

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

**PRESENTATION TO
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD**

**SUBJECT: FLOWDOWN OF REGULATORY
REQUIREMENTS TO THE
PERFORMANCE ASSESSMENT
PROGRAM**

PRESENTER: DR. LARRY D. RICKERTSEN

**PRESENTER'S TITLE
AND ORGANIZATION: MANAGER, ISSUES RESOLUTION SECTION
WESTON TECHNICAL SUPPORT TEAM
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT**

**PRESENTER'S
TELEPHONE NUMBER: (202) 646-6760**

MAY 16-17, 1989

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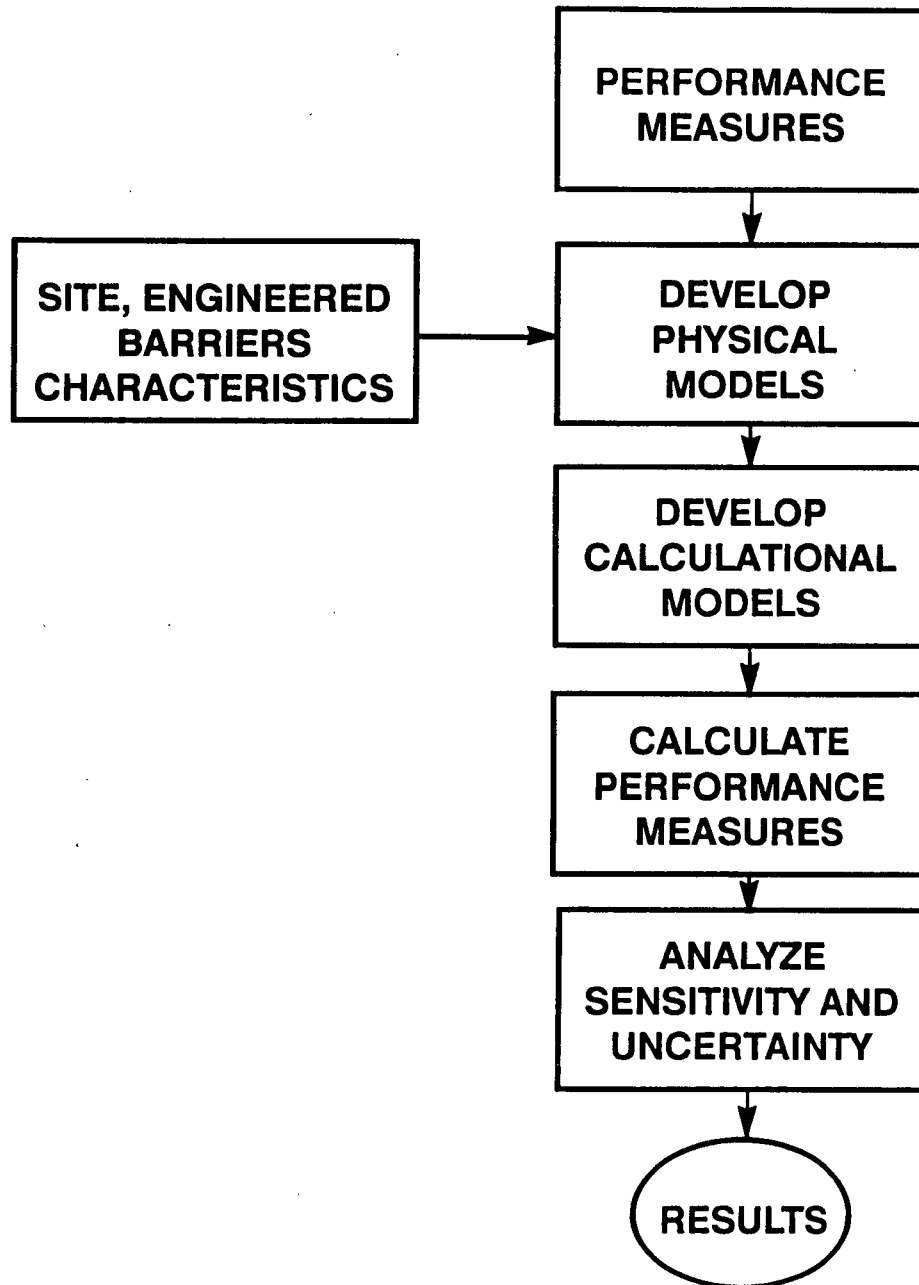
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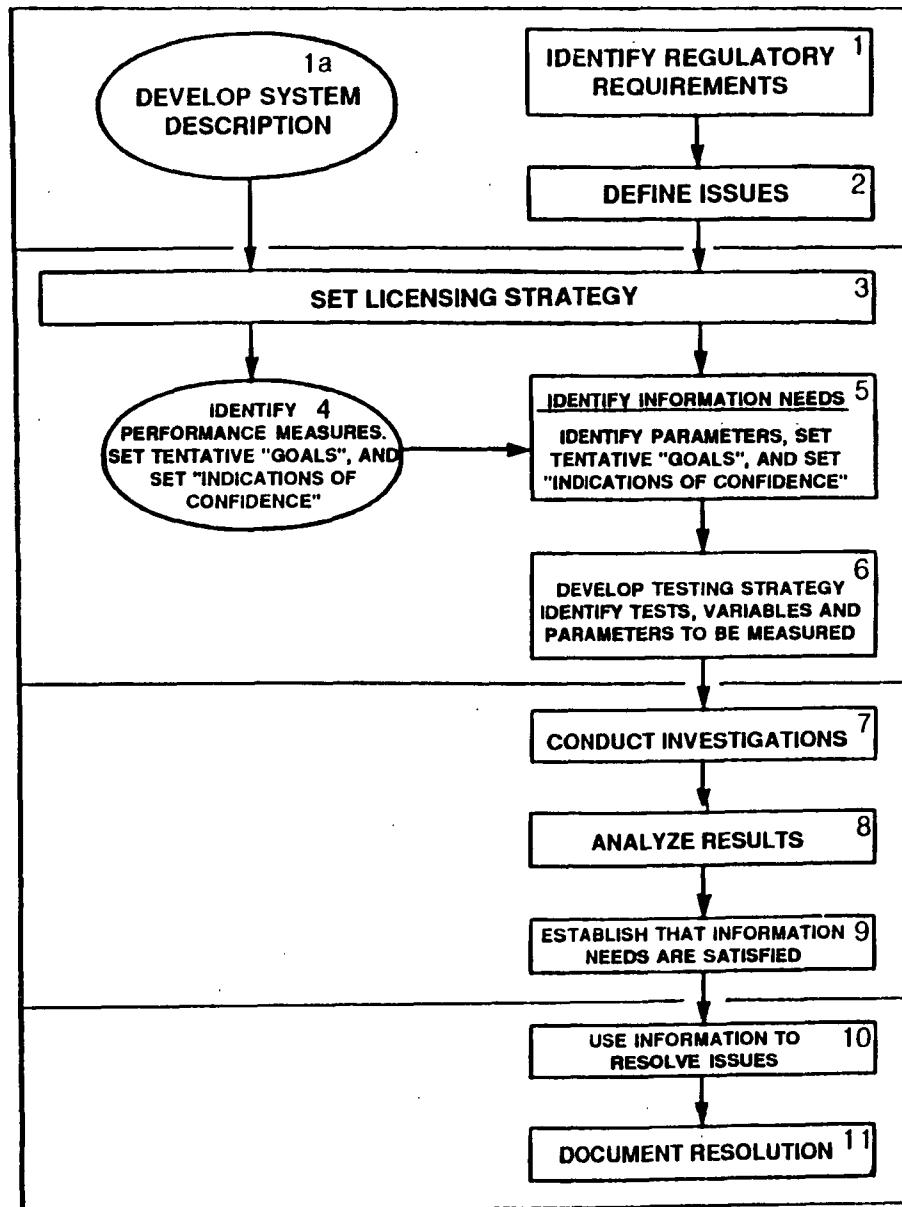
SCOPE OF PRESENTATION

