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

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: CALICO HILLS RISK/BENEFIT ANALYSIS - OVERVIEW AND SUMMARY OF RESULTS

PRESENTER: DR. DAVID C. DOBSON

PRESENTER'S TITLE AND ORGANIZATION: ACTING DIRECTOR, REGULATORY AND SITE EVALUATION DIVISION

PRESENTER'S TELEPHONE NUMBER: (702) 794-7940

DENVER, COLORADO
MARCH 6-7, 1991

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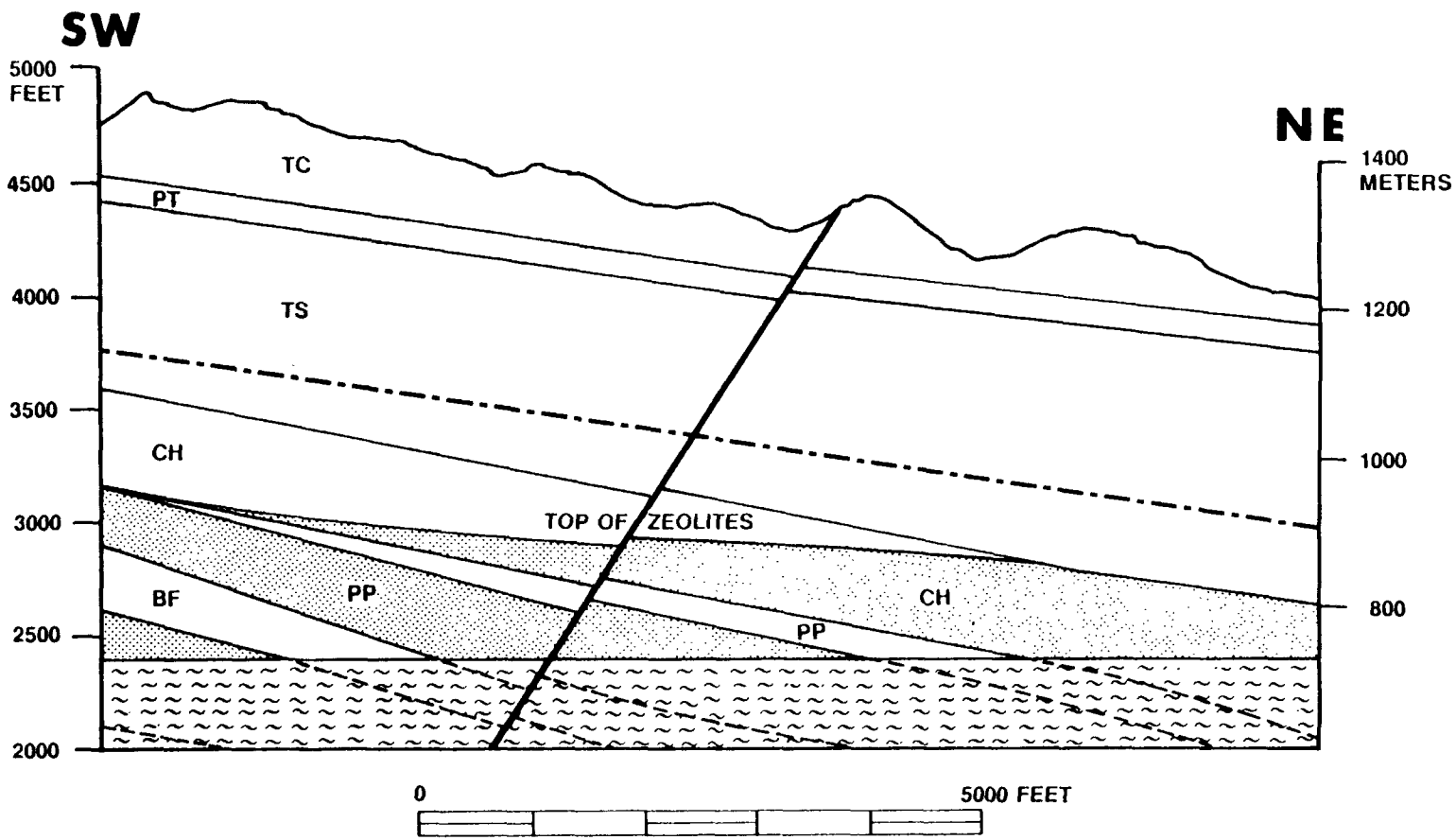
CALICO HILLS RISK/BENEFIT ANALYSIS AGENDA

• OVERVIEW/SUMMARY OF RESULTS	D.DOBSON
• MULTIATTRIBUTE UTILITY ANALYSIS	J. LATHROP
• DISCUSSION OF SATURATED ZONE PERFORMANCE, AS ADDRESSED IN THE CHRBA	J. ROBERTSON
• PROGRAMMATIC INSIGHTS AND CLOSING REMARKS	D. DOBSON

GEOLOGIC ORIENTATION:

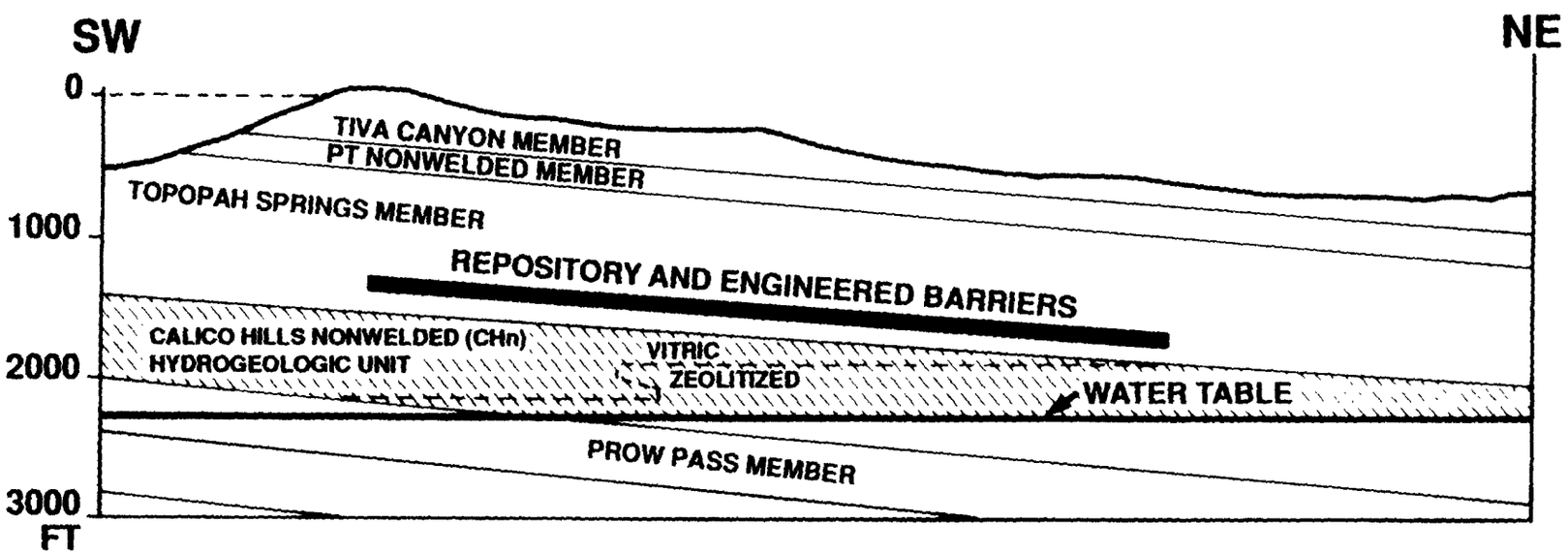
CROSS SECTION SHOWING CHn AT YUCCA MOUNTAIN



