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

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: SITE INFORMATION NEEDED FOR REPOSITORY AND WASTE PACKAGE DESIGN

PRESENTER: DR. JEAN L. YOUNKER

PRESENTER'S TITLE AND ORGANIZATION: SENIOR STAFF GEOLOGIST
SCIENCE APPLICATIONS INTERNATIONAL CORP.
LAS VEGAS, NEVADA

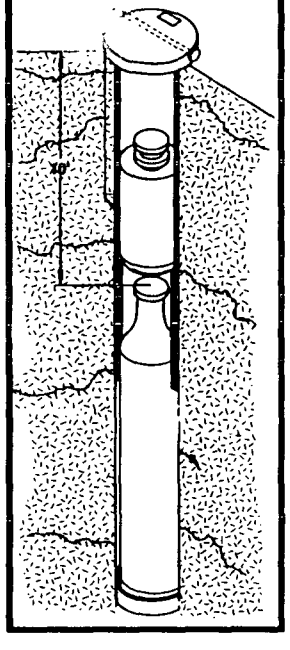
PRESENTER'S TELEPHONE NUMBER: (702) 794-7650

MARCH 19-20, 1990

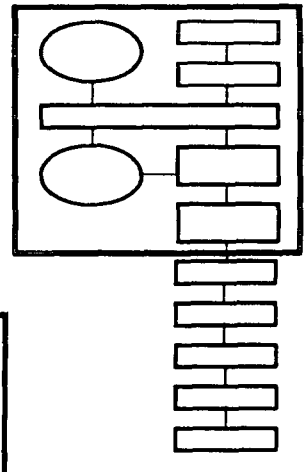
ACTIVITIES RELATED TO DEVELOPMENT OF THE SCP

