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

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: MAJOR REPOSITORY DESIGN FEATURES EXAMINED DURING ESF ALTERNATIVES STUDY

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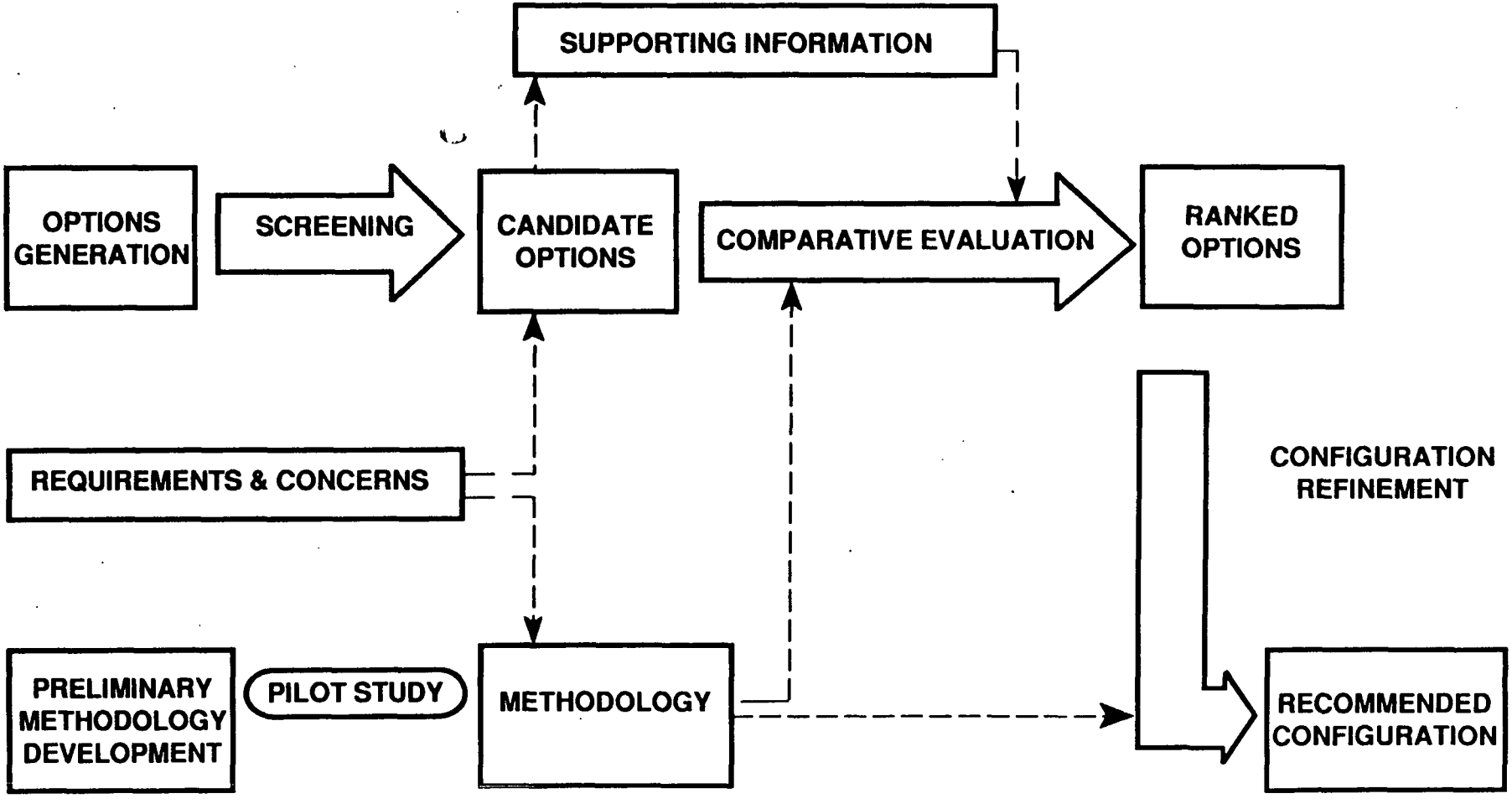
SEPTEMBER 18 - 19, 1991

ESF ALTERNATIVES STUDY



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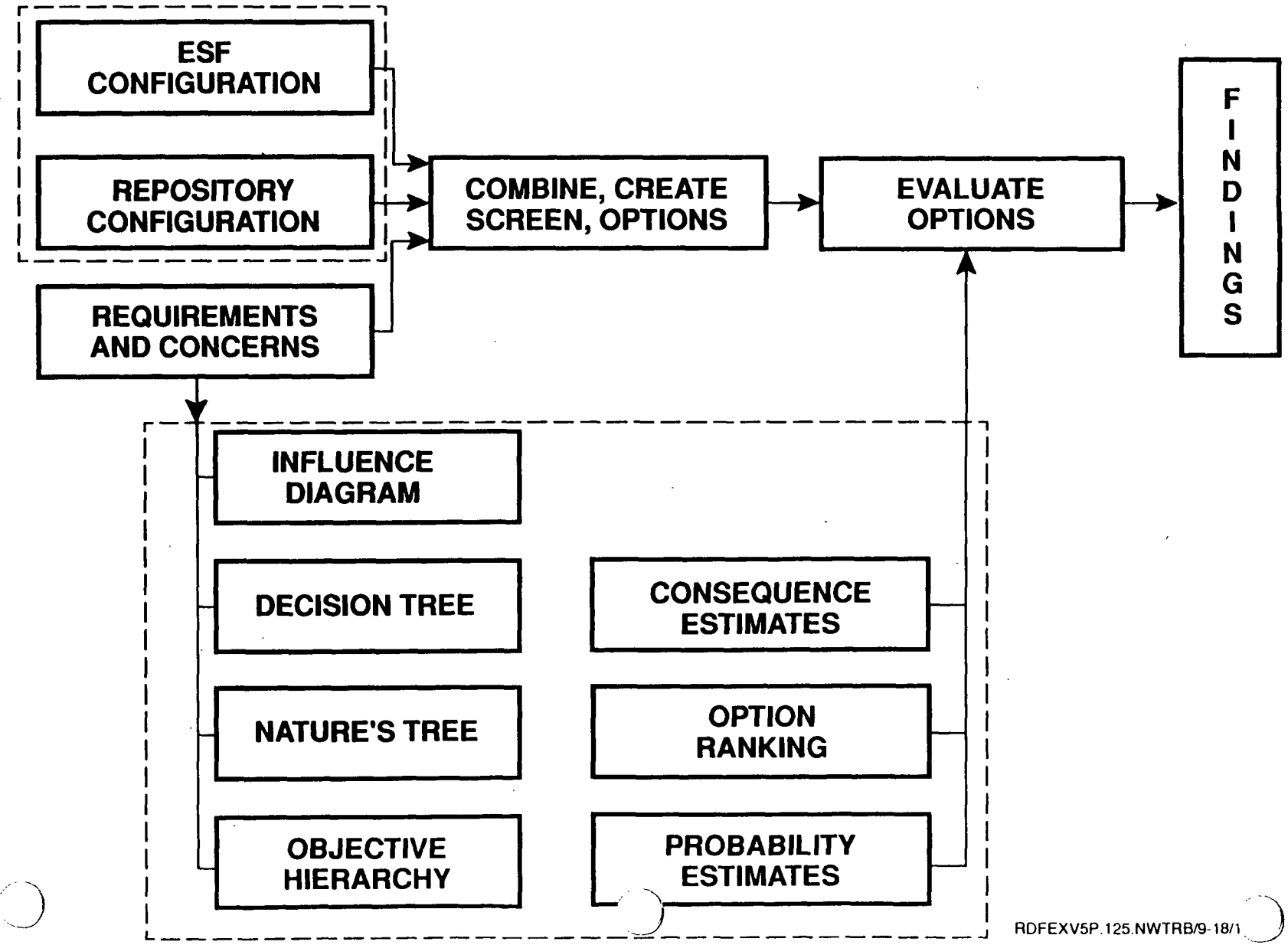
ESF ALTERNATIVES STUDY



RDFEXV5P.125.NWTRB/9-18/1

REQUIREMENTS DEVELOPED IN ESFAS

- RANKED AS TO POTENTIAL FOR DISCRIMINATION
  - PERFORMANCE STRONGLY DEPENDS ON FEATURES/ OPTION
  - HIGHER PERFORMANCE MAY BE OBTAINED BY CERTAIN OPTIONS
  - INCLUDED READILY - NOT DISCRIMINATOR
- CROSS WALK TO FACTORS IN INFLUENCE DIAGRAM SUMMARY DIAGRAM
- TESTING REQUIREMENTS

10 CFR PART 60 SUBSECTIONS DETERMINED TO BE DISCRIMINATORS FOR ESF-REPOSITORY

10 CFR 60 REFERENCES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
60.15 (c) (1)	X						X	X		X	X	X	X	X	
60.15 (c) (2)	X			X			X	X		X	X	X	X	X	
60.15 (c) (3)	X			X			X	X		X	X	X	X	X	
60.15 (c) (4)	X			X			X	X		X	X	X	X	X	
60.21 (c) (1) (ii) (D)	X							X		X	X	X	X		X
60.21 (c) (1) (ii) (E)	X														
60.21 (c) (11)	X			X			X	X							
60.74 (a)	X	X	X				X	X			X	X	X	X	
60.74 (b)	X						X	X						X	
60.111 (a)* & (b)*	X		X												X
60.112	X													X	
60.113 (a) (1) & (a) (2)	X									X	X	X	X	X	
60.122 (a) (2) & (b) (1)	X									X	X			X	
60.130	X			X										X	
60.131(b) (1)	X														
60.133 (a) (1) & (a) (2)	X			X			X							X	
60.133 (b)	X													X	
60.133 (c)															X
60.133 (e) (1) & (e) (2)	X			X			X			X	X	X	X	X	X
60.133 (f)	X						X							X	
60.133 (g)	X			X			X							X	
60.133 (h)	X													X	
60.133 (i)	X													X	
60.134	X														
60.135 (a) (1) & (2)	X	X	X				X					X	X		
[illegible]7	X							X							

LEGEND

The following titles relate to the *INFLUENCE DIAGRAM NUMBERS.

Postclosure Health	1 Health Effects Portion Transport Through Natural Barriers Portion Engineered Barrier System Portion Scenario Portion
Preclosure Health and Safety	2 Radiological Worker Health 3 Radiological Public Health 4 Nonradiological Worker Safety
Environment	5 Aesthetics 6 Historical Properties
Cost - Direct	7 Total System Life Cycle Cost Repository Life Cycle Cost ESF Cost
Schedule - Indirect	8 Schedule - Indirect Costs Schedule - Indirect Costs
Programmatic Viability	9 Probability of Programmatic Viability
Characterization Testing	10 Probability of Early False Positive 11 Probability of Late False Positive 12 Probability of Early False Negative 13 Probability of Late False Negative (Page 1 of 2) Probability of Late False Negative (Page 2 of 2)
Regulatory Authorization	14 Likelihood of Construction/Operation Approval
Closure	15 Likelihood of Retrieval

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COMPILATION OF ESF CONFIGURATIONS

SYSTEM IDENTIFICATION

- CONSTRUCTION AND ACCESS METHOD
  - SINGLE ACCESS
  - MULTIPLE ACCESS
- CONFIGURATION SUBSETS
  - ACCESS SIZING
  - DEPTH OR LENGTH OF ACCESS
  - METHOD OF GROUND SUPPORT
- UNDERGROUND TEST LEVEL CONFIGURATION
- DESIGN TIME LINES

SUMMARY OF ESF OPTION COMPILATION

- 52 HISTORICAL ESF OPTIONS IDENTIFIED
- 13 UNIQUE CONSTRUCTION AND ACCESS WITH UP TO 15 CONFIGURATION SUBSETS
- ADDITIONALLY, 9 U.G. TEST LEVEL CONFIGURATIONS INCLUDED AS PART OF EACH OF 52 CONFIGURATIONS

HISTORICAL REPOSITORY CONFIGURATIONS

- 15 CONFIGURATIONS THAT SUMMARIZED DIFFERENT HISTORICAL CONFIGURATIONS DATING FROM NWPA
  - MINING METHOD DIFFERENCES
  - MAJOR CHANGES IN ACCESS LOCATION
  - DIFFERENT REPOSITORY ORIENTATIONS
- SUMMARIZED DATA
  - NUMBER, TYPE, SIZE, AND LOCATION OF ACCESSES
  - CONSTRUCTION METHOD
  - CONSTRUCTABILITY
  - COST ESTIMATES, SCHEDULES
  - NON-RAD HEALTH AND SAFETY EVALUATIONS
  - NEED FOR DEVELOPMENT AND TESTING OF NEW EQUIPMENT

HISTORICAL REPOSITORY CONFIGURATIONS SUMMARY

No.	Alternative No.	No. of Subsets	Descriptions
1	R1	11	Initial Preconceptual - Horizontal Emplacement
2	R2	11	Initial Preconceptual - Horizontal Emplacement
3	R3	53	Two-Stage Repository Development
4	R4	1	SCP Conceptual Design - Complete Separation of DHLW from SF
5	R5	63	SCP/CDR Reference Layout
6	R6	6	SCP/CDR Based Design, Raised to New TSw1/TSw2 Interface**
7	R7	1	TBM Layout 2, 4 Blocks
8	R8	1	TBM Layout 2, 3 Blocks, Avoids Emplacement Drifts Across Ghost Dance Fault
9	R9	3	TBM Layout 3, SCP/CDR Outline and Elevation
10	R10	0	TBM Layout 4, SCP/CDR Outline, Raised to New TSw1/TSw2
11	R11	0	TBM Layout 5, SCP/CDR Outline and Elevation - Mining from South Access
12	R12	1	TBM Layout 6, Two Blocks Integrated with ESF
13	R13	0	TBM Layout 7, 4 Panels within SCP/CDR Area
14	R14	3	TBM Layout 8, 1984 Version
15	R15	1	Preconceptual Horizontal Emplacement