- **RELATION OF PERFORMANCE ASSESSMENT STRATEGY TO ISSUES RESOLUTION STRATEGY**
- **MEASURES OF PERFORMANCE TO BE EVALUATED**
- **ELEMENTS OF THE PERFORMANCE ASSESSMENT STRATEGY THAT FOLLOWS FROM THE PERFORMANCE OBJECTIVES OF 10 CFR PART 60**

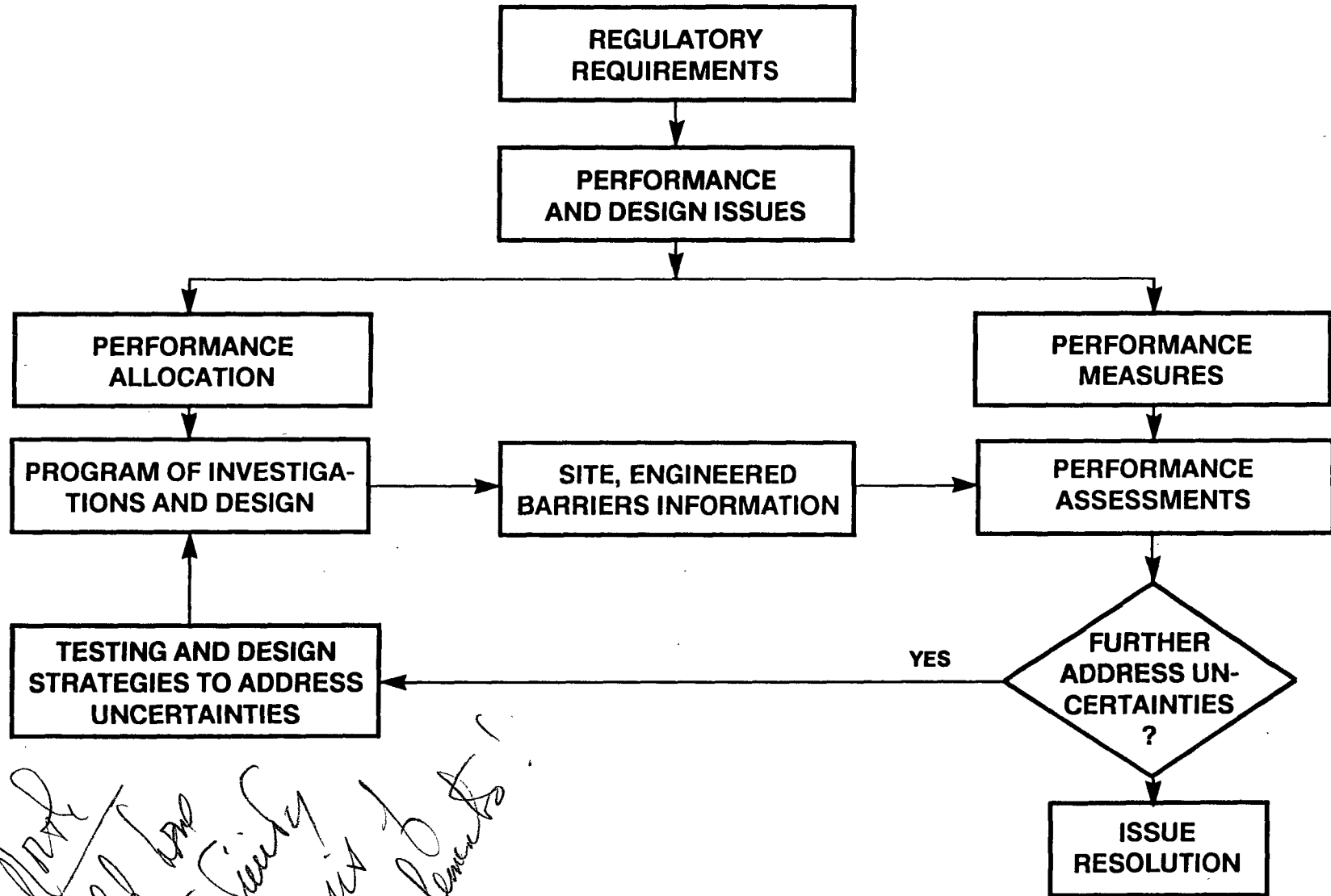
PERFORMANCE ASSESSMENT PROCESS



ISSUE RESOLUTION STRATEGY

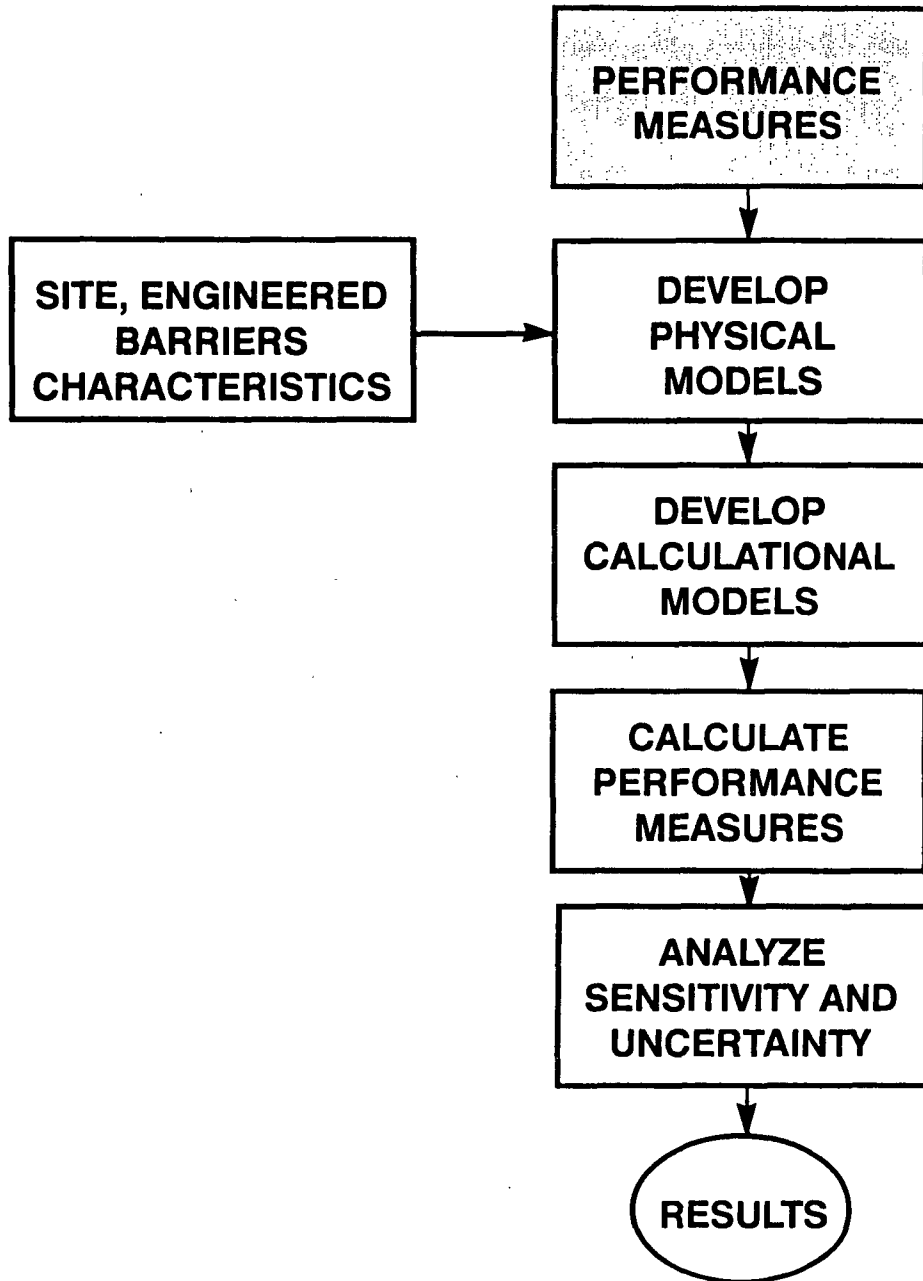


FLOWDOWN OF REGULATORY REQUIREMENTS TO SITE INVESTIGATIONS, DESIGN, AND PERFORMANCE ASSESSMENT



*Warren Mark
Should be
activity
analysis of
key elements*

PERFORMANCE ASSESSMENT PROCESS



PERFORMANCE ASSESSMENT OBJECTIVES DEFINE PERFORMANCE MEASURES

- **EVALUATE SYSTEM AND SUBSYSTEM PERFORMANCE TO DEMONSTRATE COMPLIANCE WITH THE TECHNICAL CRITERIA OF 10 CFR PART 60 FOR THE LICENSE APPLICATION**
- **EVALUATE ENVIRONMENTAL IMPACTS FOR THE ENVIRONMENTAL IMPACT STATEMENT**
- **ASSESS SENSITIVITIES AND UNCERTAINTIES IN THE PERFORMANCE ASSESSMENT**
- **GUIDE DESIGN AND TESTING ACTIVITIES**