PRE-EXISTING CONDITIONS

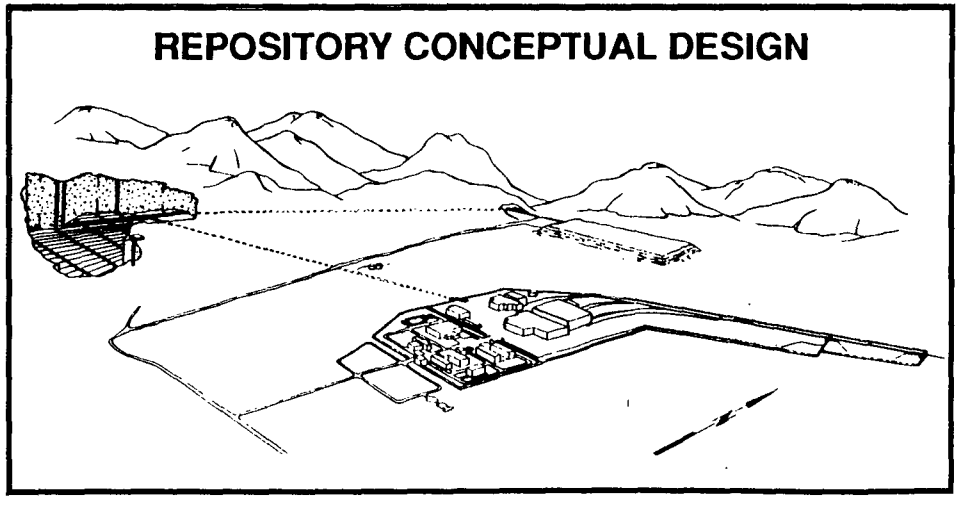
WP CONCEPTUAL DESIGN



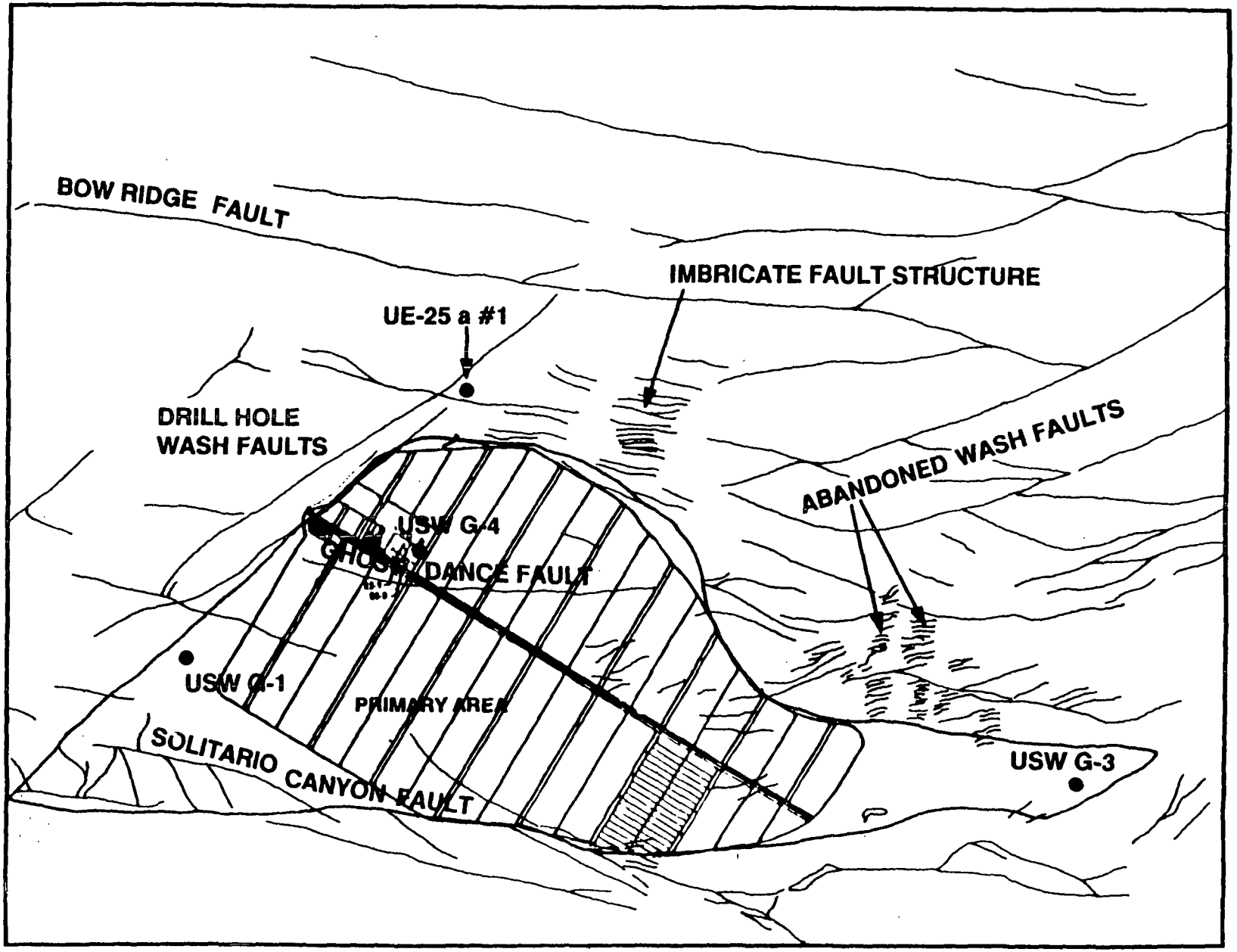
ISSUE RESOLUTION STRATEGY



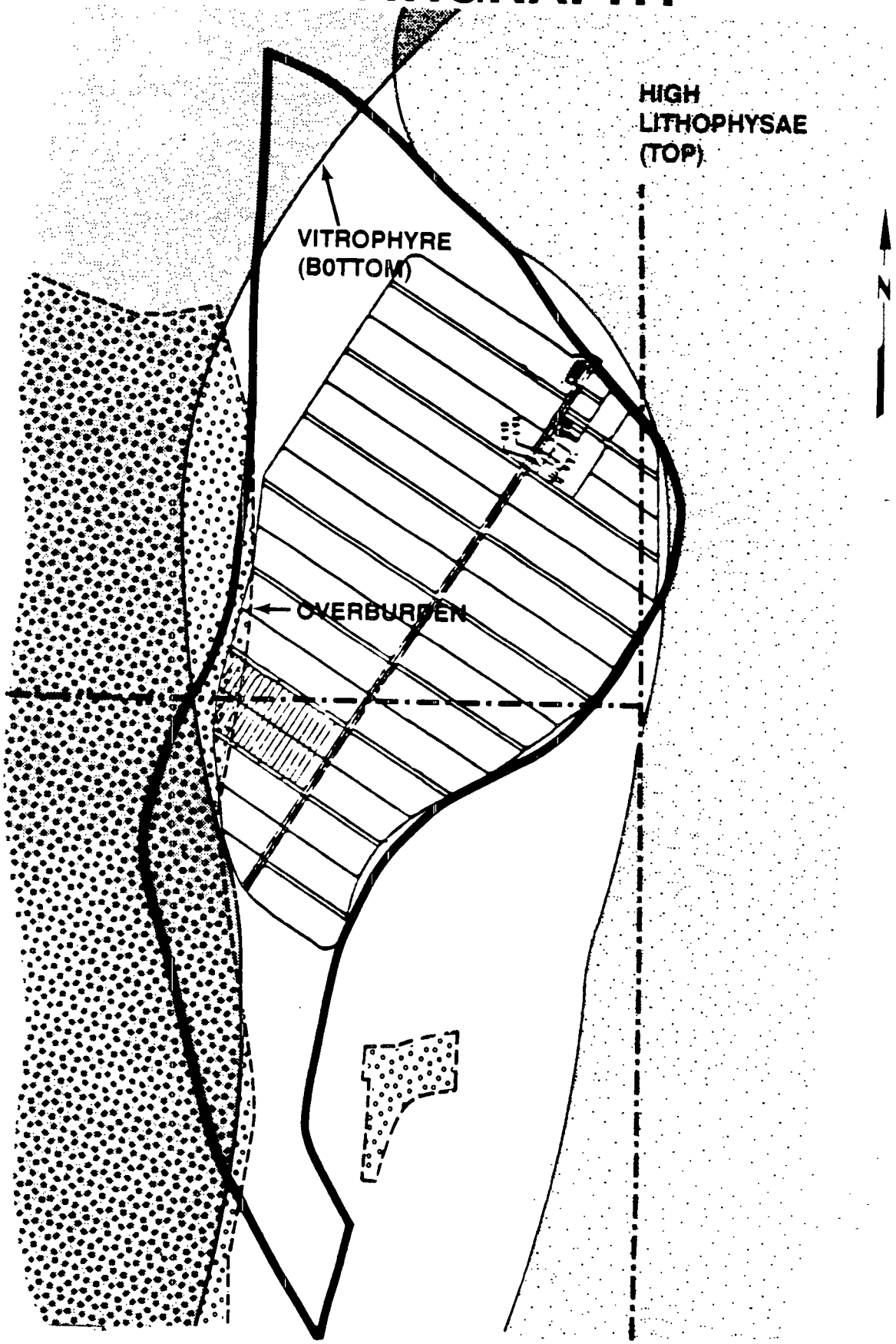
REPOSITORY CONCEPTUAL DESIGN



LARGE-SCALE SITE CONSTRAINTS-STRUCTURE



LARGE-SCALE SITE CONSTRAINTS-STRATIGRAPHY



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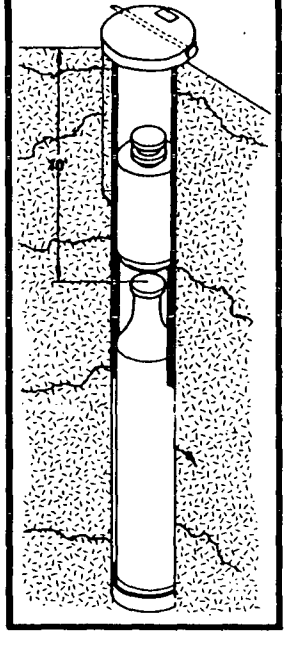
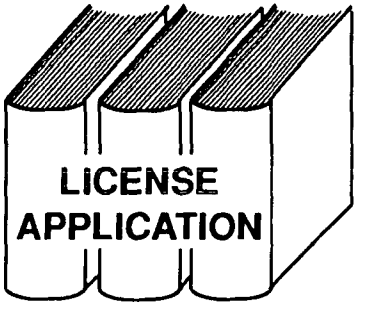
IMPLEMENTATION OF SCIENTIFIC INVESTIGATIONS

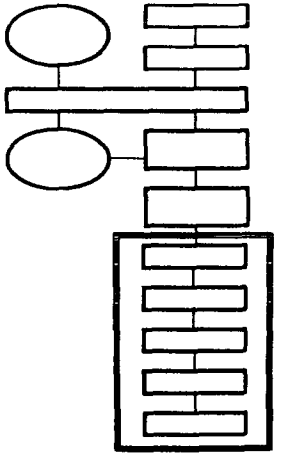
PRE-EXISTING CONDITIONS

WP FINAL DESIGN

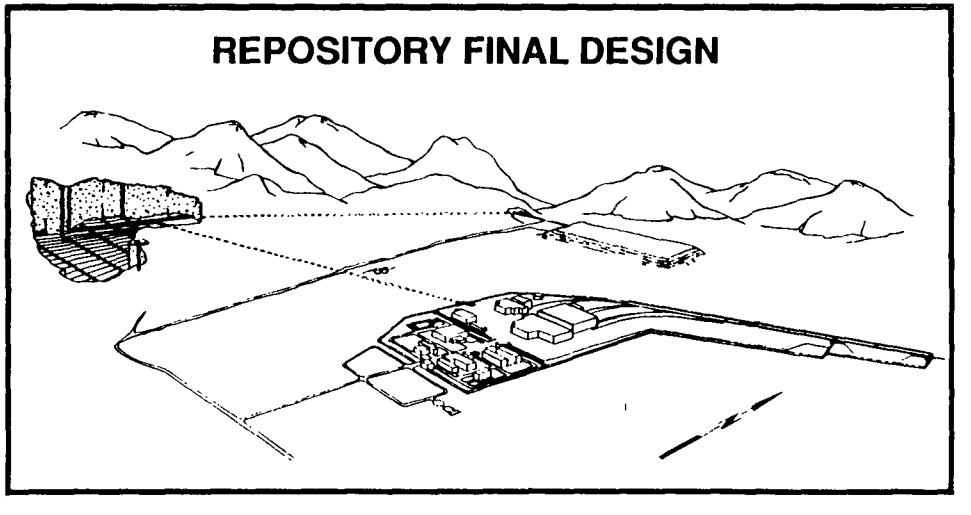




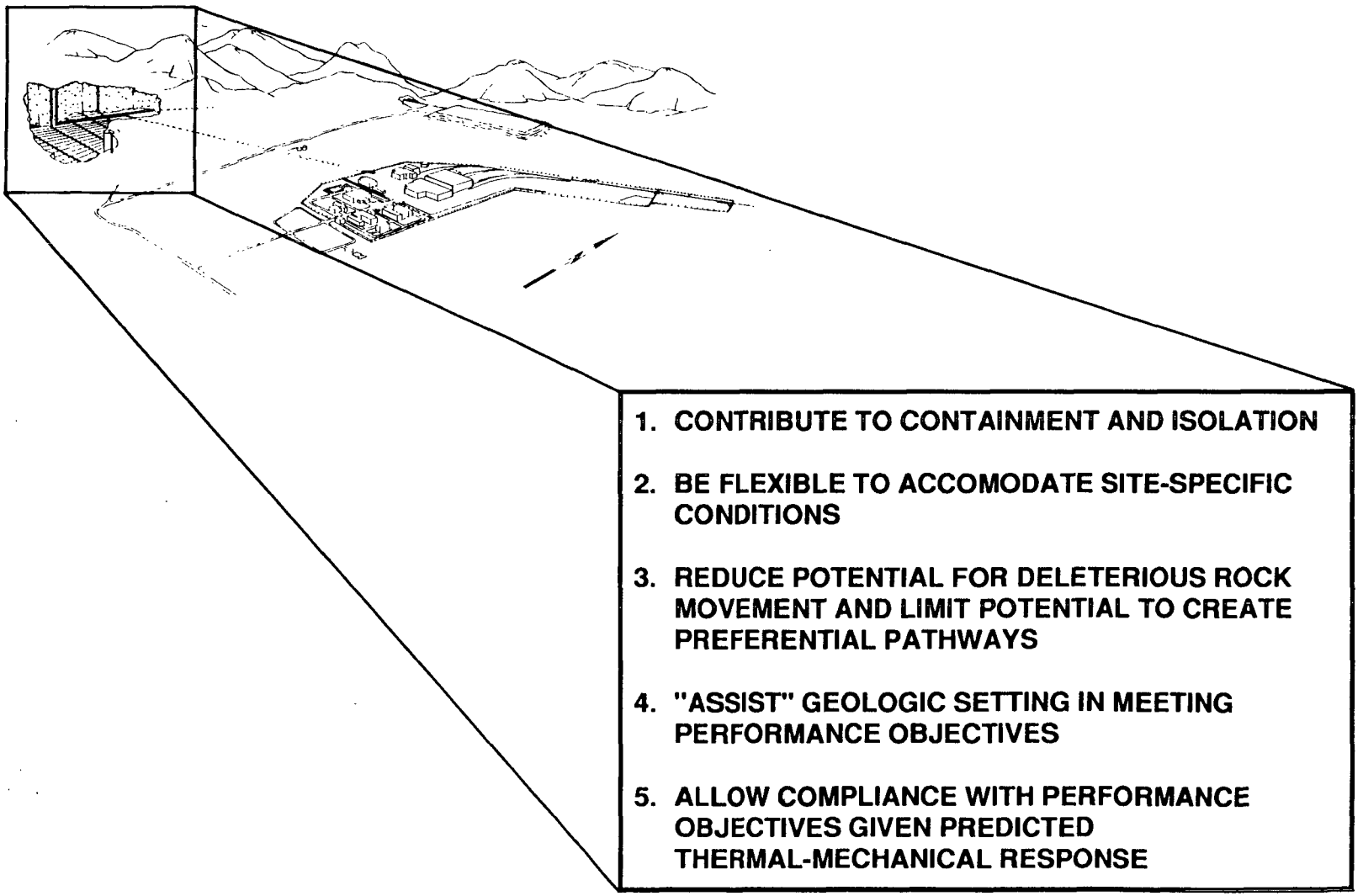
ISSUE RESOLUTION STRATEGY



REPOSITORY FINAL DESIGN



MAJOR SITE-SPECIFIC NEEDS ORIGINATE FROM "ADDITIONAL DESIGN CRITERIA FOR UNDERGROUND FACILITY" (10 CFR 60.133)