IDENTIFICATION OF PRELIMINARY NEW OPTIONS

- DEVELOP COMBINATIONS OF ESF AND FUTURE REPOSITORY ELEMENTS INTO OPTION CONFIGURATIONS THAT SATISFY OR ADDRESS

  1. REGULATORY REQUIREMENTS
  2. TESTING REQUIREMENTS
  3. COMMENTS AND CONCERNS OF OVERVIEW ORGANIZATIONS

- METHOD

  - LAYOUT OF ACCESSES & ESF TEST PANELS ON A BASIC AREA BOUNDARY
  - SPECIFY EXCAVATION METHODS AND SIZE OF ACCESS OPENINGS
  - SPECIFY FUNCTIONAL ASSIGNMENTS, INTERFACES WITH REPOSITORY, LOCATIONS OF VARIOUS COMPONENTS

IDENTIFICATION OF PRELIMINARY NEW OPTIONS

(CONTINUED)

- RESULTED IN DEVELOPMENT OF 24 NEW REPOSITORY - ESF OPTIONS, EMPHASIZING
  - ALTERNATIVE EXCAVATION METHODS
  - LOCATION OF ACCESS ENTRIES ABOVE R.M.F.
  - NEED FOR ADDITIONAL EXPLORATORY DRIFTING
  - FLEXIBILITY TO CHARACTERIZE SITE IN AREAS BELOW MTL
- MAJOR DESIGN FEATURES INCLUDED
  - MEANS OF ACCESS: SHAFT, RAMP COMBINATION
  - LOCATIONS OF ACCESS: N.E., S.E., COMBINATION
  - LOCATION OF MTL: N.E., SO., COMBINATION
  - EXCAVATION METHOD OF OPENINGS MECH. OR D & B
  - TOTAL NUMBER OF REPOSITORY ACCESSES - ESF ACCESSES ARE AN INTEGRATED SUBSET OF TOTAL NEEDED FOR REPOSITORY

IDENTIFICATION OF PRELIMINARY NEW OPTIONS

(CONTINUED)

- **CLASSIFICATION SCHEME:**

  A - SINGLE LEVEL, DRILL AND BLAST REPOSITORY
  B - SINGLE LEVEL, TBM REPOSITORY
  C - STEP BLOCK (MULTIPLE LEVEL) TBM EXCAVATED REPOSITORY
  R - HISTORICAL (CONVENTIONAL) REPOSITORY LAYOUT, EITHER D & B OR MECHANICAL

SUMMARY OF PRELIMINARY NEW OPTIONS

GROUP A. DRILL & BLAST, SINGLE LEVEL REPOSITORY

DESCRIPTIVE TITLE	ESF ACCESSESS			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

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

SUMMARY OF PRELIMINARY NEW OPTIONS

(CONTINUED)

GROUP B. TBM, SINGLE LEVEL REPOSITORY

DESCRIPTIVE TITLE	ESF ACCESSESS			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

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

SUMMARY OF PRELIMINARY NEW OPTIONS

(CONTINUED)

GROUP C. TBM, STEP BLOCK REPOSITORY

DESCRIPTIVE TITLE	ESF ACCESSESS			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

SELECTION OF ESF/REPOSITORY OPTIONS FOR EVALUATION

- PRELIMINARY SCREENING GOALS
  - REDUCE NUMBER OF ALTERNATIVES TO A SUITABLE NUMBER FOR FINAL EVALUATIONS
  - DEFINE RANGES OF MAJOR DESIGN FEATURES REASONABLE WITHIN OPTION
  - ENSURE OPTIONS SPANNED RANGE OF POSSIBILITIES

- PRELIMINARY SCREENING PROCESS
  - ELIMINATE CONFIGURATIONS THAT CAN BE SHOWN TO BE NON-COMPLIANT WITH REQUIREMENTS
  - CONSOLIDATE USING MAJOR FEATURES AS ORGANIZING PRINCIPLE
  - CHOOSE REPRESENTATIVE CONFIGURATION FOR EACH CLASS
  - RECOMMEND ADDITIONAL CONFIGURATIONS IF NECESSARY TO FORM COMPLETE SET FOR FINAL EVALUATION

OPTION CLASSES

OPTION SELECTED	MAJOR DESIGN FEATURE	DEFINITION
B3	LOCATION	LOCATION OF THE ACCESSES AND ESF APPROXIMATELY IN THE SCP-CDR CONFIGURATION
B4	LOCATION	ESF AND AT LEAST ONE ESF ACCESS IN A SUBSTANTIALLY DIFFERENT LOCATION THAN CLASS 1
A5	ACCESS MEANS	TOTAL NUMBER OF ACCESSES LESS THAN SCP-CDR
A2	ACCESS MEANS	ESF ACCESS BY TWO OR MORE SHAFTS
A7	ACCESS MEANS	ESF ACCESS BY TWO OR MORE RAMPS
C1	ACCESS MEANS	ESF ACCESS BY AT LEAST ONE SHAFT AND ONE RAMP
A4	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
B7	CONSTRUCTION METHOD	ALL CONSTRUCTION (INCLUDING ESF AND ACCESSES EXCEPT FOR SOME TESTING ALCOVES, ETC.) BY MECHANICAL MINING
B8	CONSTRUCTION METHOD	COMBINATION OF MECHANICAL AND DRILL AND BLAST METHODS, e.g. ONE SHAFT AND ESF CONSTRUCTED BY DRILL AND BLAST, WITH THE REMAINDER CONSTRUCTED BY MECHANICAL MINING (INCLUDING THE SECOND ESF ACCESS)
R11/ESF 11-5-1	TEST AREA CONFIGURATION	ESF LAYOUT (INCLUDING EXPLORATORY DRIFTING AND DESIGNATED TEST AREA) SIMILAR TO THE TITLE I OR EARLY TITLE II CONCEPTS
C4	TEST AREA CONFIGURATION	ESF LAYOUT SUBSTANTIALLY DIFFERENT FROM ABOVE WHICH MAY INCLUDE SIZE OR SCOPE OF DESIGNATED TEST AREAS
A1	ESF-REPOSITORY INTERFACE	OPTIONS THAT INTEGRATE REPOSITORY AND ESF ACCESSES

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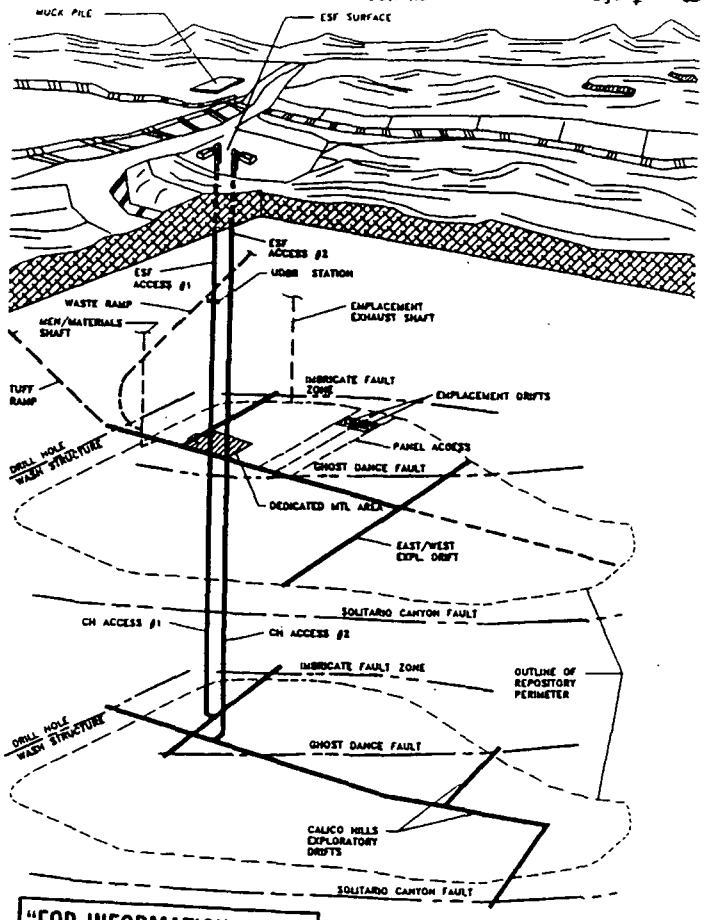

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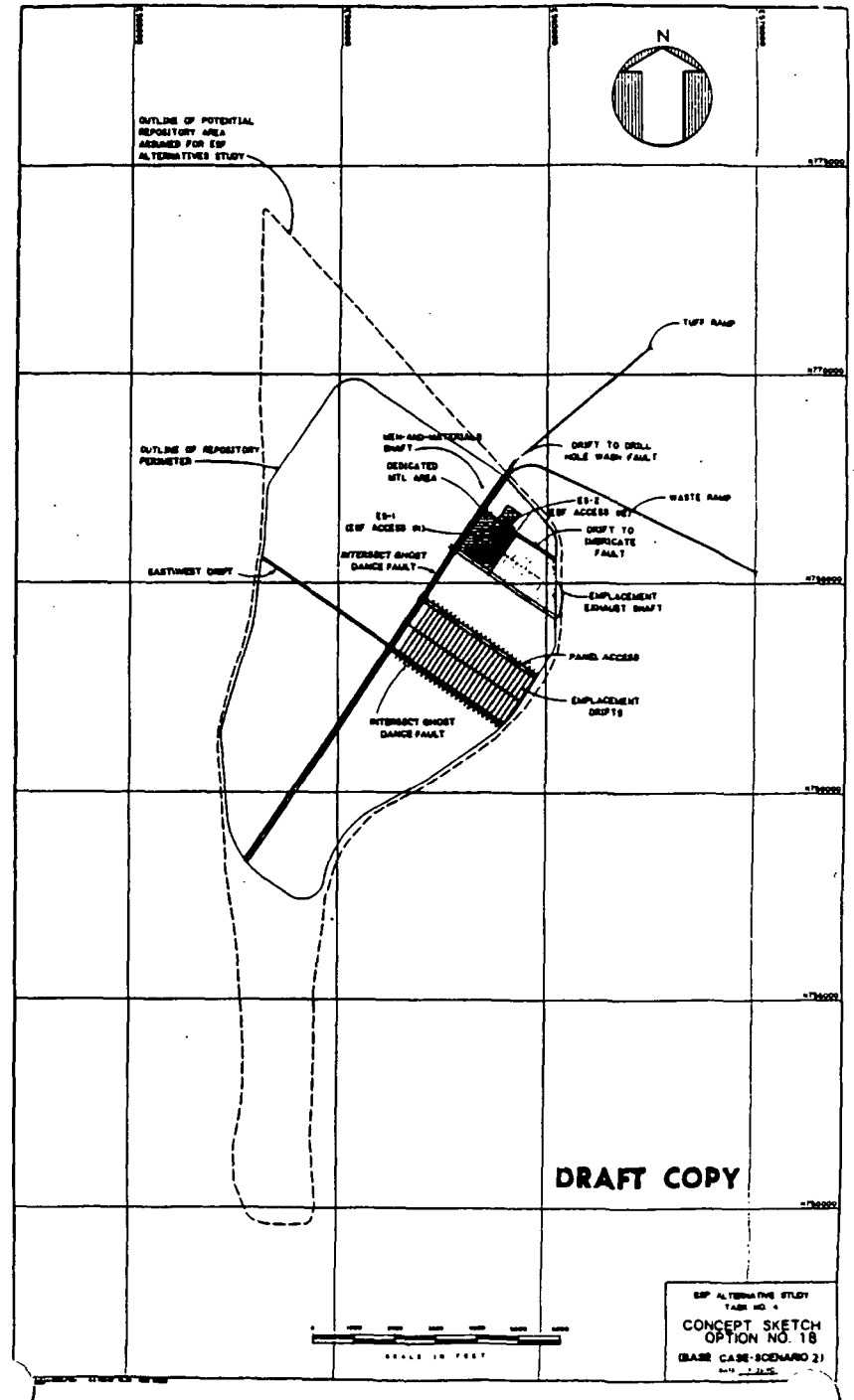
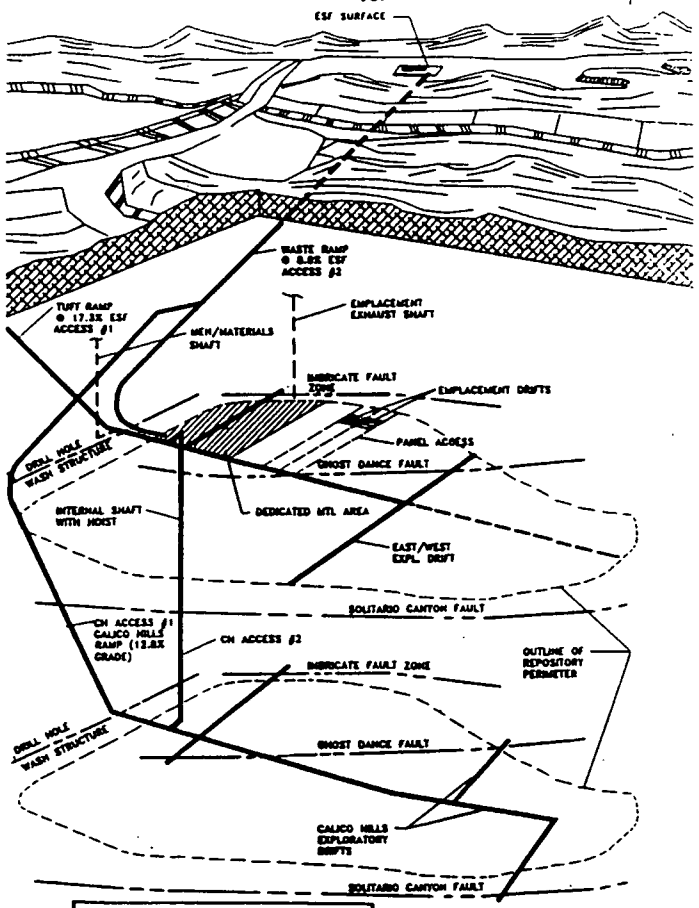
ESF ALTERNATIVES STUDY
TASK NO. 4
BASE CASE
ISOMETRIC SCENARIO #2
DATE SEP 21 1990

