Transmitted with letter dtd. 7/18/98

MINUTES OF THE DECEMBER 15, 1997
U.S. DEPARTMENT OF ENERGY/NUCLEAR REGULATORY COMMISSION
QUARTERLY TECHNICAL MEETING

On December 15, 1997, U.S. Nuclear Regulatory Commission staff met with staff from the U.S. Department of Energy (DOE) and DOE's contractor to discuss items of mutual interest regarding DOE's site characterization programs. The items discussed included updates on the status of some of the scientific studies at the site, including alcove testing within the Exploratory Studies Facility (ESF), and recent developments in the engineering design program. In addition, DOE provided an updated list and schedule of key reference documents supporting the forthcoming Viability Assessment (VA).

This meeting was another in a continuing series of periodic quarterly technical meetings. The meeting was held via a three-way videoconference at the NRC office in Rockville (Maryland); DOE office's in Las Vegas (Nevada); and the Center for Nuclear Waste Regulatory Analyses (CNWRA) office in San Antonio (Texas). Representatives from the State of Nevada; Clark County and Nye County, Nevada; and the U.S. Geological Survey (USGS) also attended. The agenda can be found in Attachment 1. Attachment 2 contains the list of attendees.

Before discussing the first formal agenda item, the NRC staff requested updates on the schedule for DOE's pending 10 CFR Part 960 rulemaking and the *Waste Isolation and Containment Strategy* (WCIS). DOE noted that the Part 960 rulemaking was in concurrence. In regard to the WCIS, DOE noted that it expected that an update to the WCIS was expected to be available by the end of calendar year 1998.[1]

In the first series of presentations, DOE provided an update on the status of the scientific studies program. The topics covered included an updates on the following: enhanced characterization of the repository block (ECRB); moisture studies within the ESF; thermal testing program; colloid-facilitated transport; and Busted Butte field tests. The briefing materials reviewed are contained in Attachment 3 and the following is a summary of the discussion highlights:

- *ECRB:* The principal ECRB effort at present is the construction of the cross-drift as an extension of the ESF north ramp. Tunnel construction will be achieved using a 5-meter diameter tunnel boring machine (TBM). DOE reported that it recently commenced with construction of a 122-meter TBM starter-tunnel using the drill and blast method. Starter tunnel construction is expected to be completed in February 1998 after which components of the TBM will be brought into the tunnel and assembled. Tunnel construction using the TBM is expected to commence sometime in April 1998. NRC questioned whether a *Determination of Importance Evaluation*

[1] Following this meeting, the staff were advised that WCIS was to be superseded by the *Repository Safety Strategy*. See U.S. Department of Energy, Repository Safety Strategy: U.S. Department of Energy's Strategy to Protect Public Health and Safety After Closure of a Yucca Mountain Repository," Office of Civilian Radioactive Waste Management, Revision 1, YMP/96-01, January 1998.

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(DIE) had been prepared for the cross-drift. DOE responded that the ECRB was being prepared in two parts (or phases): the first part concerns the construction of the starter tunnel, which has been completed; and the second part, which will focus on all remaining ECRB activities, including tunneling. The ECRB effort also includes the preparation of two predictive reports that will be used to estimate the subsurface conditions that can be expected to be encountered during tunneling operations. The reports will be in two parts and are expected to be publicly available in early 1998.

ECRB activities also include the drilling of two new boreholes, designated WT-24 and SD-6. The purpose of these boreholes is to obtain additional geologic and geotechnical data to the north and the west of the proposed repository block. DOE reported that there is good correspondence between the driller's logs and the predicted stratigraphy. In response to a question from the Nye County representative, on the origin of the water in borehole WT-24, DOE noted that the water was believed to be chemically different from that found in borehole UZ-14. DOE's preliminary interpretation of the WT-24 water chemistry data suggests that it is perched water with a near neutral pH.

Following this discussion, DOE updated the audience on the status of work at the C-Well Complex.

- *ESF Moisture Studies:* Within the ESF, DOE has established four niches and two test alcoves to test water seepage and transport within the repository block. These tests also include the monitoring of surface water percolation to the waste emplacement horizon. In response to questions about the role of the niche studies, DOE noted that these studies were not intended to be predictive in nature. In particular, it was noted that Niches 3 and 4 were constructed to better understand and monitor construction water movement within the ESF, and are not related to the study of chlorine-36.

- *Drift-Scale Heater Test:* DOE reported that instrumentation within the drift-scale heater had been completed and the 4-year heating cycle had commenced.

- *Colloidal Plutonium Studies:* Earlier in the year it had been reported that colloid-facilitated transport of plutonium (Pu) was suspected in Area 20 of the Nuclear Test Site (NTS), which was previously used for weapons testing. Preliminary investigations suggest that colloidal Pu had migrated 1.3 kilometers in about 28 years. DOE reviewed the implications that Pu migration might have on the Yucca Mountain program, discussed how colloid-facilitated transport would be integrated into the on-going total-system performance assessment (TSPA) efforts (including evaluation by an expert panel), and identified its fiscal year 1998 colloid studies.

- *Busted Butte Field Tests:* This field test will be conducted in an underground test alcove in an outcrop of the Calico Hills formation, in an area adjacent to the Yucca Mountain. The purpose of the field test is threefold: (1) to validate laboratory data on radionuclide migration; (2) to validate conceptual flow and transport models in the unsaturated zone; and (3) to reduce uncertainty in the transport of key radionuclides. Although no results of the test have been reported thus far, this work is expected to directly benefit DOE 's TSPA efforts. The testing itself will be conducted in three-phases, in the manner described in the briefing slides, in order to support development of a potential license application. In the questions and comments period that followed, DOE noted that the testing program would: include both the zeolitic and non-zeolitic units of the Calico Hills formation; examine the importance of fracture-facilitated transport; and use Phase 2 test results to validate the results of Phase 1 (this work is to be done by the Los Alamos National Laboratory).