MAJOR SITE-SPECIFIC NEEDS ORIGINATE FROM "ADDITIONAL DESIGN CRITERIA FOR SEALS" (10 CFR 60.134)

6. SEALS DESIGNED SO SHAFTS/BOREHOLES ARE NOT PATHWAYS, AND TO REDUCE PATHWAYS FOR GROUND-WATER OR RADIONUCLIDE MOVEMENT

UNDERGROUND FACILITY

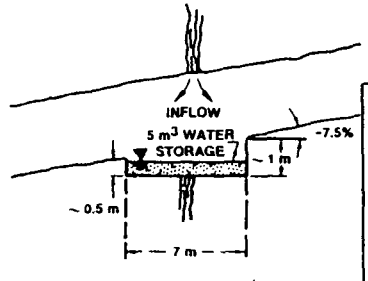
- SINGLE DAM OR BULKHEAD
  - A. EMPLACEMENT DRIFT
  - B. PERIMETER AND MAIN DRIFTS
- DOUBLE BULKHEAD
  - A. EMPLACEMENT DRIFT (NO BULKHEAD SETTLEMENT)
  - B. EMPLACEMENT DRIFT (BULKHEAD SETTLEMENT)
- BACKFILLED SUMP
- BACKFILLED CHANNEL
- PLUG IN HORIZONTAL EMPLACEMENT BORE-HOLE
- DRIFT BACKFILL

SHAFTS AND RAMPS

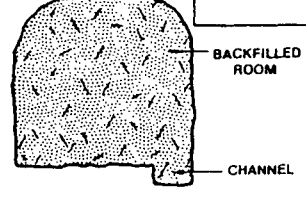
- ANCHOR-TO-BEDROCK PLUG/SEAL
- GENERAL FILL
- STATION PLUGS
- UNSATURATED TOPOPAH SPRING MEMBER AT BASE OF SHAFTS AND RAMPS

EXPLORATORY BOREHOLES

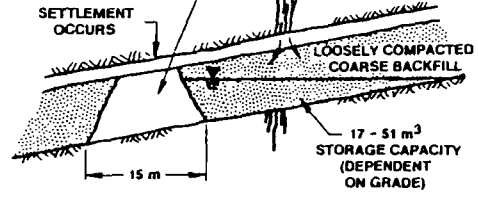
- EXPLORATORY BOREHOLE SEAL
  - A. UPPER BOREHOLE SEAL
  - B. LOWER BOREHOLE SEAL (INCL. CALICO HILLS)



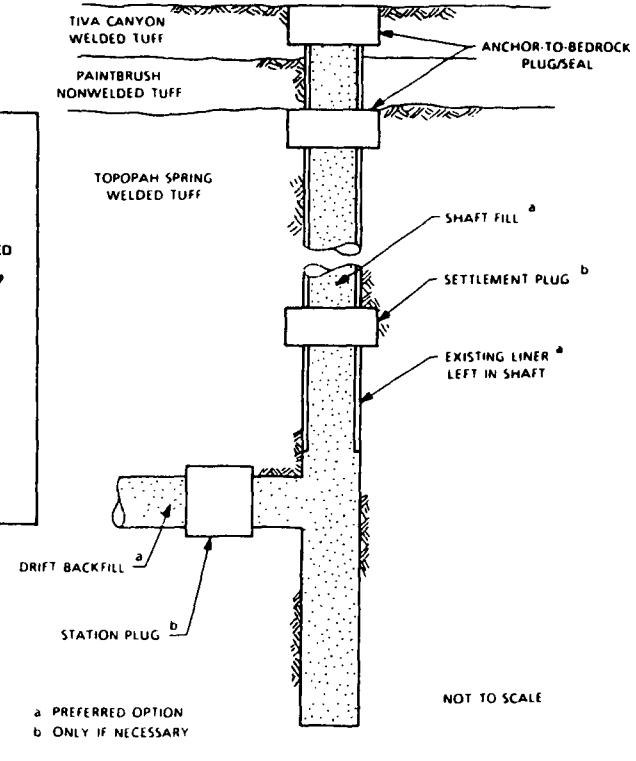
BACKFILLED SUMP



BACKFILLED CHANNEL



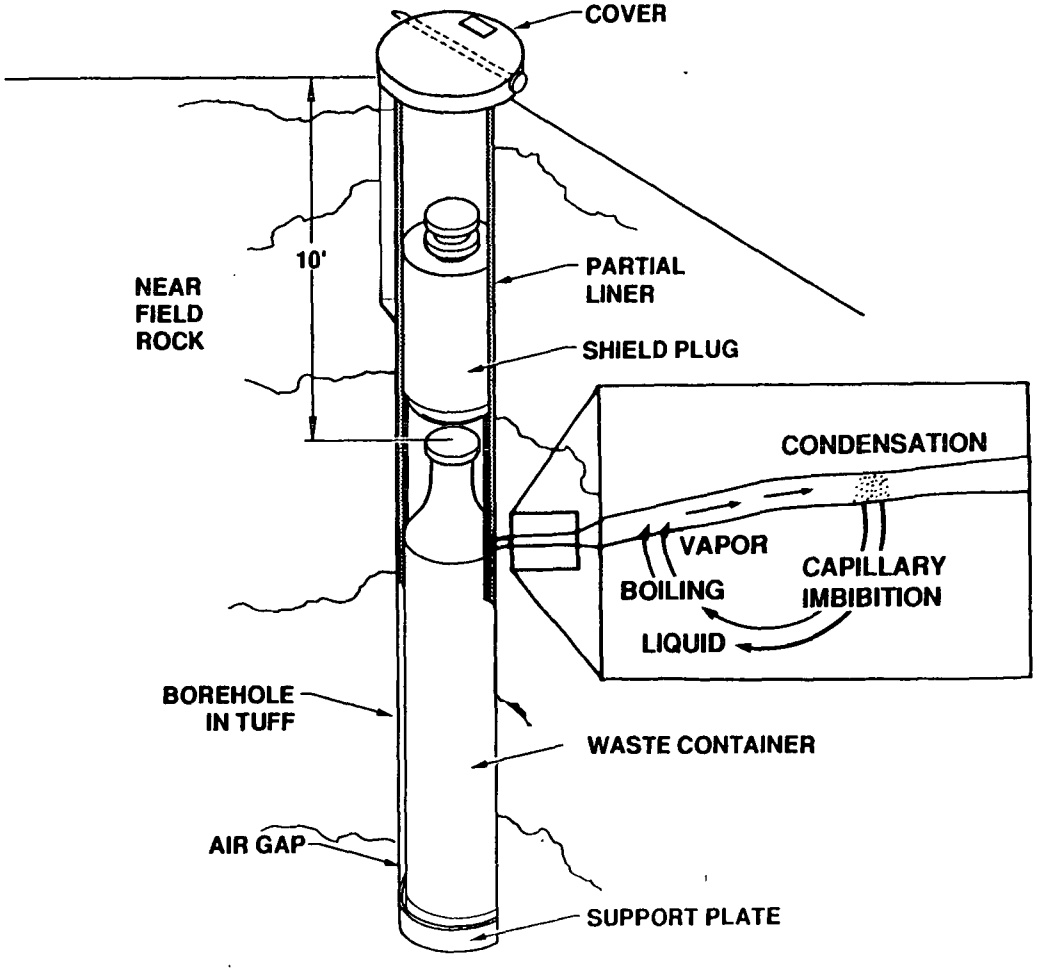
SINGLE DAM OR SINGLE BULKHEAD WITH SETTLEMENT