TC	TIVA CANYON	PP	PROW PASS	WELDED UNITS
PT	PAINTBRUSH	CH	CALICO HILLS	NONWELDED UNITS
TS	TOPOPAH SPRING	BF	BULLFROG	REPOSITORY
				ZEOLITIC REGIONS
				SATURATED ZONE

NWCRBAP 125 NWTRB/1-29-91

CROSS SECTION SHOWING CHn AT YUCCA MOUNTAIN



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OBJECTIVES AND METHODS

- THIS STUDY WAS CONDUCTED IN ACCORDANCE WITH THE REQUIREMENTS OF THE YMP QA PROGRAM

- THE DOE DECIDED TO CONDUCT THE STUDY IN ACCORDANCE WITH THE PRINCIPLES OF DECISION ANALYSIS, IN ORDER TO ENSURE THE BASIS FOR THE DECISION WAS CLEAR

- TWO DECISION-AIDING METHODOLOGIES WERE UTILIZED
  - A VALUE OF INFORMATION (VOI) TECHNIQUE
  - A MULTIATTRIBUTE UTILITY ANALYSIS (MUA)

- THE TASK GROUP WAS INSTRUCTED TO BASE THE EVALUATION PRIMARILY ON THE CRITERIA IDENTIFIED IN THE NRC OBJECTION
  - BENEFIT FROM TESTING
  - RISK TO PERFORMANCE

COMPOSITION OF THE TASK FORCE

- THE CHRBA TASK GROUP WAS COMPOSED OF SCIENTISTS, ENGINEERS, AND REGULATORY STAFF REPRESENTING THE MAJOR DISCIPLINES IN THE PROGRAM (e.g., HYDROLOGY, GEOLOGY, GEOCHEMISTRY, PERFORMANCE ASSESSMENT, ENGINEERING)

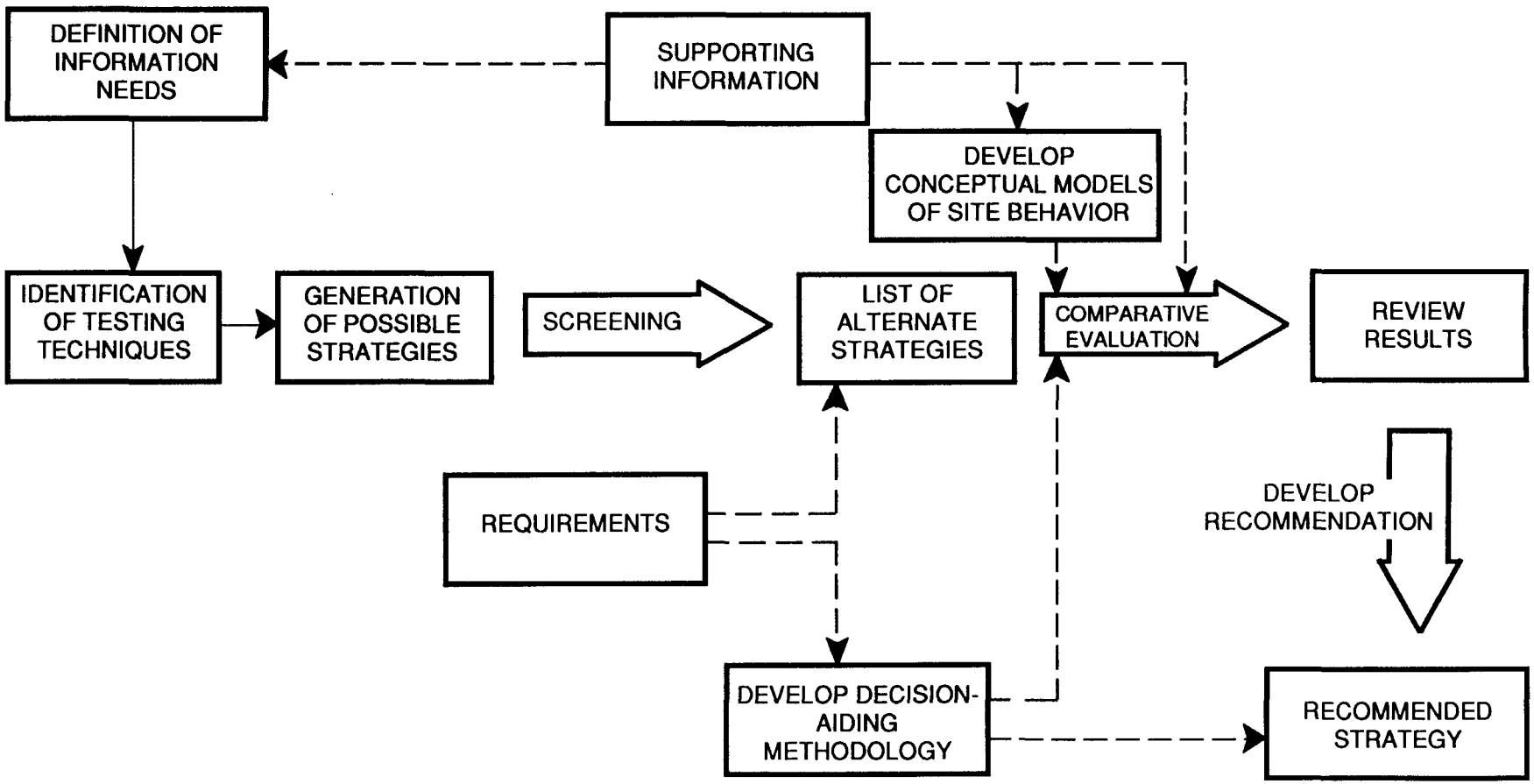
- THE TASK FORCE WAS NOT DESIGNED TO INCLUDE ALL POSSIBLE FIELDS OF EXPERTISE, BUT WAS EMPOWERED TO OBTAIN ADDITIONAL EXPERT INPUT WHERE REQUIRED

  - FOR EXAMPLE, THE TASK GROUP DID RECEIVE INPUT FROM PROJECT EXPERTS FOR THE ASSESSMENTS OF GEOCHEMICAL RETARDATION AND PERFORMANCE IMPACTS