REPOSITORY TYPE: A
NUMBER OF ACCESSES: 6
EXCAVATION: C





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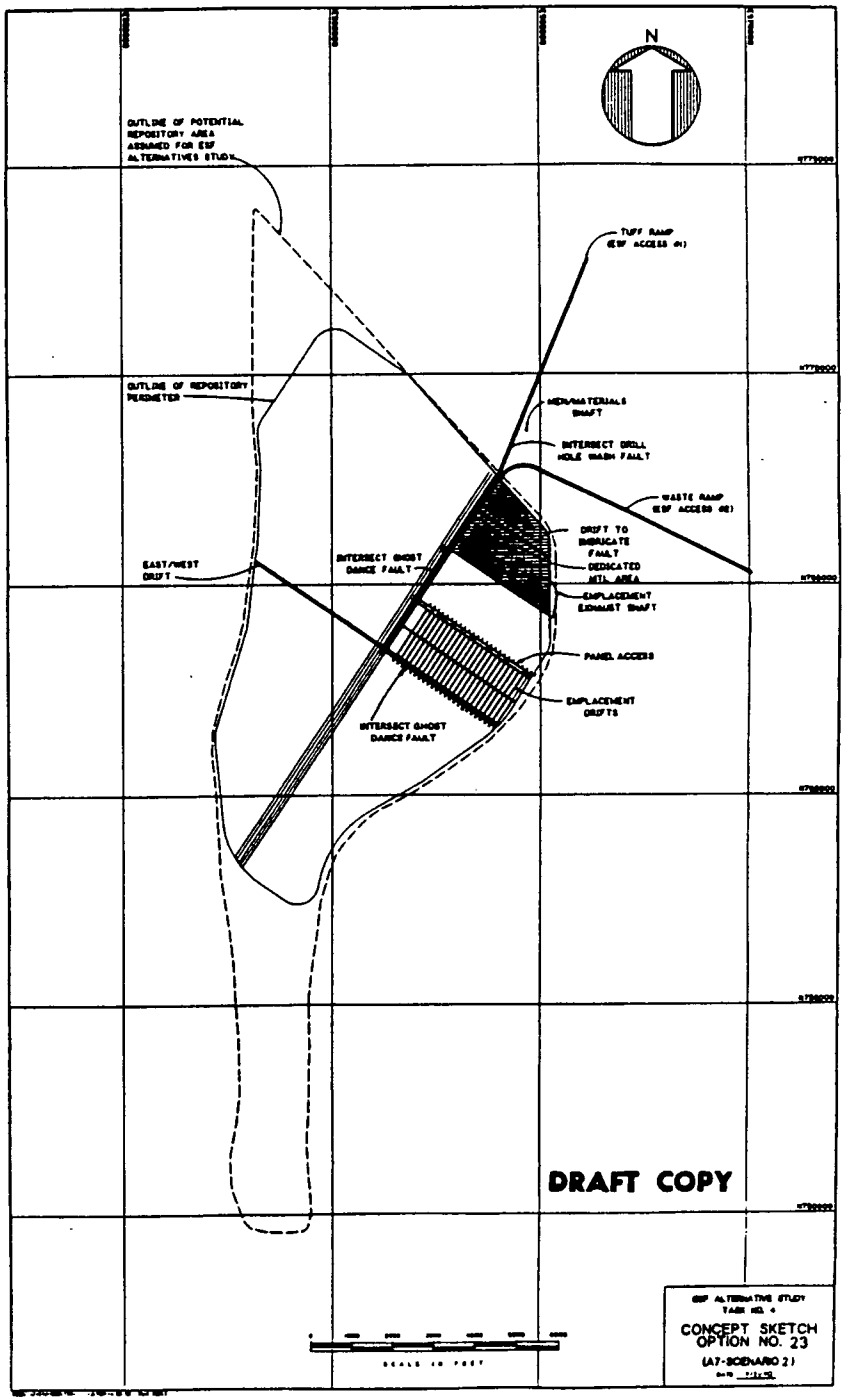
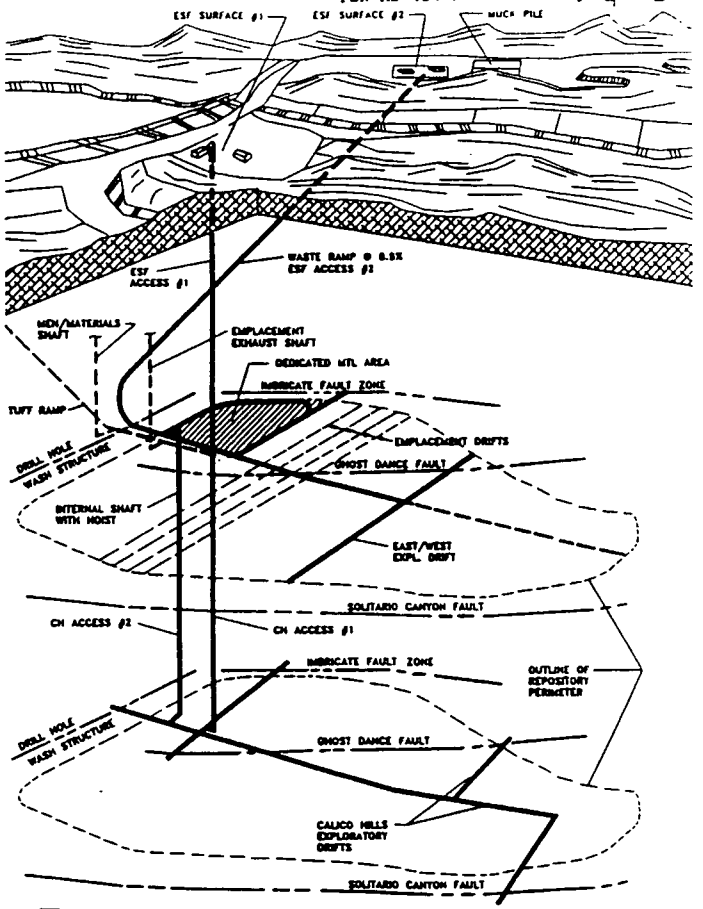
ESF ALTERNATIVES STUDY
TASK NO. 4
OPTION NO. A7
ISOMETRIC SCENARIO #2
DATE SEP 21 1990

REPOSITORY TYPE: A
NUMBER OF ACCESSES: 4
EXCAVATION: C





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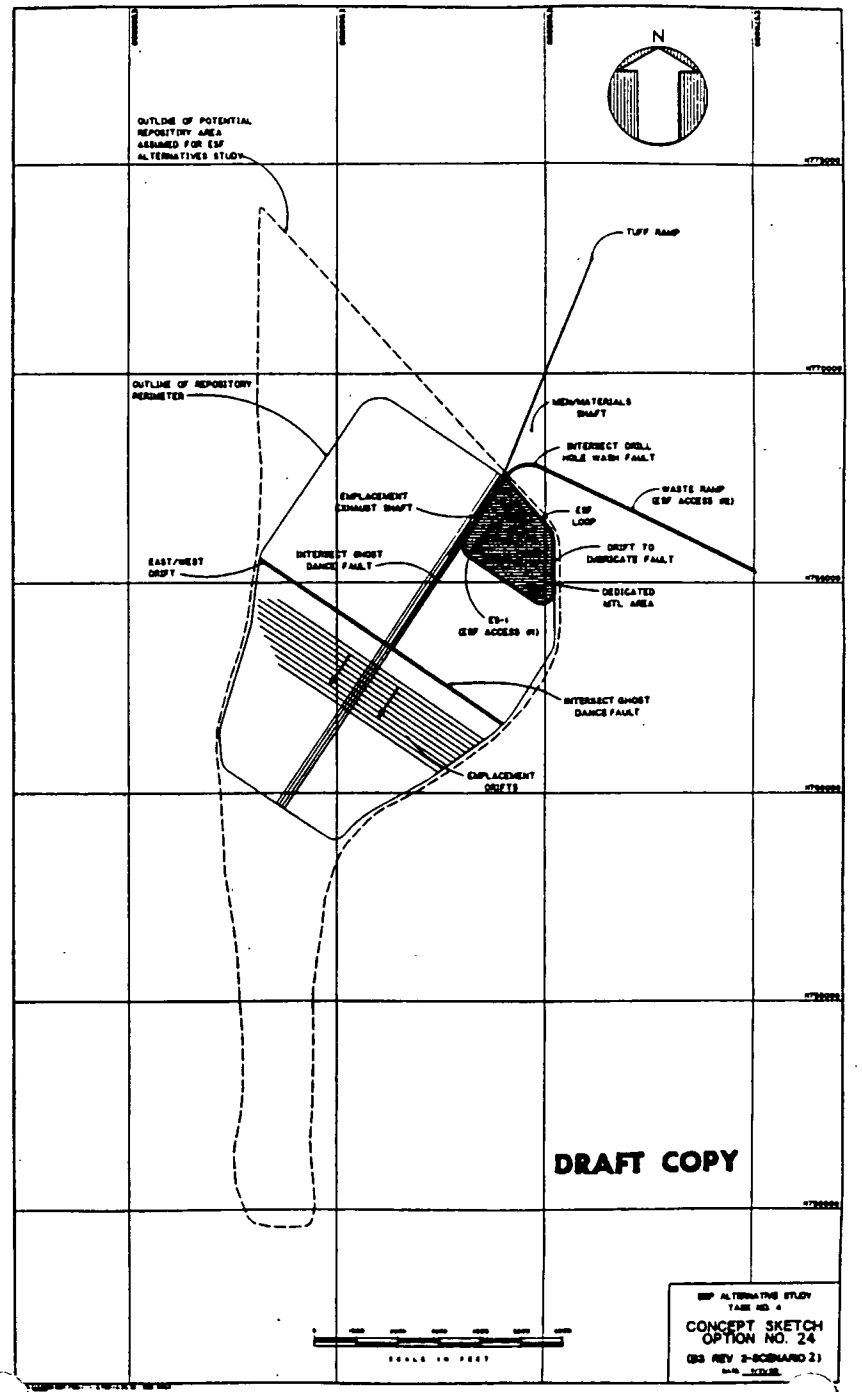
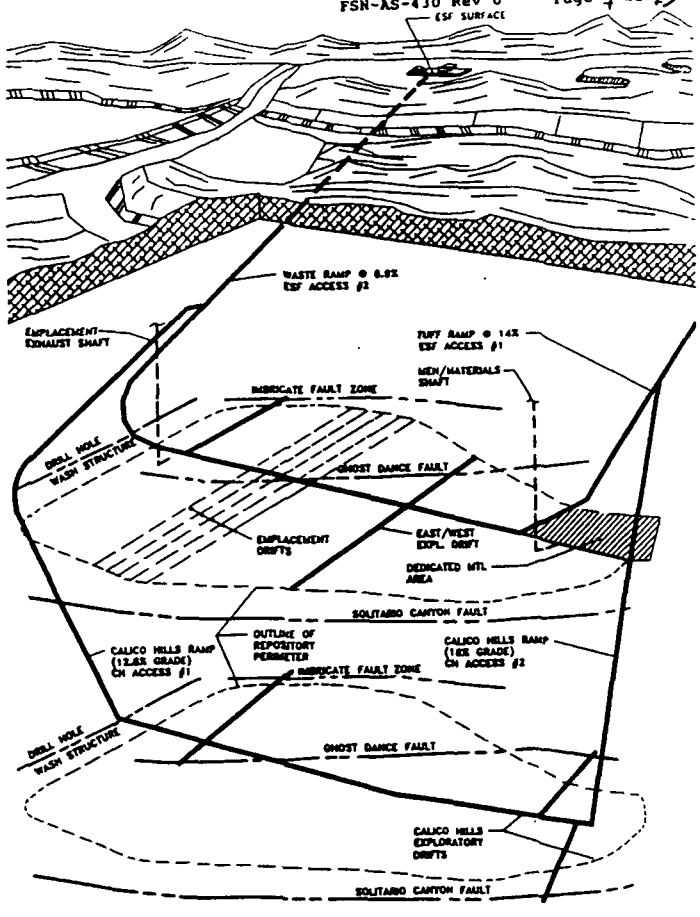
ESF ALTERNATIVES STUDY
TASK NO. 4
OPTION NO. B3 REV. 2
(SBM)
ISOMETRIC SCENARIO #2
DATE SEP 21 1990