a PREFERRED OPTION
b ONLY IF NECESSARY

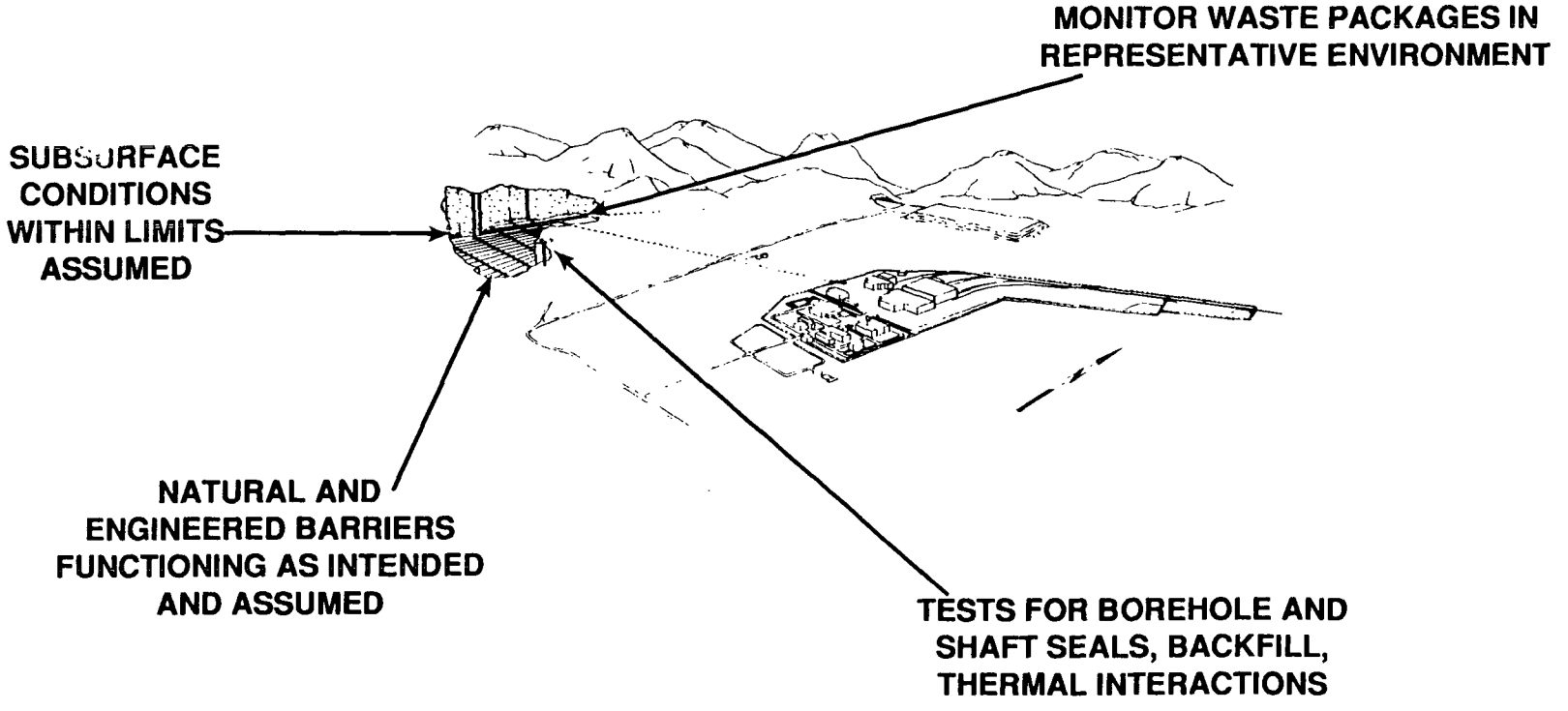
MAJOR SITE-SPECIFIC NEEDS ORIGINATE FROM "ADDITIONAL DESIGN CRITERIA FOR THE WASTE PACKAGE" (10 CFR 60.135)

7. WASTE PACKAGE INTERACTIONS WITH ENVIRONMENT DO NOT COMPROMISE PERFORMANCE



MAJOR SITE-SPECIFIC NEEDS ORIGINATE FROM PERFORMANCE CONFIRMATION REQUIREMENTS (10 CFR 60 SUBPART F)

8. PERFORMANCE CONFIRMATION PROGRAM CAN BE CONDUCTED



PERFORMANCE-DRIVEN DESIGN CONSIDERATIONS

10 CFR 60.133 - ADDITIONAL DESIGN CRITERIA FOR UNDERGROUND FACILITY (POST-CLOSURE)

- FOCUS IS TO DESIGN AN EBS THAT HELPS THE SITE MEET THE PERFORMANCE OBJECTIVES; TO DO THIS:
  - DIAGNOSE *UNFAVORABLE* AREAS AND SKIP/ISOLATE
  - USE *ACCEPTABLE* THERMAL LOADS (ADJUST LOCALLY IF NEEDED)
  - LIMIT WATER *VOLUME AND QUALITY* CONTACTING CONTAINER
  - LIMIT *ADVERSE* EXCAVATION EFFECTS
  - USE SEALS TO *REDUCE POTENTIAL* PATHWAYS
  - DESIGN WASTE PACKAGE SO THAT INTERACTIONS WITH ENVIRONMENT *DO NOT ADVERSELY AFFECT* PERFORMANCE

PERFORMANCE-DRIVEN DESIGN CONSIDERATIONS

(CONTINUED)

DATA IS NEEDED TO:

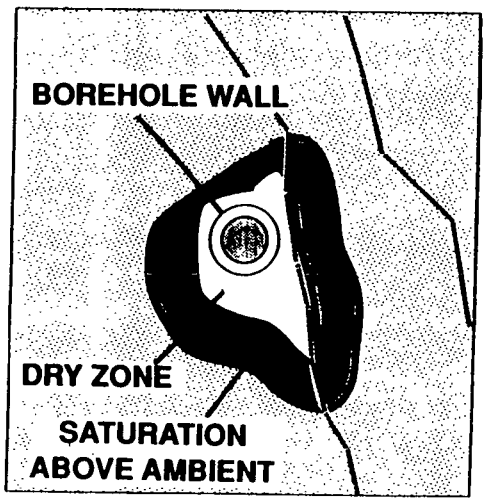
- SUPPORT PERFORMANCE ASSESSMENTS OF EFFECTS
- DEVELOP SITE MODELS
- REDUCE UNCERTAINTY IN BASIS FOR REQUIREMENTS AND ISSUE RESOLUTION

