITE PREPARATION FOR RAMP ENTRY
RAMP ENTRY
RAMP TESTING
ENTRY TO ENTRY CONNECTION
HTL (DRILL & BLAST)
EXPLORATION EXCAVATION (TUNNEL BORING)
EXPLORATION EXCAVATION (DRILL & BLAST)
HTL TEST DRILLING
HTL TESTING
NRC REVIEW
DESIGN COMPLETE
ENTRY TO ENTRY CONNECTION
TESTING COMMENCE
TESTING COMPLETE
Activity Bar/Early Dates
Critical Activity
Progress Bar
Primavera Systems, Inc. 1984-1988
Planning Unit : Day
Project Start : 1MAR91
Project Finish: 30SEP06
FENIX & SCISSON OF NEVADA
TASK #4 ESF STUDIES (FSN-SD-AS-445)
OPTION A1 - DETAILED
Sheet 1 of 1
Data Date: 1MAR91
Plot Date: 18JUN90
OPTION A1
Date
Revision
Checked
Approved

ASSESSMENTS OF REPOSITORY/ESF FEATURES

- MOTIVATION
  - COMPARATIVE EVALUATION - 10 CFR 60.21
  - INFORMATION BASE FOR EVALUATORS OF OPTIONS
- PRODUCTS
  - ASSESSMENTS OF FEATURES AS POTENTIAL PERFORMANCE DISCRIMINATORS
  - STAFF POSITION MEMOS (WITH TECHNICAL AND MANAGEMENT REVIEW)
- PROCESS
  - IDENTIFICATION OF POTENTIAL PERFORMANCE DISCRIMINATORS
  - USE OF EXISTING DATA AND ANALYSES
  - IDENTIFICATION OF NEW ANALYSES (IF ANY)

MECHANISM FOR PA SUPPORT OF ESF ALTERNATIVES



POTENTIAL PERFORMANCE DISCRIMINATING FACTORS

- **LOCATION, NUMBER, AND SIZE OF OPENINGS**
  - FLOOD CHANNELS, FRACTURE FLOW, GAS FLOW, CALICO HILLS PENETRATION
- **MEANS OF ACCESS - SHAFT vs RAMP**
  - UNIFORM GAS/LIQUID FLOW, FLOW DOWN FAULTS, SEALING EFFECTIVENESS
- **CONSTRUCTION METHOD - MECHANICAL vs DRILL AND BLAST**
  - CHANGES IN PERMEABILITY AND FLUID FLOW, INTRODUCTION OF FLUIDS/CHEMICALS
- **CONFIGURATION OF LAYOUT**
  - VERTICAL AND LATERAL LOCATION, GHOST DANCE FAULT PENETRATIONS

CONCLUSIONS OF PERFORMANCE ASSESSMENT SUPPORT

- MOST DESIGN FEATURES ARE NOT STRONG DISCRIMINATORS (EXISTING DATA AND UNDERSTANDING)
- FLEXIBILITY IN VERTICAL AND LATERAL LOCATION OF THE UNDERGROUND FACILITY MAY BE SIGNIFICANT
- RAMPS MAY BE SLIGHTLY PREFERABLE TO SHAFTS
- EVALUATIONS CONTAIN SIGNIFICANT UNCERTAINTY, BUT THE NEED FOR MORE EXTENSIVE ANALYSES IS NOT APPARENT