SUMMARY OF THE RISK/BENEFIT ANALYSIS

- OVERALL STRUCTURE
- VOI MODEL
- MUA

STRUCTURE OF THE CALICO HILLS RISK/BENEFIT ANALYSIS



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VOI ANALYSIS

- A VALUE OF INFORMATION TECHNIQUE WAS EMPLOYED FOR SEVERAL REASONS

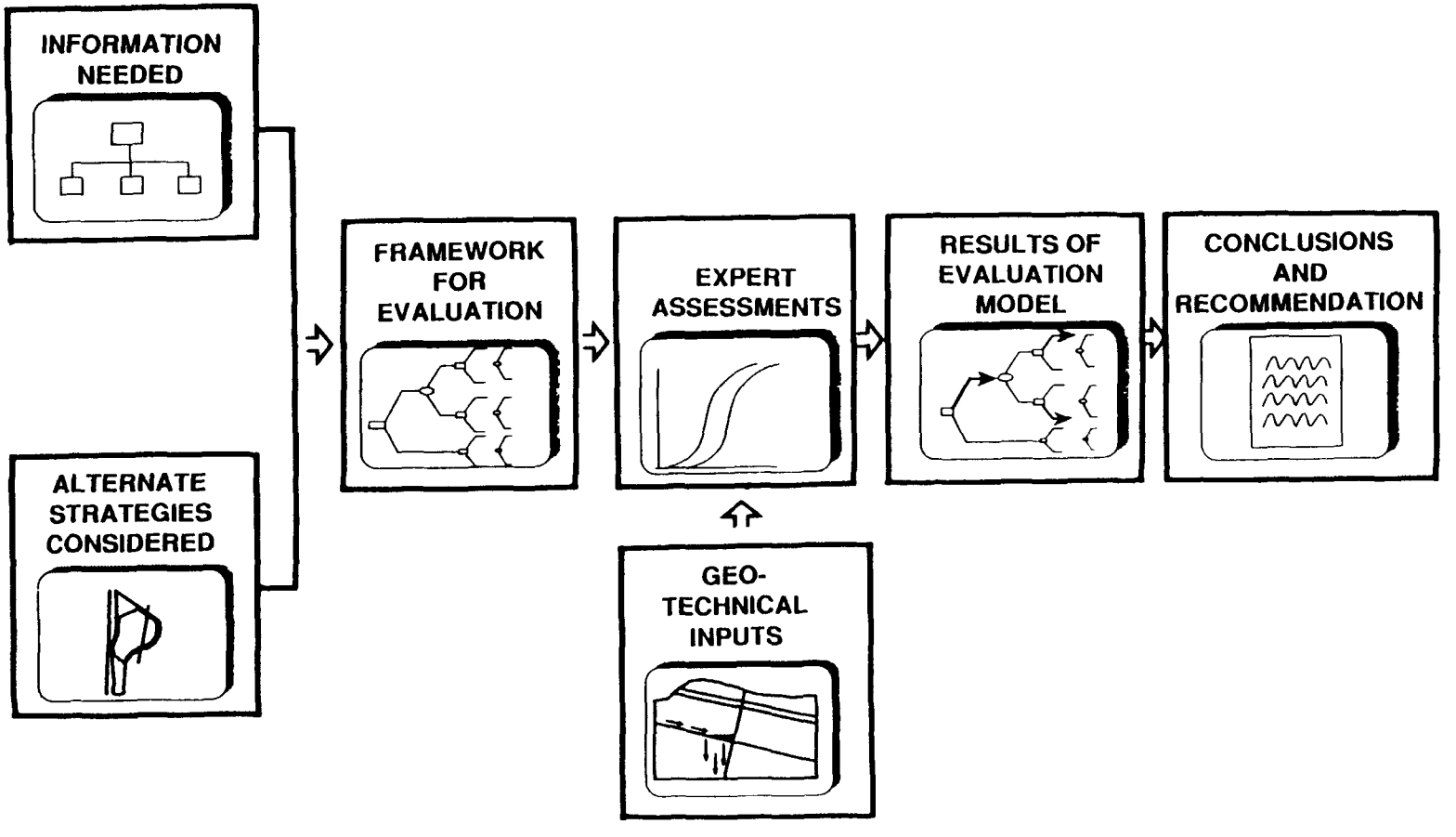
  - THE DECISION REQUIRED CONSIDERATION OF AVAILABLE QUANTITATIVE DATA AND MODEL RESULTS COMBINED WITH EXPERT JUDGEMENT

  - THE OBJECTIVE WAS TO COMPARE BENEFITS OF TESTING (MEASURED BY THE IMPROVEMENT IN DECISION MAKING DUE TO INCREASED UNDERSTANDING OF SITE PERFORMANCE) TO THE POTENTIAL FOR ADVERSE IMPACTS ON SITE PERFORMANCE AS A RESULT OF TESTING

VOI ANALYSIS

(CONTINUED)

COMPONENTS OF THE CALICO HILLS RISK/BENEFIT ANALYSIS: VOI MODEL



MULTIATTRIBUTE UTILITY ANALYSIS

A MULTIATTRIBUTE UTILITY ANALYSIS (MUA) WAS CONSIDERED BECAUSE THE VOI ANALYSIS FOUND NO VOI IN ANY OF THE TESTING STRATEGIES. THIS RESULT SUGGESTED THAT:

- DECISION MAKERS PLACE HIGH VALUE ON HIGH CONFIDENCE, EVEN AT EXTREMELY LOW LEVELS OF RELEASES; OR
- THERE IS A VALUE TO TESTING THAT WAS NOT CAPTURED BY THE VOI MODEL

THE MUA WAS INITIATED TO EVALUATE TEST STRATEGIES IN TERMS OF SEVERAL PERFORMANCE MEASURES: RELEASE RISK, COST, SCIENTIFIC CONFIDENCE, DELAY, AND PHASING POTENTIAL

MULTIATTRIBUTE UTILITY ANALYSIS

(CONTINUED)

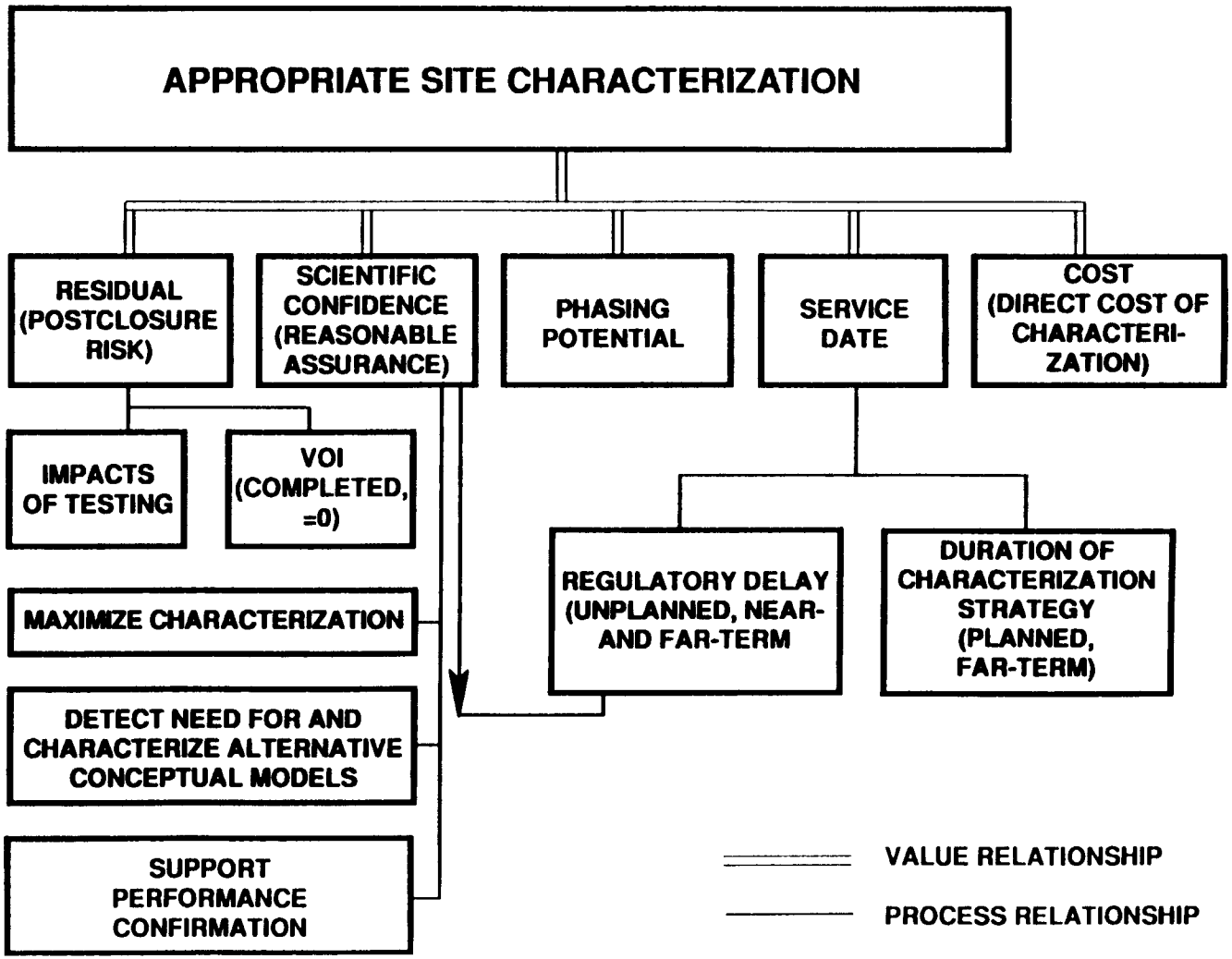
- THE MUA TECHNIQUE WAS CONSIDERED APPROPRIATE BECAUSE THE DIFFERENT TEST STRATEGIES VARY INDEPENDENTLY ON THESE PERFORMANCE MEASURES

