

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

**NUCLEAR WASTE TECHNICAL REVIEW BOARD  
FULL BOARD MEETING**

**SUBJECT: UNDERGROUND TESTING AT THE  
EXPLORATORY STUDIES FACILITY**

**PRESENTER: NED Z. ELKINS**

PRESENTER'S TITLE  
AND ORGANIZATION: OFFICE MANAGER, ESF TEST COORDINATION OFFICE  
LOS ALAMOS NATIONAL LABORATORY

TELEPHONE NUMBER: (702) 794-7097

SALT LAKE CITY, UTAH  
JULY 11, 1995

# IN SITU TEST LOCATIONS AND IMPLEMENTATION LOGISTICS FOR ESF TESTS/PROGRAMS

(SOURCES: SITE PROGRAM ANNUAL PLAN 1994 & 1995, OMB 5-YEAR PLAN)

YEARS IN PARENTHESIS INDICATE INITIAL START (PLANNED OR ACTUAL) OF TEST OR FIRST PROGRAM COMPONENT

- I. CONSTRUCTION PHASE (NON-DEFERRABLE) TESTS CONDUCTED IN TBM ENVELOPE
- Consolidated Sampling (1993)
  - Perched Water Testing in the ESF (Contingency) (1993)
  - Hydrochemistry Tests in the ESF (1995)
  - Underground Geological Mapping (1993)
  - Construction Monitoring (1993)
- II. CONSTRUCTION PHASE (NON-DEFERRABLE) TESTS IN ALCOVES
- Consolidated Sampling (1994)
  - Radial Borehole Tests in the ESF (1994)
  - Hydrochemistry Tests in the ESF (1994)
  - Hydrologic Properties of Major Faults Encountered in the ESF (1995)
  - Underground Geological Mapping (1994)
  - Construction Monitoring (1994)
- III. DEFERRED TESTS IN THE ESF RAMPS/MAIN DRIFT
- Consolidated Sampling (1997)
  - Excavation Effects Test (1997)
  - Intact-Fracture Test in the ESF (1997)
  - Seismic Tomography/Vertical Seismic Profiling at the ESF (1997)
  - Construction Monitoring (1997)
  - Air Quality and Ventilation Experiment (1996)
  - In Situ Testing of Seal Components (1998)

## IN SITU TEST LOCATIONS AND IMPLEMENTATION LOGISTICS FOR ESF TESTS/PROGRAMS (CONTINUED)

(SOURCES: SITE PROGRAM ANNUAL PLAN 1994 & 1995, OMB 5-YEAR PLAN)

### IV. IN SITU ALCOVE TESTS IN THE CORE TEST AREA/RAMP EXTENSIONS (TSw2) (Including Deferred Ramp Alcoves)

- Consolidated Sampling (1996)
- Radial Borehole Tests in the ESF (1997)
- Hydrochemistry Tests in the ESF (1996)
- Hydrologic Properties of Major Faults Encountered in the ESF (1996)
- Underground Geological Mapping (1996)
- Construction Monitoring (1996)
- Percolation Tests in the ESF (1996)
- Diffusion Tests in the ESF (1996)
- Thermal/Mechanical Properties (1996)
- Near-Field Hydrologic/Geomechanical Properties (1996)

### V. PLANNED TESTS IN CALICO HILLS NONWELDED UNIT (All Tests TBD)

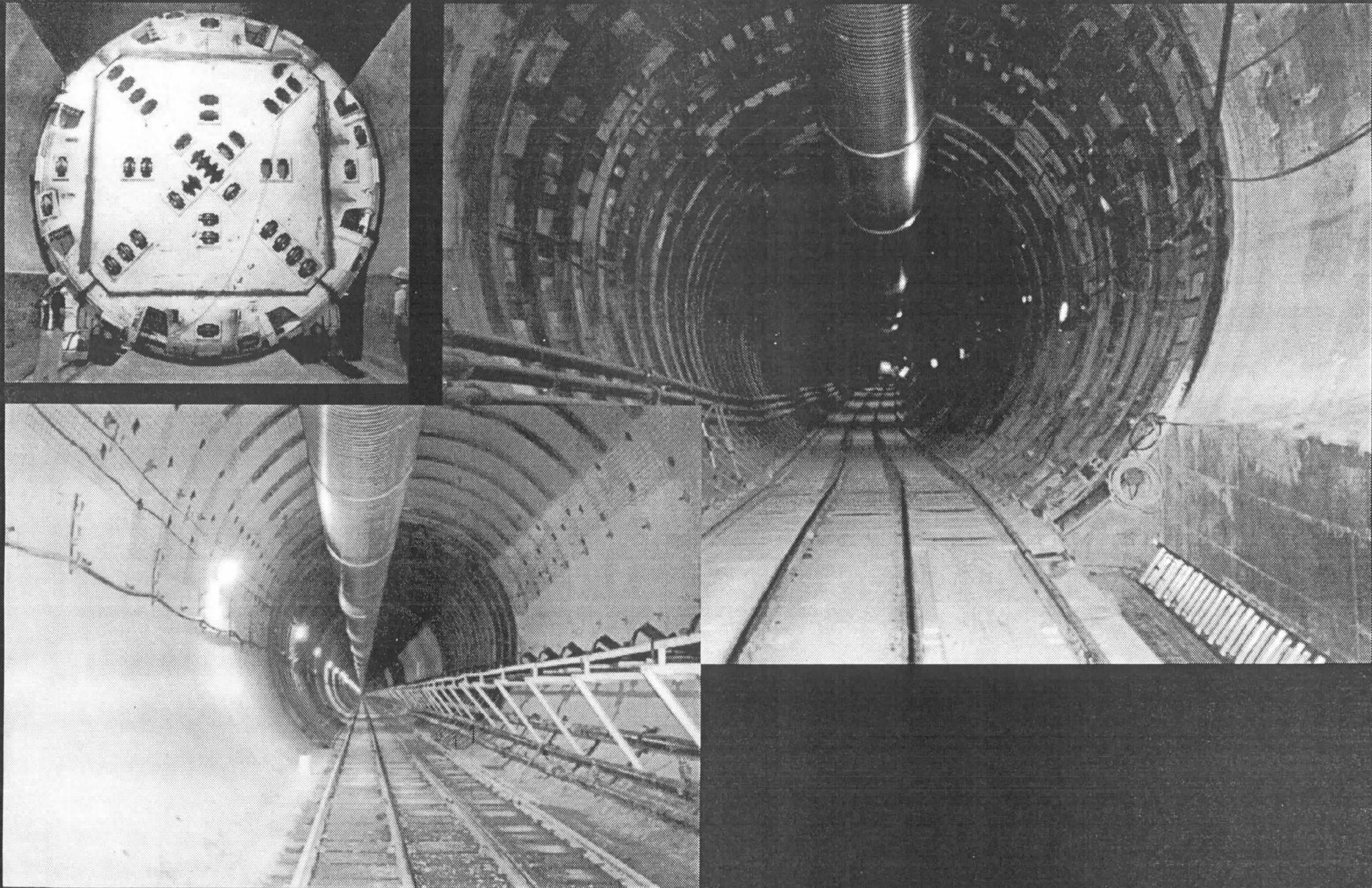
- Underground Geological Mapping
- Consolidated Sampling
- Field Scale Experiments to Study Radionuclide Transport at YM
- Intact-Fracture Test
- Percolation Tests in the ESF
- Radial Borehole Tests in the ESF/Bulk Permeability Tests in the ESF
- Hydrochemistry Tests in the ESF
- Diffusion Test in the ESF
- In Situ Testing of Seal Components

# **CURRENT ESF FIELD TESTING STATUS**

## **PROGRAMS ONGOING:**

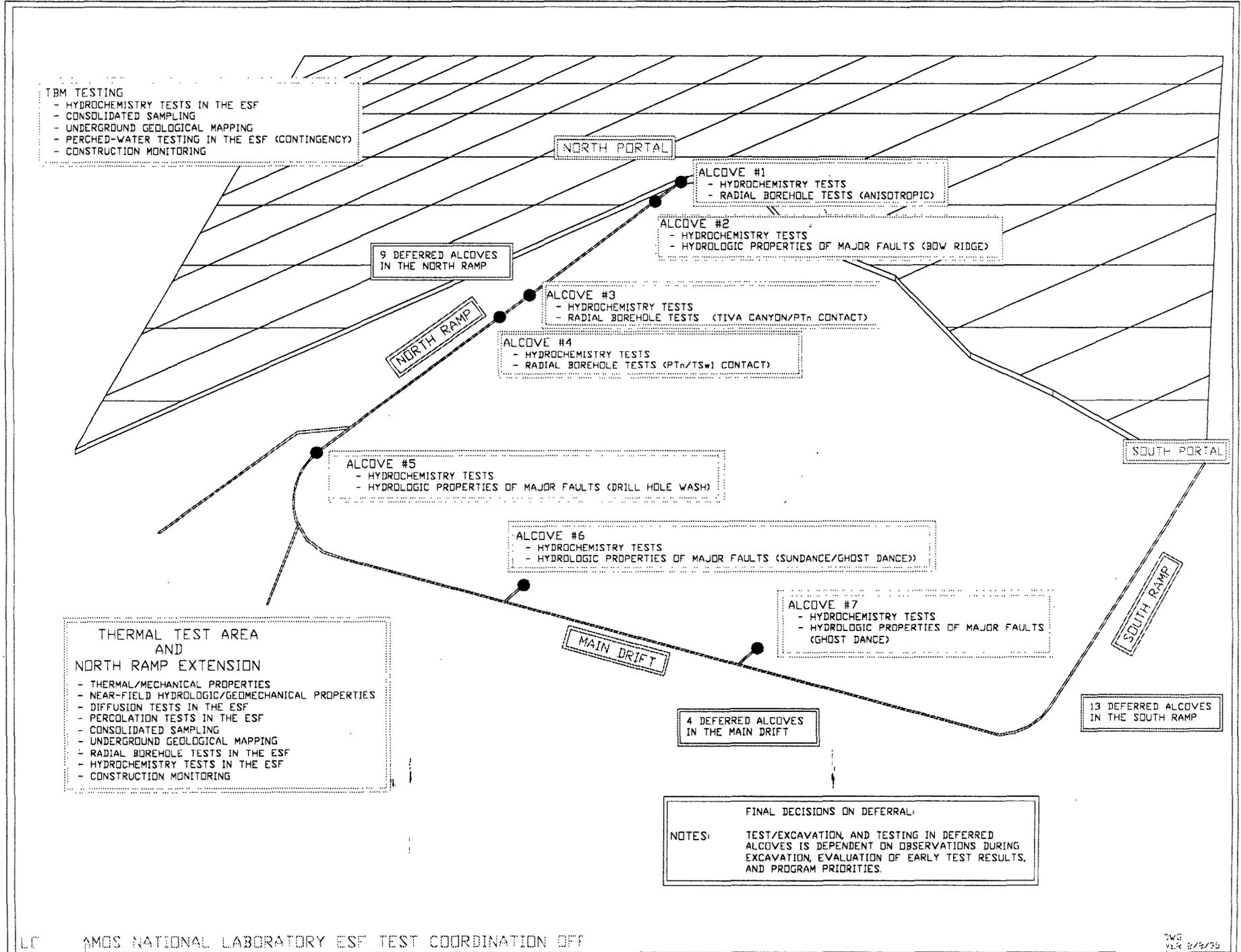
- **GEOLOGIC MAPPING/SAMPLING (14 STUDY PLANS)**
- **GEOHYDROLOGY (1 STUDY PLAN)**
- **CONSTRUCTION MONITORING ( 2 STUDY PLANS)**
- **CONSOLIDATED THERMAL TESTING ( 2 STUDY PLANS)**
  - **FRAN RIDGE LARGE BLOCK (FIELD PREPARATION)**
  - **ESF IN SITU TEST (PLANNING/DESIGN UNDERWAY FOR LATE FY 96 INITIATION)**