THREE CATEGORIES OF POTENTIAL REPOSITORY EFFECTS ARE IMPORTANT

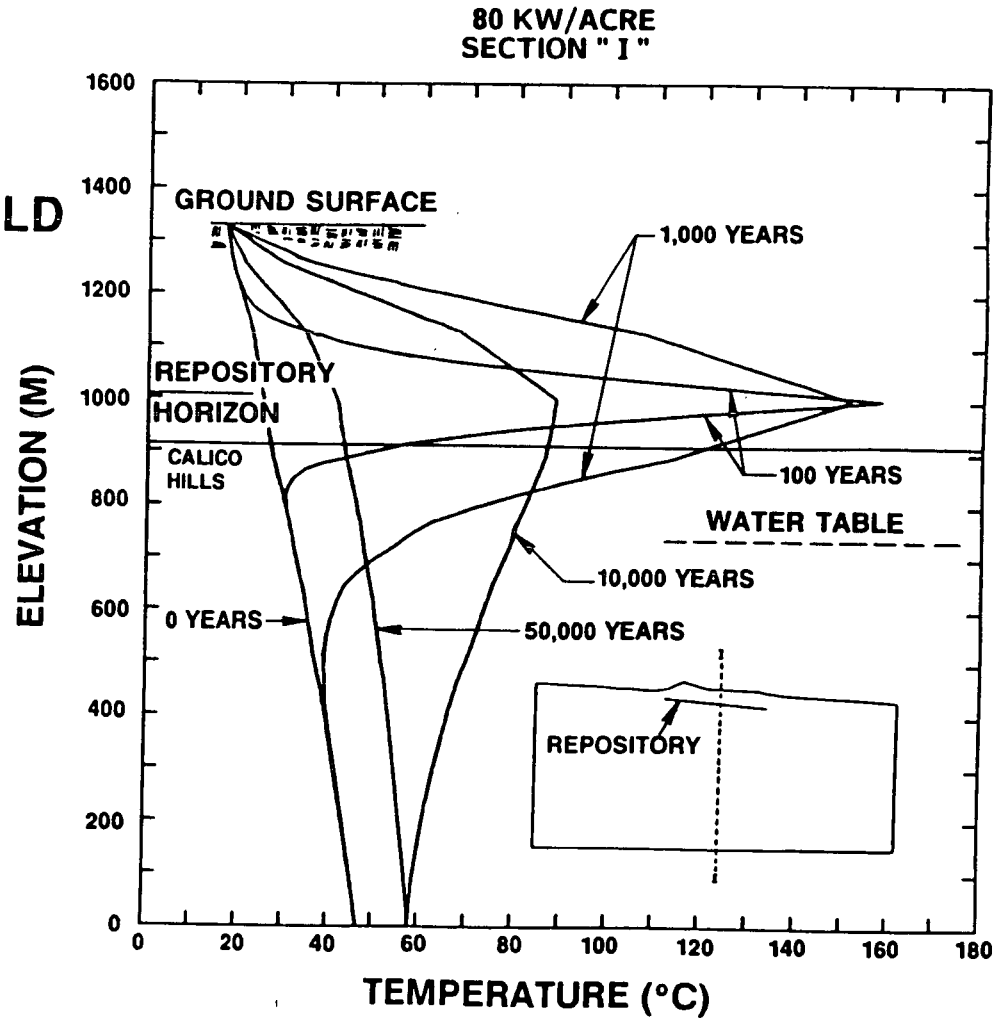
- HYDROLOGIC

FAR-FIELD

NEAR-FIELD



PREDICTED TEMPERATURES

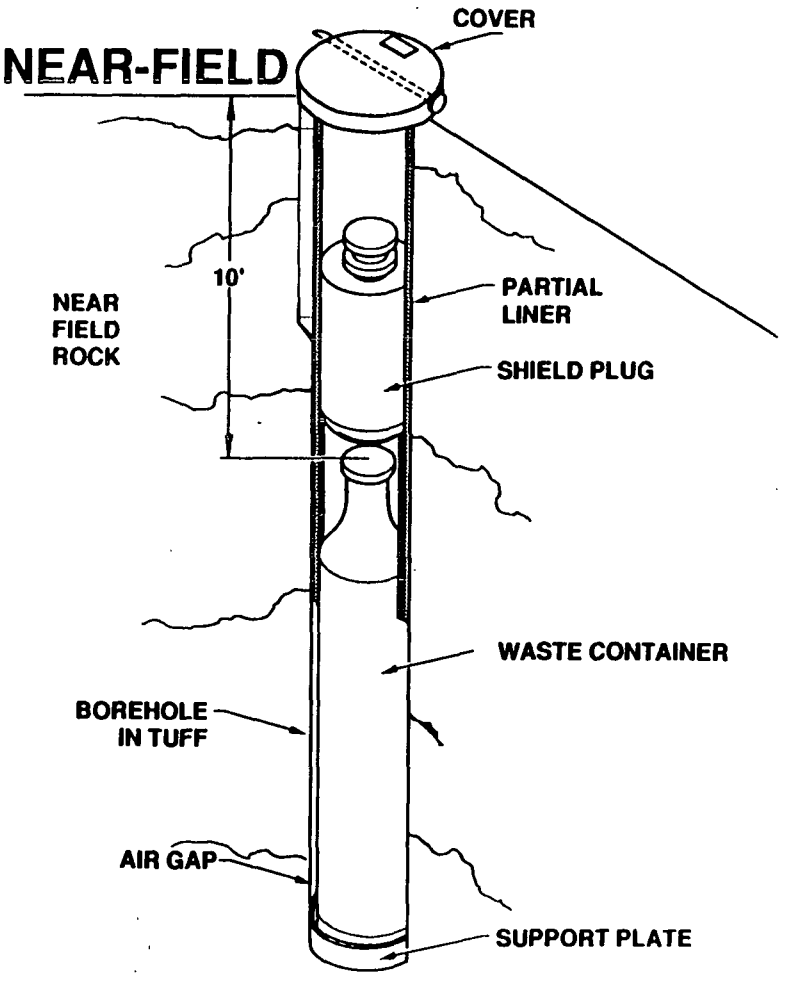


THREE CATEGORIES OF POTENTIAL REPOSITORY EFFECTS ARE IMPORTANT

(CONTINUED)

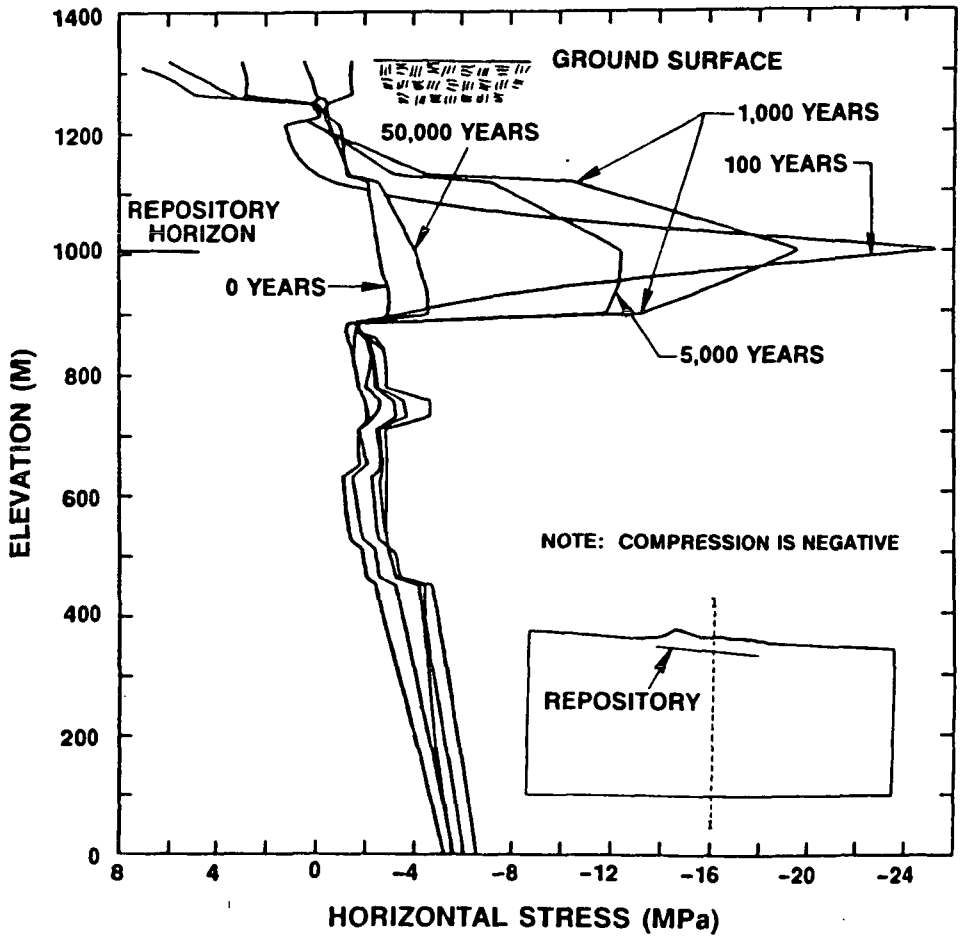
- THERMAL AND MECHANICAL

NEAR-FIELD



FAR-FIELD

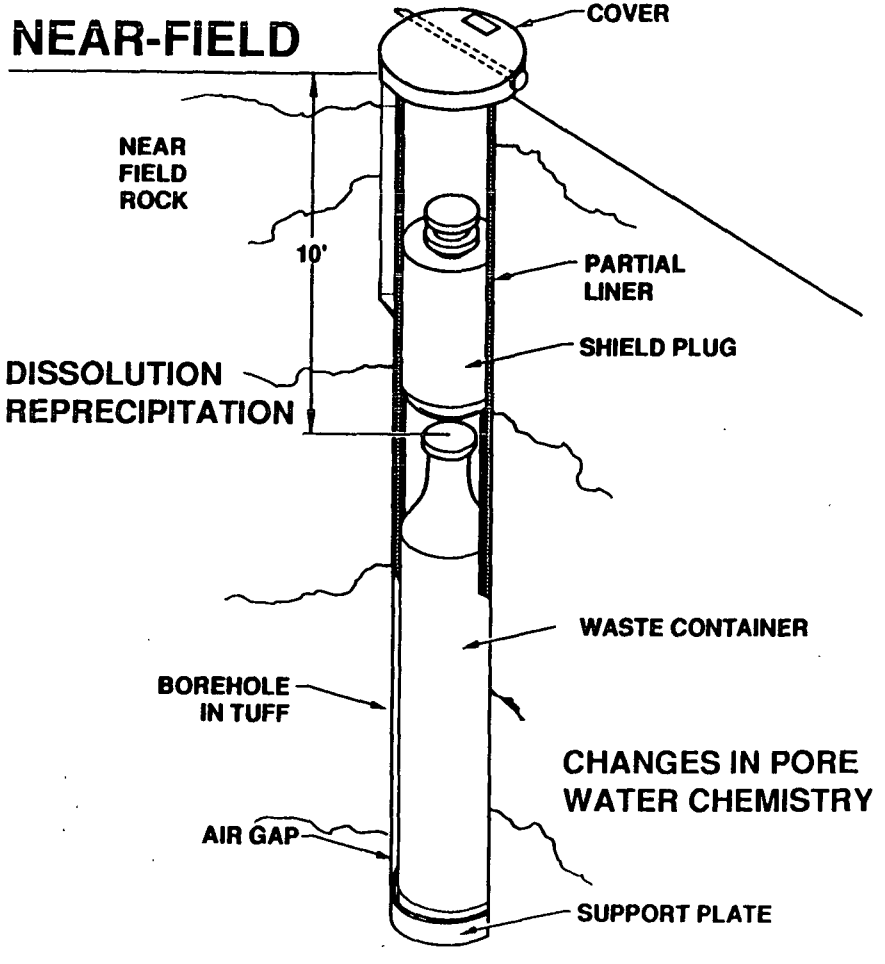
PREDICTED HORIZONTAL STRESS
ELASTIC ANALYSIS,
80 KW/ACRE
SECTION " I "