- THE MUA METHOD PROVIDED A FORMALLY STRUCTURED AND DEFENSIBLE WAY TO COMBINE SUBJECTIVE EXPERT JUDGMENTS TO ARRIVE AT A RECOMMENDATION

MULTI-ATTRIBUTE UTILITY ANALYSIS

(CONTINUED)

ISSUES/OBJECTIVES/MODEL HIERARCHY FOR THE MUA



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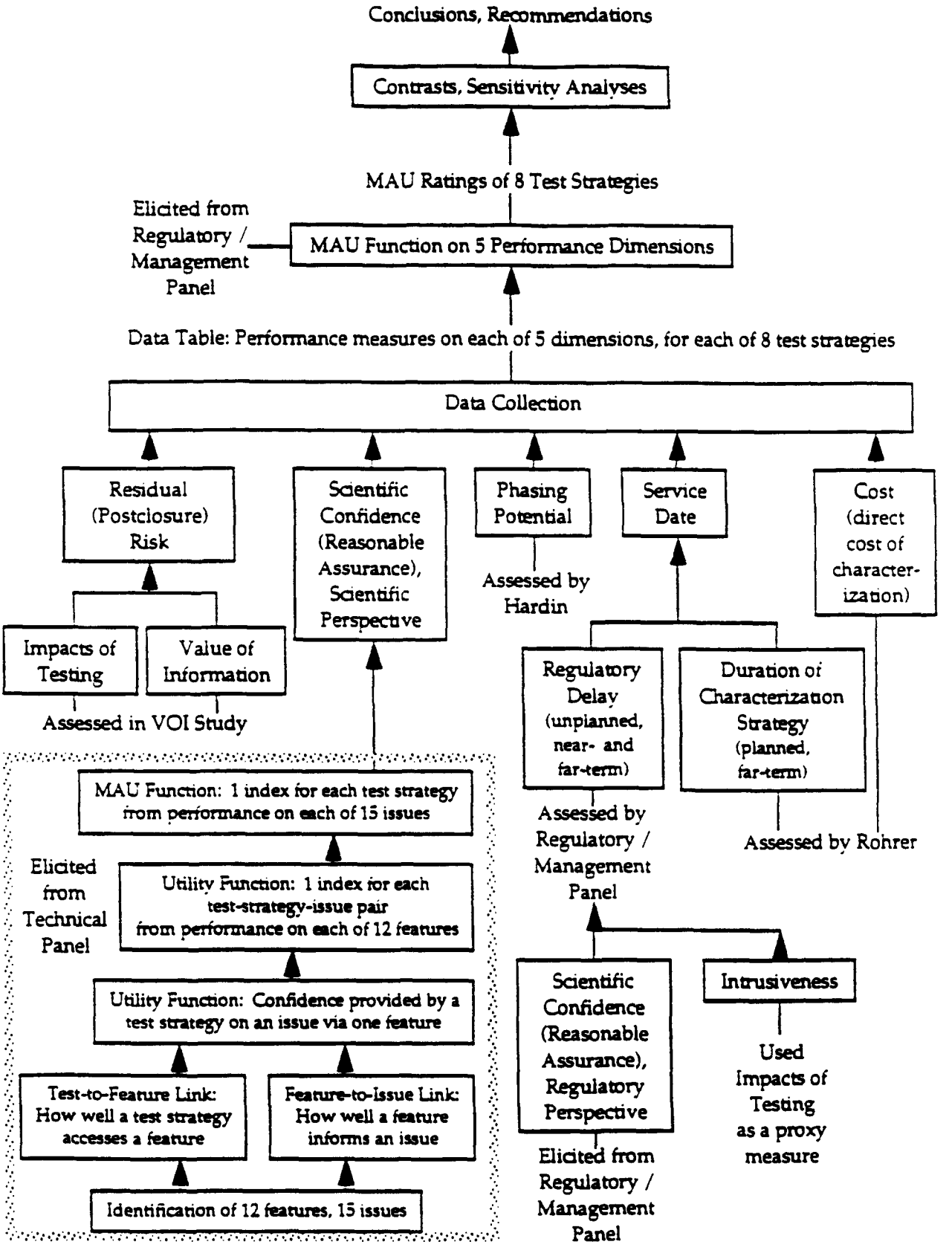
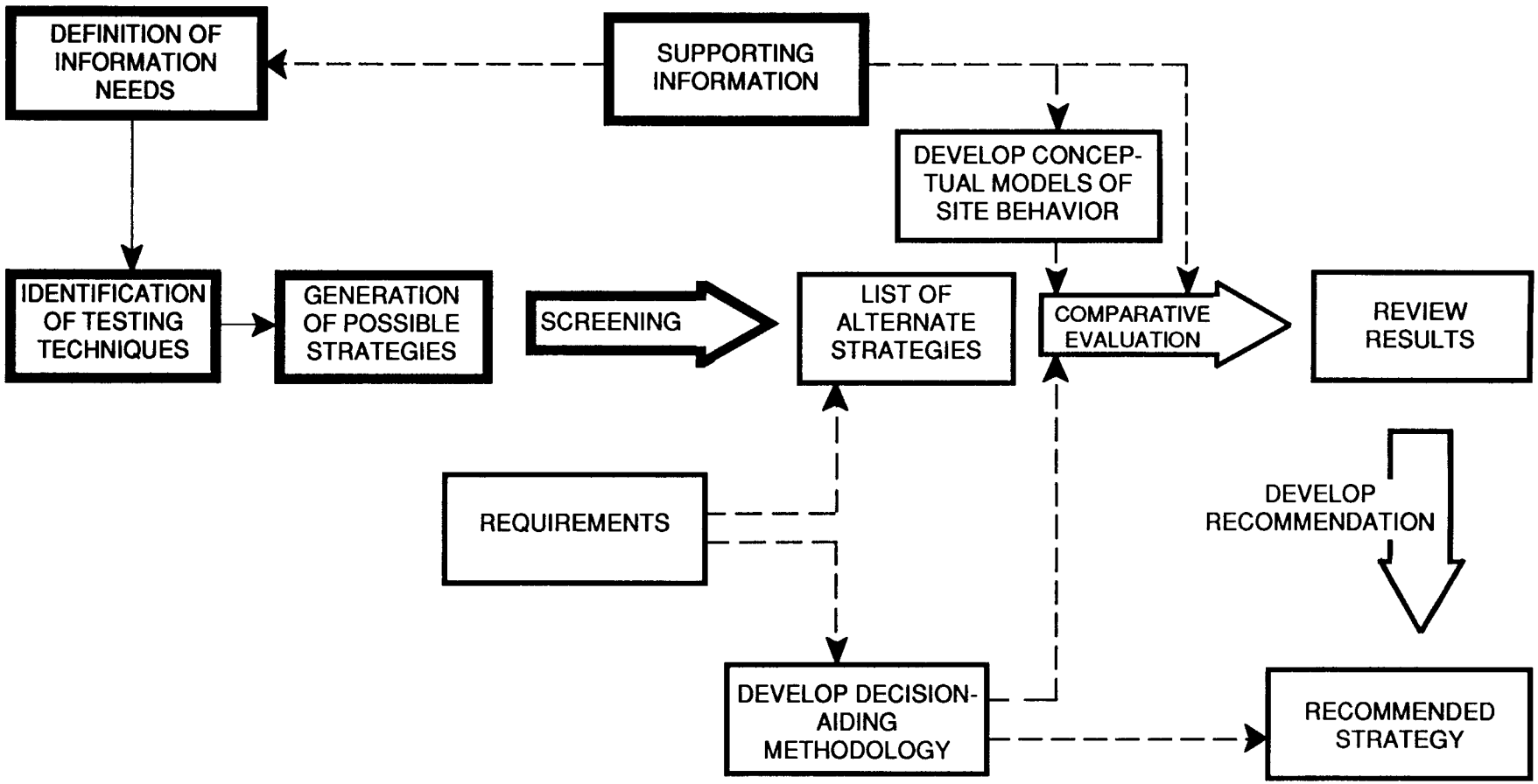
FLOWCHART OF THE COMPLETE MUA ANALYSIS