# EXCAVATION STATUS - ESF NORTH RAMP

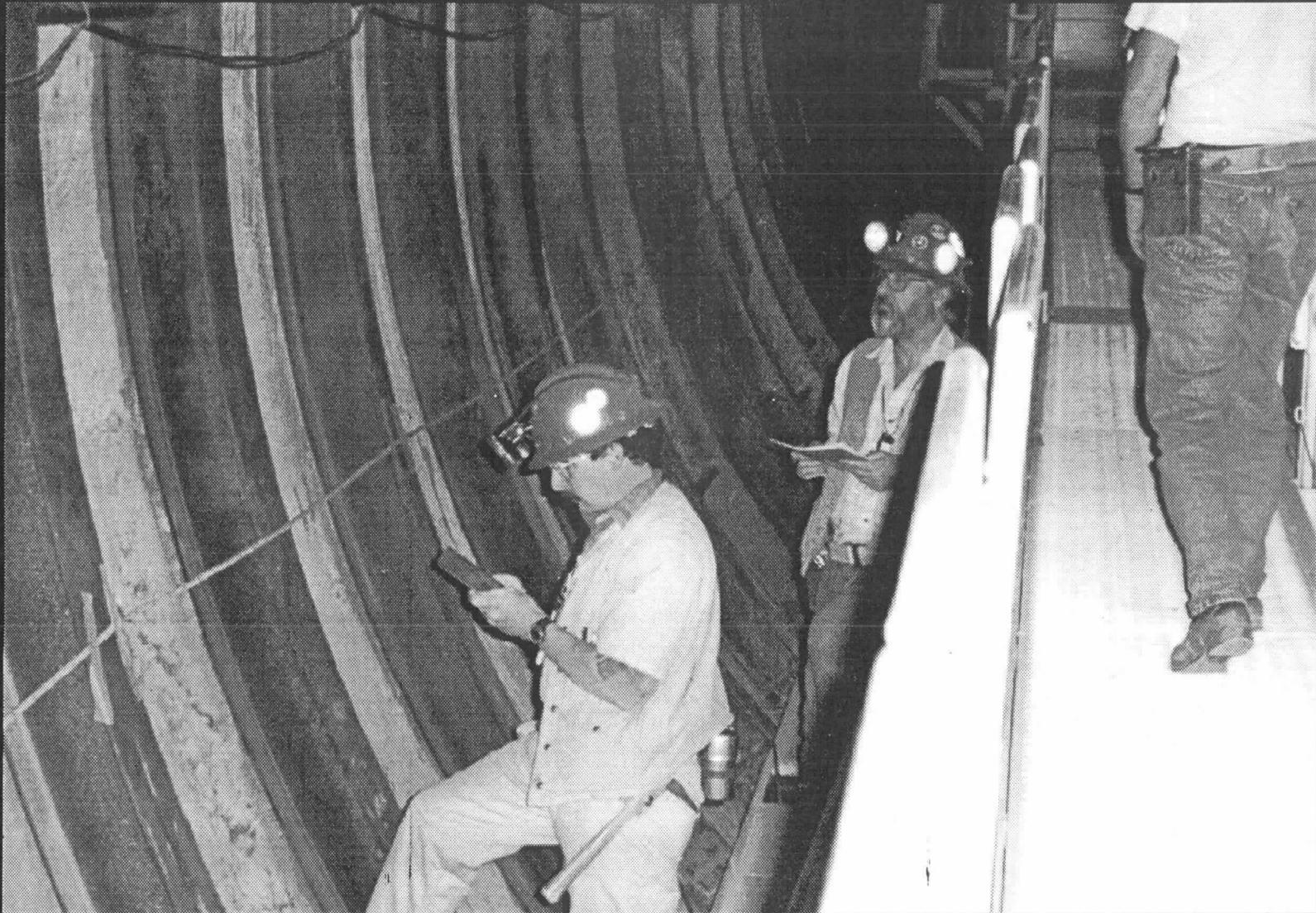


AS OF JULY 10, 1995, THE HEAD OF THE TBM IS AT STATION 11+38 METERS.

# EXPLORATORY STUDIES FACILITY - TEST LOCATIONS



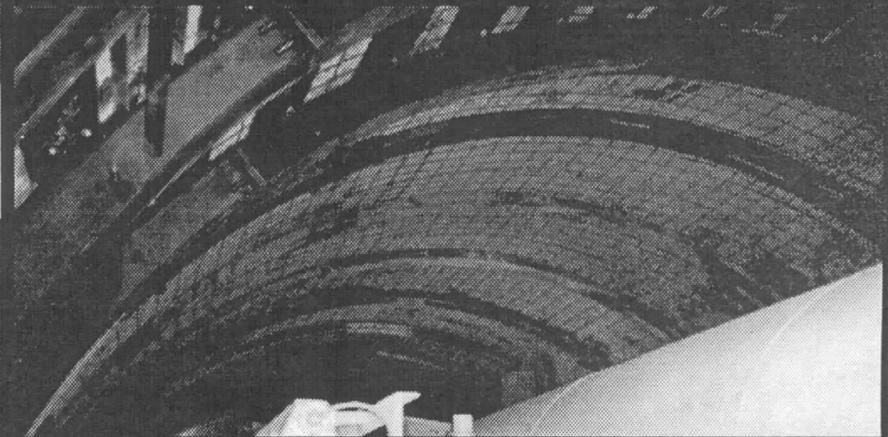
# GEOLOGIC MAPPING IN THE ESF



**AS OF JULY 10, 1995:**

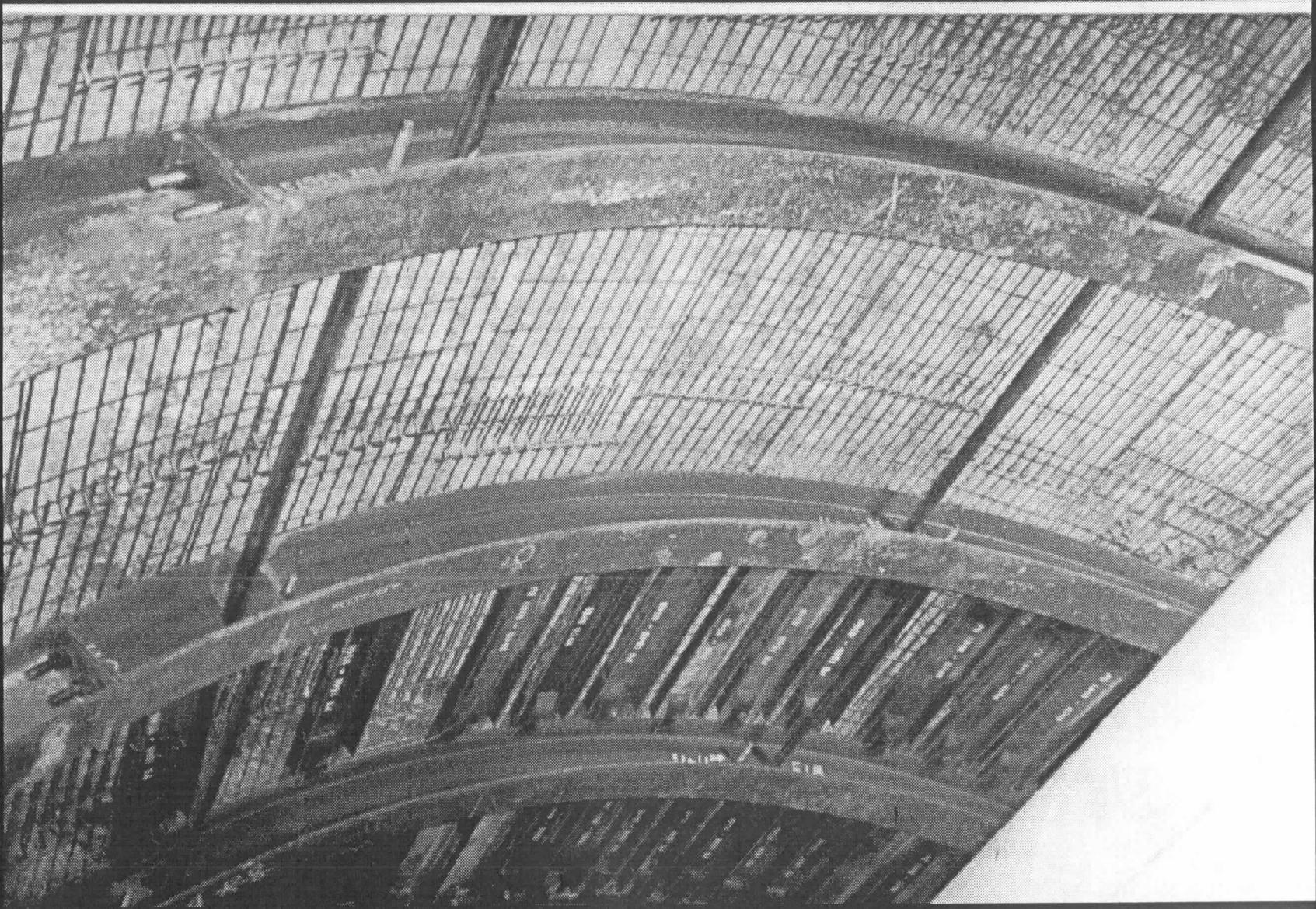
<b>FULL PERIPHERY MAPPING COMPLETED TO</b>	-	<b>CS 10+50 m</b>
<b>TUNNEL PHOTOGRAMMETRY COMPLETED TO</b>	-	<b>CS 10+60 m</b>
<b>RQD CLASSIFICATION COMPLETED TO</b>	-	<b>CS 10+40 m</b>
<b>DETAILED LINE SURVEY COMPLETED TO</b>	-	<b>CS 10+41 m</b>

# IMPACT OF GROUND CONDITIONS ON GEOLOGIC CHARACTERIZATION



**GROUND CONDITIONS AND IMPLEMENTED SUPPORT SYSTEMS VARIOUSLY AFFECT SITE CHARACTERIZATION ACTIVITIES. ESF DESIGNERS, CONSTRUCTORS, AND TEST MANAGERS WORK CLOSELY TO FACILITATE EFFECTIVE FIELDING OF TESTS.**