**REQUIREMENTS FOR PRECLOSURE
RADIOLOGICAL SAFETY
10 CFR 60.111**

**DOSES TO REPOSITORY WORKERS AND MEMBERS OF THE
GENERAL PUBLIC FROM ROUTINE OPERATIONS MUST MEET
CRITERIA SPECIFIED IN 10 CFR PART 20 AND 40 CFR PART 191,
SUBPART A**

**NO CRITERIA FOR DOSES FROM ACCIDENTS BUT CRITERION
FOR SYSTEMS, COMPONENTS AND STRUCTURES IMPORTANT
TO SAFETY**

REQUIREMENTS FOR POSTCLOSURE PERFORMANCE
10 CFR 60.112
40 CFR PART 191, SUBPART B (CURRENTLY IN REMAND)

CONTAINMENT FOR SIGNIFICANT PROCESSES AND EVENTS

PROBABILITY OF 10,000-YEAR CUMULATIVE RELEASE TO ACCESSIBLE ENVIRONMENT SHALL BE LESS THAN ONE CHANCE IN TEN OF EXCEEDING SPECIFIED LIMITS AND LESS THAN ONE CHANCE IN 1000 OF EXCEEDING TEN TIMES THESE LIMITS

INDIVIDUAL PROTECTION FOR UNDISTURBED PERFORMANCE

ANNUAL DOSE TO INDIVIDUALS LESS THAN SPECIFIED LIMITS FOR 1000 YEARS AFTER DISPOSAL

GROUND-WATER PROTECTION FOR UNDISTURBED PERFORMANCE

CONCENTRATIONS IN SPECIAL SOURCES OF GROUND WATER LESS THAN SPECIFIED LIMITS FOR 1000 YEARS AFTER DISPOSAL

Individual Distribution

**REQUIREMENTS FOR NATURAL AND
ENGINEERED BARRIERS
10 CFR 60.113**

*HLW
High level
Waste*

*quantitative
meaning*

**CONTAINMENT OF HLW WITHIN WASTE PACKAGES WILL BE
SUBSTANTIALLY COMPLETE FOR A PERIOD BETWEEN 300 AND
1000 YEARS AFTER PERMANENT CLOSURE FOR ANTICIPATED
PROCESSES AND EVENTS**

*EBS
Engineered
Barriers
System*

**ANNUAL RELEASE OF ANY RADIONUCLIDE FROM THE EBS
FOR ANTICIPATED PROCESSES AND EVENTS SHALL BE LESS
THAN SPECIFIED LIMIT**

**PRE-WASTE-EMPLACEMENT GROUND-WATER TRAVEL TIME
ALONG FASTEST PATH OF LIKELY RADIONUCLIDE TRAVEL FROM
DISTURBED ZONE TO ACCESSIBLE ENVIRONMENT SHALL BE AT
LEAST 1000 YEARS**

REQUIREMENTS FOR FAVORABLE AND POTENTIALLY ADVERSE CONDITIONS 10 CFR 60.122

**MUST EVALUATE EFFECT ON WASTE ISOLATION OF POTENTIALLY
ADVERSE CONDITIONS THAT MAY BE PRESENT:**

- (1) POTENTIAL FOR FLOODING OF UNDERGROUND FACILITY**
- (2) FORESEEABLE HUMAN ACTIVITY THAT COULD AFFECT
GROUND-WATER FLOW SYSTEM**
- (3) LARGE SURFACE WATER IMPOUNDMENTS THAT MAY BE
ADVERSE**
- (4) STRUCTURAL DEFORMATION THAT MAY AFFECT REGIONAL
GROUND-WATER SYSTEM**
- (5) CHANGES TO HYDROLOGIC CONDITIONS THAT COULD
AFFECT RADIONUCLIDE MIGRATION**
- (6) CHANGES TO HYDROLOGIC CONDITIONS THAT COULD
AFFECT EBS**
- (7) GEOCHEMICAL PROCESSES THAT COULD ADVERSELY
AFFECT THE EBS**

REQUIREMENTS FOR FAVORABLE AND POTENTIALLY ADVERSE CONDITIONS

10 CFR 60.122

(CONTINUED)

- (8) GEOCHEMICAL PROCESSES THAT COULD ADVERSELY AFFECT WASTE ISOLATION**
- (9) GROUND-WATER CONDITIONS THAT ARE NOT REDUCING**
- (10) EVIDENCE OF DISSOLUTIONING**
- (11) STRUCTURAL DEFORMATION DURING QUATERNARY PERIOD**
- (12) EARTHQUAKES THAT COULD AFFECT THE SITE SIGNIFICANTLY**
- (13) INDICATION THAT FREQUENCY OR MAGNITUDE OF EARTHQUAKES MAY INCREASE**
- (14) MORE FREQUENT OCCURRENCE OF EARTHQUAKES AT SITE THAN IN REGION**
- (15) IGNEOUS ACTIVITY SINCE THE START OF THE QUATERNARY PERIOD**
- (16) EXTREME EROSION DURING QUATERNARY PERIOD**

REQUIREMENTS FOR FAVORABLE AND POTENTIALLY ADVERSE CONDITIONS

10 CFR 60.122

(CONTINUED)

- (17) PRESENCE OF NATURAL RESOURCES**
- (18) SUBSURFACE MINING AT THE SITE**
- (19) DRILLING AT THE SITE**
- (20) ROCK OR GROUND-WATER CONDITIONS REQUIRING COMPLEX
ENGINEERING**
- (21) GEOCHEMICAL CONDITIONS THAT DO NOT PERMIT STABLE
OPENINGS**
- (22) POTENTIAL FOR WATER TABLE RISE TO SATURATE THE
UNDERGROUND FACILITY**
- (23) PERCHED WATER BODIES THAT MAY BE ADVERSE**
- (24) MOVEMENT OF GASEOUS RADIONUCLIDES THROUGH
AIR-FILLED PORE SPACES**

DESIGN CRITERIA

10 CFR 60.130-135

GENERAL DESIGN CRITERIA (60.131)

- **LIMITS SPECIFIED IN 10 CFR PART 20 (10 CFR 60.111)**
- **STRUCTURES, SYSTEMS, COMPONENTS IMPORTANT TO SAFETY**

ADDITIONAL DESIGN CRITERIA FOR SURFACE FACILITIES (60.132)

- **REQUIREMENTS OF 10 CFR 60.111**

ADDITIONAL DESIGN CRITERIA FOR THE UNDERGROUND FACILITY (60.133)

- **CONTRIBUTE TO WASTE ISOLATION AND CONTAINMENT**

DESIGN OF SEALS FOR SHAFTS AND BOREHOLES (60.134)

- **DO NOT COMPROMISE ABILITY TO MEET PERFORMANCE OBJECTIVES**
- **DO NOT CREATE PREFERENTIAL PATHWAY**

CRITERIA FOR THE WASTE PACKAGE (60.135)

- **DO NOT COMPROMISE ABILITY TO MEET PERFORMANCE OBJECTIVES**

ANALYSES REQUIRED FOR ENVIRONMENTAL IMPACT STATEMENT CEQ GUIDELINES

- **ANALYSES DEFINED DURING SCOPING**
- **ENVIRONMENTAL IMPACTS (E.G., DOSE OR HEALTH EFFECTS)**
- **ANALYSIS OF LONG-TERM PERFORMANCE**
- **ANALYSIS OF ACCIDENTS AND DISRUPTIONS**