STRUCTURE OF THE ANALYSIS



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DEFINITION OF INFORMATION NEEDS

- A SUBPANEL OF THE TASK GROUP WAS FORMED TO DEFINE INFORMATION NEEDS FROM THE CALICO HILLS NONWELDED (CHn) HYDROGEOLOGIC UNIT CONSIDERING:
  - TYPES OF INFORMATION NEEDS (PARAMETERS)
  - LOCATIONS OF INFORMATION NEEDS (MATRIX vs FAULT ZONES)
  - SPATIAL CORRELATION OF INFORMATION NEEDS

EVALUATION OF TESTING TECHNIQUES

- THE FULL CHRBA TASK GROUP THEN CONSIDERED HOW WELL VARIOUS TESTING TECHNIQUES COULD PROVIDE THE NEEDED INFORMATION

  - TECHNIQUES INCLUDED BOTH SURFACE-BASED AND UNDERGROUND METHODS

  - TECHNIQUES INCLUDED BOTH INVASIVE (e.g., DRILLING AND UNDERGROUND EXCAVATION) AND NON-INVASIVE (e.g., GEOPHYSICS AND ANALOG STUDIES) METHODS

  - TECHNIQUES WERE QUALITATIVELY RANKED AS A BASIS FOR COMPOSING STRATEGIES

DEVELOPMENT OF ALTERNATE STRATEGIES

- GIVEN THE DEFINITION OF INFORMATION NEEDS AND THE EVALUATION OF THE TECHNIQUES, A SET OF TESTING OPTIONS WERE DEVELOPED TO COMPOSE DIFFERENT CONCEPTUAL TESTING STRATEGIES

- THE EIGHT STRATEGIES REPRESENT AN APPROPRIATE RANGE OF POSSIBILITIES IN TERMS OF THE VARIABLES DEFINED

  - THE STRATEGIES UTILIZE VARYING AMOUNTS AND LOCATIONS OF EACH OF THE MAJOR TYPES OF TEST METHODS:
    * DRILLING
    * UNDERGROUND DRIFTING/EXPLORATION
    * ANALOG SITE STUDIES