# GROUND SUPPORT INNOVATION FOR MAPPING EFFICIENCY



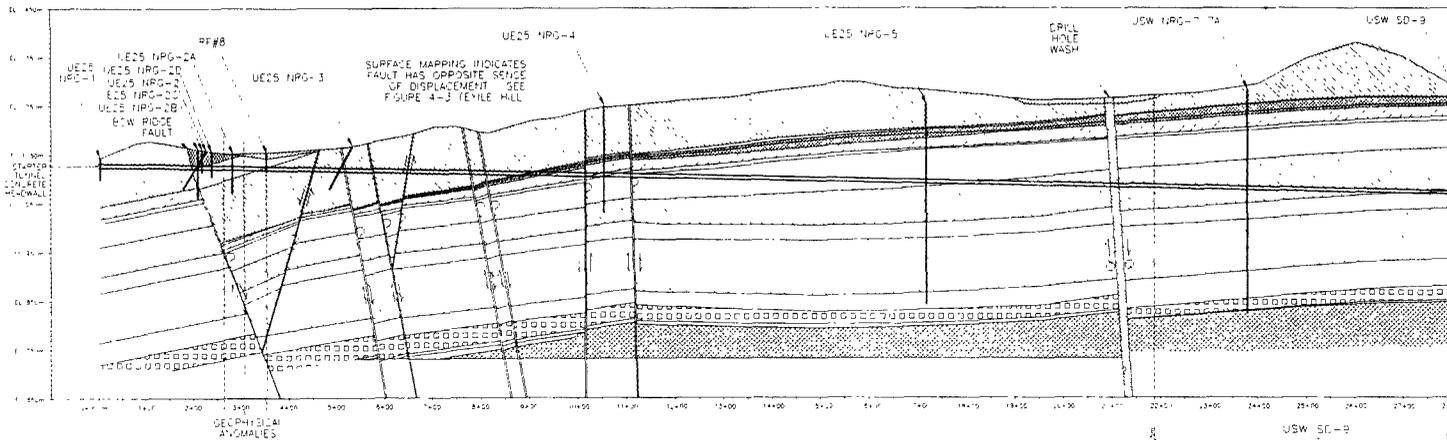
**AS AN ALTERNATIVE TO LAGGING BETWEEN STEEL SETS IN CERTAIN GROUND CONDITIONS, INTERLOCKING 2x6 INCH MESH IS NOW BEING INSTALLED WHERE APPROPRIATE IN THE NORTH RAMP. THE USE OF THIS MESH PROVIDES A BETTER EXPOSURE OF THE TUNNEL CIRCUMFERENCE AND FACILITATES MORE PRODUCTIVE GEOLOGIC MAPPING.**

# ADMINISTRATIVE RAMP CROSS SECTION: LITHOLOGY AND BOREHOLE PROJECTIONS

Produced for Sandia National Laboratories

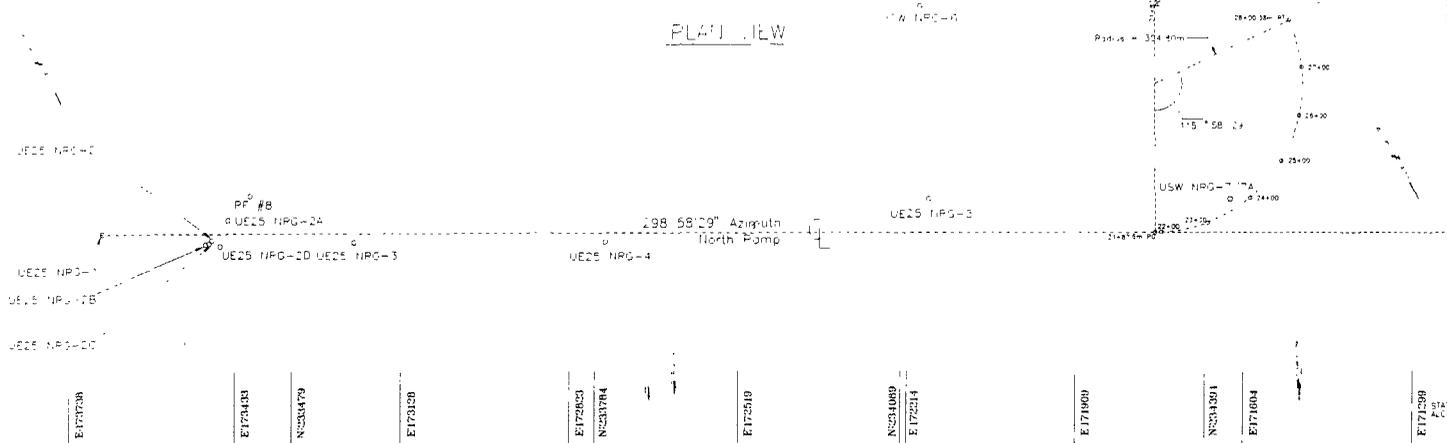
## SECTION VIEW

## SYMBOLS



GROUP	FORMATION	INTERNAL UNITS	THERMO-MECHANICAL UNITS
TRINIDAD MOUNTAIN TYPE	PARKER MPTS	U1: Alluvium	
		U2: Granitic gneiss	
		U3: Meta-sedimentary, fine grained, calcareous	U3
		U4: Meta-sedimentary, fine grained, calcareous	
		U5: Meta-sedimentary, fine grained, calcareous	
		U6: Meta-sedimentary, fine grained, calcareous	
		U7: Meta-sedimentary, fine grained, calcareous	
		U8: Meta-sedimentary, fine grained, calcareous	
		U9: Meta-sedimentary, fine grained, calcareous	
		U10: Meta-sedimentary, fine grained, calcareous	
BARTON MOUNTAIN TYPE	PARKER MPTS	U11: Meta-sedimentary, fine grained, calcareous	U11
		U12: Meta-sedimentary, fine grained, calcareous	
		U13: Meta-sedimentary, fine grained, calcareous	
		U14: Meta-sedimentary, fine grained, calcareous	
SANDIA MOUNTAIN TYPE	PARKER MPTS	U15: Meta-sedimentary, fine grained, calcareous	U15
		U16: Meta-sedimentary, fine grained, calcareous	
		U17: Meta-sedimentary, fine grained, calcareous	
CALICO HILLS	PARKER MPTS	U18: Meta-sedimentary, fine grained, calcareous	U18
		U19: Meta-sedimentary, fine grained, calcareous	

## PLAN VIEW



## STRATIGRAPHIC NOMENCLATURE DEVELOPED BY USGS

- DRILL HOLE WASH FAULT ZONE LOCATION AND ATTITUDE UNCERTAIN
- B/W RIDGE FAULT ZONE
- MINOR FAULT ATTITUDE UNCERTAIN
- PROPOSED NORTH RAMP ALIGNMENT
- APPROXIMATE
- STRAKE-SLIP SEPARATION INTO PAGE
- STRAKE-SLIP SEPARATION INTO PAGE

### PRELIMINARY RAMP DATA ADMINISTRATIVE ONLY

Station	Grade	State Plane Coord (m)	Site Plane Coord (m)	Elevation (m)
2370		232205.0	13675.8	1122.55
2400		234339.4	17175.5	1029.79
2430		236473.8	20775.2	937.03
2460		238608.2	24374.9	844.27
2490		240742.6	27974.6	751.51
2520		242877.0	31574.3	658.75
2550		245011.4	35174.0	566.00
2580		247145.8	38773.7	473.24
2610		249280.2	42373.4	380.48
2640		251414.6	45973.1	287.72
2670		253549.0	49572.8	194.96

Reference: (a) M-53-1020 and verbal communication from M-7, December 1993

### BOREHOLE PROJECTIONS ADMINISTRATIVE ONLY

Borehole	Projected to Station (m)	Ground Elevation (m)	Distance to Surface (m)
UE25 NPG-1	NP	1144.00	0.0
UE25 NPG-2	NP	1172.22	15.20
UE25 NPG-3	NP	1192.31	30.60
UE25 NPG-4	NP	1198.67	46.00
UE25 NPG-5	NP	1198.60	22.34
USW NPG-7	NP	1193.92	28.96
USW SD-9	NP	1182.35	20.20
USW NPG-1	NP	1249.67	18.52
USW NPG-2	NP	1251.71	88.44
USW NPG-3	NP	1252.78	22.08
USW NPG-4	NP	1254.33	86.52
USW SD-9	NP	1302.28	72.60

Note: Boreholes projected into cross section using strike of rock units.  
NP = Not projected.  
USW SD-9 Projected approximately down-slope to nearest point on cross section.

### FOR INFORMATION ONLY - NOT CONTROLLED

CSF NORTH RAMP CHARACTERIZATION PROJECT  
TRANSVERSE SECTION ALONG RAMP FROM 0+00 TO 28+00 (38m) P11

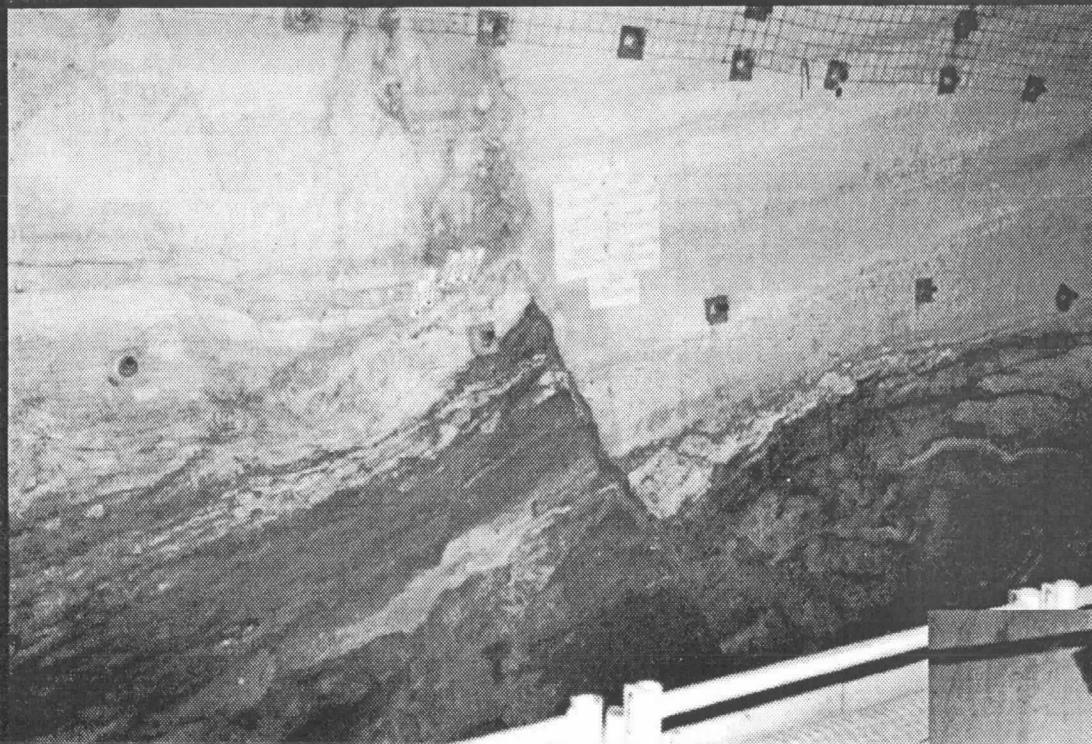
Sandia National Laboratories

DATE DRAWN: 11/28/93  
SCALE: AS SHOWN  
INDICATORS: 1-1-94 VERT. SCALE: AS SHOWN

TH NAME LETTER FROM: J. H. MOSELEY (JHMOSE)