*accident
scenarios*

SITE SUITABILITY ANALYSIS AND ANALYSES TO SUPPORT DESIGN AND TESTING PROGRAMS

**ANALYSES FOCUS ON PERFORMANCE
MEASURES OF 10 CFR PART 60**

PERFORMANCE MEASURES

PRECLOSURE SAFETY

- DOSES TO WORKERS AND MEMBERS OF PUBLIC FROM ROUTINE OPERATIONS
- DOSES TO MEMBERS OF PUBLIC FROM ACCIDENTS

POSTCLOSURE TOTAL SYSTEM PERFORMANCE

- 10,000-YEAR CUMULATIVE RELEASE TO ACCESSIBLE ENVIRONMENT (CCDF)
- ANNUAL DOSE TO INDIVIDUALS
- CONCENTRATIONS IN SPECIAL SOURCES OF GROUND WATER

ENGINEERED BARRIERS PERFORMANCE

- TIME OF CONTAINMENT OF RADIOACTIVE MATERIAL IN WASTE PACKAGES
- RATE OF RELEASE OF FROM ENGINEERED BARRIER SYSTEM

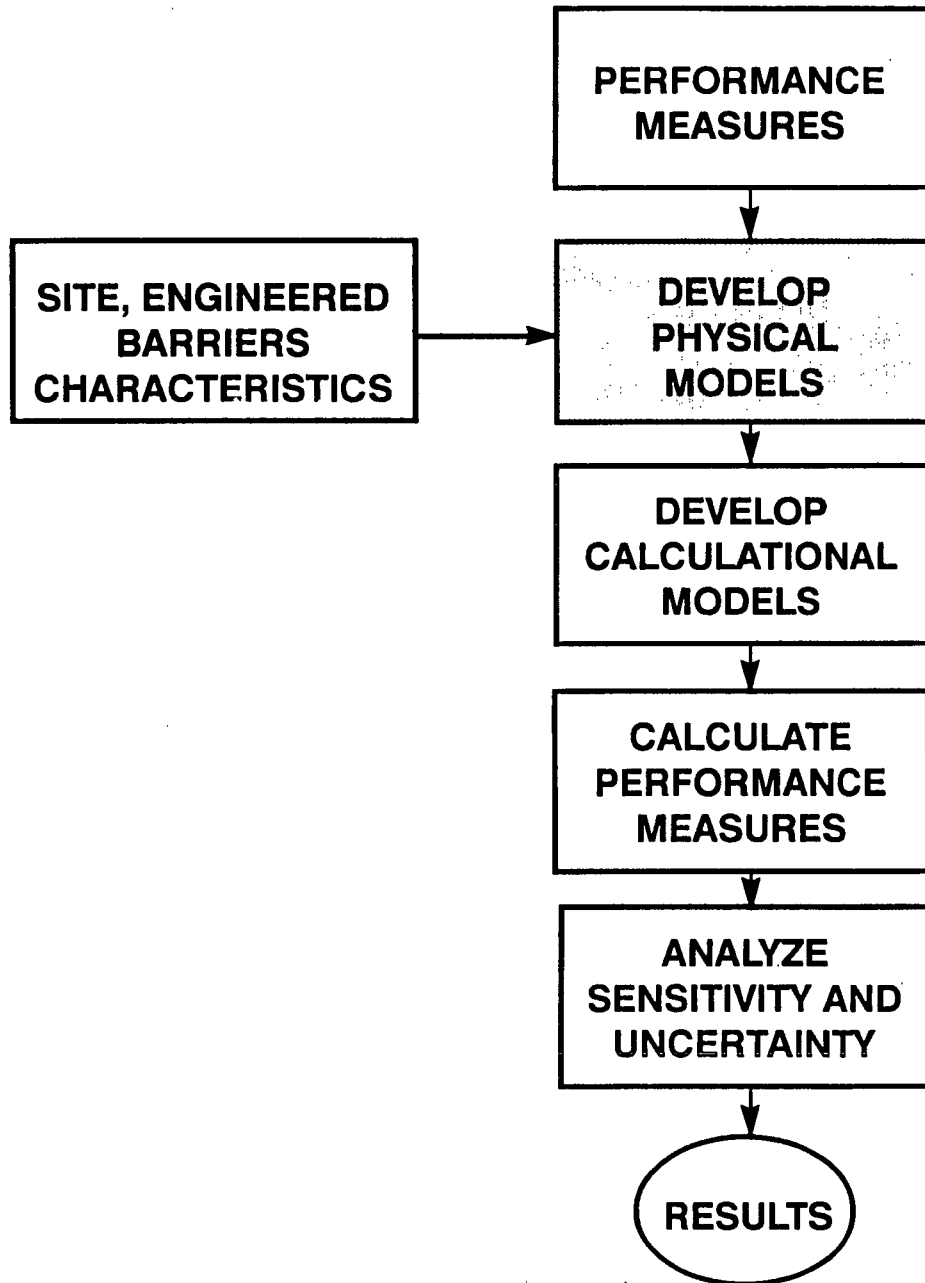
NATURAL BARRIERS PERFORMANCE

- PRE-WASTE-EMPLACEMENT GROUND-WATER TRAVEL TIME ALONG FASTEST PATH OF LIKELY RADIONUCLIDE TRAVEL FROM DISTURBED ZONE TO ACCESSIBLE ENVIRONMENT