The second major agenda item was a series of presentations on the status of design product development anticipated at the time of VA publication. The first present in the series (Attachment 4) was a summary of the 21 principal design elements for the geologic repository, their so-called "bin" assignment, the degree to which the design product had been developed thus far, and the long-term schedule for product completion (i.e., by the time of an NRC construction authorization decision).

The second presentation in this series was an overview of the repository subsurface design (see Attachment 5). The material covered included a review of the factors influencing the subsurface design (including site geology), thermal mass-loading design considerations (including drift spacing), sequencing of drift construction/development (including waste canister emplacement configurations), design proposals for underground ventilation, and illustrations depicting handling concepts for waste emplacement. In the question and comment period that followed, DOE noted that it expected it would take approximately 24 years for concurrent construction and emplacement of high-level radioactive waste (HLW) (assuming the emplacement of two waste canisters per day).

The third presentation in this series was an overview of the repository surface design (see Attachment 6). The material covered included a review of those factors influencing the surface design - i.e, waste form characteristics, waste canister arrival schedule, National program assumptions, site operations and floor plans, and illustrations showing waste handling operations at the surface. In the question and comment period that followed, DOE noted that it expected about 11,000 spent fuel assemblies/year to be handled in the operation described with the current design.[2] DOE also noted that for the purposes of the VA, there would be a summary of the major aspects of the surface and subsurface design. In response to questions regarding the management of low-level radioactive waste (LLW) associated with the use of dual/multi-purpose canisters, DOE noted that it was likely that LLW of this type would be disposed of elsewhere at the Nuclear Test Site and not in Yucca Mountain.

The third major agenda item to be discussed was the status of waste package design work for a potential license application. The material covered included major design goals for the

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[2] DOE also noted that the VA design description would not include design features for spent nuclear fuel (SNF) rod consolidation or cask maintenance - as would be the case in an *Independent Spent Fuel Storage Installation.*

waste package, current waste package design proposals,[3] thermal and structural analyses, analysis of criticality, and material selection criteria and testing programs. This presentation was followed by several questions and comments. In response, DOE noted the following:

- The types and kinds of HLW from the Hanford nuclear reservation, bound for disposal in the geologic repository at Yucca Mountain, are not well known, at this time.

- An analysis of aluminum-uranium criticality has been completed. It is undergoing programmatic review at present and should be available shortly. This report is one in a series of four on criticality, and is in a topical report format.

- Evaluations of rockfall on waste packages as part of a post-closure analysis of performance have begun.

- The VA design will not be taking credit for galvanic protection although research and analyses are continuing in this area.

- The Department has no plans to independently identify leaking fuel rods when it takes title to SNF. For the purposes of waste package handling and design, the number of leaking fuel rods has been estimated at this time to be 0.5 percent (although this number will be subject to verification through a review of the utilities' loading/inventory records).

  Similarly, By the time of license application submittal, it is expected that the effects of pitting corrosion on structural integrity of the waste package canister will be considered.

- Evaluation of N-reactor fuel design and performance issues will be discussed in the up-coming Appendix 7 meeting at Hanford (Washington) in April 1998.

The fourth agenda item was an overview by DOE of the major design products and their anticipated status of completion, in concert with major HLW program milestones: the VA (Fall 1998), the site suitability recommendation to the President (ca. 2001), the license application submittal (ca. 2002), and the construction authorization decision (ca. 2005). The briefing materials relied on were those found previously in Attachment 4. The following table summarizes anticipated status of product design completion, in terms of the percentage completed, by "bin" designation:[4]

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[3] i.e., uncanistered commercial fuel, canistered commercial fuel, defense HLW, DOE-owned fuel, and canistered U.S. Navy fuel.

[4] DOE has defined three bins of structures, systems, and components (SSCs), as follows: Bin 1 SSCs are believed to have no impact on public health and safety. Bin 2 SSCs are believed to potentially affect public health and safety; however, in DOE's estimation, there exists adequate guidance and/or previous engineering precedent that can be followed when preparing (and reviewing) a design. Bin 3 SSCs are believed to potentially affect public health and safety; in DOE's estimation, there is no previous licensing precedent that can be followed when preparing (and reviewing) a design.

	VIABILITY ASSESSMENT	SITE RECOMMENDATION	LICENSE APPLICATION	CONSTRUCTION AUTHORIZATION
BIN 1 (13 designs) [5]	5	n/a	15	40
BIN 2 (17 designs)	5	n/a	35	60
BIN 3 (10 designs)	40	60	95	≈ 100

In the question and comment period that followed, DOE confirmed that the VA would contain some type of an overview that summarized the major design features of the proposed repository. During this presentation, the State of Nevada noted that thermal (design basis) calculations that may form the basis for some of DOE's waste emplacement designs are believed to be based on an average age of spent nuclear fuel (SNF) rather than on a range of thermal outputs and thus may not provide DOE with the correct thermal design basis. In response, DOE agreed and noted that the concept of emplacing older (cooler) SNF first is being considered as part of the DOE design process.

The final agenda item was a presentation by DOE in which the key fiscal year 1997 deliverables (reference documents) relevant to the VA were identified and briefly discussed (see Attachment 8). These deliverables cover all four components of the VA - i.e., the design, the total system performance assessment, the license application development plan, and the life-cycle cost estimate, and were correlated to each of the NRC *key technical issues*. Through the course of the presentation, DOE noted that it was preparing to formally transmit copies of these documents to the NRC, to the extent that the deliverables were available. For those deliverables not available, DOE committed to provide copies to NRC and other interested parties as soon as they become available. DOE also noted that a more detailed discussion of the four VA components was to be the subject of a forthcoming DOE/NRC technical exchange in January 1998. In the question and comment period that followed, NRC noted that the staff now have a better understanding of and appreciation for how the four VA components fit together.