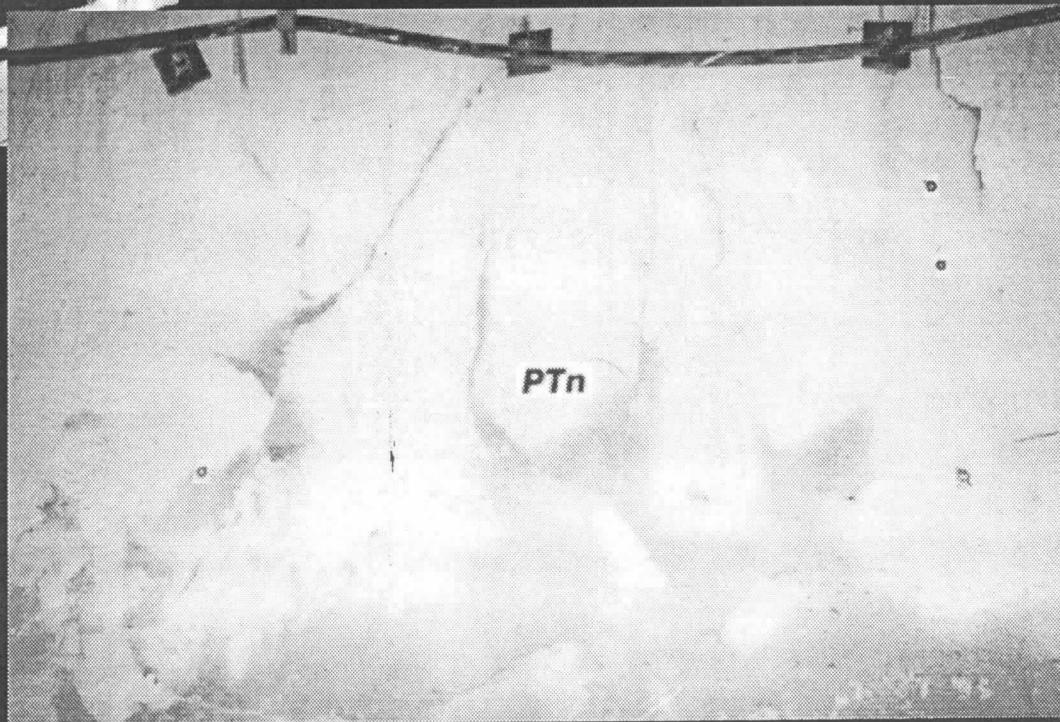
JOB NO: 88-80-09  
DRAWING NO: 28-80-09  
SHEET: 11

# RECENT GEOLOGIC CONDITIONS IN THE ESF

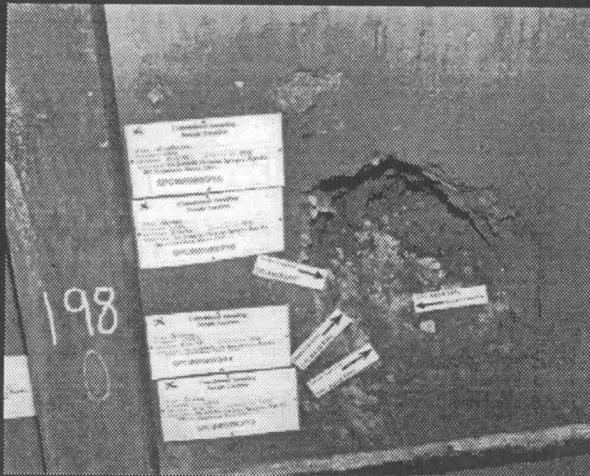


ALTERED TUFF (Tpbt2) BISECTED BY FAULT PLANE AT STATION 10+31 m,  
LEFT RIB

UPPER PAINTBRUSH NONWELDED (PTn) AT APPROX. CS 7+51 m



# CONSOLIDATED SAMPLING IN THE ESF

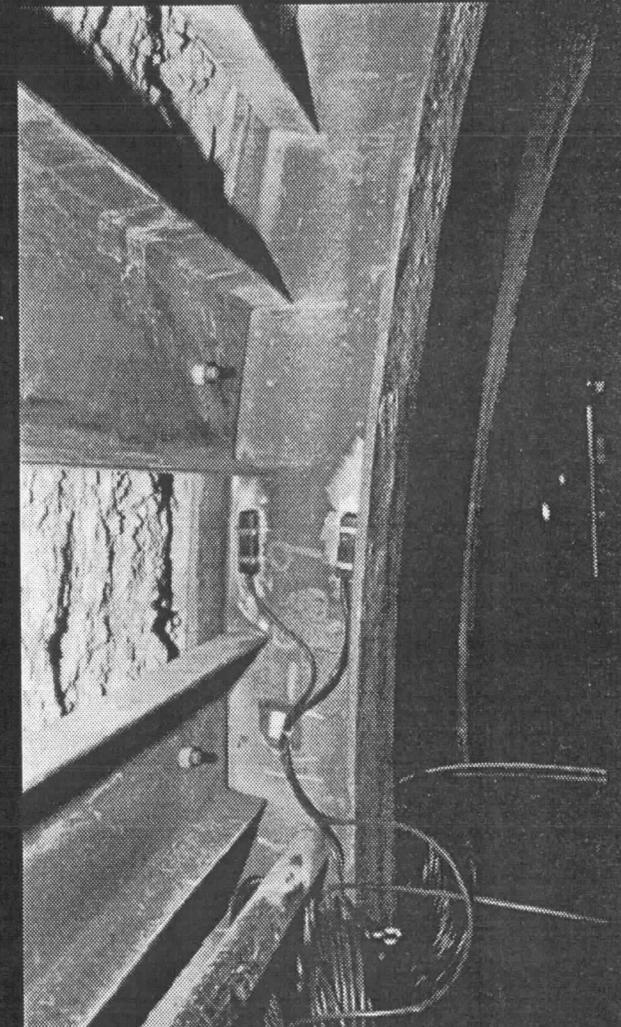
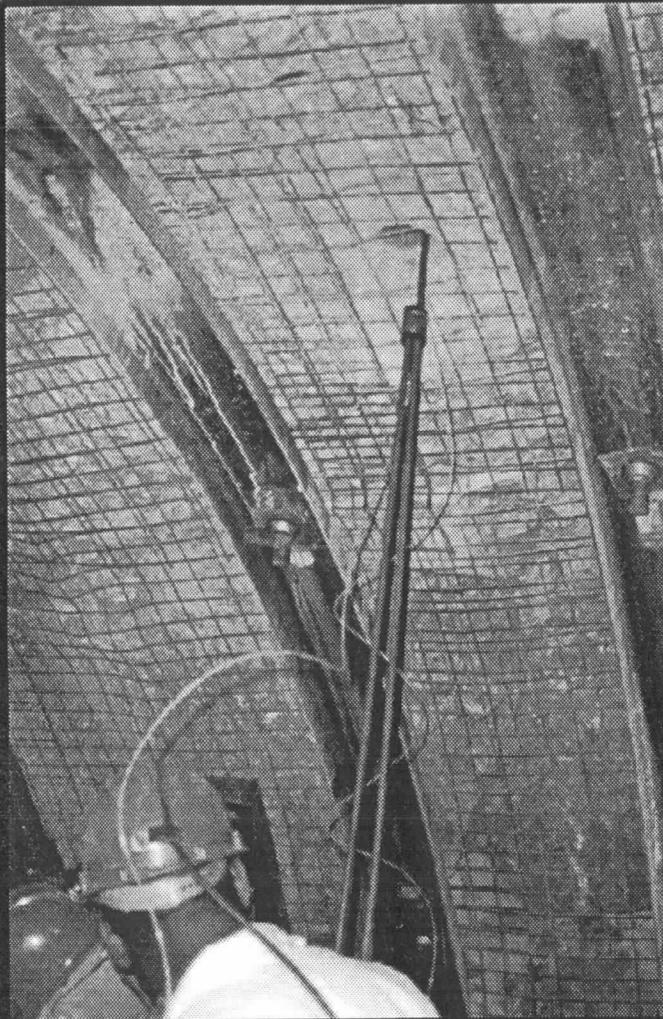


## LIST OF STUDIES SUPPORTED BY CONSOLIDATED SAMPLING PROGRAM:

- LABORATORY DETERMINATION OF MECHANICAL PROPERTIES OF INTACT ROCK
- LABORATORY DETERMINATION OF THE MECHANICAL PROPERTIES OF FRACTURES
- IN-SITU DESIGN VERIFICATION
- CHARACTERIZATION OF THE EFFECT OF INTRODUCED MATERIALS ON CHEMICAL AND MINERALOGICAL CHANGES IN THE POST-EMPLACEMENT ENVIRONMENT
- WATER MOVEMENT TESTS, REV. 1
- CHARACTERIZATION OF THE PERCOLATION IN THE UNSATURATED ZONE - SURFACE-BASED STUDY
- CHARACTERIZATION OF THE PERCOLATION IN THE UNSATURATED ZONE - ESF INVESTIGATION
- MINERALOGY, PETROLOGY, AND CHEMISTRY TRANSPORT PATHWAYS
- HISTORY OF MINERALOGIC AND GEOCHEMICAL ALTERATION OF YM
- BIOLOGICAL SORPTION AND TRANSPORT
- CHARACTERIZATION OF STRUCTURAL FEATURES IN THE SITE AREA
- CHARACTERIZATION OF YUCCA MOUNTAIN QUATERNARY REGIONAL HYDROLOGY
- UNSATURATED ZONE HYDROCHEMISTRY
- LABORATORY THERMAL PROPERTIES

AS OF JUNE 28, 1995, 668 SAMPLES HAVE BEEN COLLECTED IN THE STARTER TUNNEL, ESF NORTH RAMP AND ALCOVES IN SUPPORT OF 14 STUDY PLANS.