OTHER PERFORMANCE MEASURES

- **SURROGATE PERFORMANCE MEASURES WHEN DATA ARE INCOMPLETE**
- **VARIABLES IMPORTANT TO THE PERFORMANCE MEASURES**

PERFORMANCE ASSESSMENT PROCESS

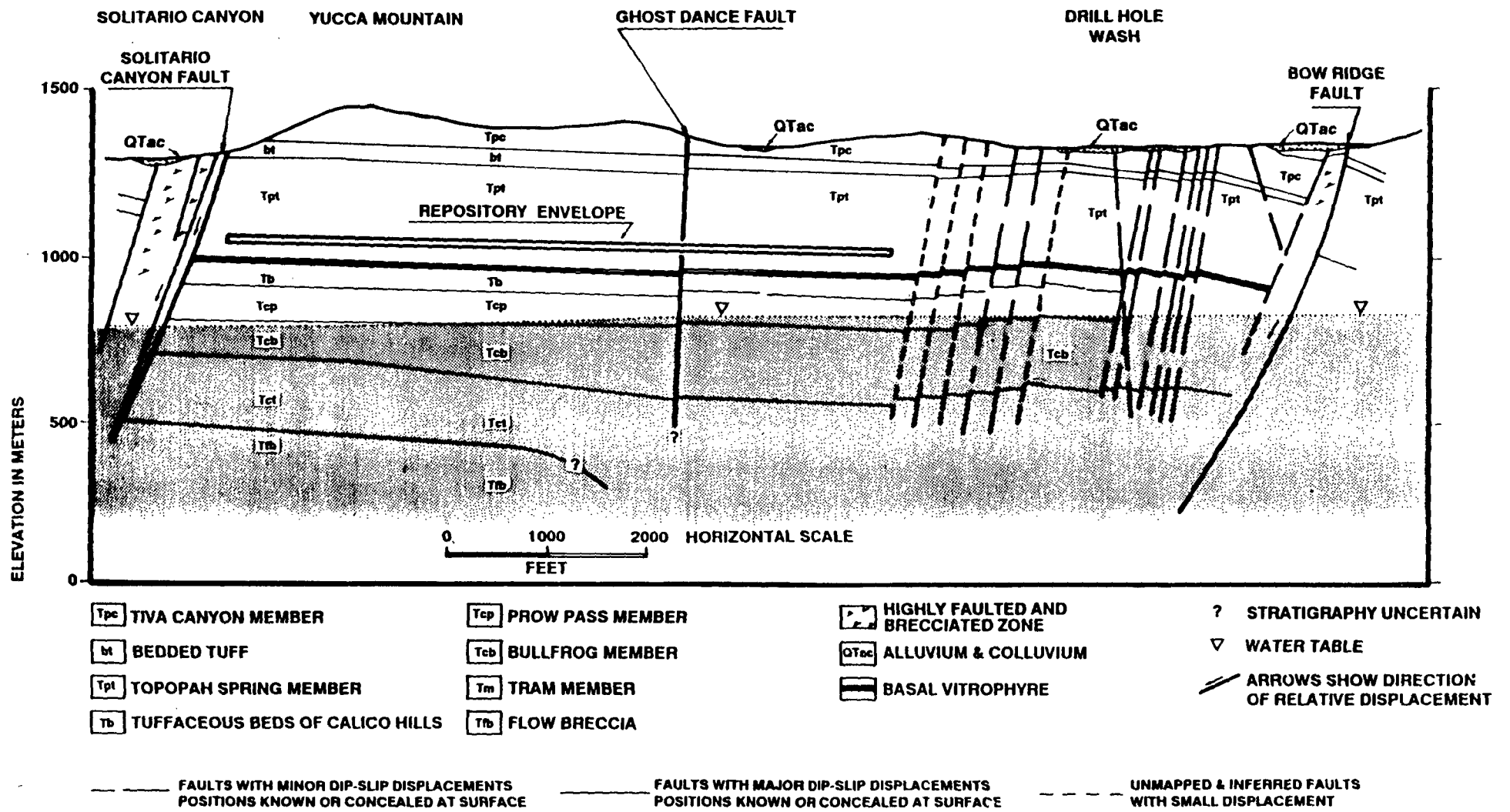


PHYSICAL MODELS

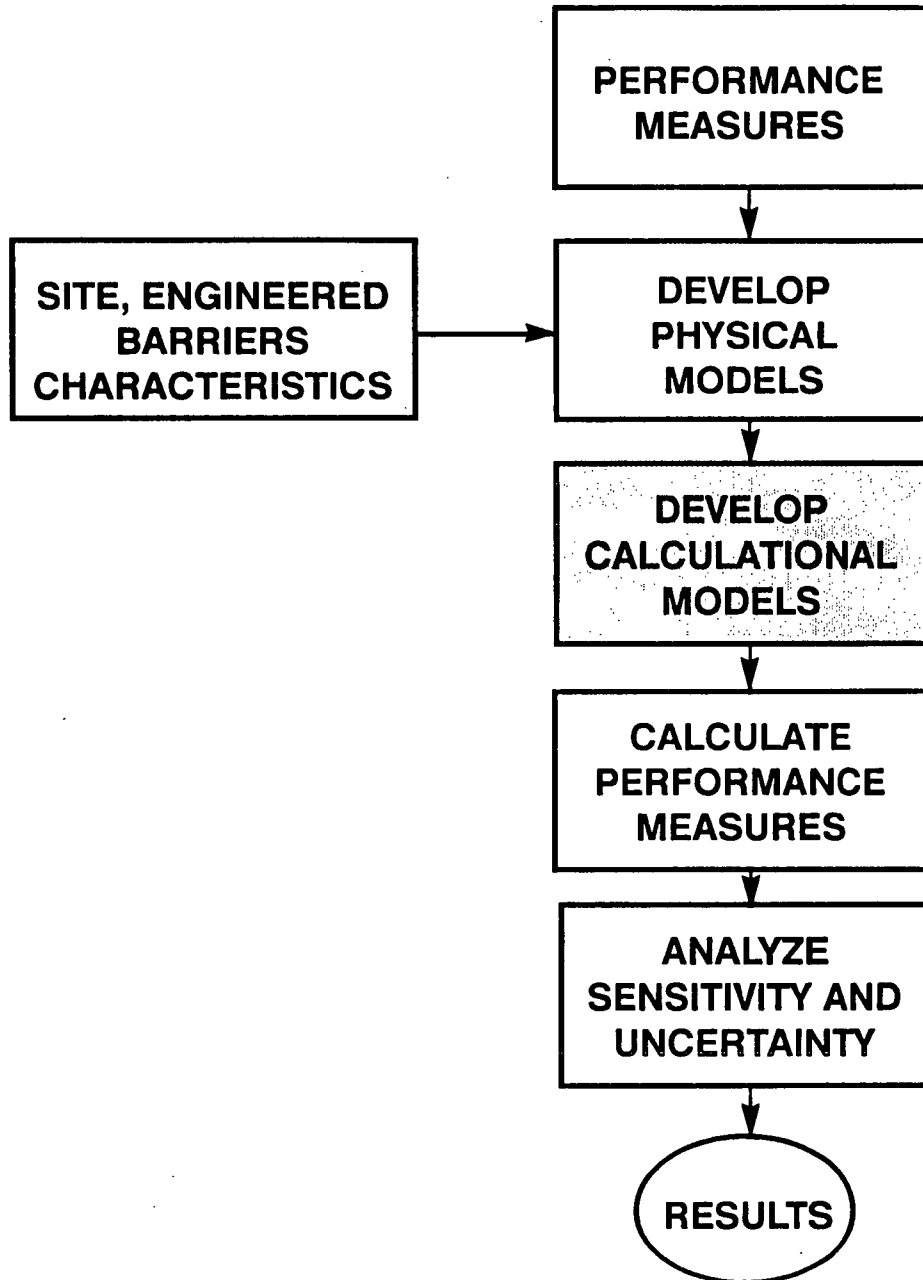
SITE CONCEPTUAL MODELS

SCENARIOS

PROCESS AND CONSTITUTIVE MODELS



PERFORMANCE ASSESSMENT PROCESS



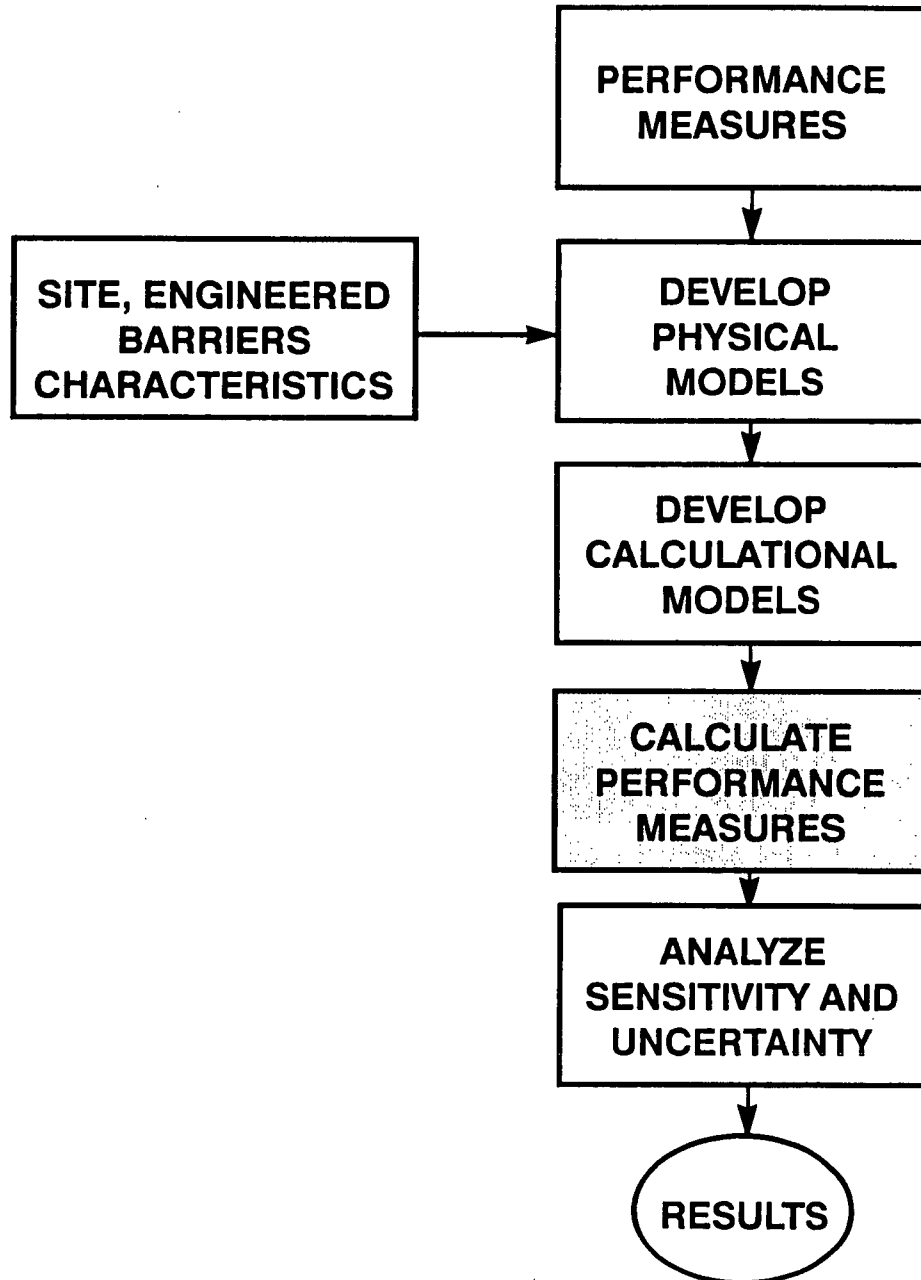