At the close of these discussions, the staff representing the State of Nevada and Clark and Nye Counties (Nevada), were invited to make some closing comments. These participants declined to make comments.

Michael P. Lee
Division of Waste Management
Office of Nuclear Material
Safety and Safeguards
U.S. Nuclear Regulatory Commission

Christian E. Einberg
Regulatory Coordination Division
Office of Civilian Radioactive
Waste Management
U.S. Department of Energy

[5] There are approximately 40 design packages covering the design of 21 major repository systems.

AGENDA FOR THE QUARTERLY DOE/NRC TECHNICAL VIDEOCONFERENCE

December 15, 1997
8:30 a.m. — 2:00 p.m. (PST)

DOE Location:
Summerlin ("Blue Room")
1551 Hillshire Drive
North Las Vegas, Nevada 89134

NRC Location:
Two White Flint North, 11555 Rockville Pike, Room T2B5
Rockville, Maryland 20852

CNWRA Location:
Southwest Research Institute Campus, Building 189, 6220 Culebra Road
San Antonio, Texas 78238

Time	*Agenda Item*	*Lead(s)*
8:30 PST	**Opening Remarks**	All
8:45 PST	**Scientific Studies Update**	DOE
10:00 PST	**Engineering Design Program** - VA design review - Surface design - Subsurface design - Waste package design - Design products	DOE
1:00 PST	**Other Topics** - List of VA design supporting products	DOE
1:45 PST	**Closing Remarks and Discussion**	DOE, NRC, NV, AUG
2:00 PST	**Adjourn**	

ATTACHMENT 1

LIST OF ATTENDEES
AT THE QUARTERLY DOE/NRC
TECHNICAL VIDEOCONFERENCE

December 15, 1997

Booze, Allen, and Hamilton
J. York

Center for Nuclear Waste Regulatory Analyses
R. Green   L. McKague   W. Patrick
J. Russell

Clark County, Nevada
E.V. Tieseshausen

Nevada Nuclear Waste Task Force
J. Treichel

Nye County, Nevada
M. Murphy   N. Stellavato

State of Nevada
S. Frishman

U.S. Department of Energy (DOE)
D. Coleman   R. Craun   C. Einberg   A. Gil   P. Harrington   T. Hawe
D. Kane   D. Spence   T. Sullivan

DOE Management and Operating Contractor
F. Afshar   K. Ashe   H. Benton   P. Dixon   B. Fish   A. Haghi
K. Iyengar   S. Meyers   D. McKenzk   B. Mukhopadhyay   S. Schuermann

U.S. Geological Survey
R. Wallace

U.S. Nuclear Regulatory Commission
M. Bell   T. Carter   K. Chang   P. Justus   M. Lee   B. Leslie   C. Lui
M. Nataraja   K. Stablein   S. Wastler

ATTACHMENT 2

ATTACHMENT-3

YUCCA
MOUNTAIN
PROJECT

Studies

Scientific Studies Update

Presented to:
DOE/NRC Quarterly Technical Meeting

Presented by:
Drew Coleman, Licensing, USDOE
Paul Dixon, NEPO, M&O / LANL

December 15, 1997

LV.NEPO.NRC121597

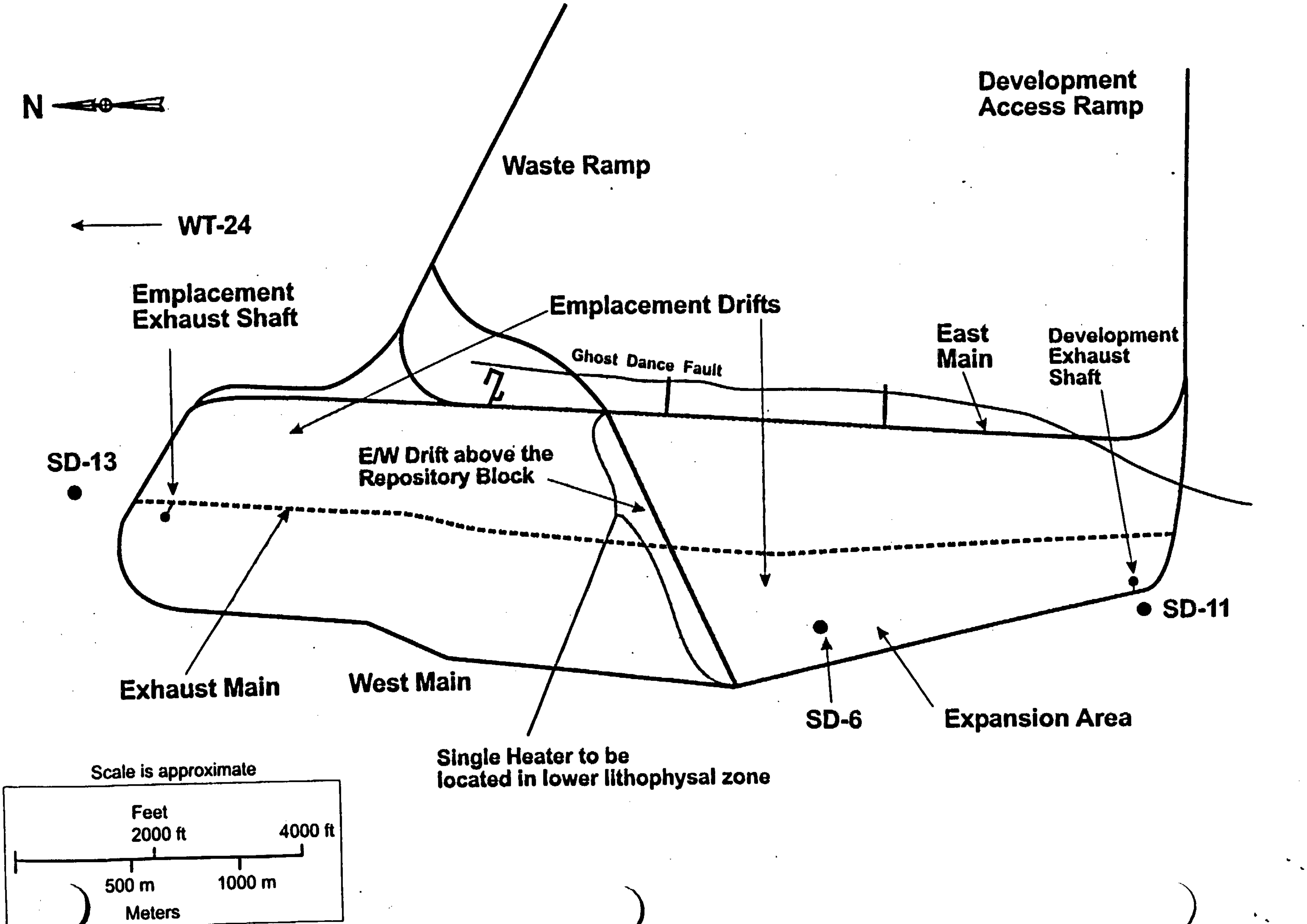
U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