REPOSITORY TYPE: B
NUMBER OF ACCESSES: 5
EXCAVATION: M





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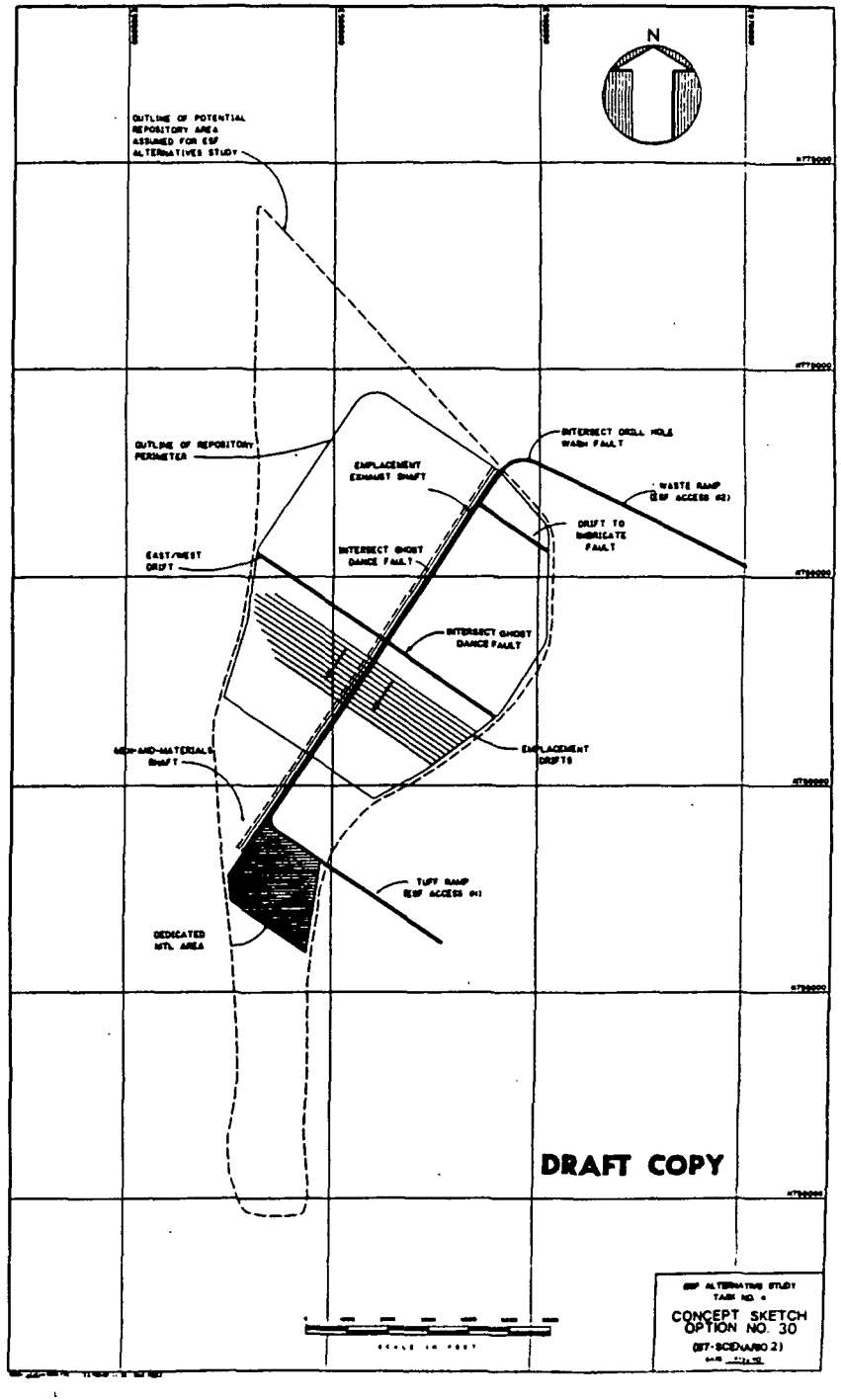
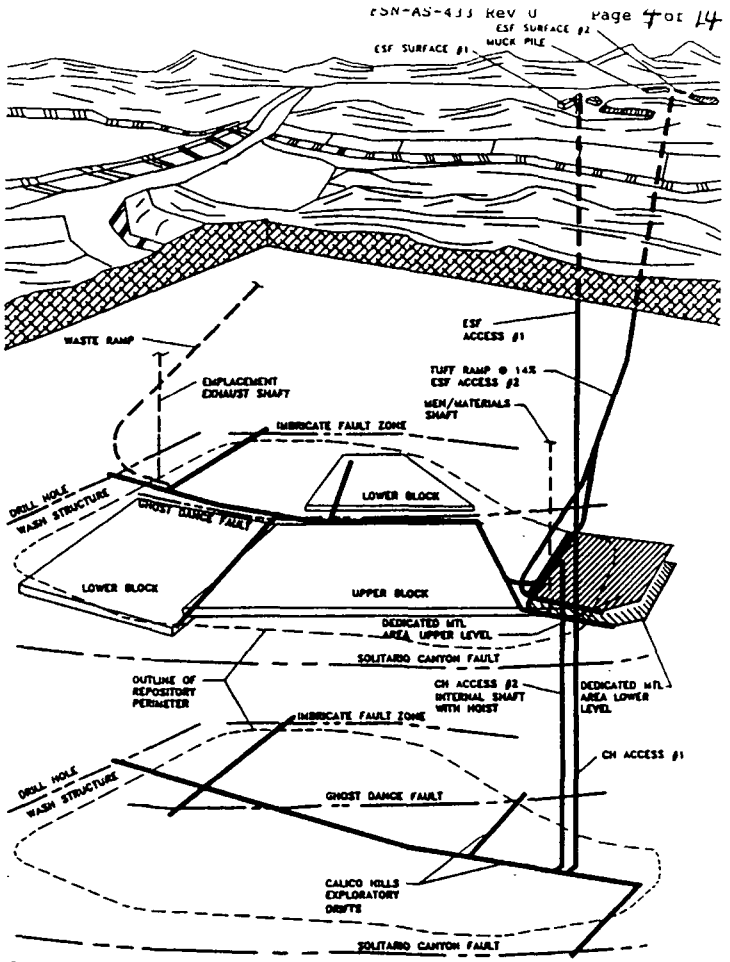
ESF ALTERNATIVES STUDY
TASK NO. 4
OPTION NO. B7
ISOMETRIC SCENARIO #2
DATE SEP 21 1990

REPOSITORY TYPE: B
NUMBER OF ACCESSES: 4
EXCAVATION: M





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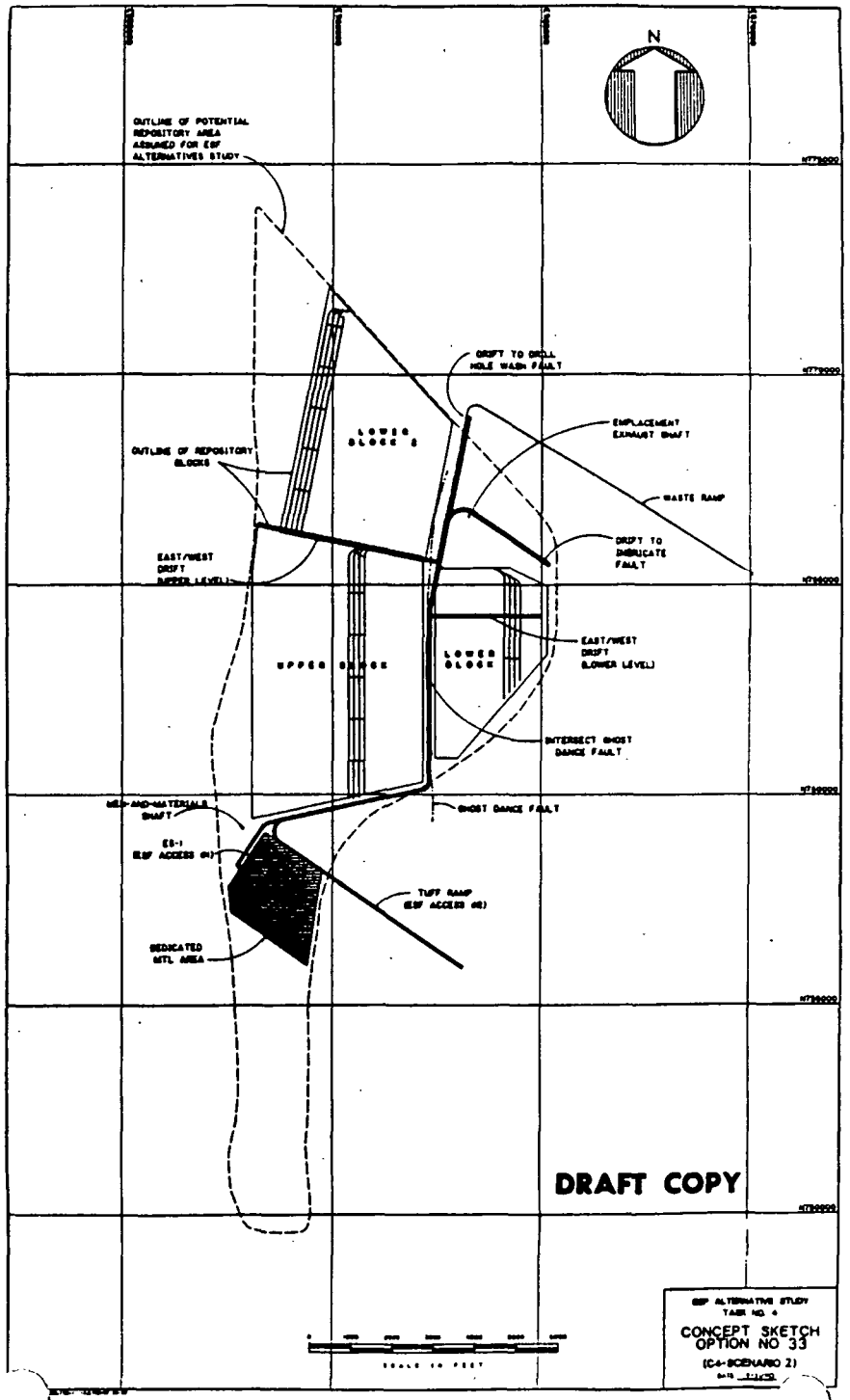
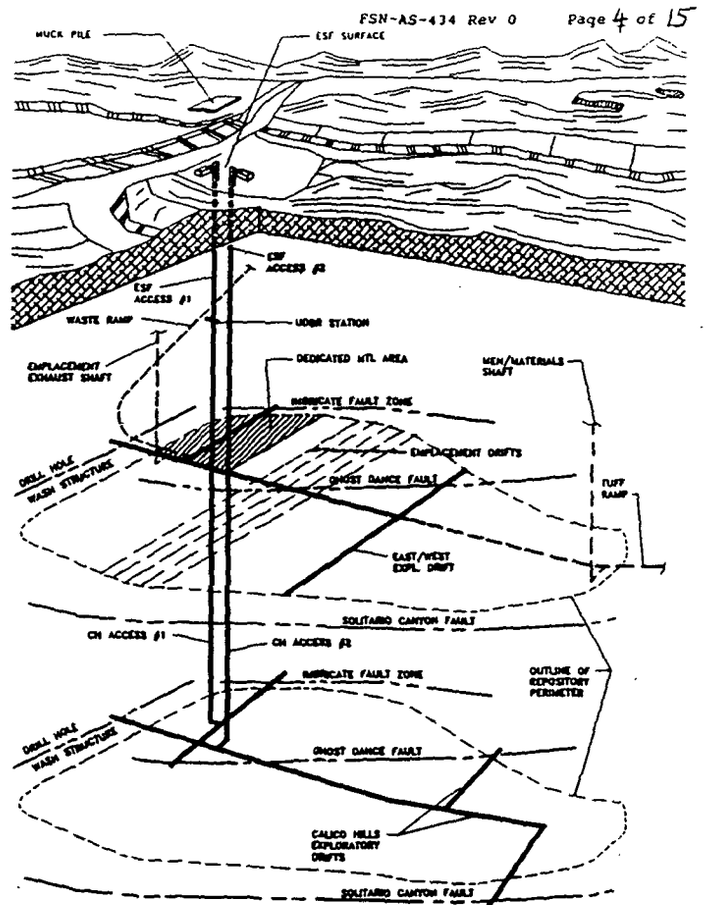
ESF ALTERNATIVES STUDY
TASK NO. 4
OPTION NO. C4
ISOMETRIC SCENARIO #2
DATE SEP 21 1990

REPOSITORY TYPE: C
NUMBER OF ACCESSES: 5
EXCAVATION: M





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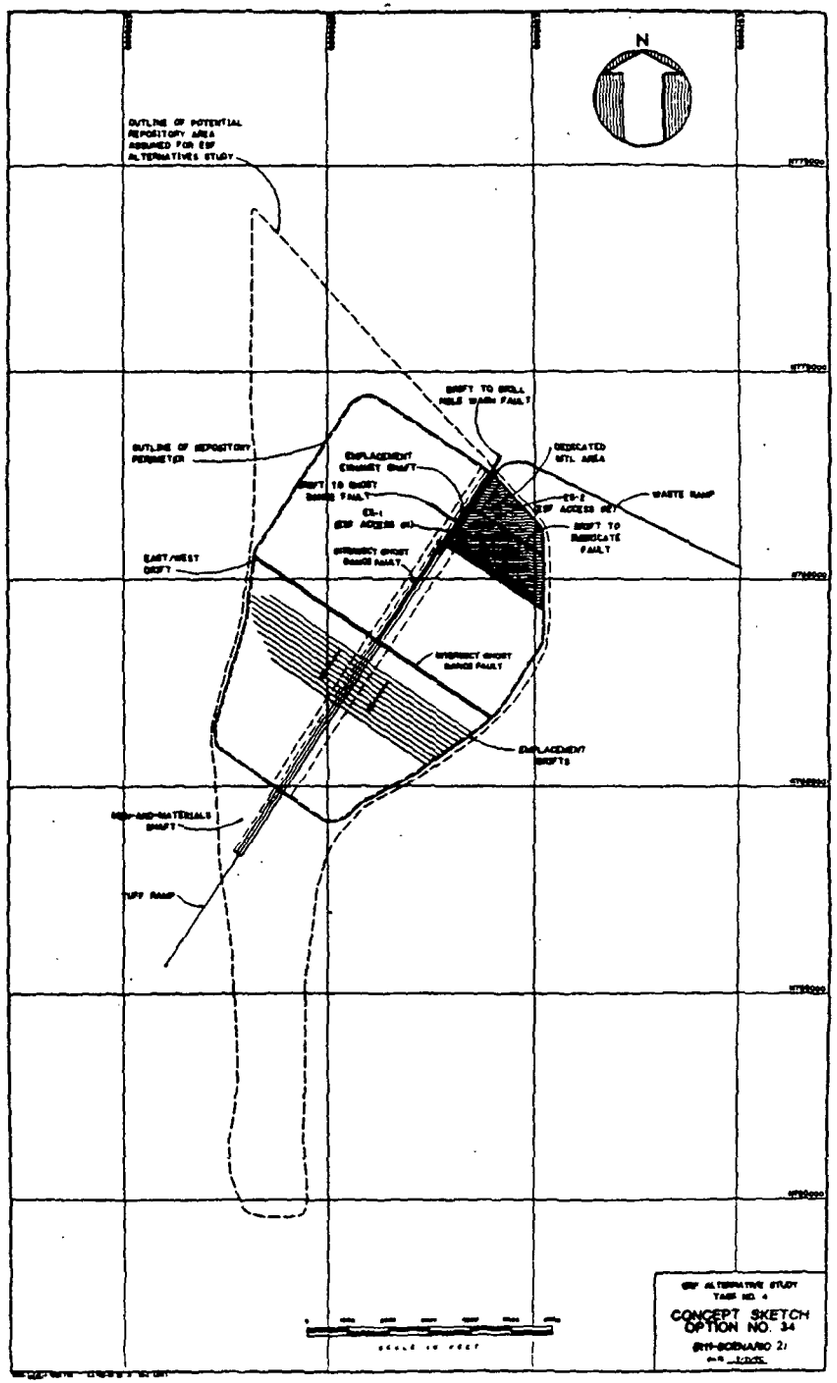
TO BE USED IN THE
ESF ALTERNATIVE STUDIES