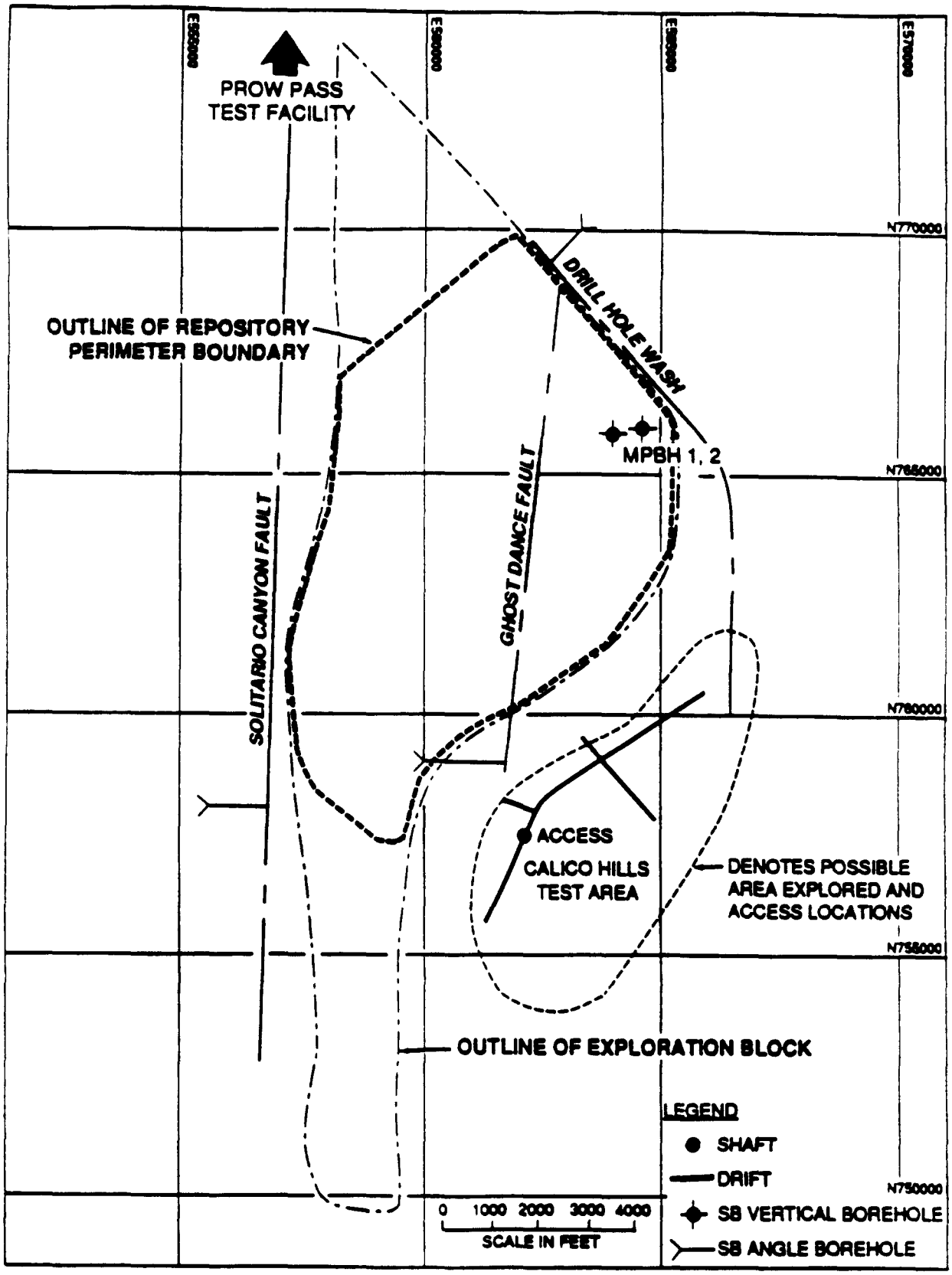
DEVELOPMENT OF ALTERNATE STUDIES

- THE EIGHT STRATEGIES WERE NOT INTENDED TO REPRESENT FINAL DESIGN CONFIGURATIONS
- THE CHRBA TASK GROUP EXPECTS THAT STRATEGIES WILL BE MODIFIED DURING DESIGN
- THE CHRBA TASK GROUP DID NOT EXPLICITLY ADDRESS MEANS OF ACCESS TO THE CHn, BUT FOCUSED ON CHARACTERIZATION WITHIN THE UNIT
  - EVALUATIONS OF ALTERNATE MEANS OF ACCESS WERE PERFORMED BY THE ESF AS, WITH INPUT FROM (AND COORDINATION WITH) THE CHRBA GROUP

DESCRIPTION OF THE HIGHEST RANKED STRATEGIES (1, 2, 5, AND 7)

STRATEGY NO. 7

OUTSIDE; SE; EXTENDED DRIFTING; NO ESF CONNECTION - ADDITIONAL SBT



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CALICO HILLS STRATEGIES

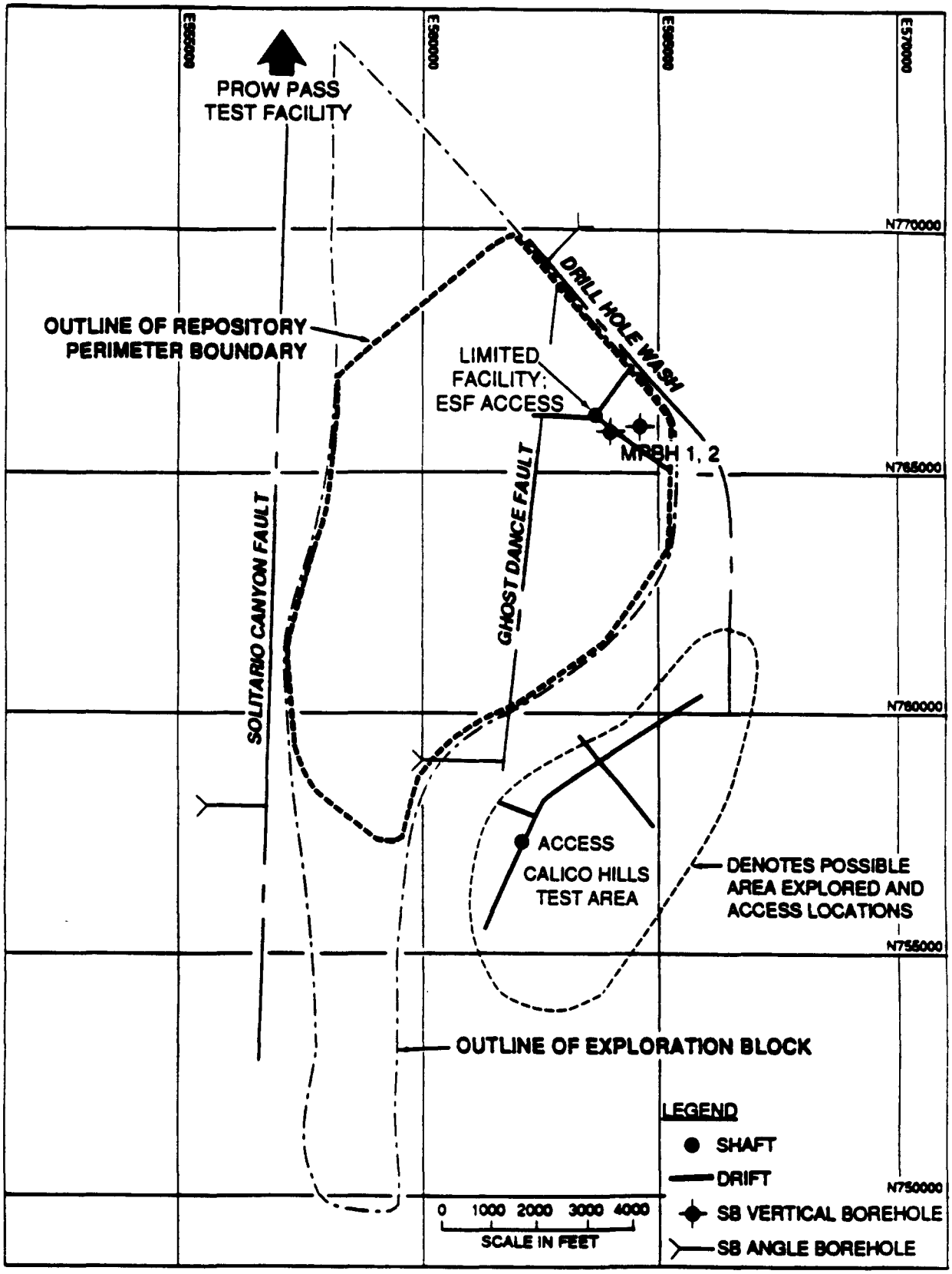
(CONTINUED)

STRATEGY #7

- ATTEMPT TO MAXIMIZE TEST ACCURACY WITHOUT EXCAVATION INSIDE THE REPOSITORY BLOCK
- SIMILAR TO #8, BUT WITH EXPANDED EXCAVATION OUTSIDE THE BLOCK TO THE SOUTHEAST
- EXTENSIVE EXCAVATION OUTSIDE THE BLOCK EXPLORES FACIES TRANSITION AND THE SOUTHERN EXTENSION OF THE GHOST DANCE FAULT OR RELATED FAULTS)
- INCLUDE ADDITIONAL SBT (IN ADDITION TO SCP) TO MAXIMIZE INFORMATION WITHOUT EXCAVATION INSIDE THE BLOCK

STRATEGY NO. 1

OUTSIDE; SE; EXTENDED DRIFTING; NO ESF CONNECTION - ADDITIONAL SBT - WITH INSIDE, NE, LIMITED FACILITY; INTEGRATED WITH ESF