Issues to be Discussed

- Enhanced Characterization of the Repository Block (ECRB)
  - Starter Tunnel for Cross Drift
  - ECRB Predictive Reports
  - Drilling of new boreholes WT-24 and SD-6
  - Workover at the C-wells complex
- Seepage into Drifts, Lateral Diversion, and Moisture Studies
- Thermal Testing : Drift Scale Test
- Colloidal Facilitated Transport
- Busted Butte : Unsaturated Zone Transport Test

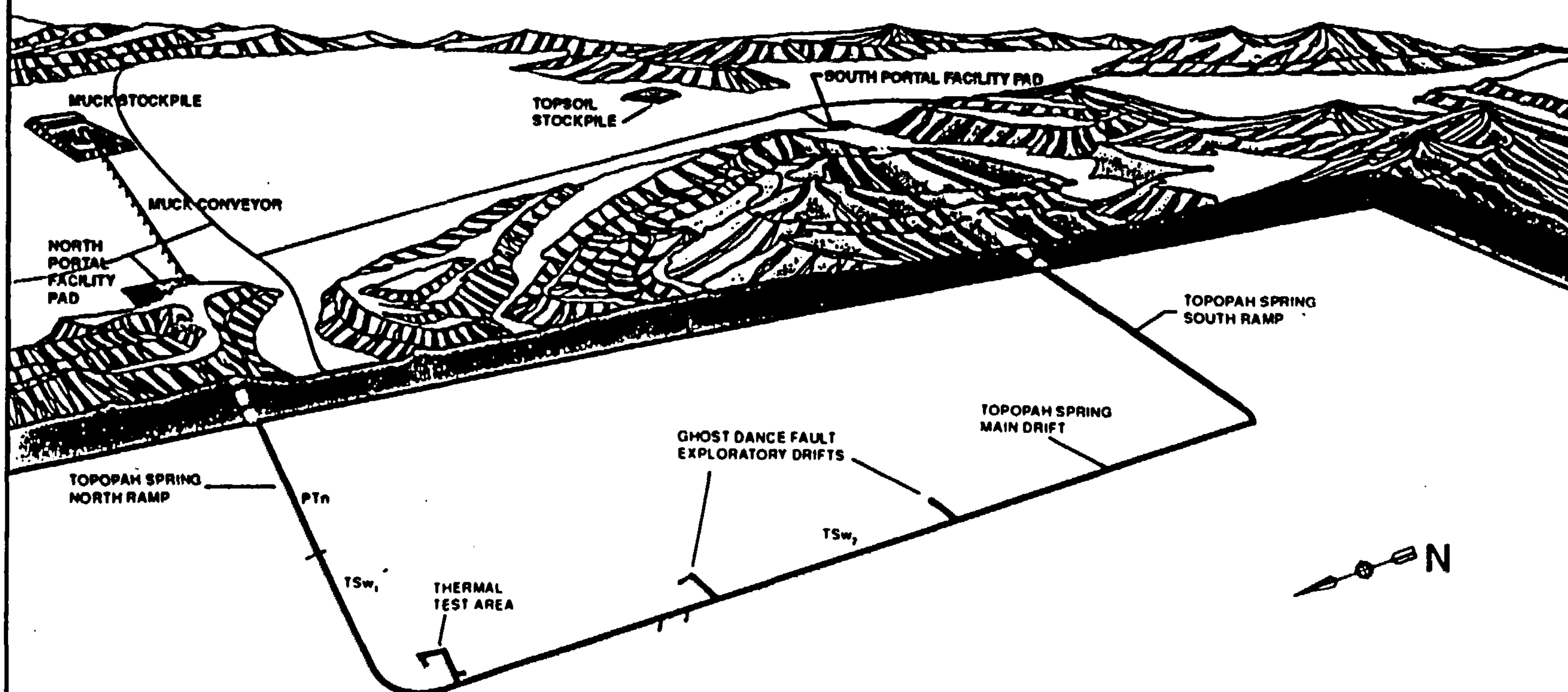
Drew Coleman
Field Test Coordinator
Yucca Mountain Site Characterization Office
USDOE