ESF ALTERNATIVES STUDY
TASK NO. 4
OPTION NO. R-11
ISOMETRIC SCENARIO #2
DATE SEP 21 1990

REPOSITORY TYPE: R
NUMBER OF ACCESSES: 6
EXCAVATION: M



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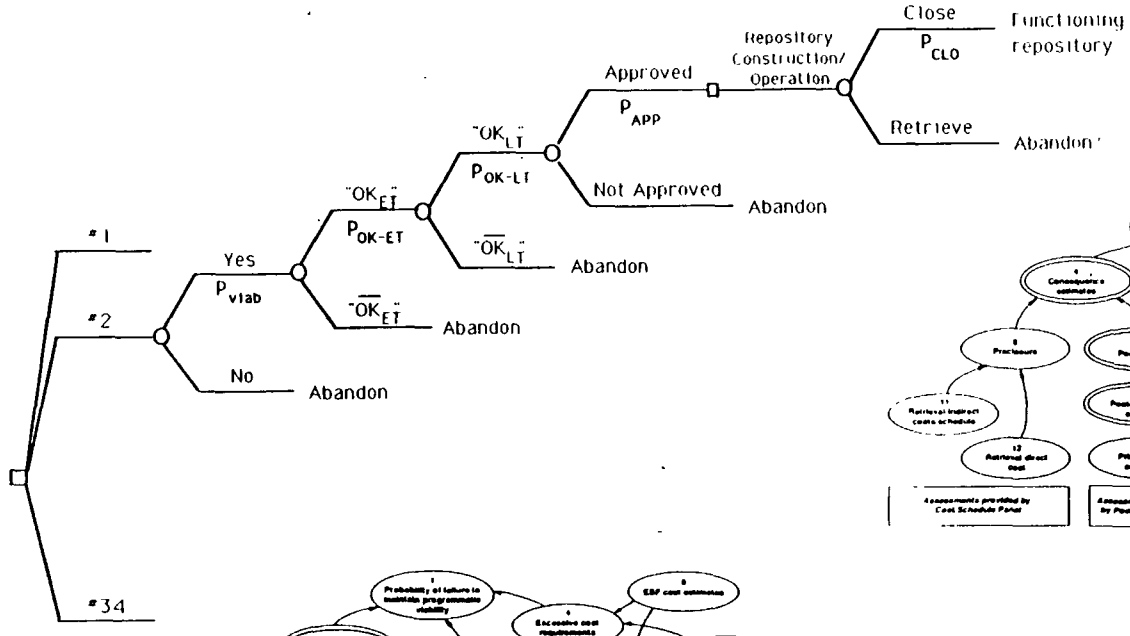
SUMMARY OF ESF/REPOSITORY OPTIONS

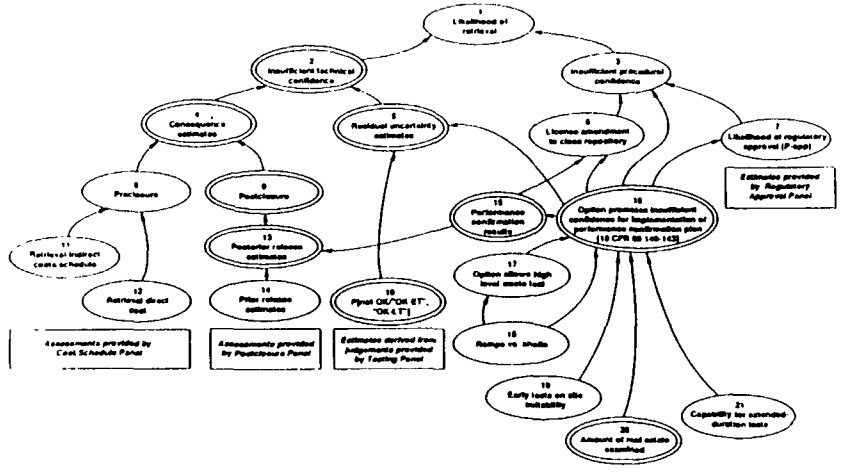
OPTION #			ESF								REPOSITORY				
			ACCESS-1		ACCESS-2		MAIN TEST LEVEL				ACCESSES		CONSTRUCTION METHOD		
			SIZE	CONST. METHOD	SIZE	CONST. METHOD	LAYOUT	CONST. METHOD	LOCATION	ELE-VATION	SHAFTS	RAMPS (TBM)	RAMPS & DRIFTS	EMPL. AREA	TOTAL ACCESSES
1	18	BASE CASE	12' SHAFT	DRILL & BLAST	12' SHAFT	DRILL & BLAST	TITLE II G.A.	DRILL & BLAST	NE	SAME AS REPOS.	2 - 20'	1 - 25' 1 - 23'	TBM	DRILL & BLAST	6
2	19	A1	16' SHAFT	--- " ---	25' RAMP	TBM	MODIFIED T II G.A.	--- " ---	--- " ---	--- " ---	2 - 25'	1 - 25' + ESF	--- " ---	--- " ---	5
3	20	A2	16' SHAFT	--- " ---	16' SHAFT	DRILL & BLAST	--- " ---	--- " ---	--- " ---	--- " ---	--- " ---	2 - 25'	--- " ---	--- " ---	6
4	21	A4 REV. 1	16' SHAFT	--- " ---	12' SHAFT 25' RAMP	DRILL & BLAST TBM	--- " ---	--- " ---	--- " ---	--- " ---	1 - 25' ENLARGE ES - 2 25'	1 - 25' + ESF	--- " ---	--- " ---	5
5	22	A5	16' SHAFT	--- " ---	25' RAMP	TBM	--- " ---	--- " ---	S	--- " ---	2 - 25'	--- " ---	--- " ---	--- " ---	5
6	23	A7	25' RAMP	TBM	25' RAMP	--- " ---	--- " ---	--- " ---	NE	--- " ---	--- " ---	IN ESF	--- " ---	--- " ---	4
7	24	B3, REV. 2 —	16' SHAFT	· SBM	--- " ---	--- " ---	--- " ---	MECH.	--- " ---	--- " ---	--- " ---	1 - 25' + ESF	--- " ---	TBM	5
8	25	B3, REV. 3 —		· V-MOLE											
9	26	B3, REV. 4 —		· BLIND BORE											
10	27	B3, REV.5 —		· RAISE BORE											
11	28	B3, REV. 6 —		· DRILL/BLAST											
12	29	B4	16' SHAFT	DRILL & BLAST	--- " ---	--- " ---	--- " ---	--- " ---	S	--- " ---	--- " ---	--- " ---	--- " ---	--- " ---	5
13	30	B7	25' RAMP	TBM	--- " ---	--- " ---	--- " ---	--- " ---	--- " ---	--- " ---	--- " ---	IN ESF	--- " ---	--- " ---	4
14	31	B8	16' SHAFT	DRILL & BLAST	--- " ---	--- " ---	--- " ---	--- " ---	--- " ---	--- " ---	1 - 25'	2 - 25' + ESF	--- " ---	--- " ---	5
15	32	C1	16' SHAFT	--- " ---	--- " ---	--- " ---	TWO LEVEL	--- " ---	NE	TWO LEVELS SAME AS REPOS.	2 - 25' ENLARGE ES - 1 25'	1 - 25' + ESF	--- " ---	--- " ---	4
16	33	C4	16' SHAFT	--- " ---	--- " ---	--- " ---	--- " ---	--- " ---	S	--- " ---	2 - 25'	--- " ---	--- " ---	--- " ---	5
17	34	R11	12' SHAFT	--- " ---	12' SHAFT	DRILL & BLAST	TITLE II G.A.	DRILL & BLAST	NE	SAME AS REPOS.	2 - 25'	2 - 25'	--- " ---	--- " ---	6

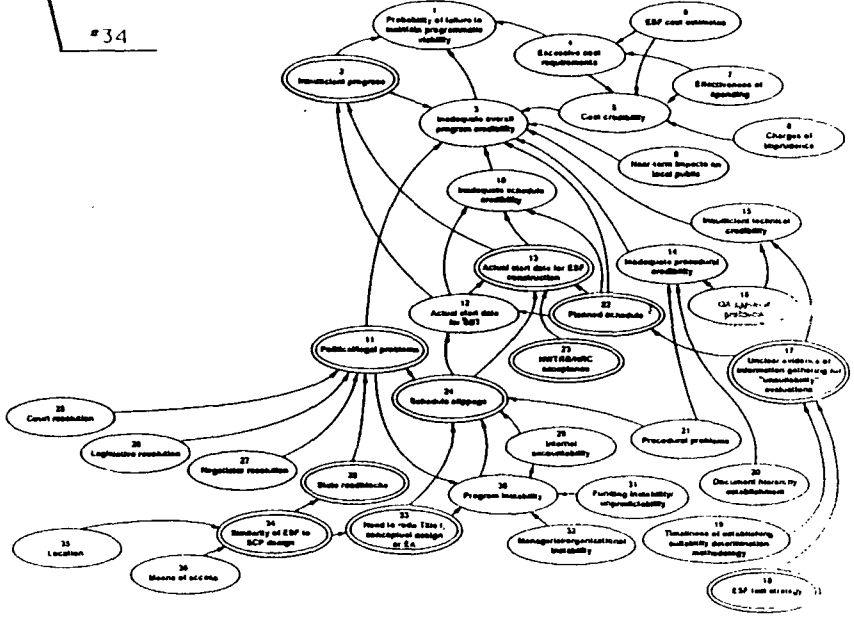
EVALUATION

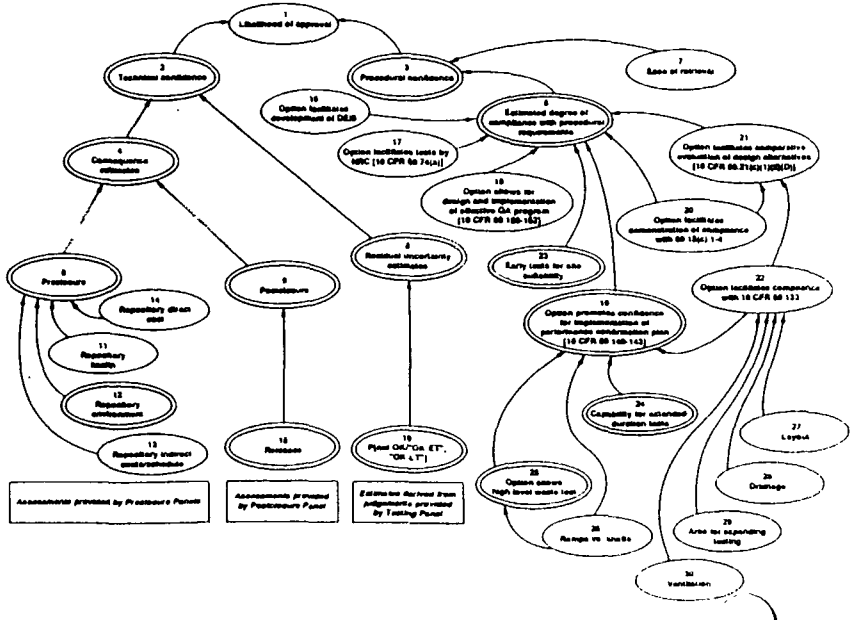
- ASSESS 5 PROBABILITIES TO QUANTIFY NATURE'S TREE; USE TREE TO COMPILE TESTING OUTCOME PROBABILITIES
- ASSESS OTHER 3 PROBABILITIES NEEDED FOR DECISION TREE
  - PROGRAMMATIC VIABILITY
  - REGULATORY APPROVAL
  - CLOSURE
- ASSESS 8 CONSEQUENCE MEASURES FOR EACH SCENARIO IN DECISION TREE
- DEVELOP SCALING FUNCTIONS AND WEIGHTS FOR MUA
- SOLVE DECISION TREE FOR OVERALL RANKING