CALCULATIONAL MODELS

LEVEL I SIMPLIFIED SYSTEM AND SUBSYSTEM MODELS

**LEVEL II INTEGRATED SYSTEM AND SUBSYSTEM MODELS
(MODELS TO CALCULATE PERFORMANCE MEASURES)**

**LEVEL III SUBMODELS FOR PROCESSES, COMPONENTS
(E.G., FLOW MODELS, THERMAL MODELS)**

PERFORMANCE ASSESSMENT PROCESS



CALCULATIONS OF PERFORMANCE MEASURES

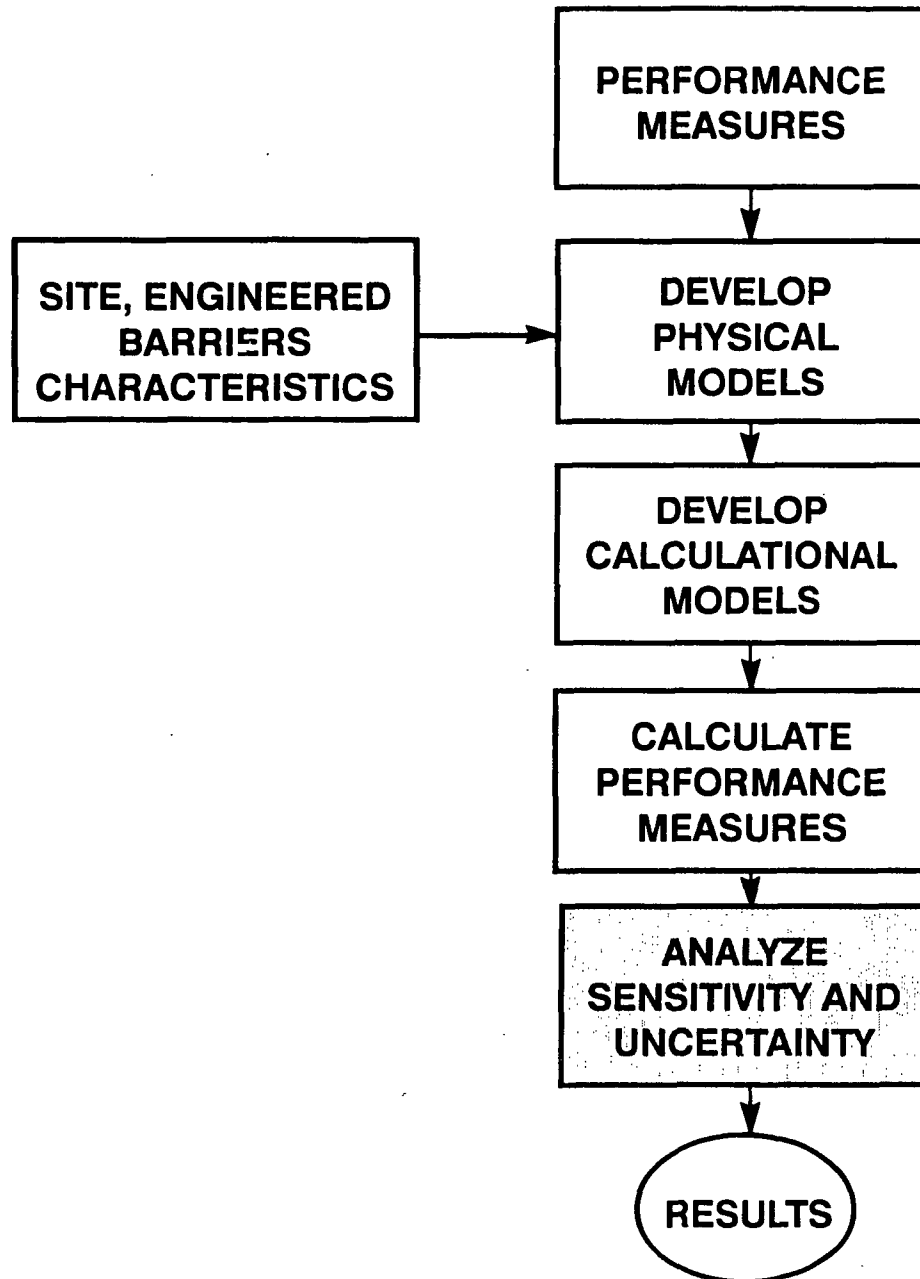
ONLY ONE ASPECT OF PERFORMANCE ASSESSMENT