Enhanced Characterization of the Repository Block

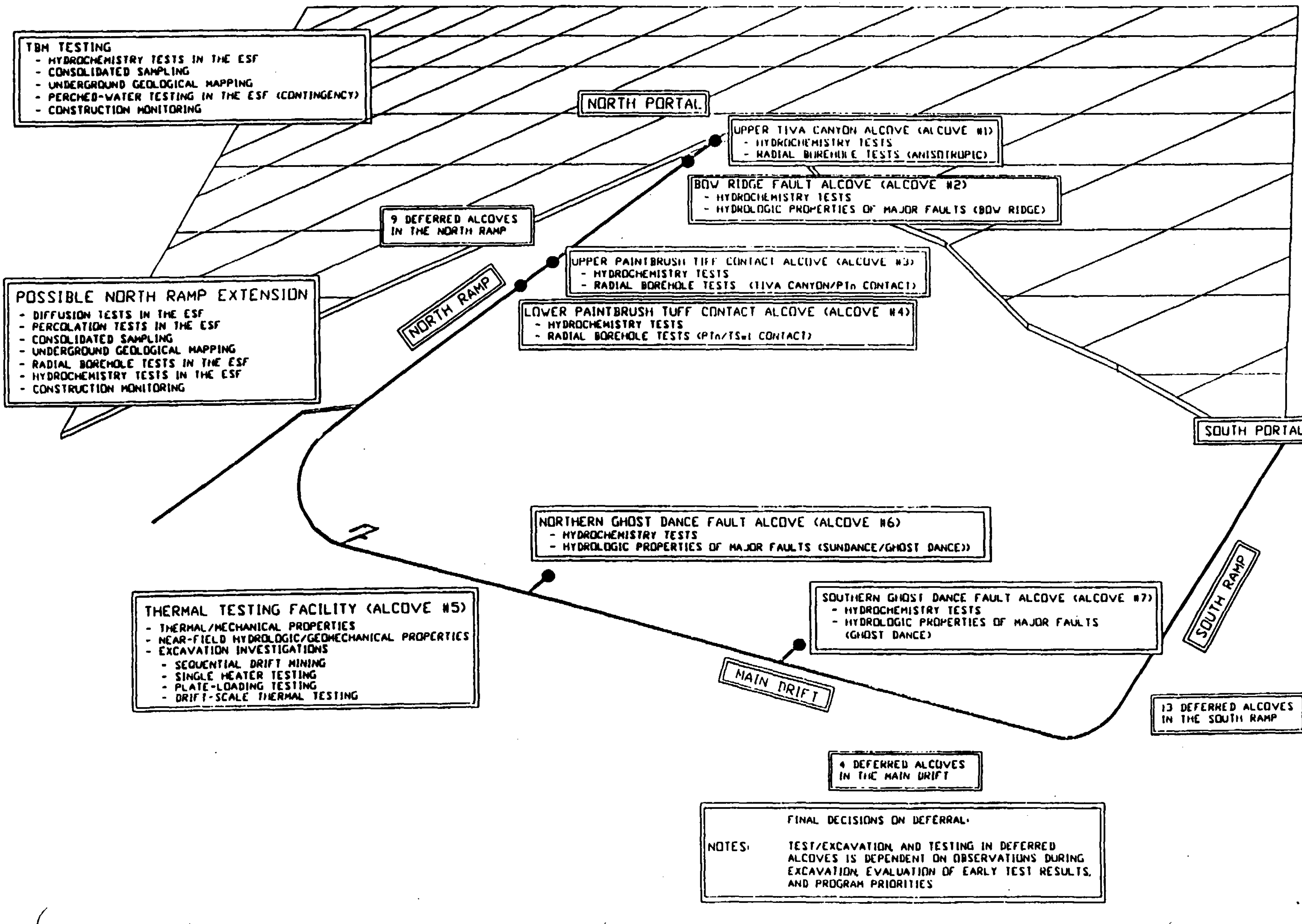


ECRBJONES.CDR.124/10-10-97

Exploratory Studies Facility Design



EXPLORATORY STUDIES FACILITY - TEST LOCATIONS

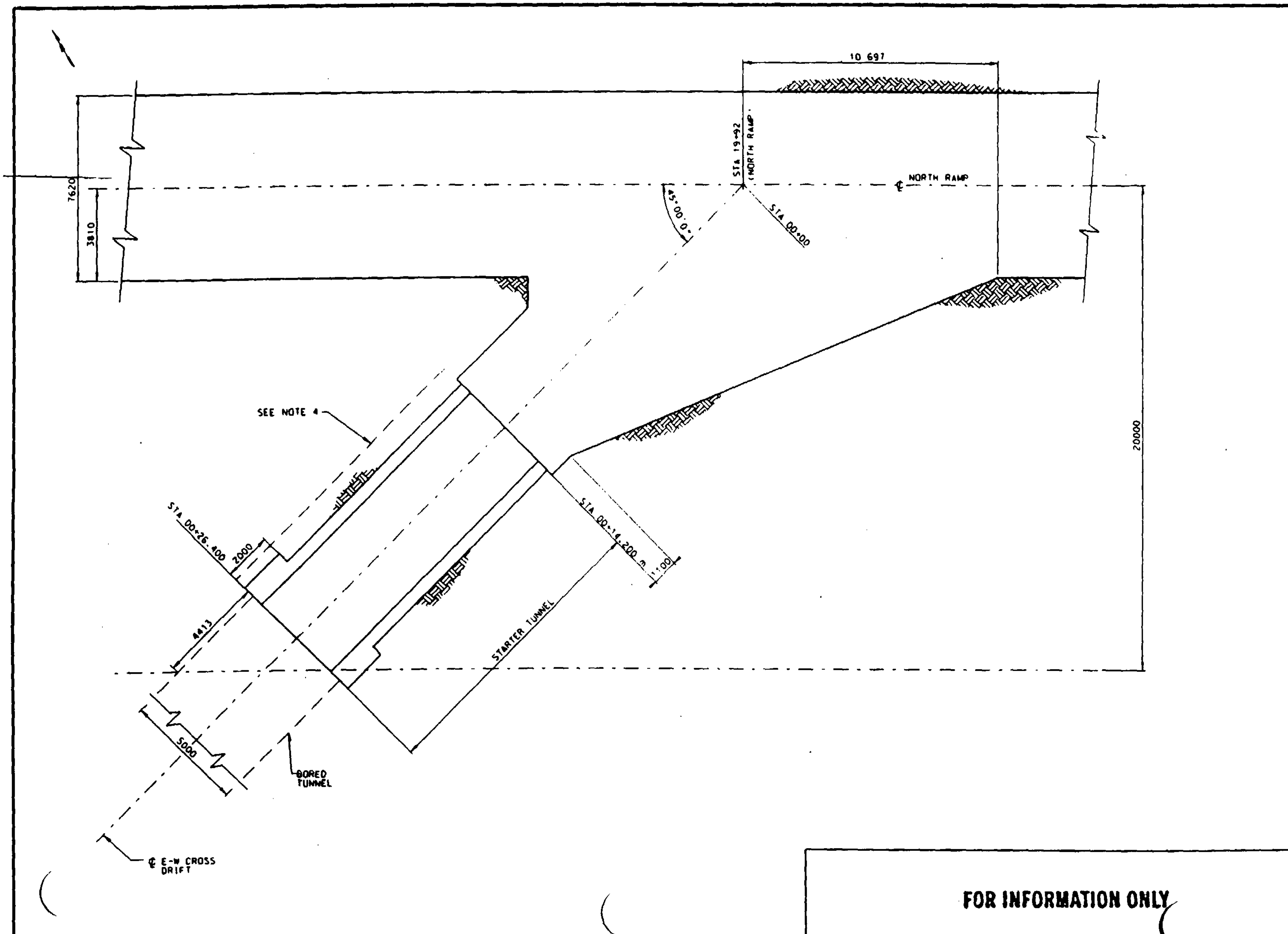


LOS ALAMOS NATIONAL LABORATORY ESF TEST COORDINATION OF[illegible]CE

NRC4.DVG
WEAVER 11/17/95