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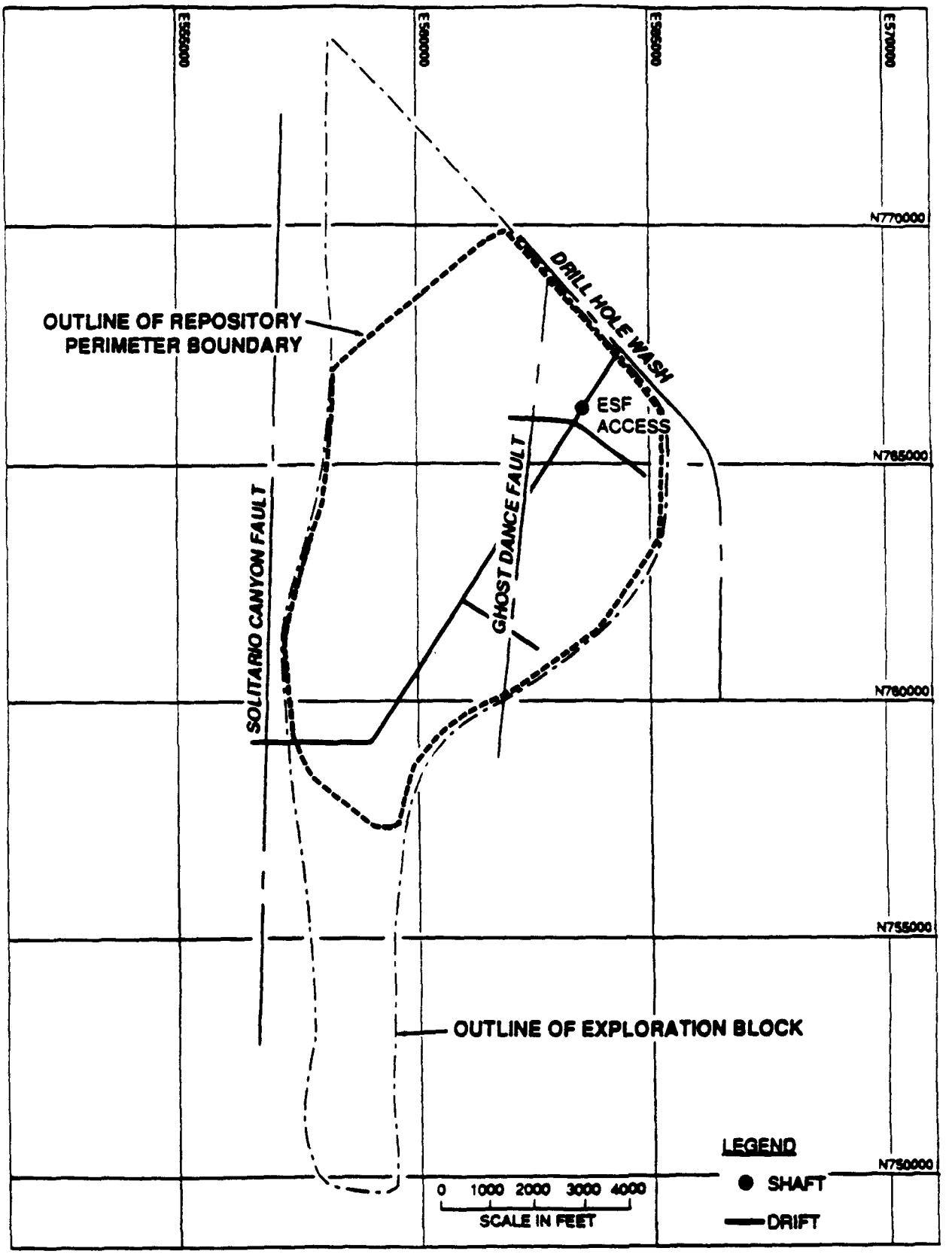
CALICO HILLS STRATEGIES

STRATEGY #1

- ATTEMPT TO ACHIEVE HIGH TEST ACCURACY WHILE LIMITING EXCAVATION WITHIN THE BLOCK
- SIMILAR TO #7, WITH THE ADDITION OF LIMITED EXCAVATION INSIDE THE NORTHEAST PART OF THE BLOCK
- EXTENSIVE EXCAVATION OUTSIDE THE BLOCK EXPLORES FAULTING AND FACIES TRANSITION
- LIMITED EXCAVATION INSIDE THE BLOCK EXPLORES GHOST DANCE FAULT, DRILLHOLE WASH, AND OTHER FEATURES IN THE ZEOLITIC FACIES
- INCLUDE ADDITIONAL SBT (IN ADDITION TO SCP) TO MAXIMIZE INFORMATION WHILE LIMITING EXCAVATION INSIDE THE BLOCK

STRATEGY NO. 5

INSIDE; NE; EXTENDED DRIFTING; INTEGRATED WITH ESF



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CALICO HILLS STRATEGIES

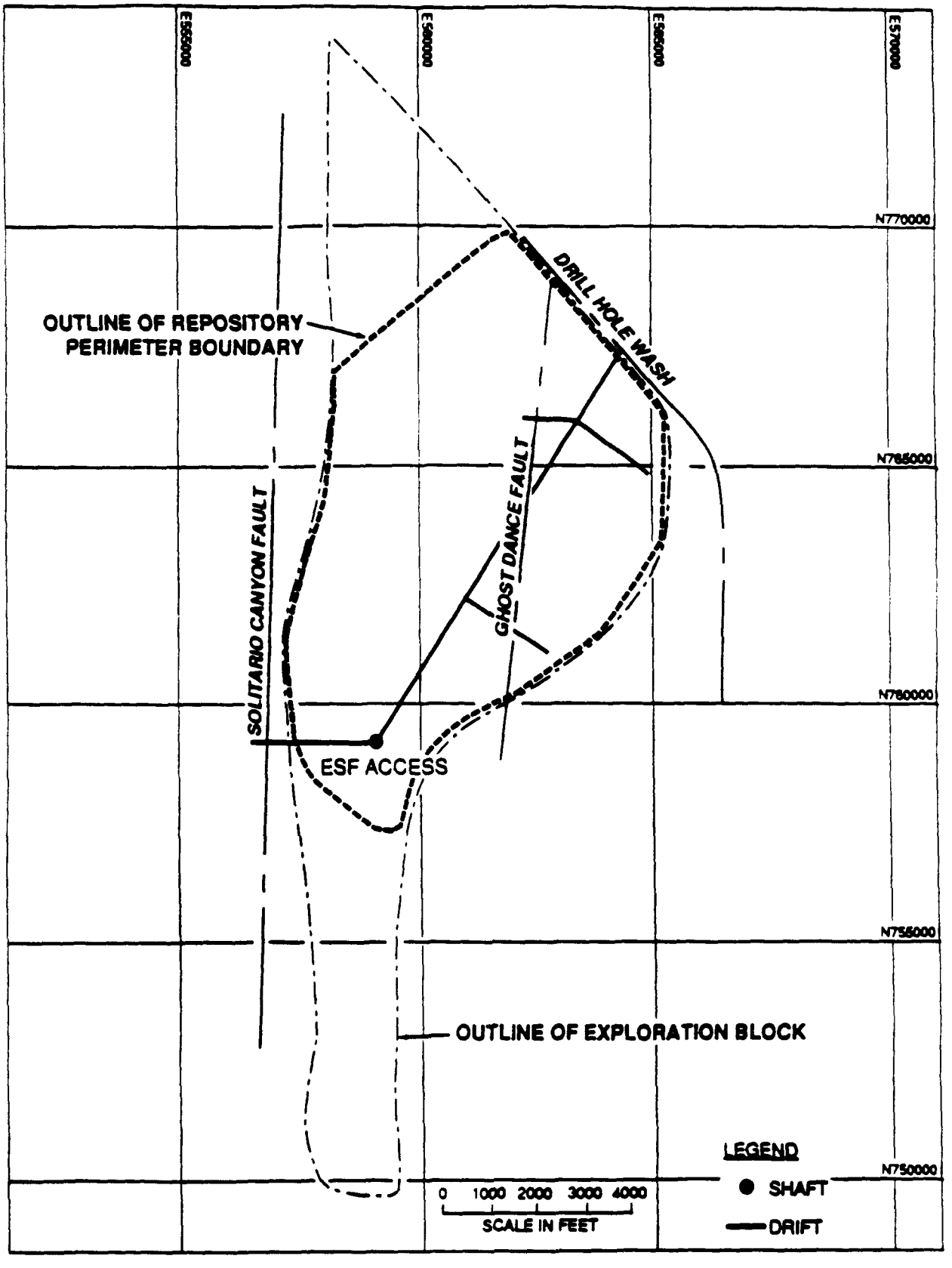
(CONTINUED)