PROBABILITIES NEEDED FOR DECISION TREE



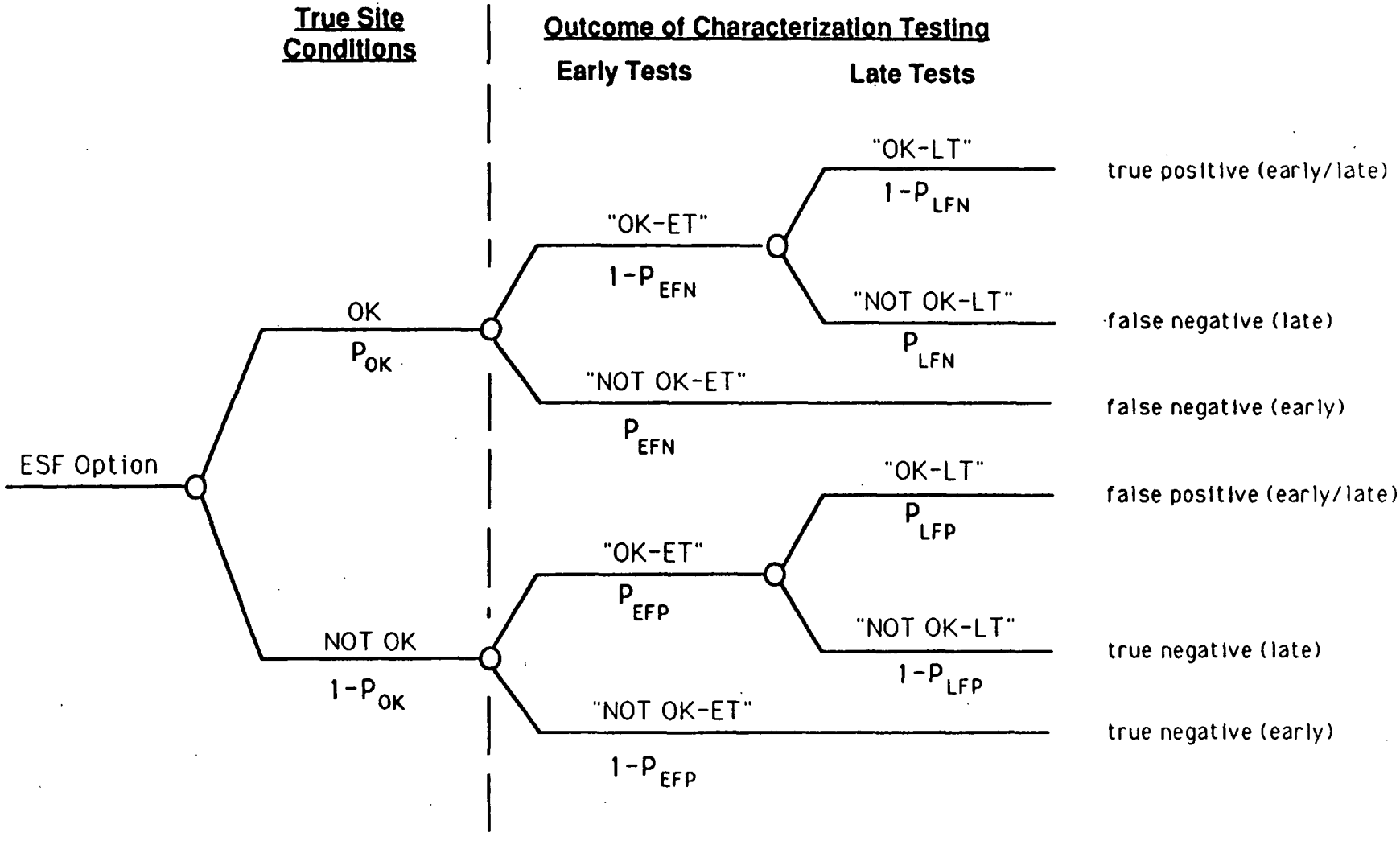






RDFEXV5P.125.NWTRB/9-18/19-91

NATURE'S TREE



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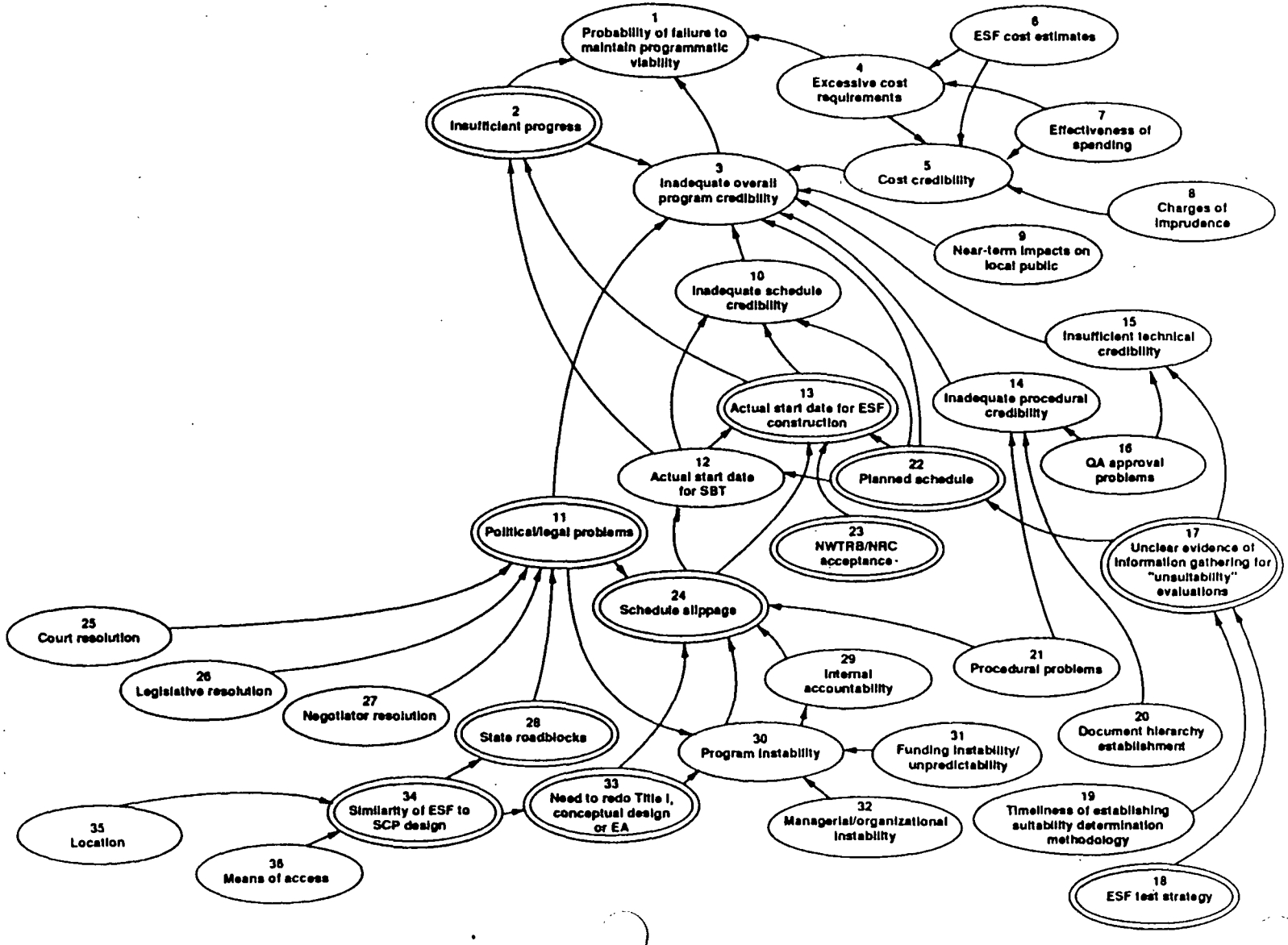
FACTORS THAT INFLUENCE THE PROBABILITY OF PROGRAMMATIC VIABILITY



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PROGRAMMATIC VIABILITY

Option	$ M/ month (average)	Compared to ESF original Title II Design (w/o CH), what is potential for:		What is potential for resolution of concerns by:		Prob site not OK given "OK-ET","OK-LT" (%)	Probability of Regulatory Approval (%)	Option
		Design Dis-similarity?	Schedule Slippage in Re-Design?	NWTRB	NRC			
1	4.6	✱✱	☹	•	☺	1.0	78	1
2	5.7	✱✱✱✱	☹☹	• • •	☺☺	0.7	93	2
3	4.9	✱✱✱	☹	•	☺☺	0.8	89	3
4	6.2	✱✱✱✱	☹☹	• • •	☺☺☺	0.6	87	4
5	6.0	✱✱✱✱	☹☹	• • •	☺☺☺	0.7	85	5
6	6.2	✱✱✱✱	☹☹	• • • •	☺☺☺☺	0.8	93	6
7	6.4	✱✱✱✱	☹☹	• • • •	☺☺☺	0.8	92	7
8	6.3	✱✱✱✱	☹☹	• • • • •	☺☺☺	0.9	85	8
9	6.4	✱✱✱✱	☹☹	• •	☺☺	2.6	67	9
10	6.2	✱✱✱✱	☹☹	• •	☺☺	1.3	74	10
11	5.9	✱✱✱✱	☹☹	• • •	☺☺	0.9	83	11
12	6.5	✱✱✱✱	☹☹	• • •	☺☺☺	0.7	81	12
13	7.3	✱✱✱✱	☹☹	• • • •	☺☺☺☺	0.8	89	13
14	6.1	✱✱✱✱	☹☹	• • •	☺☺☺	0.7	78	14
15	7.1	✱✱✱✱✱	☹☹☹☹	• • •	☺☺☺	0.5	95	15
16	6.8	✱✱✱✱✱	☹☹☹☹	• • •	☺☺☺☺	0.6	90	16
17	4.8	✱✱	☹	•	☺☺	0.9	70	17
18	5.7	✱✱	☹☹	•	☺	1.0	77	18
19	6.1	✱✱✱✱	☹☹	• • •	☺☺	0.9	90	19
20	5.5	✱✱✱	☹☹	•	☺☺	0.9	83	20
21	6.8	✱✱✱✱	☹☹	• • •	☺☺☺	0.8	84	21
22	6.3	✱✱✱✱	☹☹	• • •	☺☺☺	0.9	78	22
23	7.1	✱✱✱✱	☹☹	• • • •	☺☺☺☺	0.9	90	23
24	6.7	✱✱✱✱	☹☹	• • • •	☺☺☺	1.0	86	24
25	6.1	✱✱✱✱	☹☹	• • • •	☺☺☺	1.0	80	25
26	6.8	✱✱✱✱	☹☹☹☹	• •	☺☺	2.5	66	26
27	6.1	✱✱✱✱	☹☹☹☹	• •	☺☺	1.2	73	27
28	6.2	✱✱✱✱	☹☹	• •	☺☺	0.9	82	28
29	6.7	✱✱✱✱	☹☹	• • •	☺☺☺	0.9	79	29
30	7.4	✱✱✱✱	☹☹☹☹	• • • •	☺☺☺☺	0.8	87	30
31	6.4	✱✱✱✱	☹☹	• •	☺☺☺	0.9	77	31
32	7.5	✱✱✱✱✱	☹☹☹☹	• • •	☺☺☺	0.7	94	32
33	6.4	✱✱✱✱✱	☹☹☹☹	• • •	☺☺☺	0.7	88	33
34	4.5	✱✱	☹☹	•	☺☺	1.1	69	34

NWTRB CONCERNS

- SHAFT CONSTRUCTION DISTURBANCE:
  (1) BY INTRODUCING WATER INTO ROCK FROM BLAST-HOLE DRILLING, AND
  (2) BY CREATING OR OPENING EXISTING OR NATURAL FRACTURES

- EXPLORATION OF THE GHOST DANCE FAULT AT LEAST TWICE BY EXPLORATORY DRIFTS; ONE FARTHER SOUTH

- AN EAST-WEST EXPLORATORY DRIFT TO FACILITATE THE DETECTION OF NORTH-SOUTH TRENDING FAULTS AND CHARACTERIZE A LARGER EXTENT OF ROCK AWAY FROM THE SHAFTS

NWTRB CONCERNS

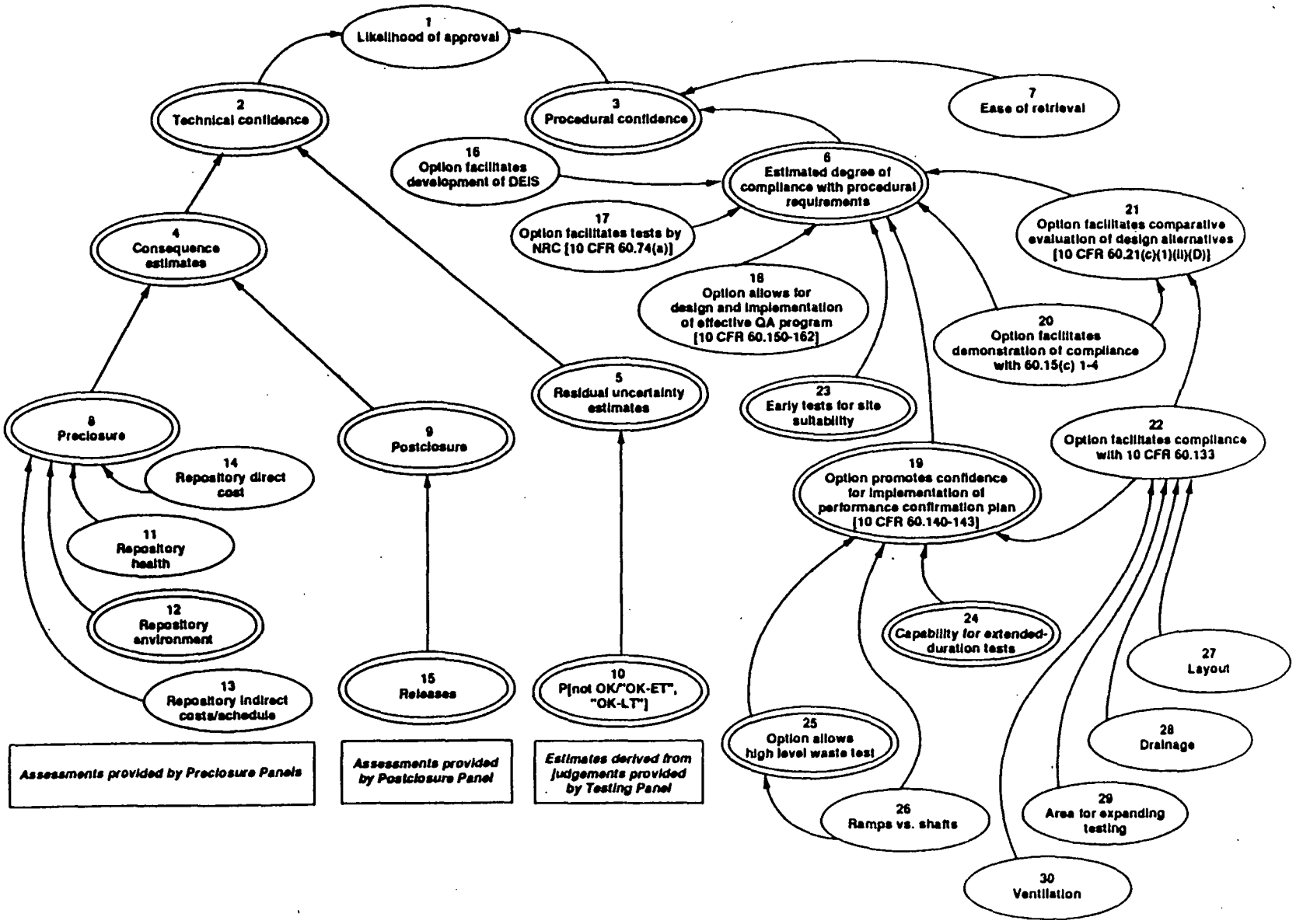
(CONTINUED)