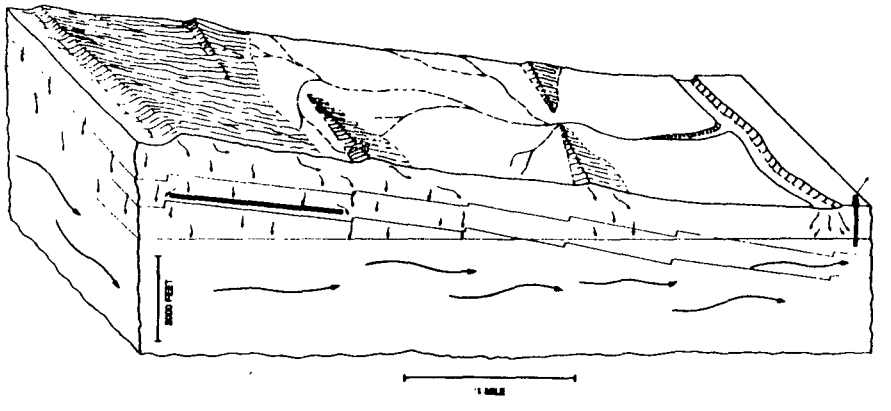
THREE CATEGORIES OF POTENTIAL REPOSITORY EFFECTS ARE IMPORTANT

(CONTINUED)

- GEOCHEMICAL



FAR-FIELD HEATING EFFECTS ON ZEOLITES & SMECTITE



SELECTED CHARACTERIZATION TESTS

TESTING PROVIDES DATA TO:

- REDUCE UNCERTAINTY IN ASSESSMENTS OF EFFECTS OF REPOSITORY ON SITE
- DESIGN REPOSITORY AND WASTE PACKAGE

ENGINEERED BARRIER SYSTEM FIELD TESTS ARE PLANNED TO IMPROVE UNDERSTANDING OF HYDROLOGIC AND GEOCHEMICAL EFFECTS

GOALS:

- DETERMINE THERMAL RESPONSE AND MOVEMENT OF MOISTURE IN WASTE PACKAGE ENVIRONMENT
- VALIDATE AND CALIBRATE FLUID FLOW AND TRANSPORT MODELS

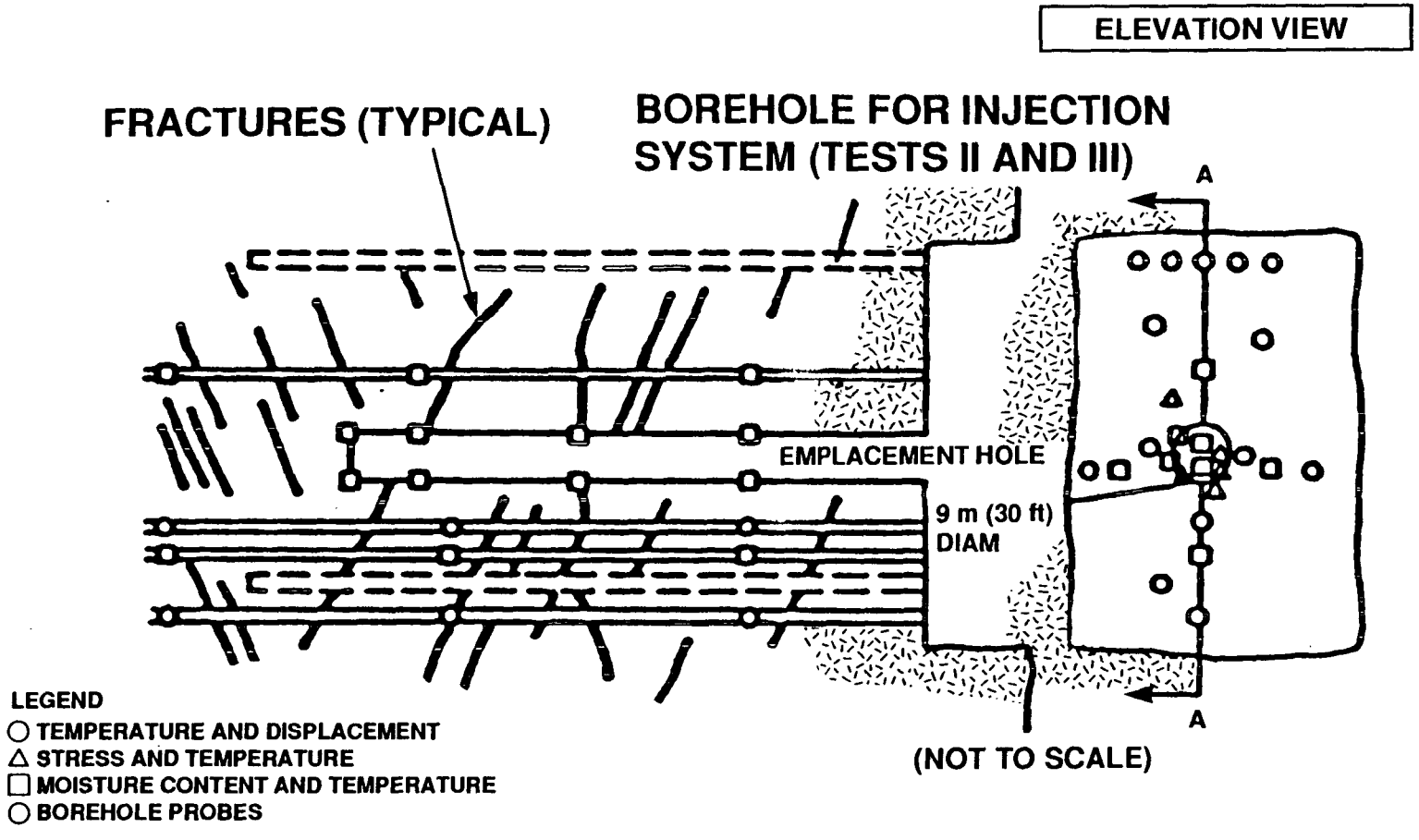
ENGINEERED BARRIER SYSTEM FIELD TESTS ARE PLANNED TO IMPROVE UNDERSTANDING OF HYDROLOGIC AND GEOCHEMICAL EFFECTS

(CONTINUED)

PARAMETERS TO BE MEASURED:

- DEGREE AND DISTRIBUTION OF LIQUID WATER SATURATION
- RELATIVE PERMEABILITY
- MATRIC POTENTIAL
- FLUID FLOW PATHWAYS AND RATES
- FRACTURE CHARACTERISTICS
- THERMAL LOADING: TEMPERATURE, TEMPERATURE GRADIENT
- MECHANICAL AND THERMAL PROPERTIES OF THE ROCK
- PRE- AND POST-TEST WATER CHEMISTRY
- PRE- AND POST-TEST MINERALOGICAL CHANGES
- SORPTION