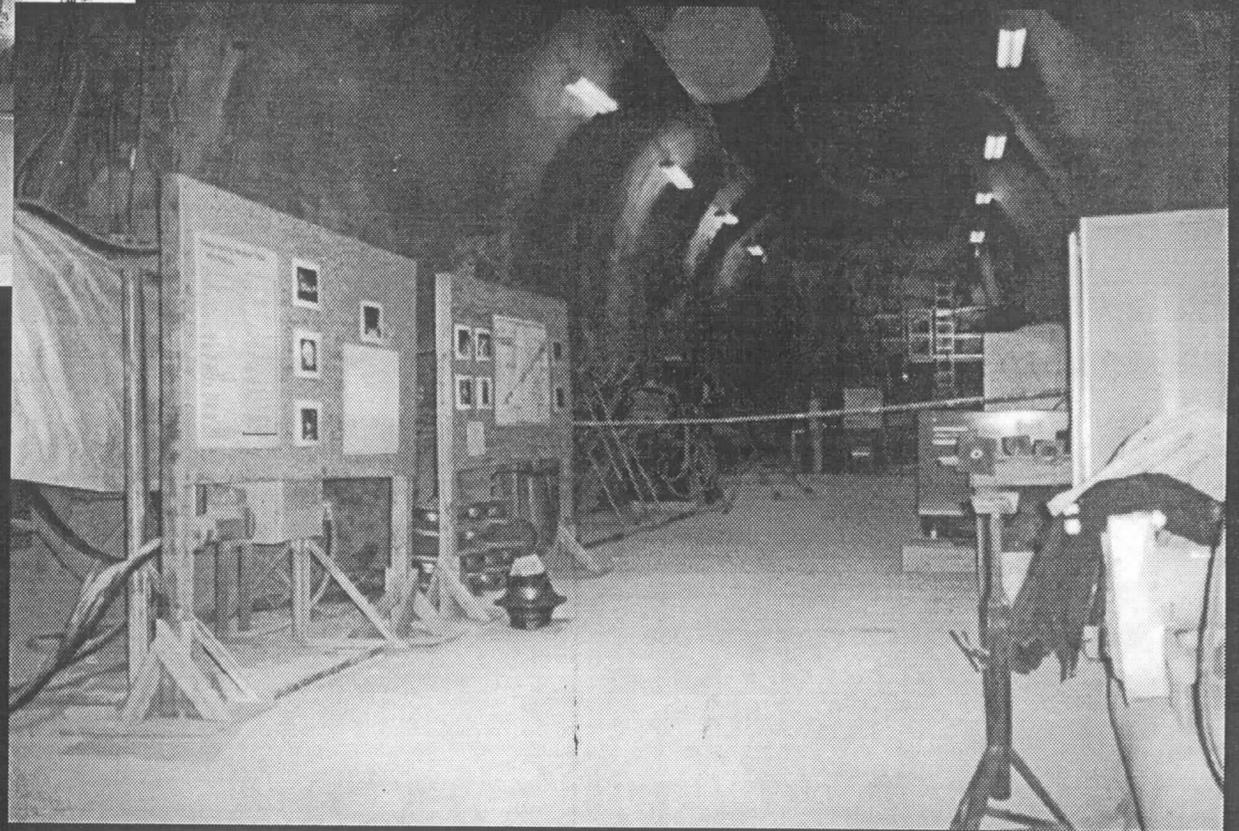
# CONSTRUCTION MONITORING IN THE ESF



AS OF JULY 10, 1995, 26 STEEL SETS HAVE BEEN INSTRUMENTED WITH 6-POINT CONVERGENCE PINS AND A TOTAL OF 324 STRAIN GAUGES. 4 MPBXs AND 1 SPBX HAVE BEEN INSTALLED IN THE ESF NORTH RAMP, AND 1 MPBX AND 2 SPBXs WERE INSTALLED IN ALCOVE #1 FOR THE MEASUREMENT OF ROCK DEFORMATION. RQD SCAN LINES ARE CONDUCTED ON 5 METER INTERVALS BEHIND THE TBM SHIELD.

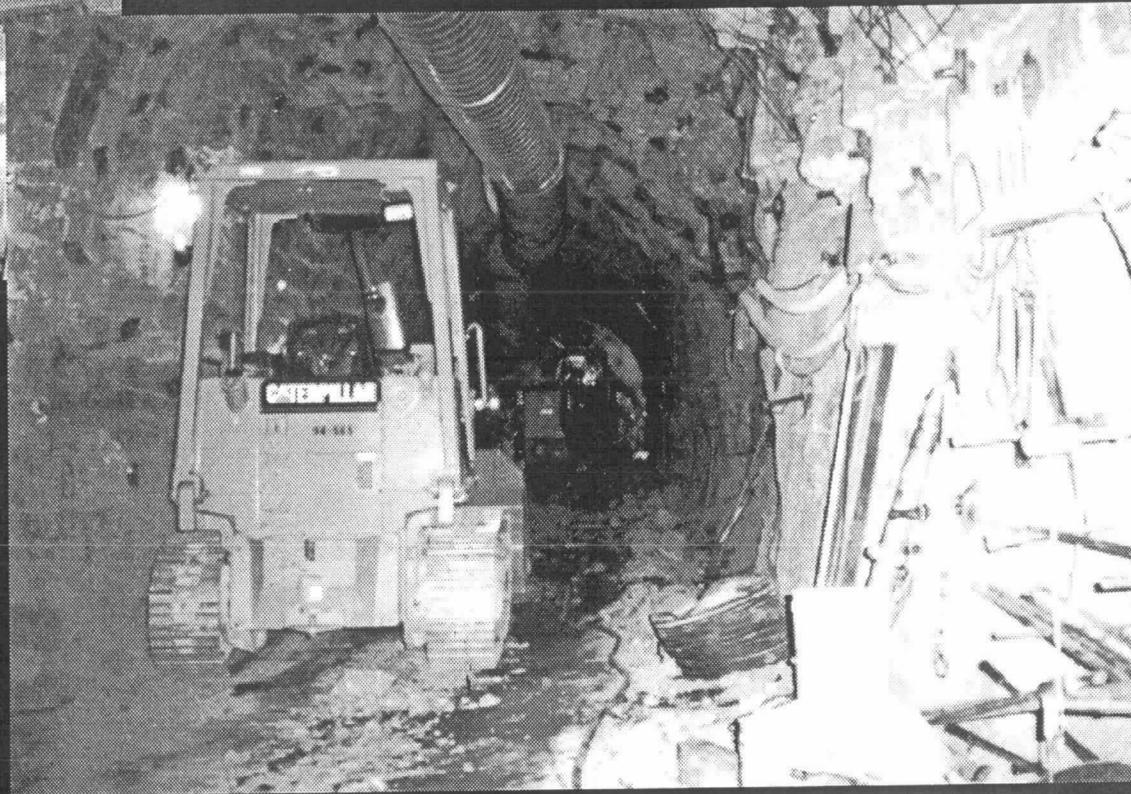
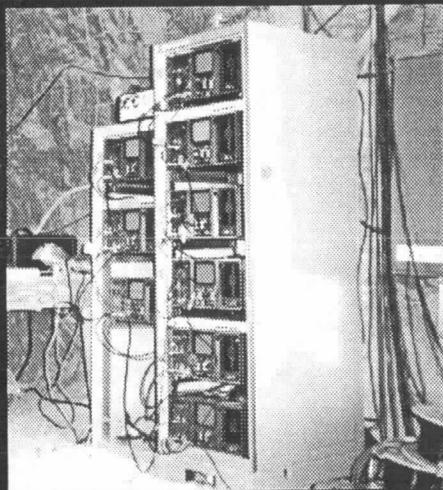
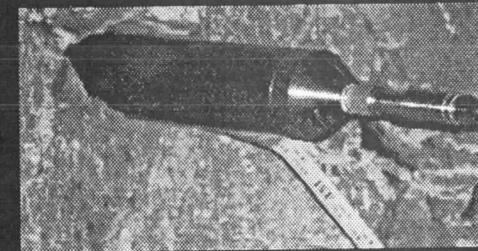
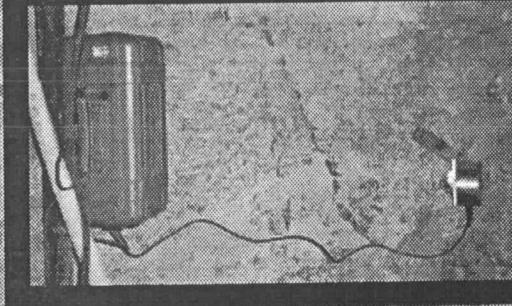
# GEOHYDROLOGY TESTING STATUS

## ESF ALCOVE 1



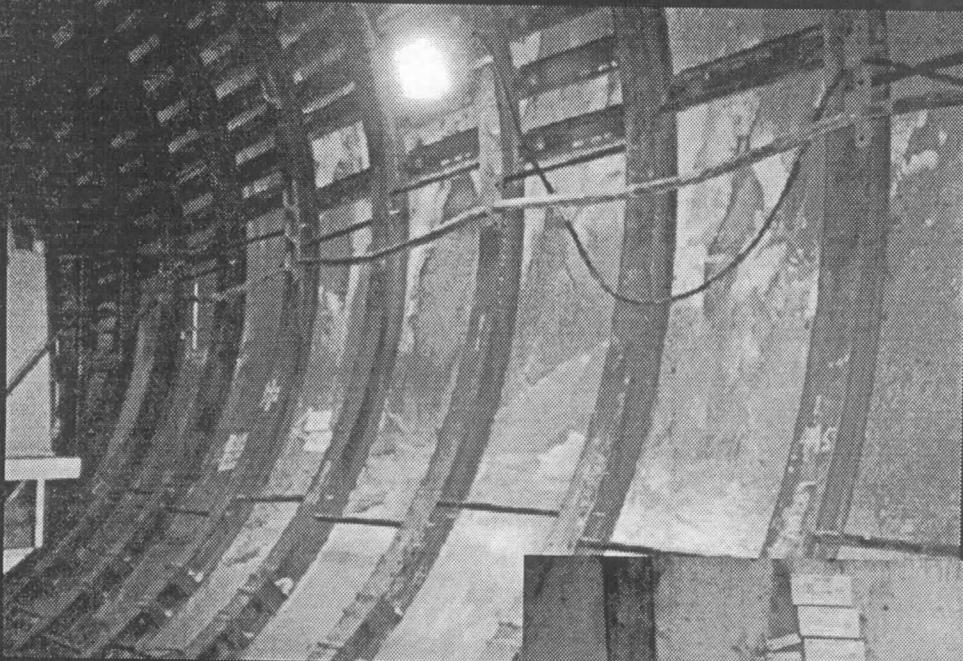
ESF ALCOVE #1, LOCATED AT APPROXIMATELY CS 0+40 m, WAS CONSTRUCTED TO INITIATE HYDROCHEMISTRY AND RADIAL BOREHOLE TESTING IN APRIL, 1994. CROSS-HOLE TESTING BEGAN IN APRIL, 1995. THE FIRST 10 METERS OF ALCOVE #1 IS BEING USED AS A DISPLAY AND INFORMATION AREA FOR UNDERGROUND TOURS OF THE ESF.