- INCLINED RAMP INTO THE EAST SIDE OF THE YUCCA MOUNTAIN BLOCK TO REPLACE ONE EXPLORATORY SHAFT, FAULTS TO BE INSPECTED AT DEPTH, INTERSECT MOST OF THE TUFF UNITS, AND ALLOW EXPLORATORY ROOMS AT POINTS OF INTEREST
- GEOLOGIC MAPPING OF SHAFTS AND TUNNELS THAT HAVE BEEN BORED SHOULD PROVIDE MOST RELIABLE DATA
- EXPLORATION OF THE SOFTER TUFF UNITS THAT OCCUR ABOVE AND BELOW THE REPOSITORY LEVEL THAT ARE IMPORTANT IN IMPEDING DOWNWARD FLOW OF SURFACE INFILTRATION

NRC CONCERNS

- (SCA COMMENT 35) THE PROGRAM OF DRIFTING .... APPEARS UNLIKELY TO PROVIDE THE INFORMATION NECESSARY TO ADEQUATELY INVESTIGATE POTENTIALLY ADVERSE CONDITIONS ... BIAS TOWARD NORTHERN PART OF BLOCK ... MANY NORTH TRENDING FAULTS IN ABANDONED WASH BLOCK (S.E.)
- (SCA COMMENT 37) NOT CLEAR THAT BLAST INDUCED FRACTURES CAN BE DIFFERENTIATED FROM NATURAL FRACTURES
- (SCA COMMENT 82) INCLUDE IN SITU WASTE PACKAGE TESTS TO OBTAIN THE INFORMATION NEEDED TO VERIFY WASTE PACKAGE PERFORMANCE AT THE TIME OF LICENSE APPLICATION
- (SCA OBJECTION 1) INCOMPATIBILITY OF SOME TESTS WITH CONSTRUCTION OPERATIONS
- (SCA OBJECTION 1) LONGER TEST DURATIONS WILL BE NECESSARY; DELAYS IN TESTING COULD AFFECT THE TIMING WHERE MULTIPLE TESTS ARE PLANNED FOR THE SAME LOCATION
- (SCA OBJECTION 1) THE SPACE DESIGNATED FOR TESTS WITHIN THE UNDERGROUND TEST AREA LAYOUT IS VERY LIKELY TO BE INADEQUATE

FACTORS THAT INFLUENCE THE LIKELIHOOD OF CONSTRUCTION AND/OR OPERATION APPROVAL



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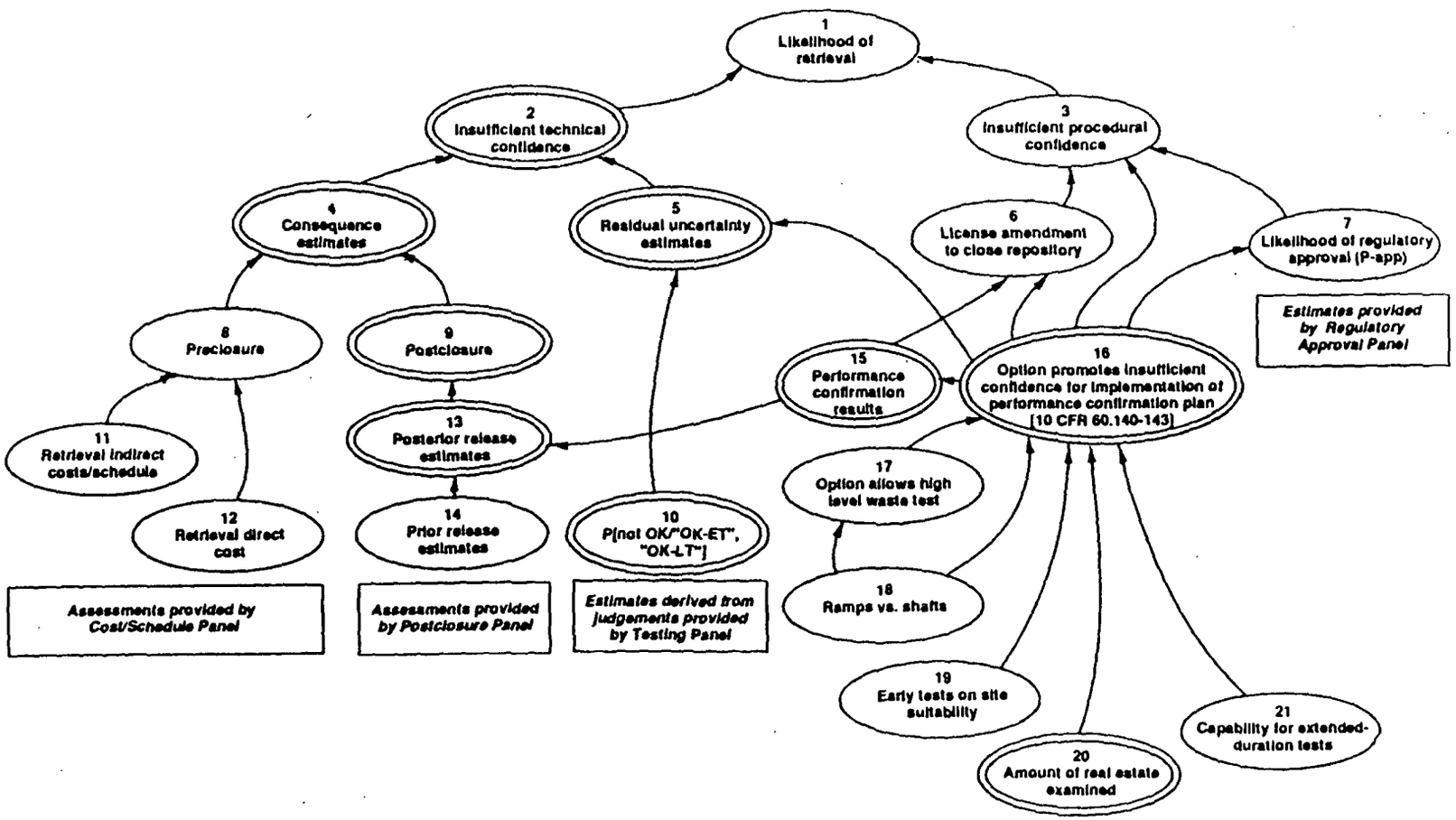
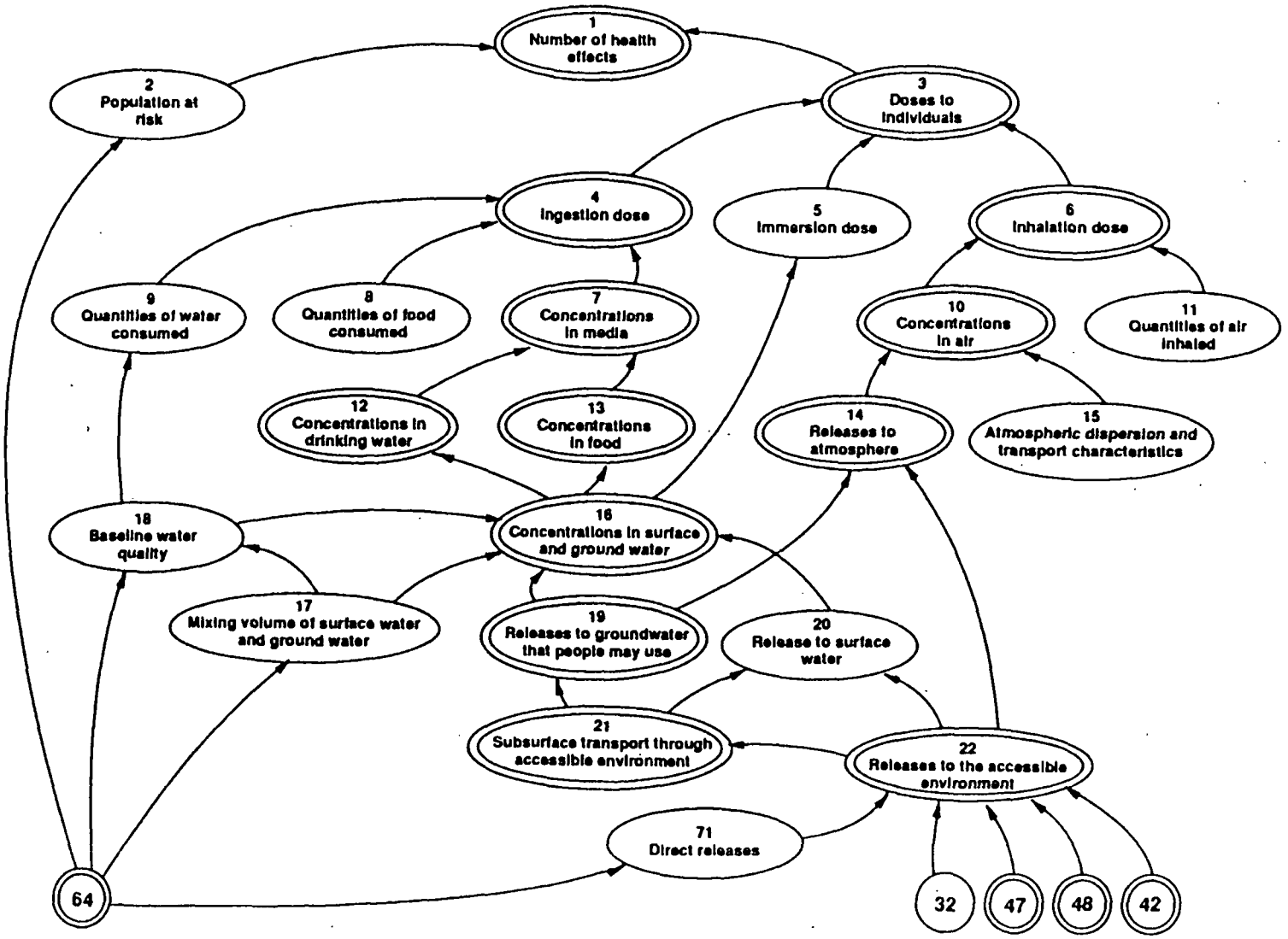
FACTORS THAT INFLUENCE THE LIKELIHOOD OF RETRIEVAL



FACTORS THAT INFLUENCE THE NUMBER OF POSTCLOSURE HEALTH EFFECTS ATTRIBUTABLE TO THE ESF-REPOSITORY HEALTH EFFECTS PORTION



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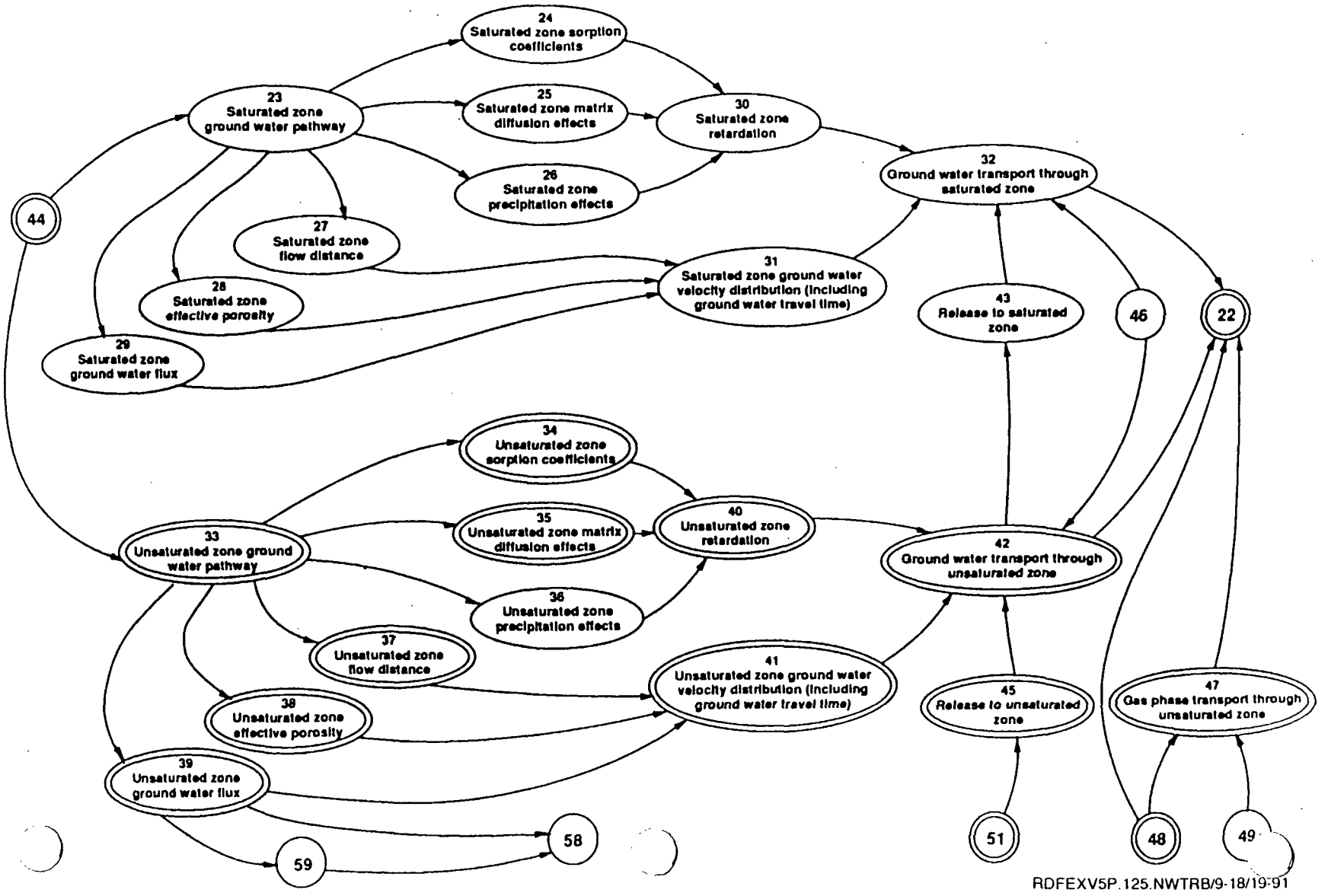
FACTORS THAT INFLUENCE THE NUMBER OF POSTCLOSURE HEALTH EFFECTS ATTRIBUTABLE TO THE ESF-REPOSITORY TRANSPORT THROUGH NATURAL BARRIERS PORTION