STRATEGY #5

- SIMILAR TO STRATEGY #2, EXCEPT ACCESSES WOULD BE LOCATED IN THE SOUTH, WHERE THE CHn IS THICKER AND VITRIC
- PERFORMANCE IMPACTS MAY BE LESS THAN FOR STRATEGY #2
- USE OF BOTH #2 AND #5 ASSURES THAT AT LEAST ONE STRATEGY WITH HIGH TEST ACCURACY CAN BE INTEGRATED WITH ANY OPTION CONSIDERED IN THE ESF STUDY

STRATEGY NO. 2

INSIDE; S; EXTENDED DRIFTING; INTEGRATED WITH ESF



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CALICO HILLS STRATEGIES

(CONTINUED)

STRATEGY #2

- ATTEMPT TO MAXIMIZE TEST ACCURACY BY PROVIDING EXTENSIVE, REPRESENTATIVE DATA
- LARGEST EXTENT OF EXCAVATION CONSIDERED INSIDE THE BLOCK
- AS MUCH AS 19,000 FT OF DRIFTING EXPLORES:
  - GHOST DANCE FAULT
  - SOLITARIO CANYON FAULT
  - DRILLHOLE WASH
  - FAULTING TO THE EAST
  - FACIES TRANSITION

CONCLUSIONS AND RECOMMENDATIONS

- THE RECORD MEMORANDUM OF THE CHRBA CONTAINS SEVEN CONCLUSIONS AND FIVE RECOMMENDATIONS

CONCLUSIONS OF THE CHRBA

1. POTENTIAL IMPACTS FROM CHARACTERIZATION ON POSTCLOSURE AQUEOUS RELEASES FROM THE TOTAL SYSTEM ARE EXPECTED TO BE LOW AND DO NOT PRECLUDE EXTENSIVE UNDERGROUND EXPLORATION IN THE CHn BELOW THE PROPOSED REPOSITORY

2. TESTING STRATEGIES 1,2,5, AND 7 INCLUDE EXTENSIVE UNDERGROUND EXPLORATION WITHIN OR NEAR THE REPOSITORY BLOCK AND PROVIDE A SIGNIFICANT IMPROVEMENT IN SCIENTIFIC CONFIDENCE RELATIVE TO STRATEGIES 3,4,6, AND 8

CONCLUSIONS OF THE CHRBA

(CONTINUED)

3. WHEN ALL OBJECTIVES (CONFIDENCE, RISK, COST, DELAY, AND PHASING POTENTIAL) ARE CONSIDERED, STRATEGIES 2 AND 5 ARE PREFERRED TO STRATEGY 1 BY A SMALL MARGIN

4. MODIFICATIONS OF 2 AND 5 WHICH ARE CONSISTENT WITH THEIR DEFINITION WOULD PROVIDE GREATER SCIENTIFIC CONFIDENCE THAN STRATEGY 1

CONCLUSIONS OF THE CHRBA

(CONTINUED)

5. EACH OF THE 12 KEY FEATURES OF THE SITE WOULD BE INVESTIGATED BY STRATEGY 2 OR 5. THE BENEFIT OF EARLY ACCESS TO THE CHn WOULD BE DIRECTLY RELATED TO THE NUMBER OF THESE FEATURES THAT ARE INTERCEPTED EARLY

6. A RAMP FROM THE EAST OF THE REPOSITORY BLOCK COULD PROVIDE SIGNIFICANT INFORMATION WHICH COULD POTENTIALLY BE USED TO AID IN CHARACTERIZATION OF THE CALICO HILLS UNIT

CONCLUSIONS OF THE CHRBA

(CONTINUED)

7. THE RELATIVE IMPORTANCE OF THE CHn UNIT AS A BARRIER DEPENDS ON THE IMPORTANCE OF THE OTHER BARRIERS, BOTH NATURAL AND ENGINEERED

   FOR THE CHRBA, ESTIMATED PERFORMANCE OF THE ENGINEERED BARRIERS AND THE HOST ROCK WERE CONSERVATIVE, WHEREAS ESTIMATES OF THE PERFORMANCE OF THE SATURATED ZONE WERE INTENDED TO BE REALISTIC, BUT NOT NECESSARILY CONSERVATIVE

RECOMMENDATIONS

1. THE CHRBA WORKING GROUP RECOMMENDS USING EXTENSIVE DRIFTING WITHIN THE BLOCK, AN APPROACH SIMILAR TO STRATEGIES 2 AND 5 (STRATEGIES 2 AND 5 ARE VERY SIMILAR AND WERE RATED ABOUT THE SAME BY THE CHRBA)

   IT ALSO RECOMMENDS THAT THESE STRATEGIES BE MODIFIED TO INCLUDE A DRIFT TO EXPLORE THE ABANDONED WASH FAULT AND AN UNDERGROUND ACCESS OUTSIDE THE REPOSITORY BLOCK FOR AGGRESIVE TESTING

RECOMMENDATIONS

(CONTINUED)

- THE MODIFICATIONS WOULD PROVIDE A MORE ROBUST DECISION

- THE RECOMMENDATION COULD BE DEPENDENT ON THE SENSITIVITY TO THE DIFFERENCE IN RISK (IMPACTS ON WASTE ISOLATION) BETWEEN TESTING INSIDE AND OUTSIDE THE BLOCK

- A FINAL COMMITMENT TO FULL EXCAVATION OF STRATEGY 2 OR 5 IS NOT CURRENTLY REQUIRED BECAUSE FUTURE UNDERSTANDING OF IMPACTS TO WASTE ISOLATION OR THE SUFFICIENCY OF DATA REQUIRED FOR SITE CHARACTERIZATION MAY INDICATE THAT THE FULL AMOUNT OF DRIFTING IS NOT NECESSARY

RECOMMENDATIONS

(CONTINUED)

2. PLANNING FOR CHn UNIT EXPLORATION FACILITIES SHOULD FOCUS ON PROVIDING ACCESS TO THE 12 GEOLOGIC FEATURES (SEE TABLE 2.5.2.5-1) IDENTIFIED IN THE MUA AS EARLY AS PRACTICABLE

3. REVIEW OF EXISTING DATA AND COLLECTION OF OBSERVATIONAL DATA AT RAINIER MESA SHOULD BE UNDERTAKEN

4. WASTE ISOLATION IMPACTS SHOULD BE ADDRESSED IN TITLE II DESIGN TO FURTHER EXAMINE THE ASSUMPTIONS AND ASSESSMENTS MADE BY THE CHRBA

5. CERTAIN ASSUMPTIONS AND CRITERIA (SUCH AS THE WATER-TABLE STANDOFF DISTANCE AND THE DEFINITIONS OF INSIDE/OUTSIDE THE BLOCK) FROM THE CHRBA MAY BE IMPORTANT WITH RESPECT TO CONTROL OF INPUT TO THE ESF DESIGN