ECRB Starter Tunnel Progress

- Ground support design and layout analyses completed
- Starter tunnel construction by Drill and Blast Excavation — first blast round completed on 12/09/97
- ECRB Cross Drift construction by 5-m diameter Tunnel Boring Machine (TBM)



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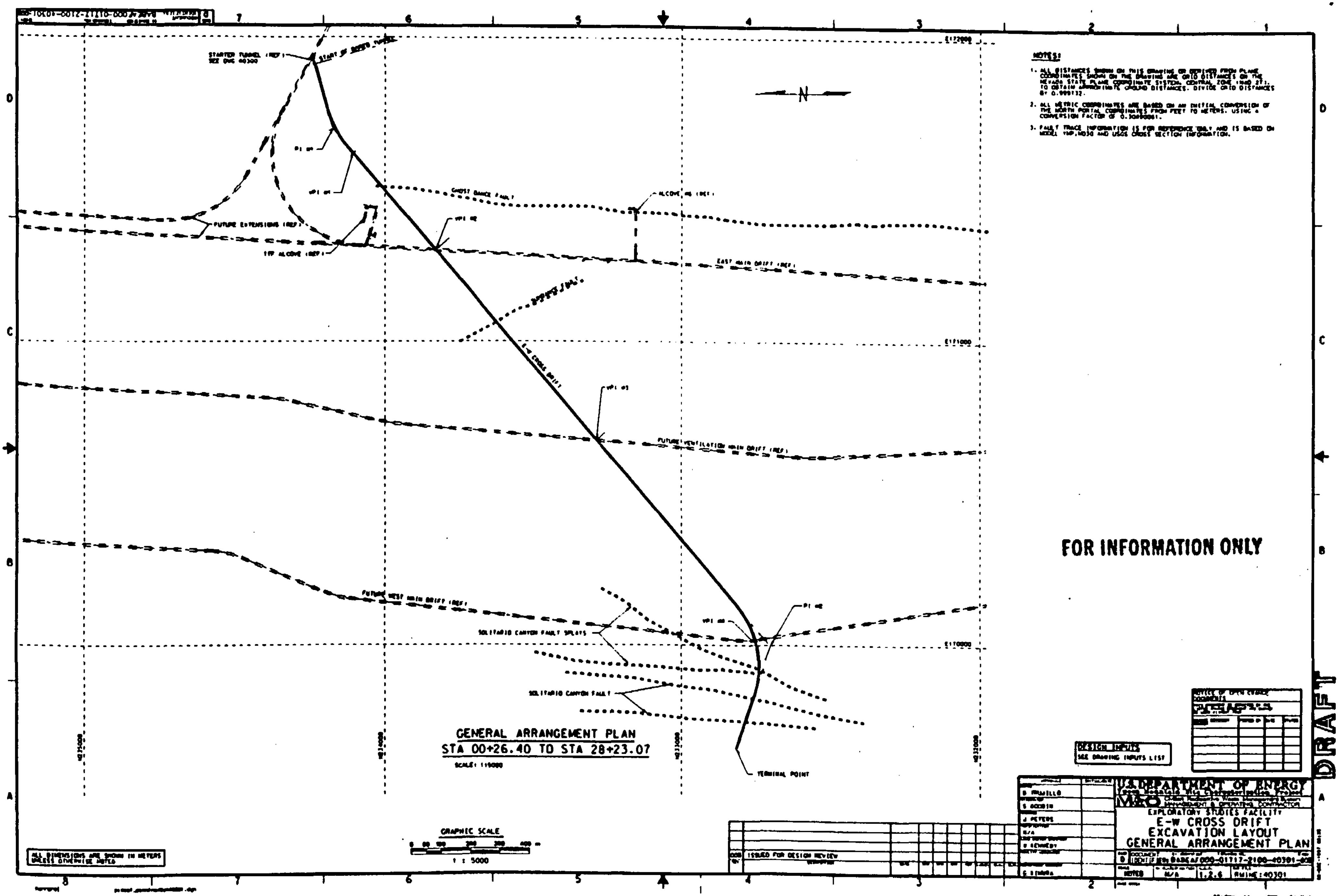