DETERMINISTIC vs PROBABILISTIC ANALYSIS

CONSERVATIVE ANALYSIS

BOUNDING ANALYSIS

PERFORMANCE ASSESSMENT PROCESS



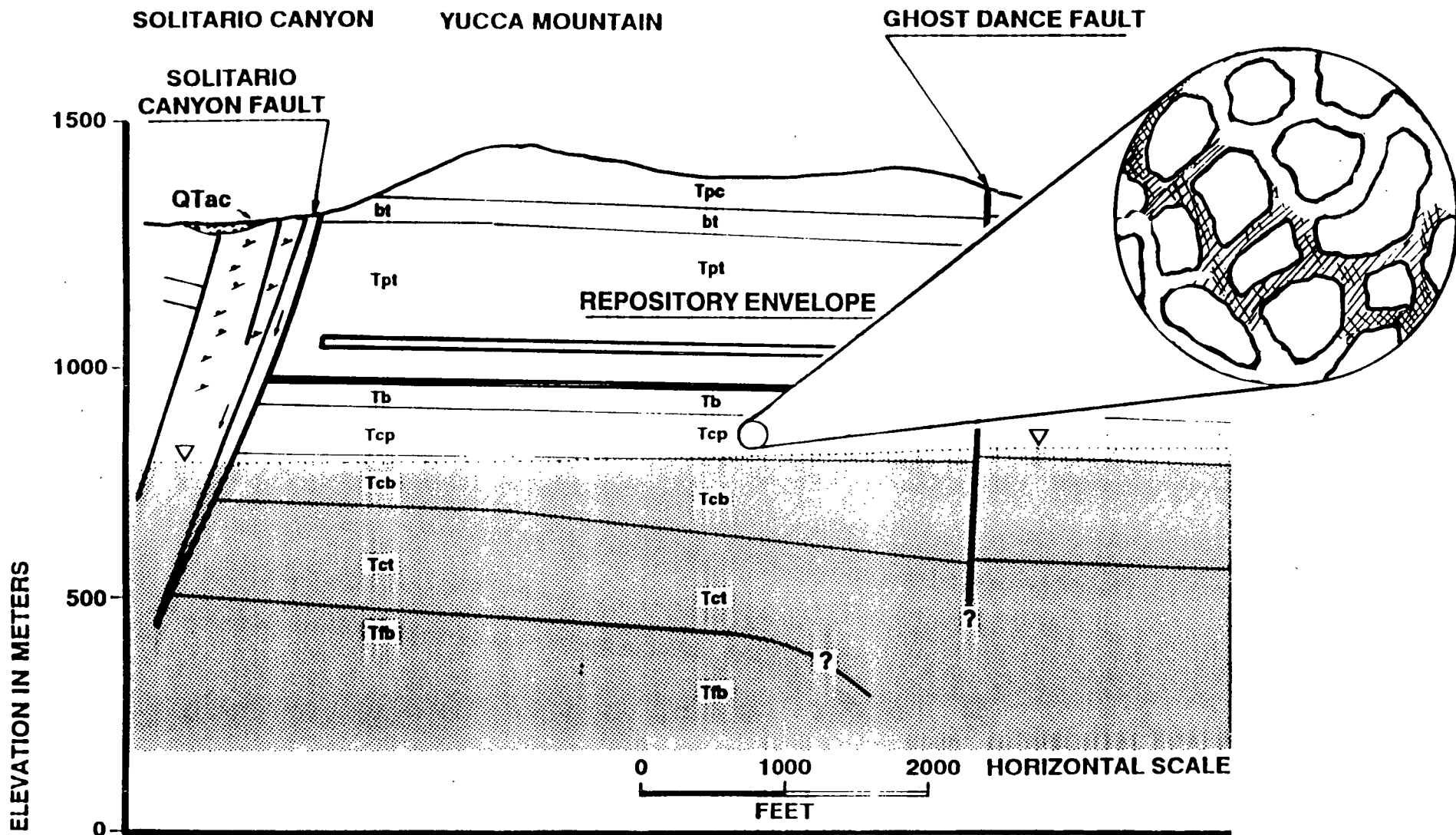
TYPES OF UNCERTAINTIES

UNCERTAINTIES IN PHYSICAL MODELS

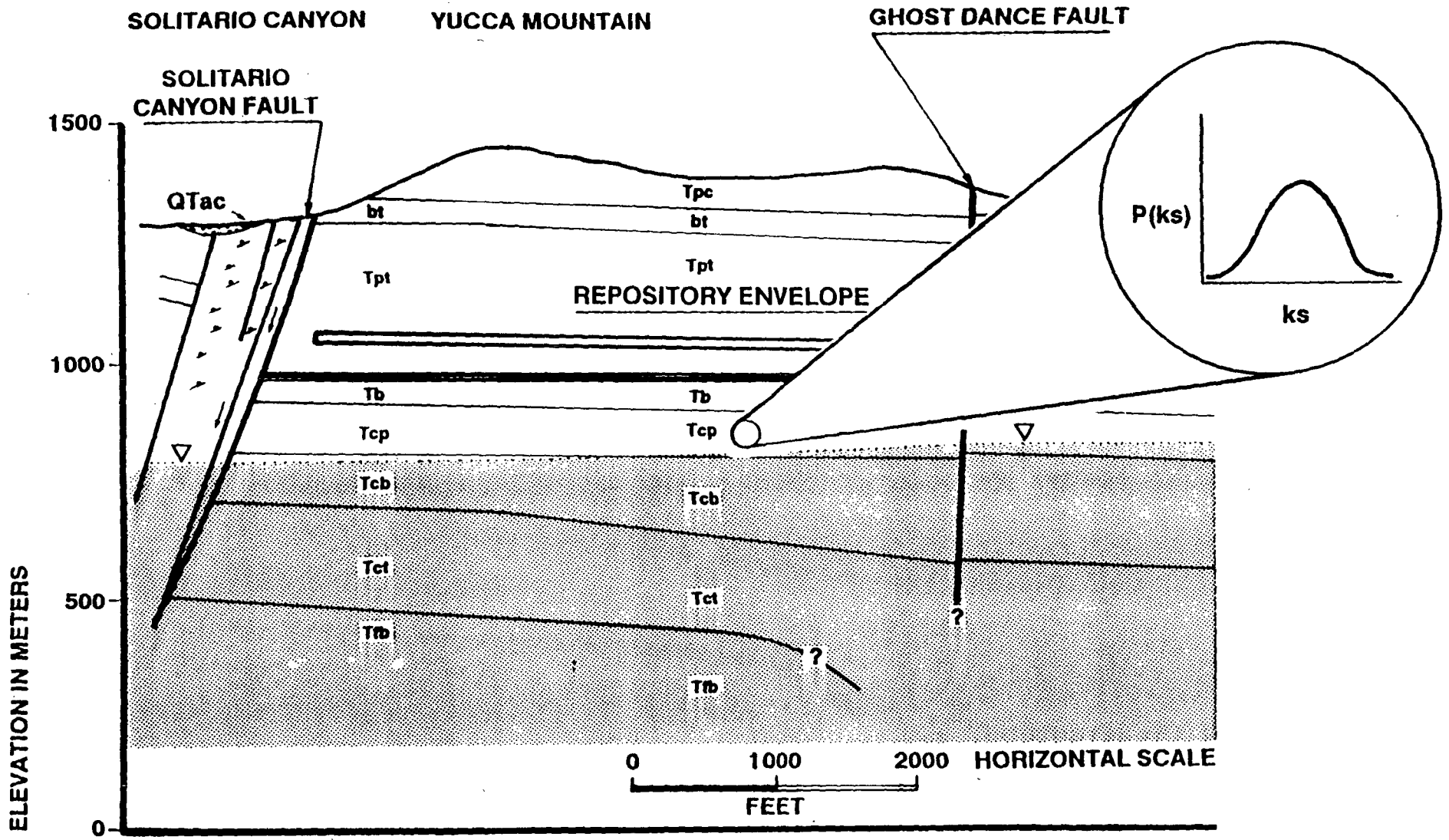
PARAMETER UNCERTAINTY

UNCERTAINTY DUE TO EXTRAPOLATION OF MODELS

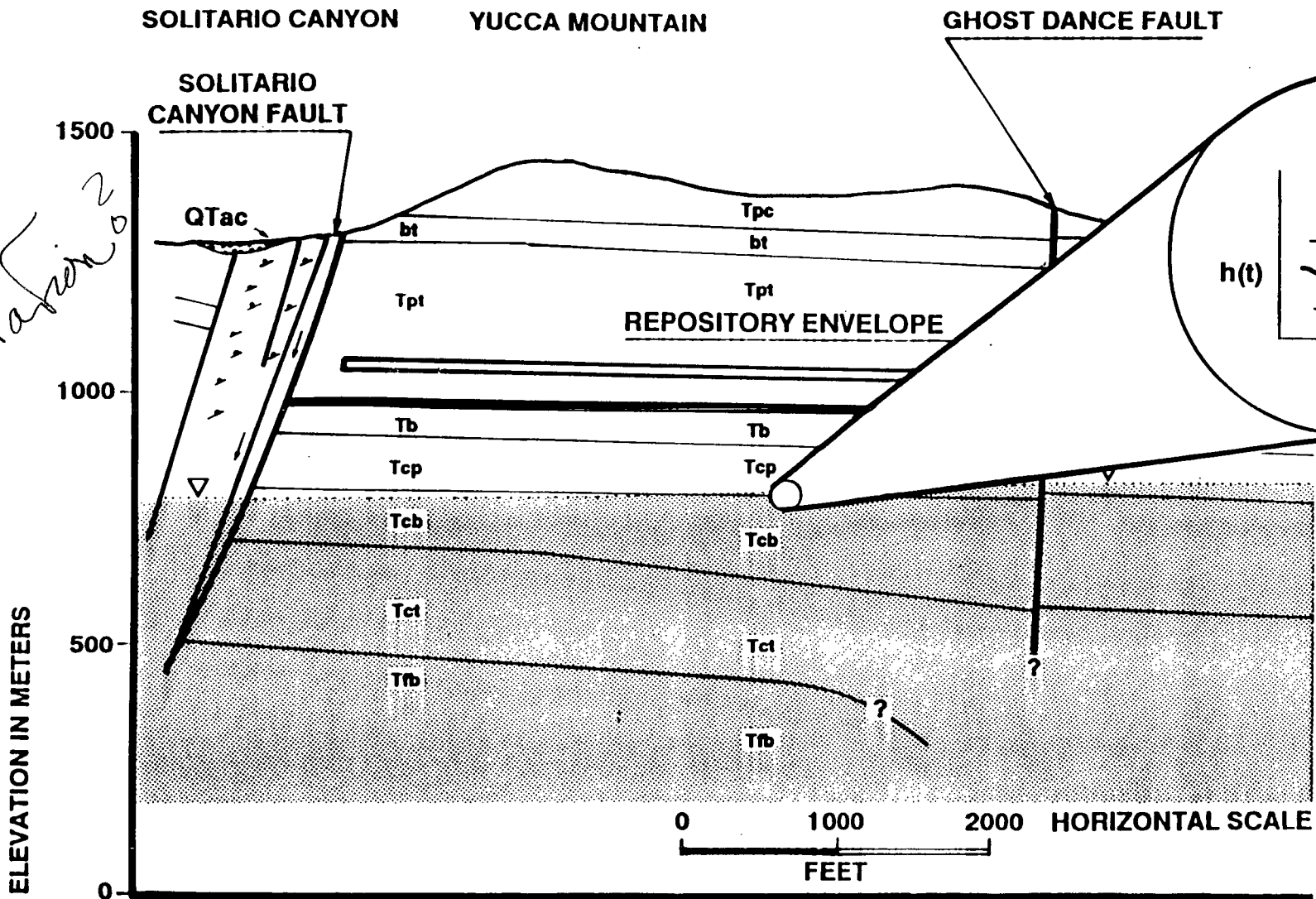
**UNCERTAINTIES DUE TO UNANTICIPATED PROCESSES
OR EVENTS**



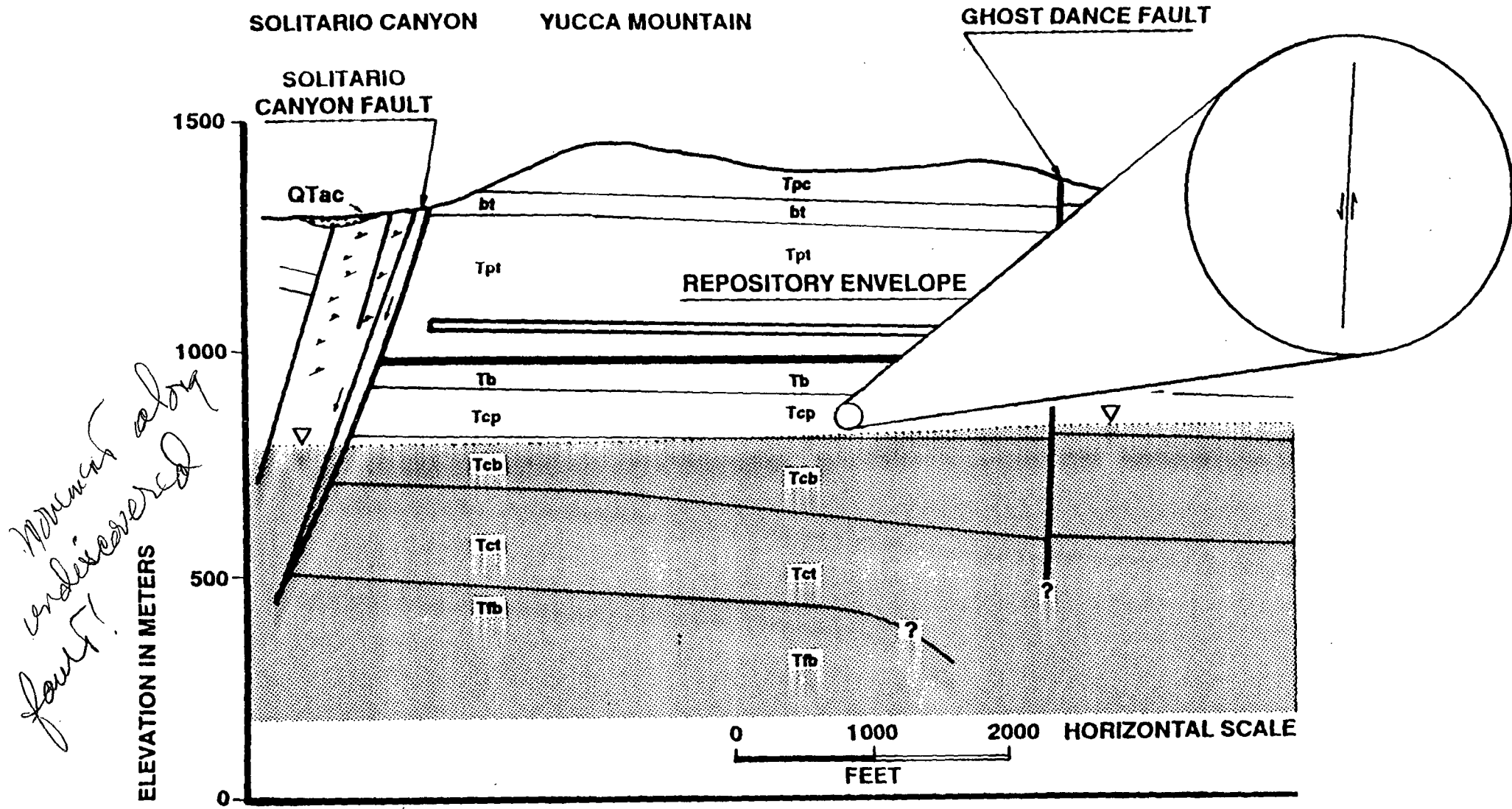
UNCERTAINTY IN MODEL OF FLOW PROCESS



UNCERTAINTY IN PARAMETERS



UNCERTAINTY IN EXTRAPOLATION OF MODELS



UNCERTAINTY DUE TO UNANTICIPATED EVENTS

ADDRESSING UNCERTAINTIES