ENGINEERED BARRIER SYSTEM FIELD TESTS

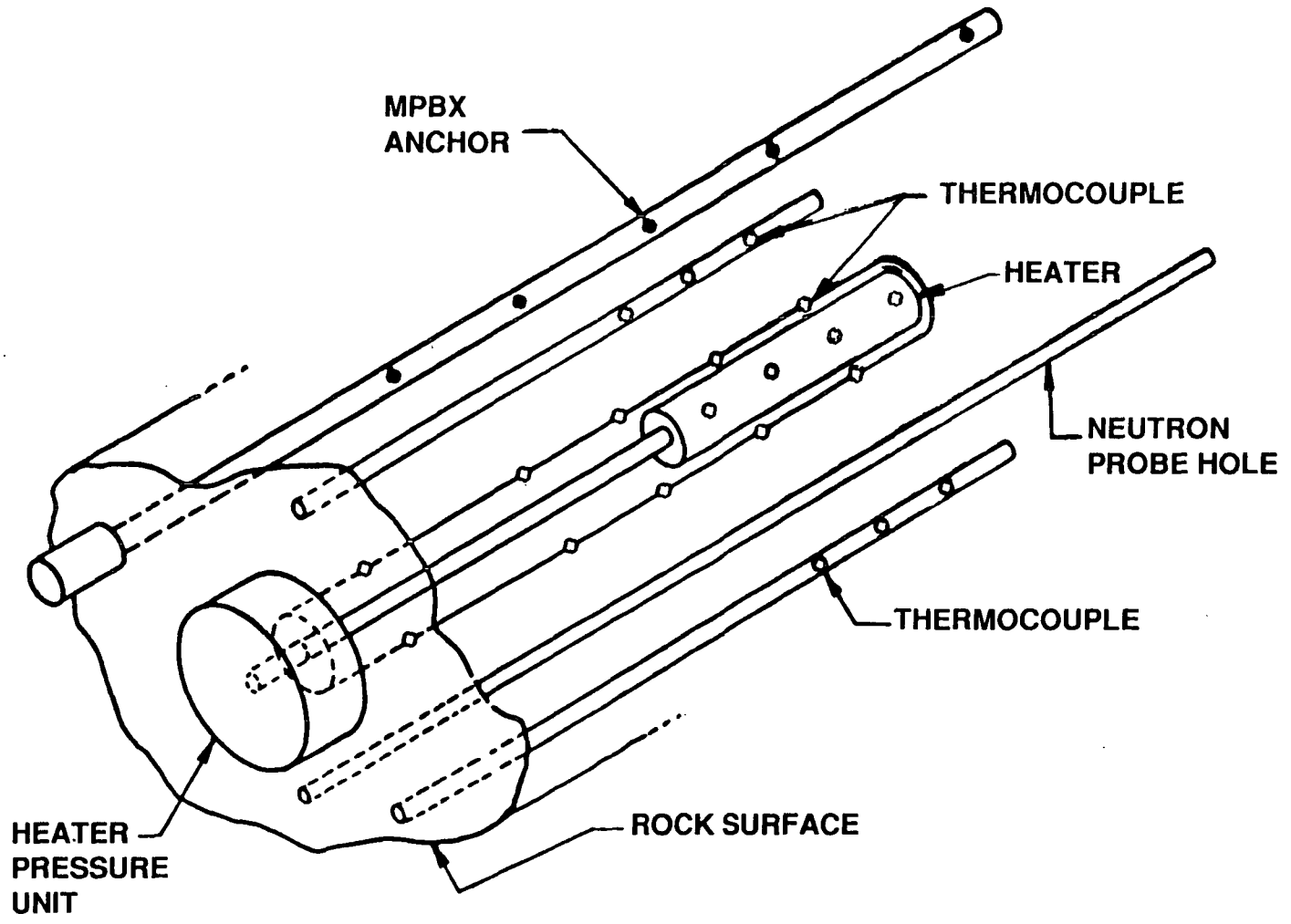


- TESTS WILL DETERMINE THE EFFECT ON WATER CHEMISTRY OF NEAR-FIELD THERMAL PERTURBATION
- TESTS WILL DEFINE THE SPATIAL DISTRIBUTION OF LIQUID WATER WITH TIME AROUND THE EMPLACEMENT HOLE

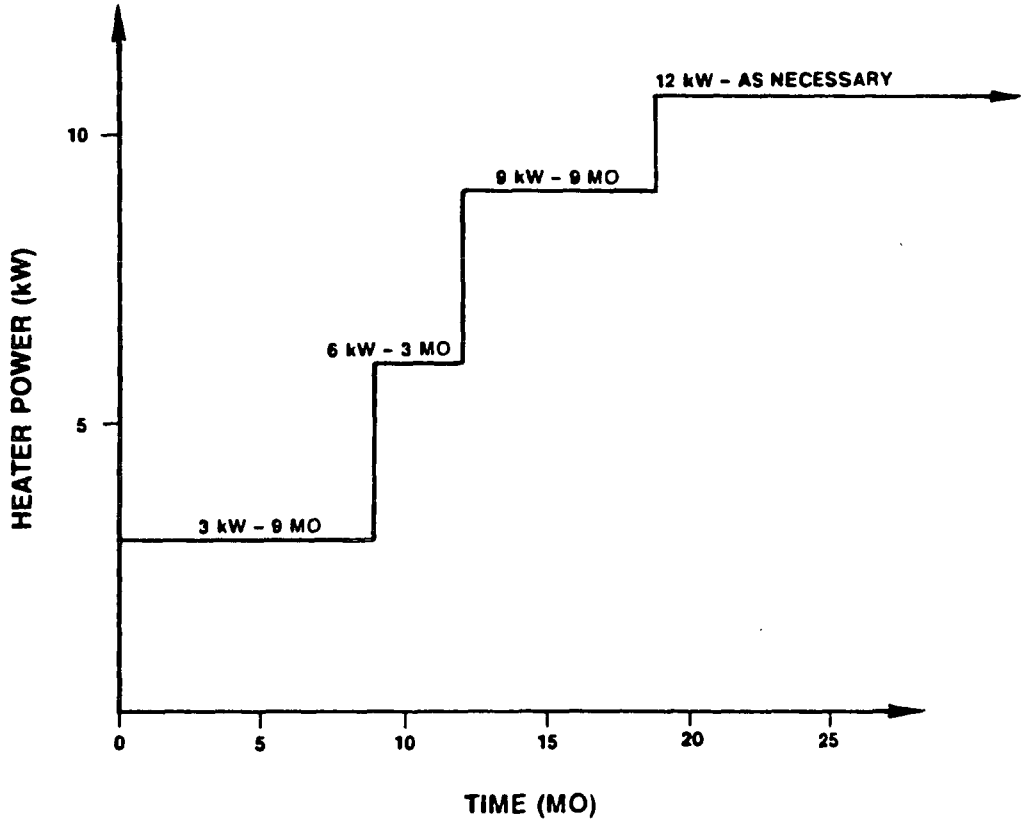
EXAMPLES OF TESTS PLANNED TO IMPROVE UNDERSTANDING OF THERMAL AND MECHANICAL EFFECTS

- IN SITU THERMOMECHANICAL PROPERTIES
  - HEATER EXPERIMENT IN HIGH-LITHOPHYSAL TOPOPAH SPRING TUFF
  - HEATED BLOCK TEST
  - HEATED ROOM EXPERIMENT
- EXCAVATION INVESTIGATIONS
  - SEQUENTIAL DRIFT MINING