## ESF ALCOVE 2

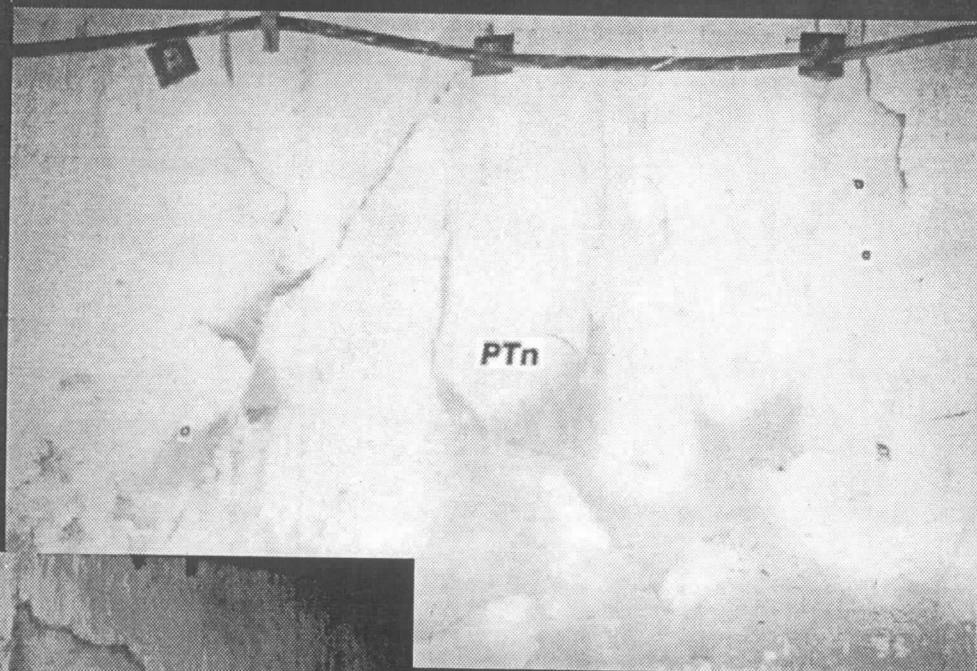


**FINAL PREPARATION FOR ALCOVE #2 BEGAN IN MARCH, 1995 AND IS LOCATED AT APPROXIMATELY CS 1+70 m. THE ALCOVE WILL BE USED FOR THE TESTING OF HYDROLOGIC PROPERTIES OF THE BOW RIDGE FAULT. DURING THE CONSTRUCTION, SANDIA NATIONAL LABORATORIES IS MONITORING CONSTRUCTION EFFECTS WITH STRAIN GAGES AND ACCELEROMETERS. AS OF JULY 10, THE ALCOVE IS APPROXIMATELY 37 m LONG.**

# ESF ALCOVE 3



CS 7+70



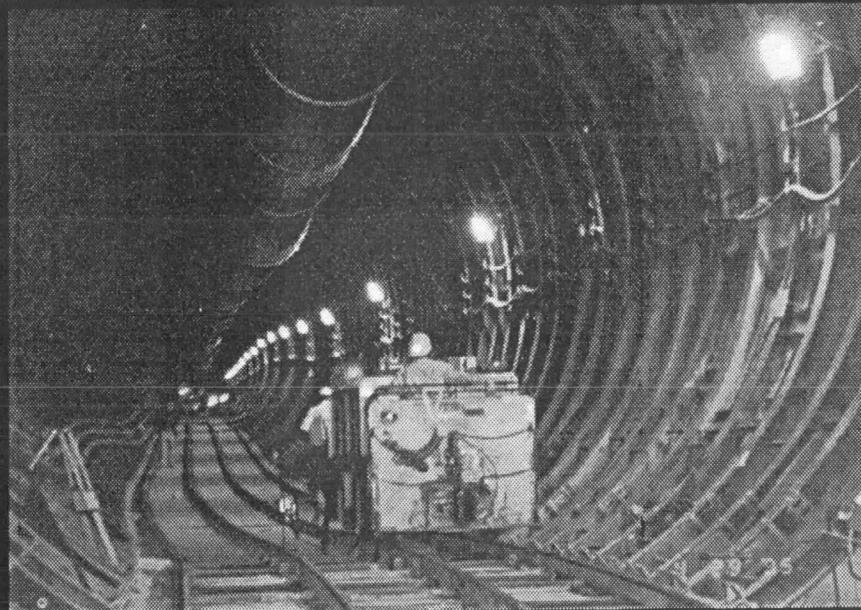
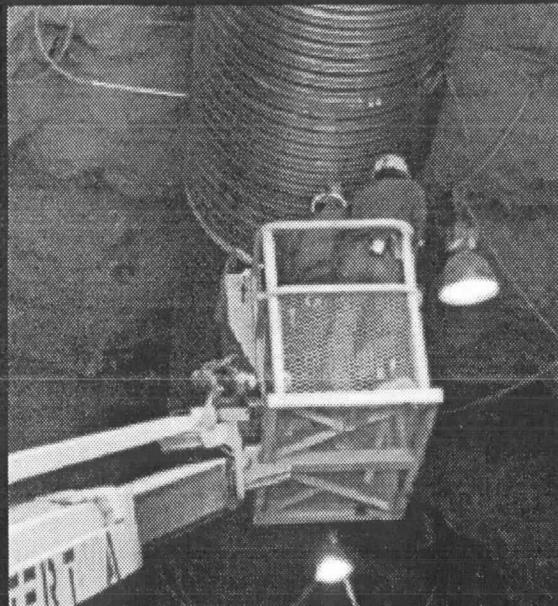
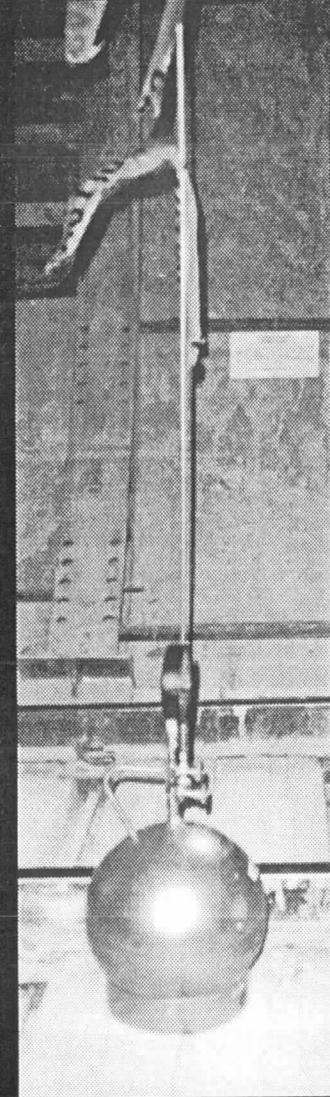
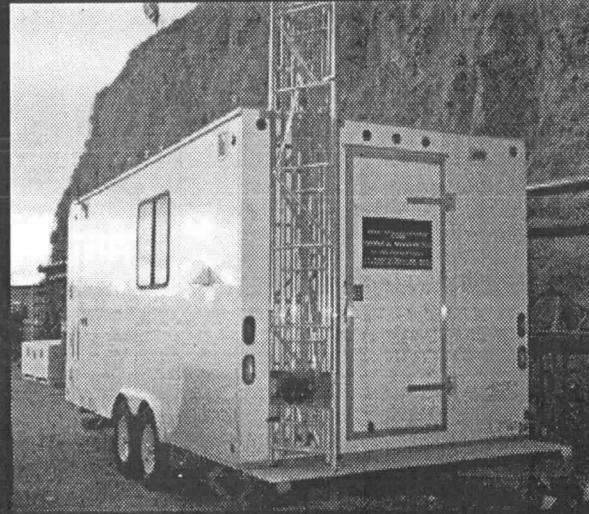
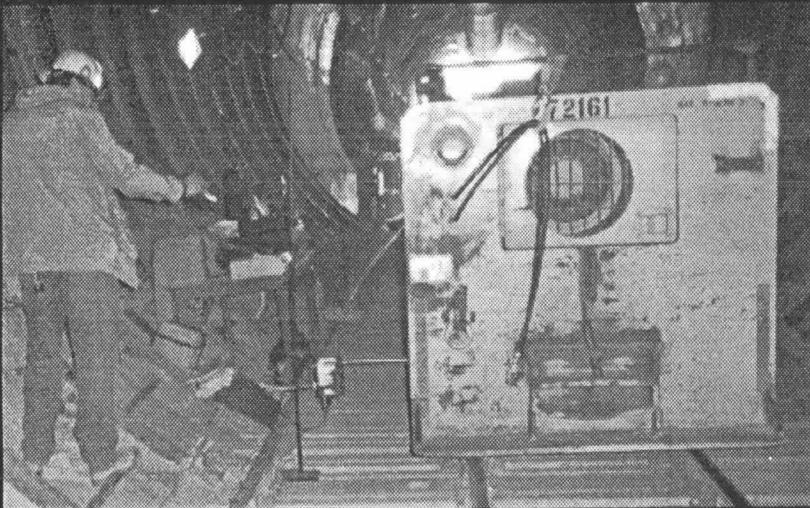
CS 7+50



CS 7+60

ALCOVE #3 WILL BE PLACED SUCH THAT TWO GEOHYDROLOGIC FEATURES CAN BE TESTED: AT APPROXIMATELY 7+50, THE TIVA CANYON DENSELY WELDED TO UPPER PAINTBRUSH NONWELDED CONTACT (UPPER RIGHT) AND AT APPROXIMATELY 7+70, THE LITHOSTRATIGRAPHIC CRYSTAL POOR LOWER NONLITHOPHYSAL TO THE CRYSTAL POOR CONTACT (UPPER LEFT). THE LOWER PHOTO SHOWS A POTENTIAL ALCOVE BREAKOUT LOCATION.

# DIESEL EMISSIONS TESTING IN THE ESF



THE DIESEL EXHAUST EMISSIONS STUDY WAS CONDUCTED IN THE ESF NORTH RAMP AT STATION 0+70 m ON APRIL 29, 1995. THE STUDY WAS ESTABLISHED TO CARRY OUT ESF VENTILATION AIR COMPOSITION ANALYSIS BEFORE, DURING, AND AFTER THE OPERATION OF A LOCOMOTIVE DIESEL ENGINE PARKED IN THE TUNNEL'S VENTILATION AIR STREAM. AT RIGHT IS THE VOLATILE ORGANIC COMPOUNDS (VOC) SAMPLE BOTTLE.

# DIESEL EXHAUST VENTILATION TEST - APRIL 29, 1995

Tunnel Face at: 633.86 Meters  
Average Ventilation Flow Rate: 1166.41 Cubic Meters/Min  
Average Dilution Rate: 93.39:1  
Total Air Change: 26.30 Min

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## AVERAGE EXHAUST CONSTITUENT VALUES

### At Locomotive

NOX 42.6 (ppm)  
SOX 0.0\* (ppm)  
CO 15.5 (ppm)

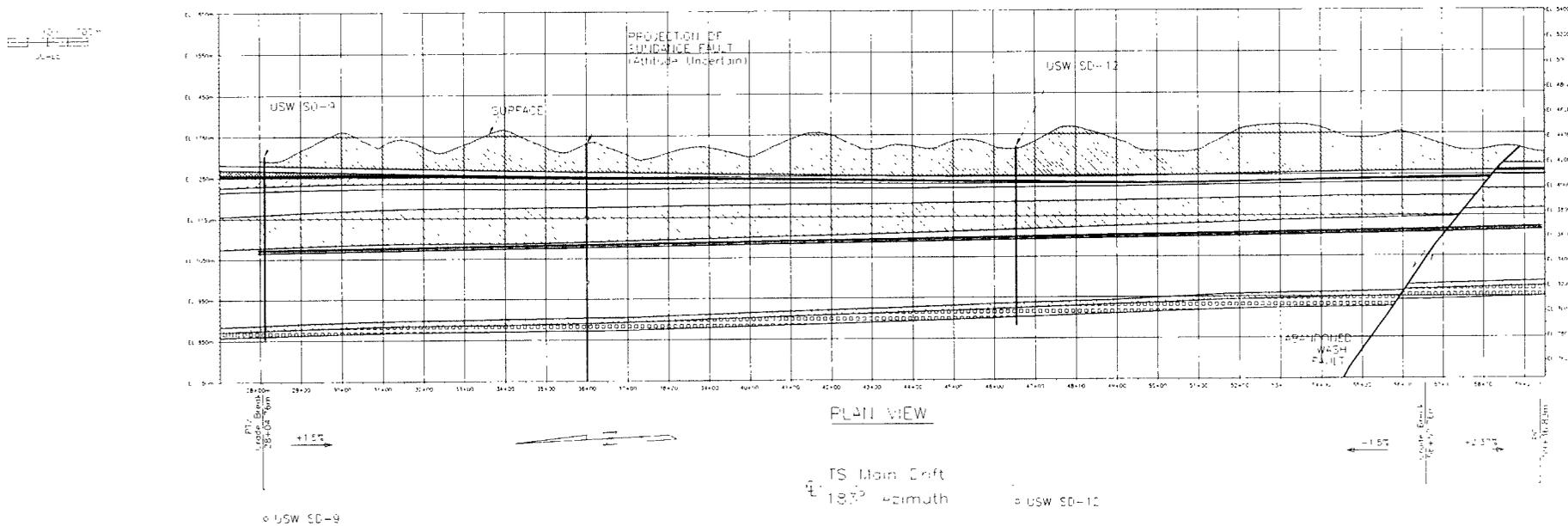
### Vent Line

98.2 (ppb)  
116.3 (ppb)  
3.85 (ppm)

\*Threshold Detection Limit: 1 ppm

# ADMINISTRATIVE MAIN DRIFT CROSS SECTION: LITHOLOGY AND BOREHOLE PROJECTIONS

SECTION: NEW



PLAN VIEW

TS Main Drift  
18.3° Azimuth  
USW SD-9  
USW SD-12

LEGEND

Note: Stratigraphic contacts based on USGS L-74 Model USRP 1, N-1 qualified data. Projections of stratigraphic contacts from USW SD-9 and USW SD-12, qualified data.