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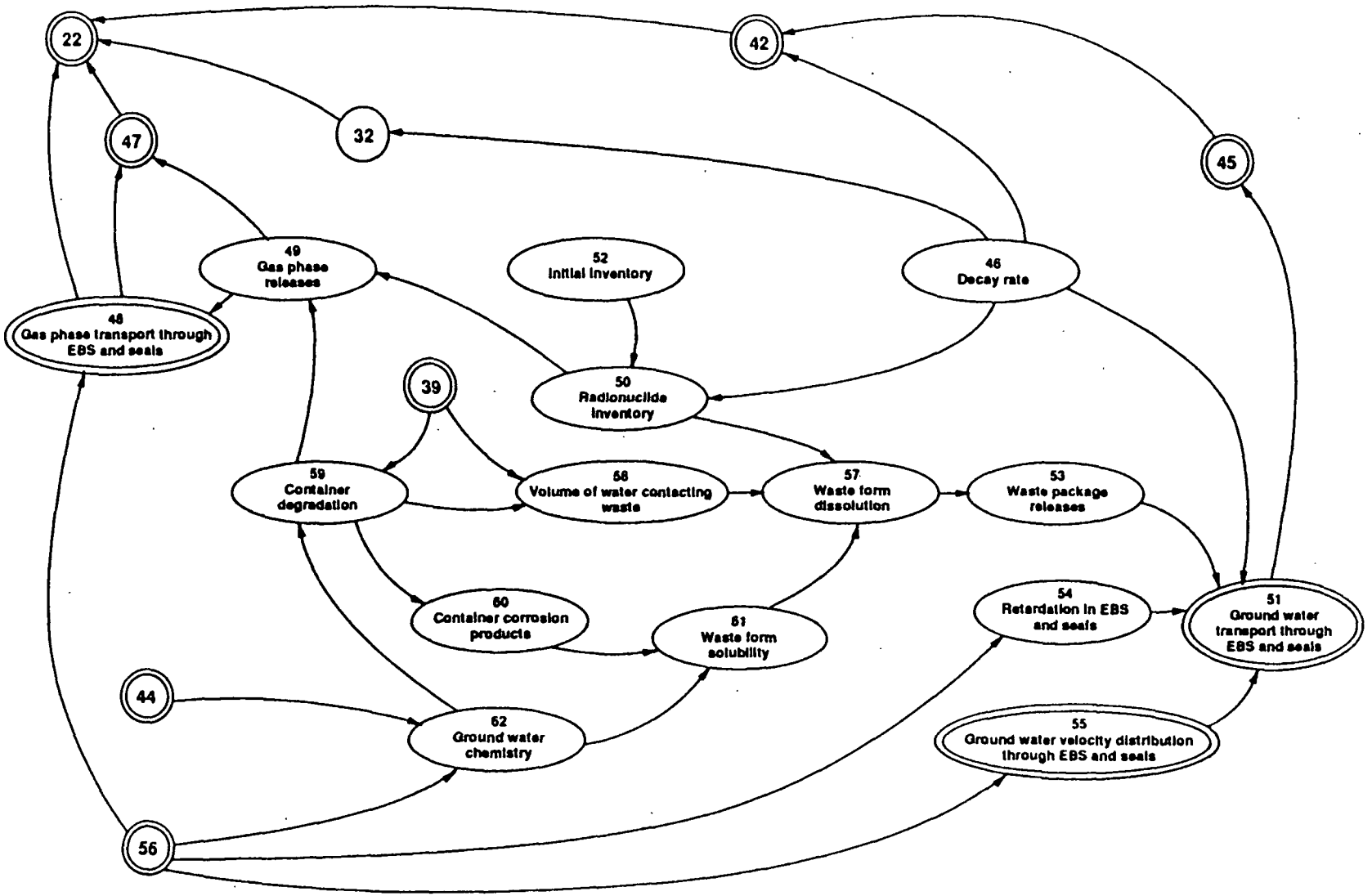
FACTORS THAT INFLUENCE THE NUMBER OF POSTCLOSURE HEALTH EFFECTS ATTRIBUTABLE TO THE ESF-REPOSITORY ENGINEERED BARRIER SYSTEM (EBS) PORTION



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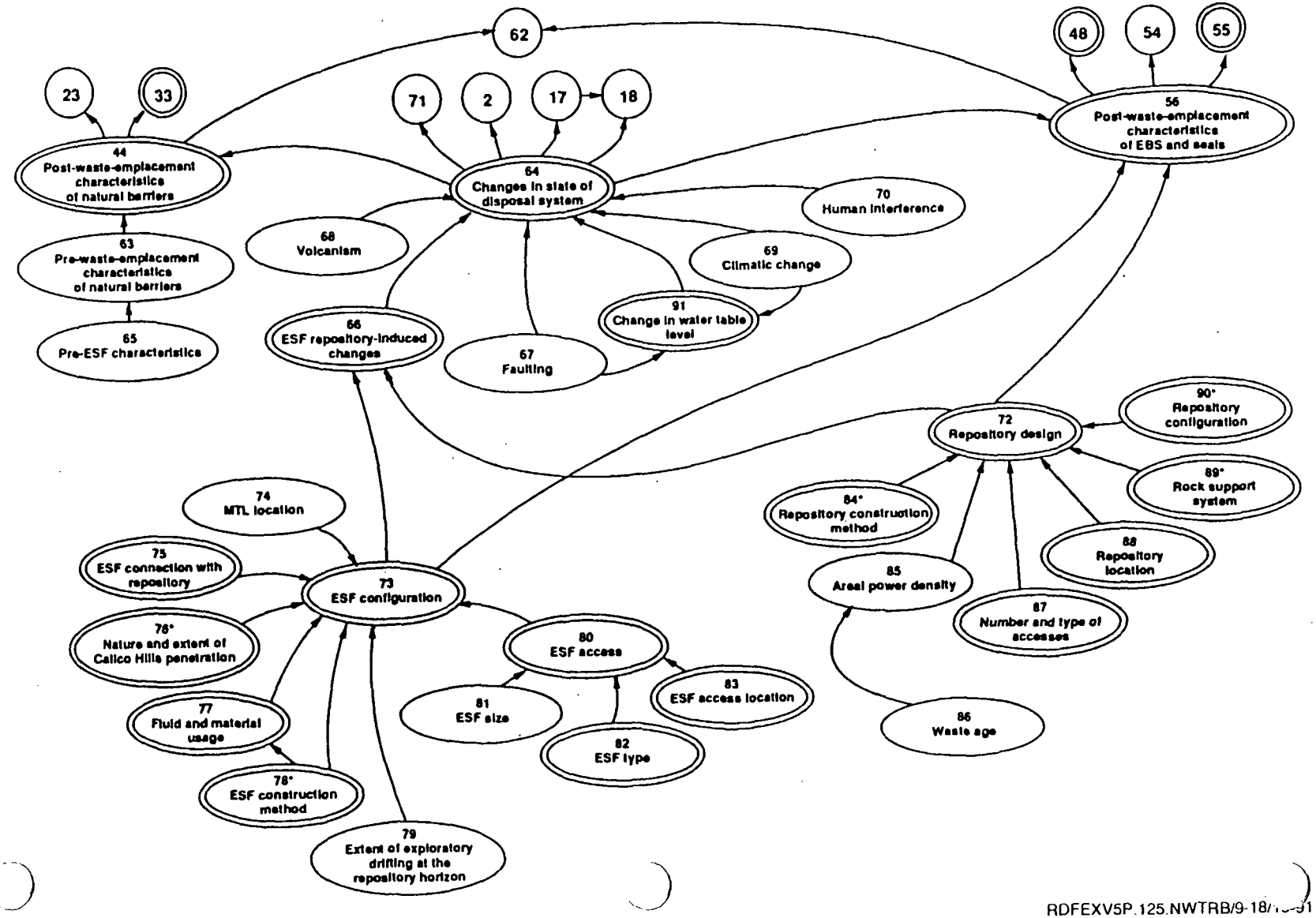
FACTORS THAT INFLUENCE THE NUMBER OF POSTCLOSURE HEALTH EFFECTS ATTRIBUTABLE TO THE ESF-REPOSITORY SCENARIO PORTION



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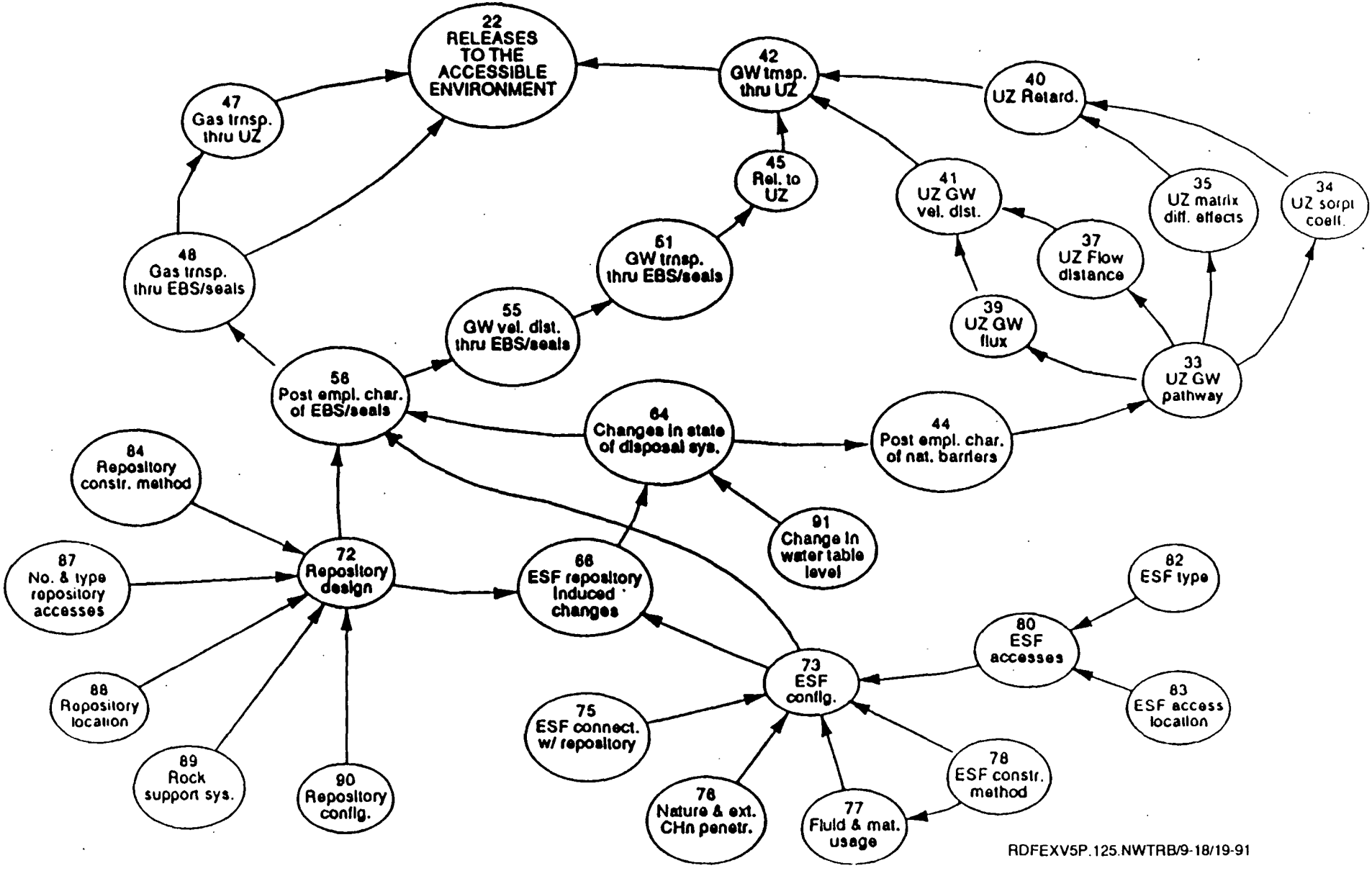
POST-CLOSURE RELEASES INFLUENCE DIAGRAM



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IMPORTANT INFLUENCING FACTORS FOR POSTCLOSURE RELEASES

Release (frctn of EPA std)	repository location (above water table) 80	Post emplacement charactistics of EDS/seals 56	ESF/repository access type,number and location (ramps vs shafts) 82 and 87	Change in Water Table Level 91	ESF Connection with Repository 75	Fluid/material usage 77	Nature & Extent of CH penetration 76	ESF/repository Construction Method 78 and 84	Repository Configuration 90	Rock Support System 89
BEST	Matrix flow 10^-8 | Fracture flow 10^-4 50% increase increase is good 10^-7 | 10^-3	0 No change in best est. of rel if effective, ramps better than shafts 20 m^3/yr	high above flood plain: no change in best est. of releases fewer is better more is better for water vapor removal good location if above max. flood plain level outside block is better above flood plain	decrease is good connection is better if down gradient	unconnected is better if outside repos. emplacement area	less is better (especially if fracture flow) non-discriminator if matrix flow	better if no penetration minimal impact if matrix flow	mechanical mining less extent of damage better than drill and blast controlled drill & blast drill and blast	lower extraction ratio better minimal no. of fault intersections better	low extraction ratio better circular cross-section better additional fracturing of already fractured rock is better arched
BASE CASE	no change Decrease is not good 50% Decrease 10^-6 | 10^-2	if ineffective, ramps worse than shafts 200 m^3/yr No sig impact on worst rel. est.	4 shafts, 2 ramps 20-200 m^3/yr inside block is worse bad location if below or at PMF more is worse 200 (shafts) to 2000 (ramps) m^3/yr/opening; Ramp below flood plain/rock has high-density of fractures and fault zone intersection	increase is bad (change in stratigraphy thru which water moves)	connected is worse if inside repository emplacement area	more is worse (if fracture flow)	worse if fracture flow together with connection to repository and distance to water table	production mining drill & blast	self-draining low potential for self-draining worse non-preferred alignment with structure worse higher extraction ratio is worse	rectangular opening higher extraction ratio is worse
WORST										

NOTE Must consider aggregate impact of factors on performance of repository system.

RDFEXV5P.125.NWTRB/9-18/1