MODIFY PERFORMANCE ASSESSMENTS TO ADDRESS UNCERTAINTIES

- **CONSERVATIVE ANALYSES**
- **BOUNDING ANALYSES**
- **SCENARIO ANALYSIS TO ADDRESS UNANTICIPATED PROCESSES AND EVENTS**
- **SENSITIVITY AND UNCERTAINTY ANALYSIS**

ADDITIONAL TESTING TO REDUCE UNCERTAINTIES

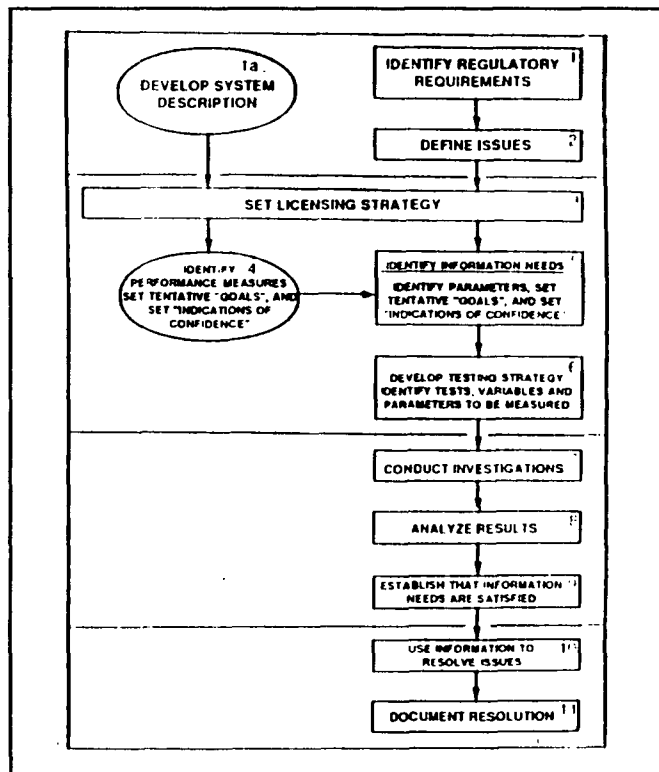
- **SITE CHARACTERIZATION AND ENGINEERED BARRIERS TESTING**
- **MODEL VALIDATION**
- **PERFORMANCE CONFIRMATION**

MODIFY DESIGN TO MITIGATE UNCERTAINTIES

- **MULTIPLE BARRIERS**
- **DESIGN MARGIN**

STRATEGY AND IMPLEMENTATION

SITE CHARACTERIZATION PLAN STUDY PLANS



PERFORMANCE ASSESSMENT STRATEGY PLAN (PASP) IMPLEMENTATION PLAN (PAIP)