PROPOSED TS MAIN DRIFT ALIGNMENT

DRILLHOLE CONTACTS BASED ON PROJECTING BOREHOLE ALONG DP

PRELIMINARY TS MAIN DRIFT DATA  
ADMINISTRATIVE USE ONLY

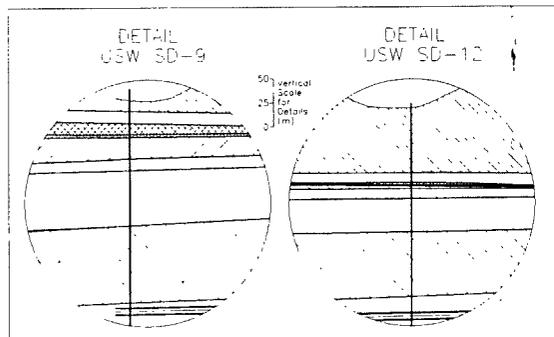
Station (ft)	Grade	Strike Pipe Top (ft)	Strike Pipe Cap (ft)	Elevation (ft)
28+04.76 (PT)	+1.5%	22026.8	22026.8	1463.30
28+24.76 (US)	+2.3%	22026.8	22026.8	1377.4
38+30.92 (US)		22026.8	17,48.9	1114.1

BOREHOLE PROJECTIONS  
ADMINISTRATIVE USE ONLY

Borehole	Projected to Station (ft)	Grade (ft/100 ft)	Distance to Station (ft)
USW SD-9	57'	1.5%	74.2
USW SD-12	57'	2.3%	29.3

BOREHOLE CONTACT PROJECTIONS

Borehole	Projection	St.	Grade to Station (ft/100 ft)
USW SD-9	57'	1.5%	74.2
USW SD-12	57'	2.3%	29.3



## LITHO-STRATIGRAPHIC UNITS

## THERMAL-MECHANICAL UNITS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
[Symbol]	Yucca Canyon Tuff, undifferentiated, bedded	Tcpw	
[Symbol]	Yucca Canyon Tuff, crystal-poor, vitric nonwelded to moderately welded	Tcpw-1 & 2	
[Symbol]	Pre-Triassic Canyon Tuff, bedded tuff	Tcpb4	
[Symbol]	Yucca Mountain Tuff	Tcpw	
[Symbol]	Pre-Yucca Mountain Tuff, bedded tuff	Tcpb3	
[Symbol]	Rah Canyon Tuff	Tcpw	
[Symbol]	Pre-Rah Canyon Tuff, bedded tuff	Tcpb2	
[Symbol]	Tapoach Spring Tuff, crystal-rich, vitric nonwelded to moderately welded	Tcpw-2 & 3	
[Symbol]	Tapoach Spring Tuff, crystal-rich, bedded, includes vitrophyres	Tcpw	
[Symbol]	Tapoach Spring Tuff, crystal-poor, upper lithovisid, includes crystal-rich lithovisid	Tcpw	
[Symbol]	Tapoach Spring Tuff, crystal-poor, middle lithovisid	Tcpw	
[Symbol]	Tapoach Spring Tuff, crystal-poor, lower lithovisid	Tcpw	
[Symbol]	Tapoach Spring Tuff, crystal-poor, lower nonlithovisid	Tcpw	
[Symbol]	Tapoach Spring Tuff, crystal-poor, vitrophyre subzone	Tcpw-3	
[Symbol]	Tapoach Spring Tuff, crystal-poor, vitric nonwelded to moderately welded	Tcpw-1&2	

Lithostratigraphic and thermal-mechanical units as defined by Busch et al. (1958) Open File Report 14-189 in press. Revised stratigraphic nomenclature and macroscopic identification of lithostratigraphic units of the Paintbrush Group exposed at Yucca Mountain, Nevada.

FOR INFORMATION ONLY - NOT CONTROLLED

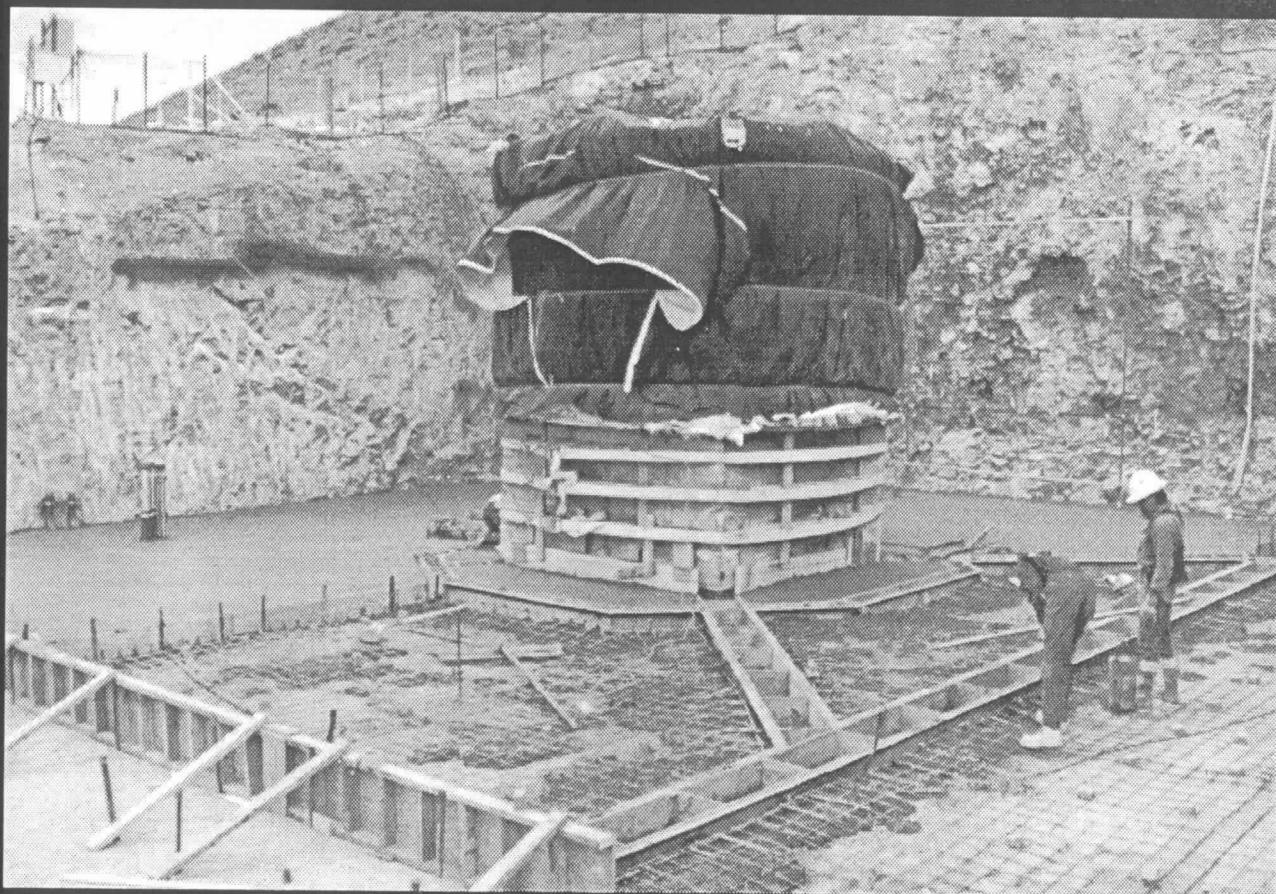
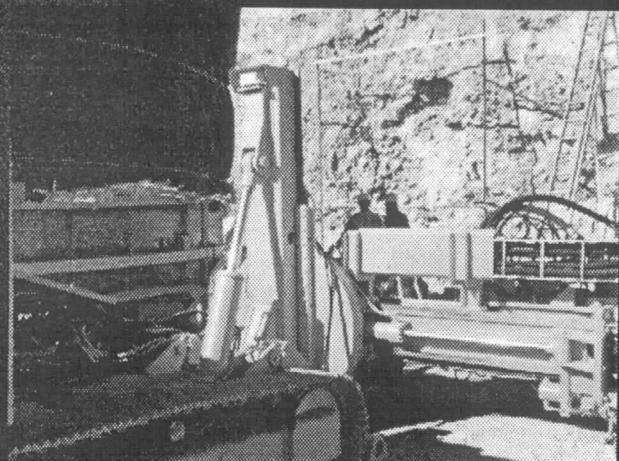
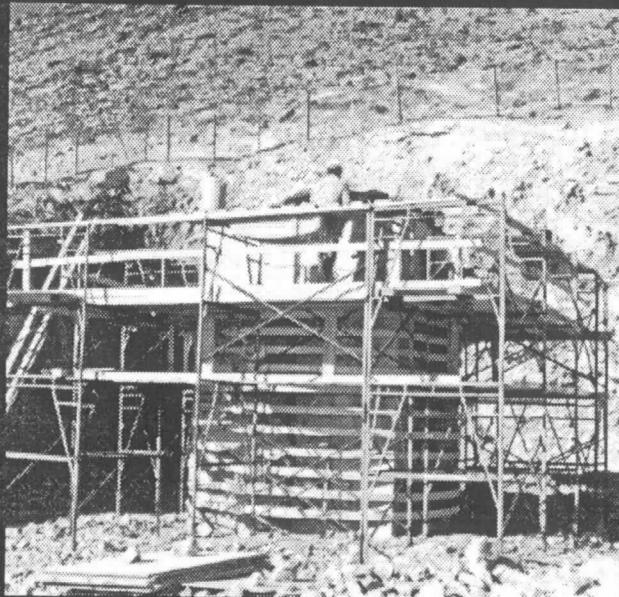
TS MAIN DRIFT  
YUCCA MOUNTAIN SITE  
CHARACTERIZATION PROJECT  
CROSS SECTION ALONG DRIFT FROM  
CR-04 TEM (PT) TO L14-35 B9 (PT)