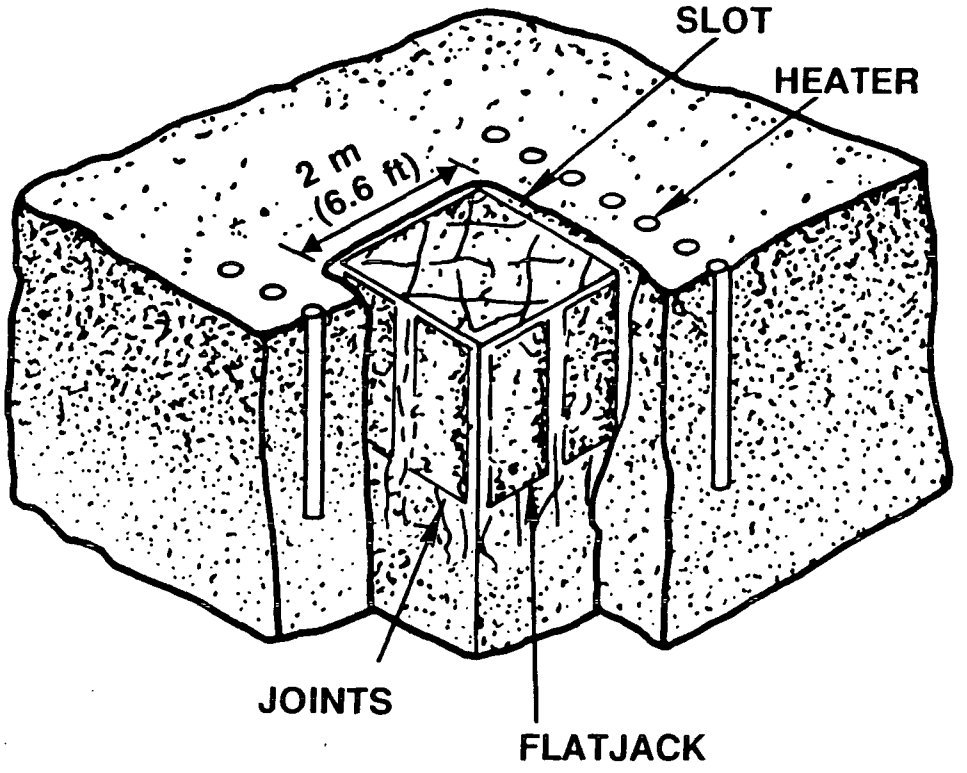
INSTRUMENTED HEATER EXPERIMENT



POWER SCHEDULE FOR THE CANISTER-SCALE HEATER



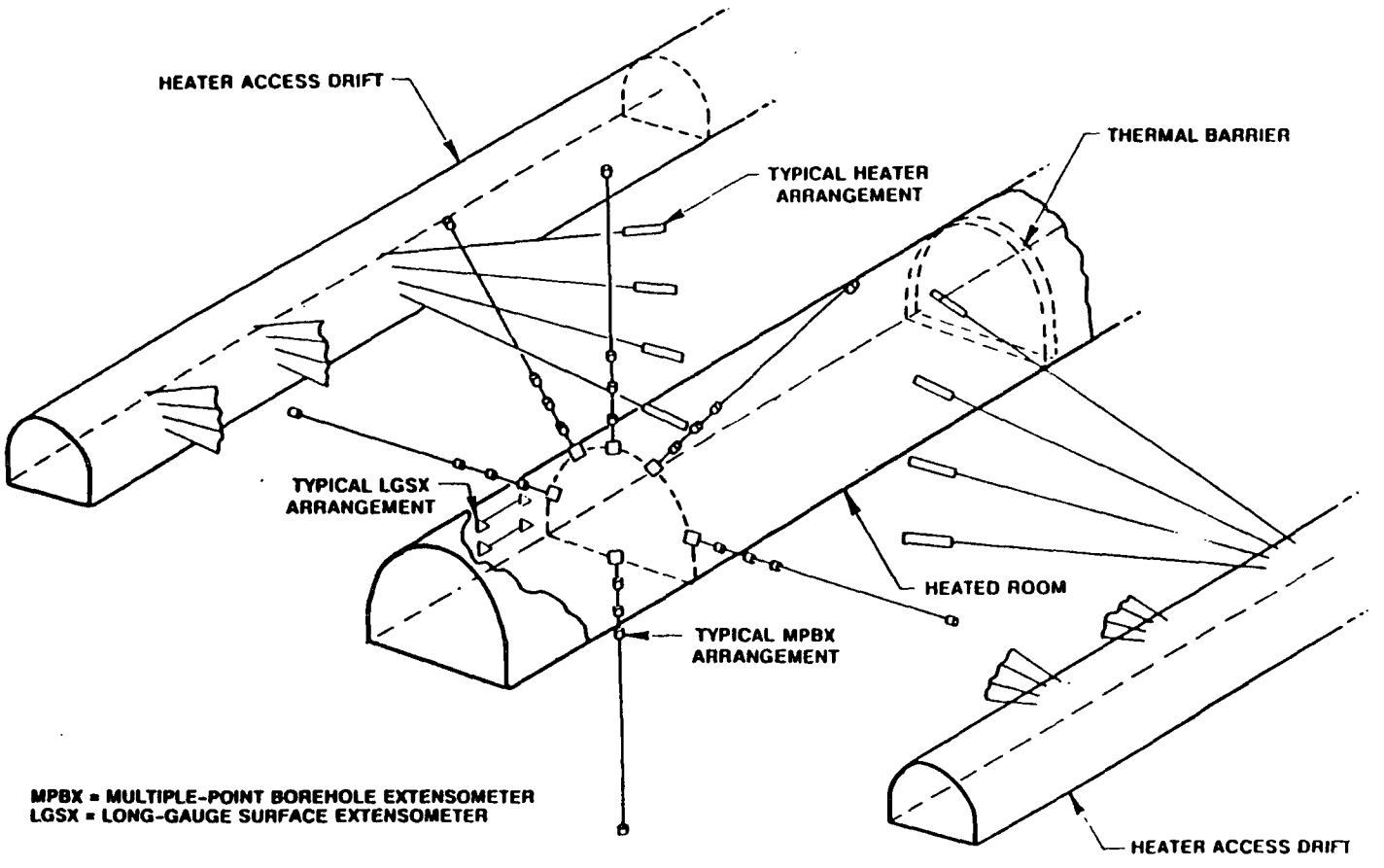
HEATED BLOCK EXPERIMENT



NOTE:
INSTRUMENTATION IN BOREHOLES AND ON THE SURFACE IS NOT SHOWN

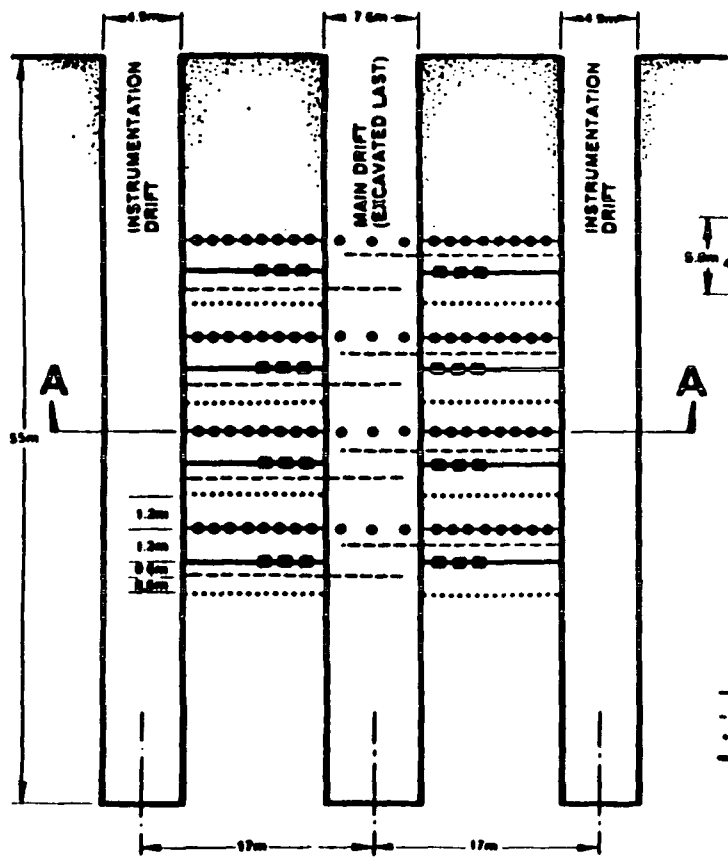
- MEASURE THREE-DIMENSIONAL DEFORMATION AND TEMPERATURE CHANGES FOR MODELING
- MEASURE RELATIONSHIPS AMONG FRACTURE PERMEABILITY, STRESS, AND TEMPERATURE
- MONITOR MOISTURE MOVEMENT RELATIVE TO TEMPERATURE
- EVALUATE CROSS-HOLE MEASUREMENT METHODS IN LARGE BLOCKS OF WELDED TUFF

HEATED ROOM TEST

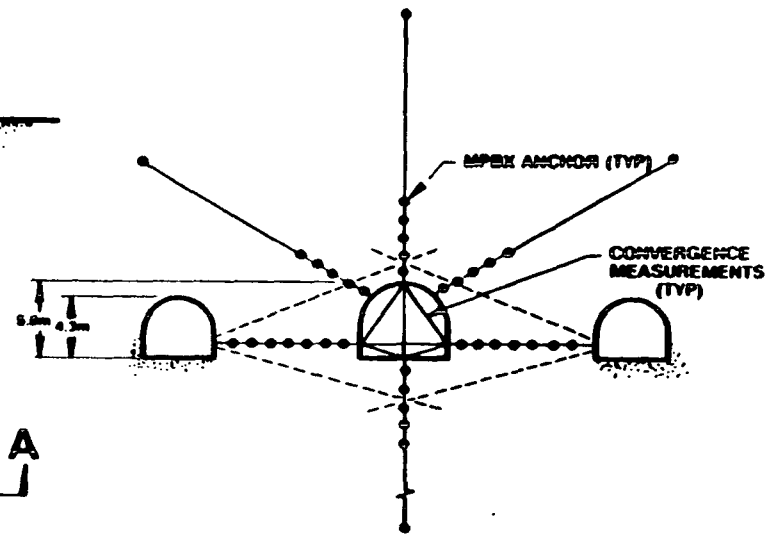


- **MEASURE THERMOMECHANICAL RESPONSES IN FRACTURED WELDED TUFF AT A DRIFT-SIZE SCALE TO ACQUIRE DATA FOR EVALUATING BOTH PRECLOSURE AND POSTCLOSURE DESIGN**

SEQUENTIAL DRIFT MINING EXPERIMENT



PLAN VIEW



SECTION A - A

MULTIPLE-POINT BOREHOLE EXTENSOMETER (MPBX)
BOREHOLE DEFLECTOMETER (BD)
BOREHOLE PERMEABILITY MEASUREMENTS (BP)
BOREHOLE STRESSMETER (BSM)

- DOCUMENT GEOMECHANICAL BEHAVIOR
- DEVELOP DATABASE TO VALIDATE MODELS
- DEFINE THE LIMITS OF THE RELAXED ZONE

SUMMARY

SUFFICIENT UNDERSTANDING OF THE SITE DATA COLLECTED AND THE UNCERTAINTY IN THAT DATA ALLOWS:

- DEVELOPMENT OF A FINAL DESIGN THAT CONTRIBUTES TO NATURAL BARRIER PERFORMANCE
- PERFORMANCE PREDICTIONS FOR THE SITE