NOTES:
1. ALL DISTANCES SHOWN ON THIS DRAWING OR DERIVED FROM PLANE COORDINATES SHOWN ON THE DRAWING ARE GRID DISTANCES ON THE NEVADA STATE PLANE COORDINATE SYSTEM, CENTRAL ZONE (NAD 27). TO OBTAIN APPROXIMATE GROUND DISTANCES, DIVIDE GRID DISTANCES BY 0.999132.
2. ALL METRIC COORDINATES ARE BASED ON AN INITIAL CONVERSION OF THE NORTH PORTAL COORDINATES FROM FEET TO METERS, USING A CONVERSION FACTOR OF 0.30480061.
3. FAULT TRACE INFORMATION IS FOR REFERENCE ONLY AND IS BASED ON MODEL YMP.MD30 AND USGS CROSS SECTION INFORMATION.
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STARTER TUNNEL (REF)
SEE DWG 40300
GHOST DANCE FAULT
ALCOVE #6 (REF)
FUTURE EXTENSIONS (REF)
EAST MAIN DRIFT (REF)
E-W CROSS DRIFT
FUTURE VENTILATION MAIN DRIFT (REF)
FUTURE WEST MAIN DRIFT (REF)
SOLITARIO CANYON FAULT SPLAYS
SOLITARIO CANYON FAULT
TERMINAL POINT
E171000
E170000
FOR INFORMATION ONLY
GENERAL ARRANGEMENT PLAN
STA 00+26.40 TO STA 28+23.07
GRAPHIC SCALE
1 : 5000
ALL DIMENSIONS ARE SHOWN IN METERS UNLESS OTHERWISE NOTED
ISSUED FOR DESIGN REVIEW
DESIGN INPUTS
SEE DRAWING INPUTS LIST
U.S. DEPARTMENT OF ENERGY
EXPLORATORY STUDIES FACILITY
E-W CROSS DRIFT
EXCAVATION LAYOUT
GENERAL ARRANGEMENT PLAN
1.2.6
40301
DRAFT

ECRB Predictive Reports

- Developed to provide an understanding of the subsurface conditions anticipated during construction of the ECRB

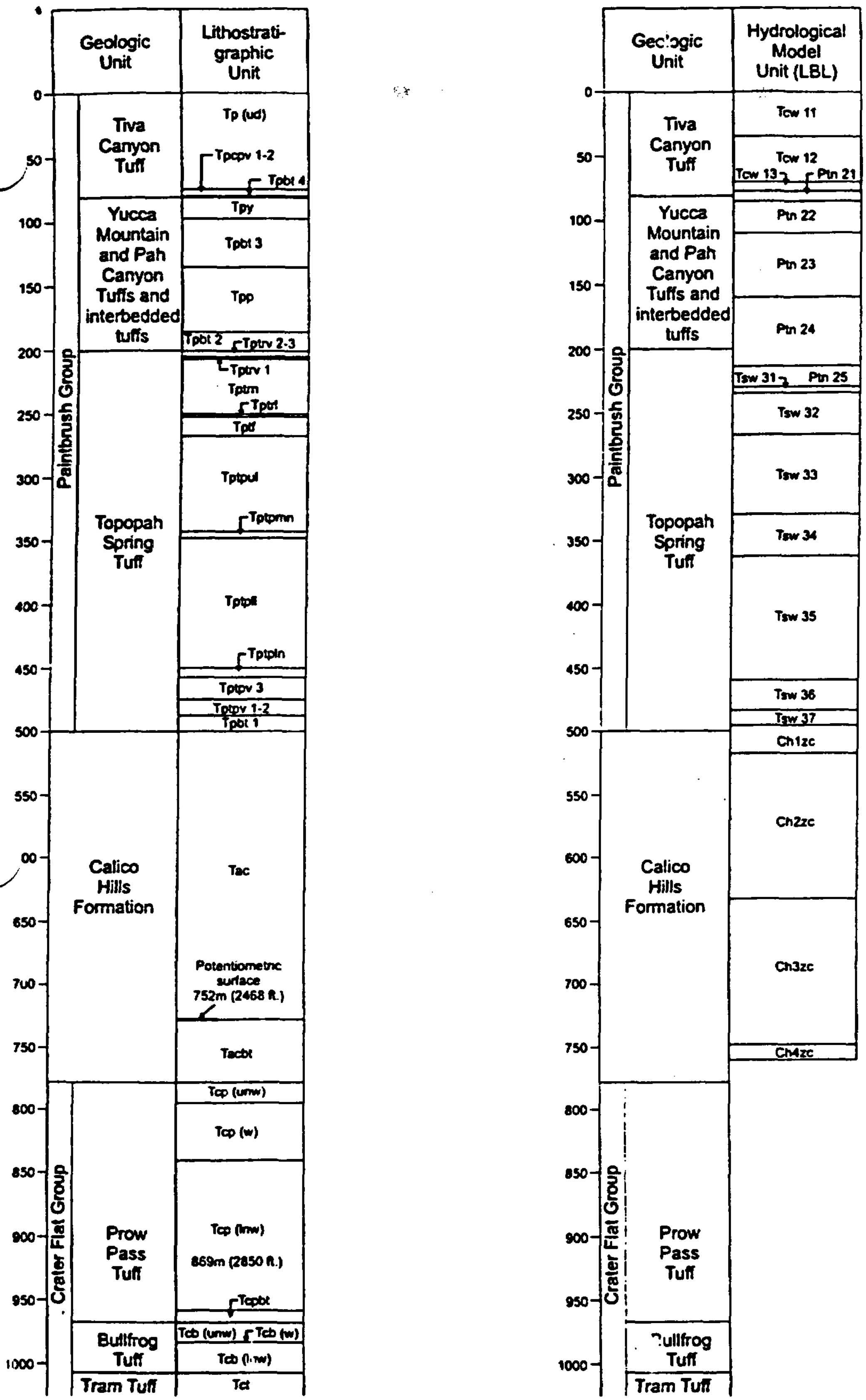
- Presented in two parts:
  - Geotechnical Data Report (GDR)
  - Geotechnical Baseline Report (GBR)