Florida National Laboratories

DATE DRAWN: USGS L-74 Model USRP 1, N-1  
REVISION: 1994  
DRAWN BY: J. W. GARDNER  
CHECKED BY: J. W. GARDNER  
DATE: SEPTEMBER 1994

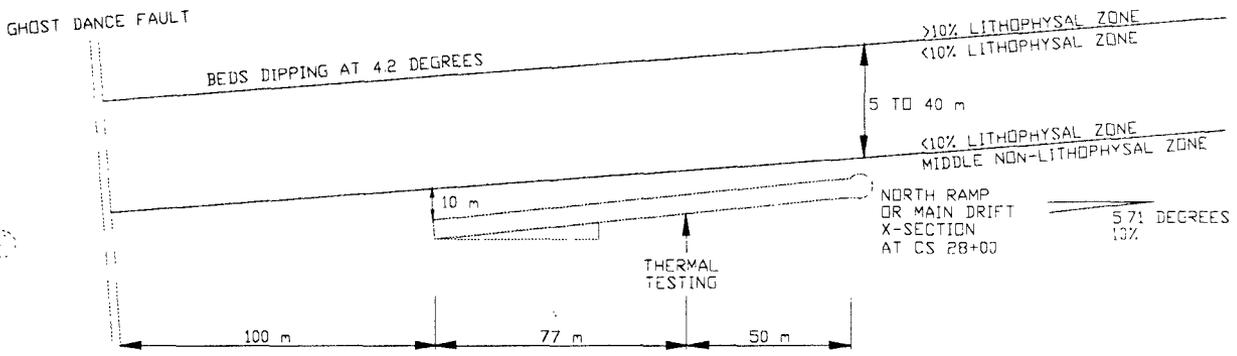
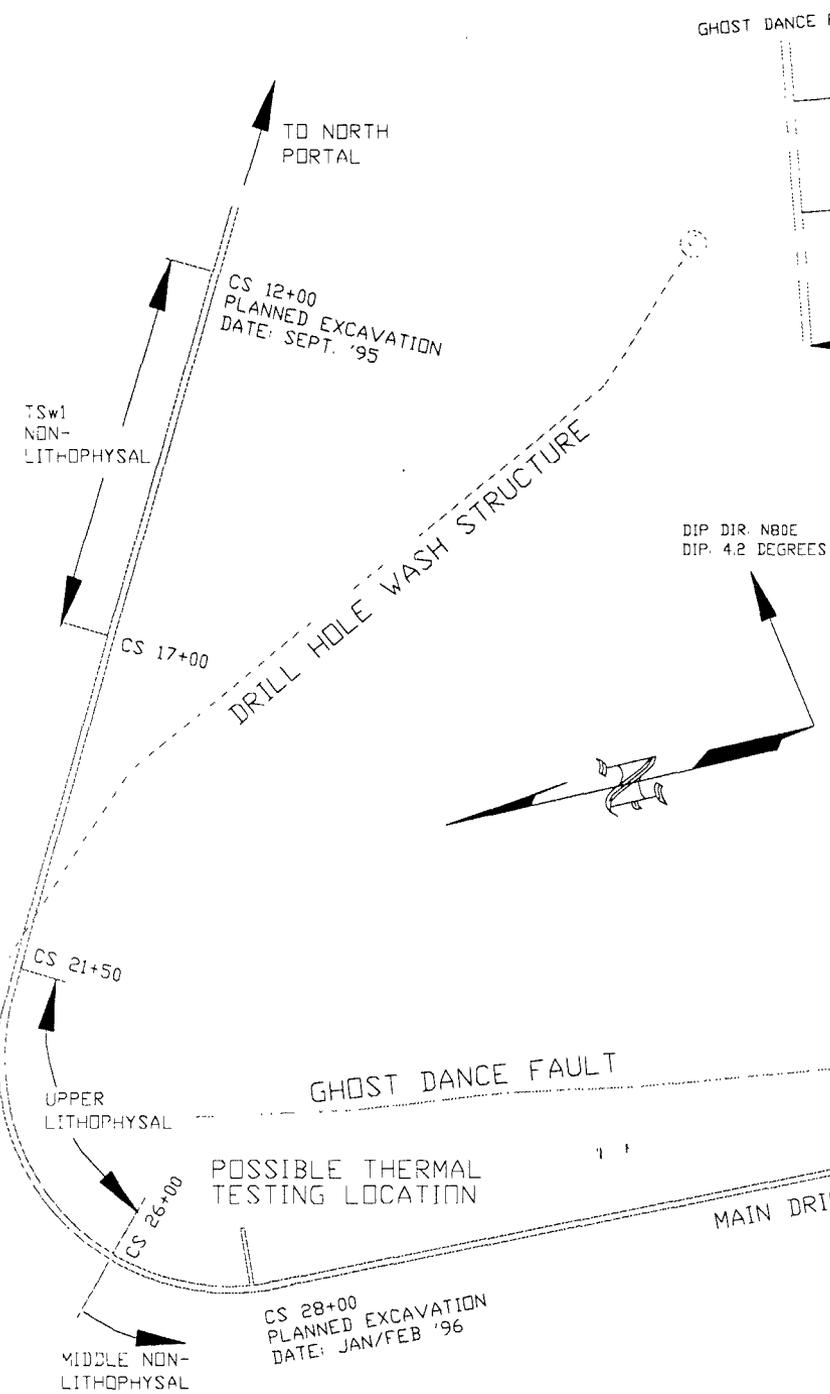
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DRAWING TITLE: TS MAIN DRIFT CROSS SECTION  
SCALE: AS SHOWN  
DATE: SEPTEMBER 1994

# LARGE BLOCK TESTS AT FRAN RIDGE



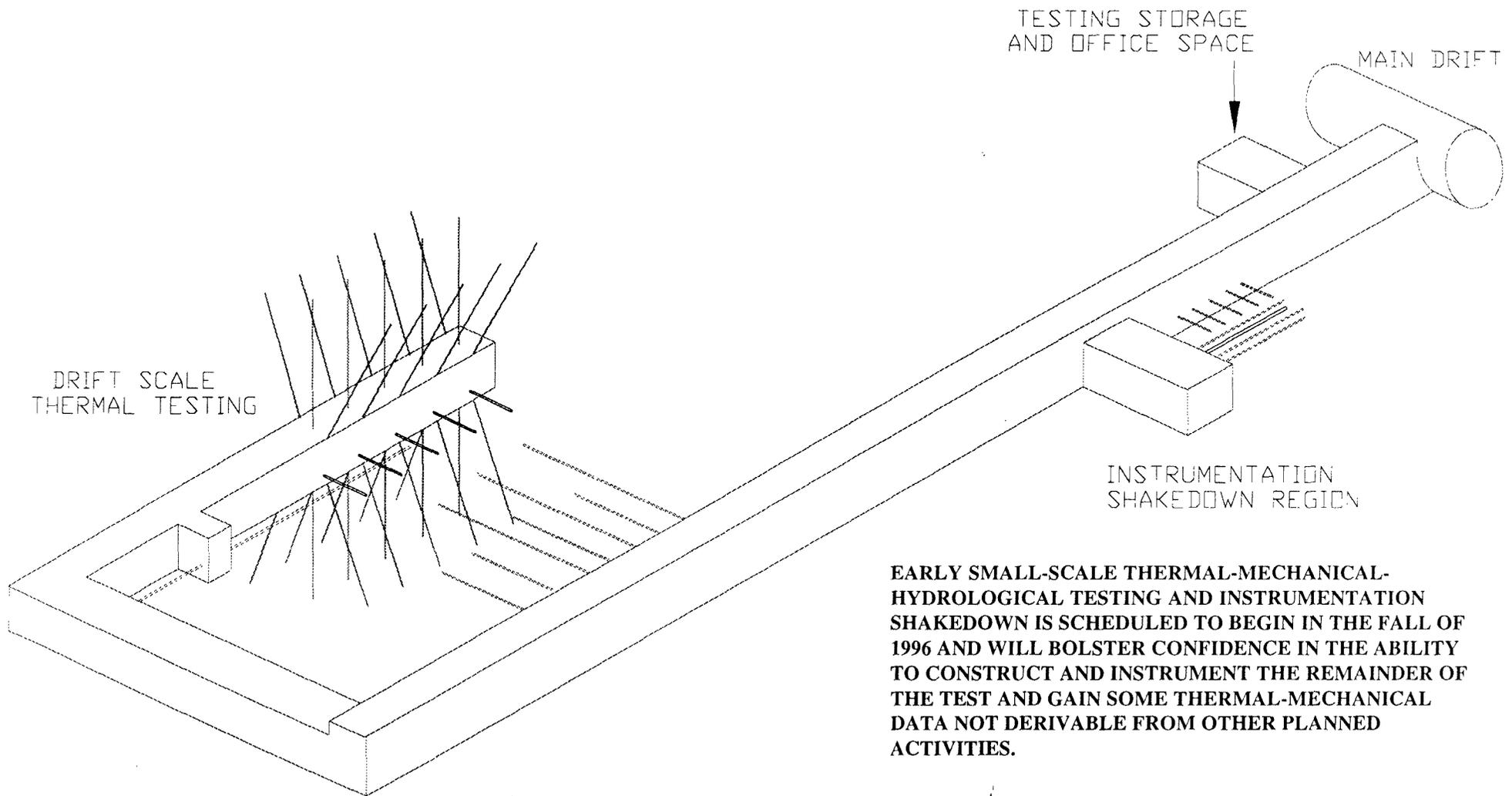
THE LARGE BLOCK TESTS AT FRAN RIDGE CONTINUE WITH THE CONSTRUCTION OF A CONCRETE PAD WITH CABLE WAYS AROUND THE BLOCK AND THE HORIZONTAL CORING OF HEATER AND INSTRUMENTATION EMPLACEMENT HOLES IN THE BLOCK. THE GOALS OF THE TEST ARE TO GAIN INFORMATION ON THE COUPLED THERMAL-MECHANICAL-HYDROLOGICAL-CHEMICAL PROCESSES THAT WILL BE ACTIVE IN THE NEAR-FIELD ENVIRONMENT OF A REPOSITORY; TO PROVIDE FIELD DATA FOR TESTING AND CALIBRATION MODELS; AND TO HELP IN THE DEVELOPMENT OF MEASUREMENT SYSTEMS AND TECHNIQUES.

# GEOLOGIC AND FACILITY LOCATION OF ESF THERMAL TEST



**PROFILE VIEW OF POSSIBLE BREAKOUT DRIFT (TO THE EAST)**

# THERMAL TESTING IN THE ESF CONCEPTUAL LAYOUT APPROVED BY TEST ORGANIZATIONS



AS THE SHAKEDOWN/GEOMECHANICAL AREA IS BEING CONSTRUCTED AND INSTRUMENTED, CONSTRUCTION WILL CONTINUE ON THE THERMAL TEST FACILITY. THIS WILL INCLUDE A REPOSITORY EMPLACEMENT-SCALE, HEATED DRIFT WITH SIGNIFICANT THERMAL-MECHANICAL-HYDROLOGICAL INSTRUMENTATION, WING HEAT PIPES AND A PLATE-LOADING COMPONENT. TESTING IS SCHEDULED TO BEGIN IN THE SPRING OF 1997