ECRB Predictive Reports

- Prepared by several YMP organizations:
  - ESF Design, USGS, USBR, SNL, LANL, WCFS, TRW Systems Engineering, CMO
- Schedule:
  - Draft GDR completed by 12/19/97; issued on 01/16/98
  - Draft GBR completed by 01/30/98; issued on 02/21/98

WT-24 Progress

- Stratmaster moved to pad on 7/19/97
- Began drilling on 7/23/97
- Completed a 12 ¼" to 1747' (1st water @1663') basal vitrophere in the Topopah member
- USGS began characterizing zone on 10/14/97
- Currently pumping (plan to stop on 12/19/97)
- Plan to resume drilling on 1/5/98


Geologic Unit
Lithostratigraphic Unit
Hydrological Model Unit (LBL)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
Paintbrush Group
Crater Flat Group
Tiva Canyon Tuff
Yucca Mountain and Pah Canyon Tuffs and interbedded tuffs
Topopah Spring Tuff
Calico Hills Formation
Prow Pass Tuff
Bullfrog Tuff
Tram Tuff
Tp (ud)
Tpcpv 1-2
Tpbt 4
Tpy
Tpbt 3
Tpp
Tpbt 2
Tptrv 2-3
Tptrv 1
Tptrn
Tptpl
Tptf
Tptpul
Tptpmn
Tptpll
Tptpln
Tptpv 3
Tptpv 1-2
Tpbt 1
Tac
Potentiometric surface 752m (2468 ft.)
Tacbt
Tcp (umw)
Tcp (w)
Tcp (lmw)
869m (2850 ft.)
Tcpbt
Tcb (umw)
Tcb (w)
Tcb (lmw)
Tct
Tcw 11
Tcw 12
Tcw 13
Ptn 21
Ptn 22
Ptn 23
Ptn 24
Tsw 31
Ptn 25
Tsw 32
Tsw 33
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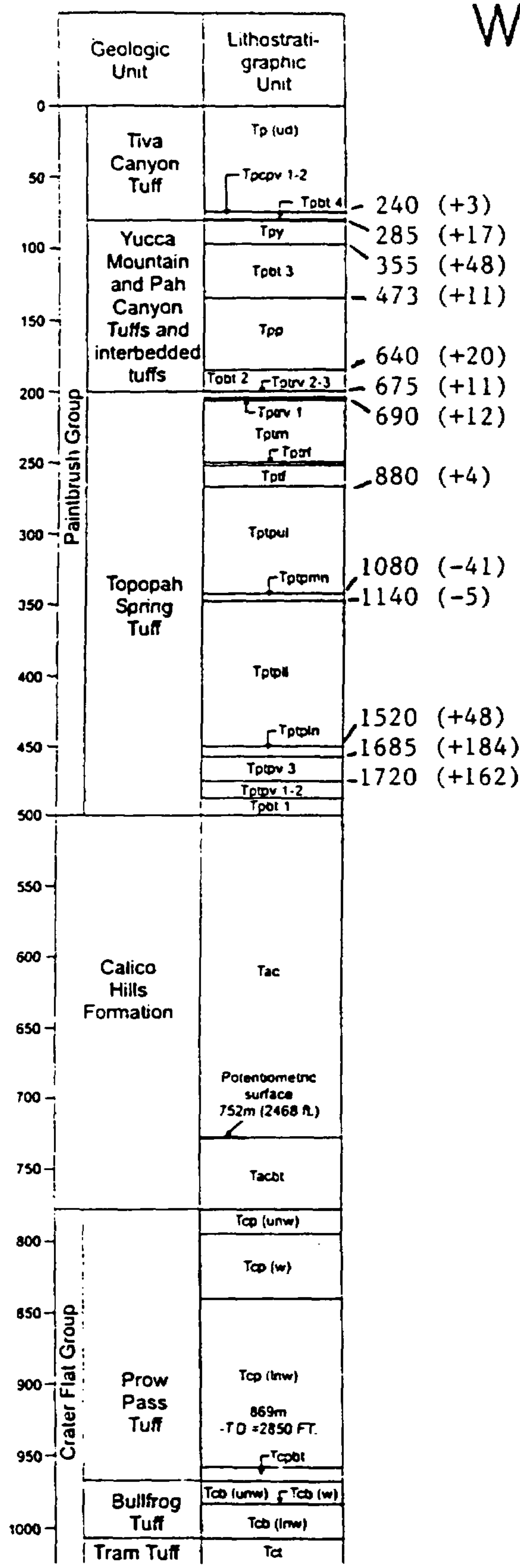
Tsw 37
Ch1zc
Ch2zc
Ch3zc
Ch4zc

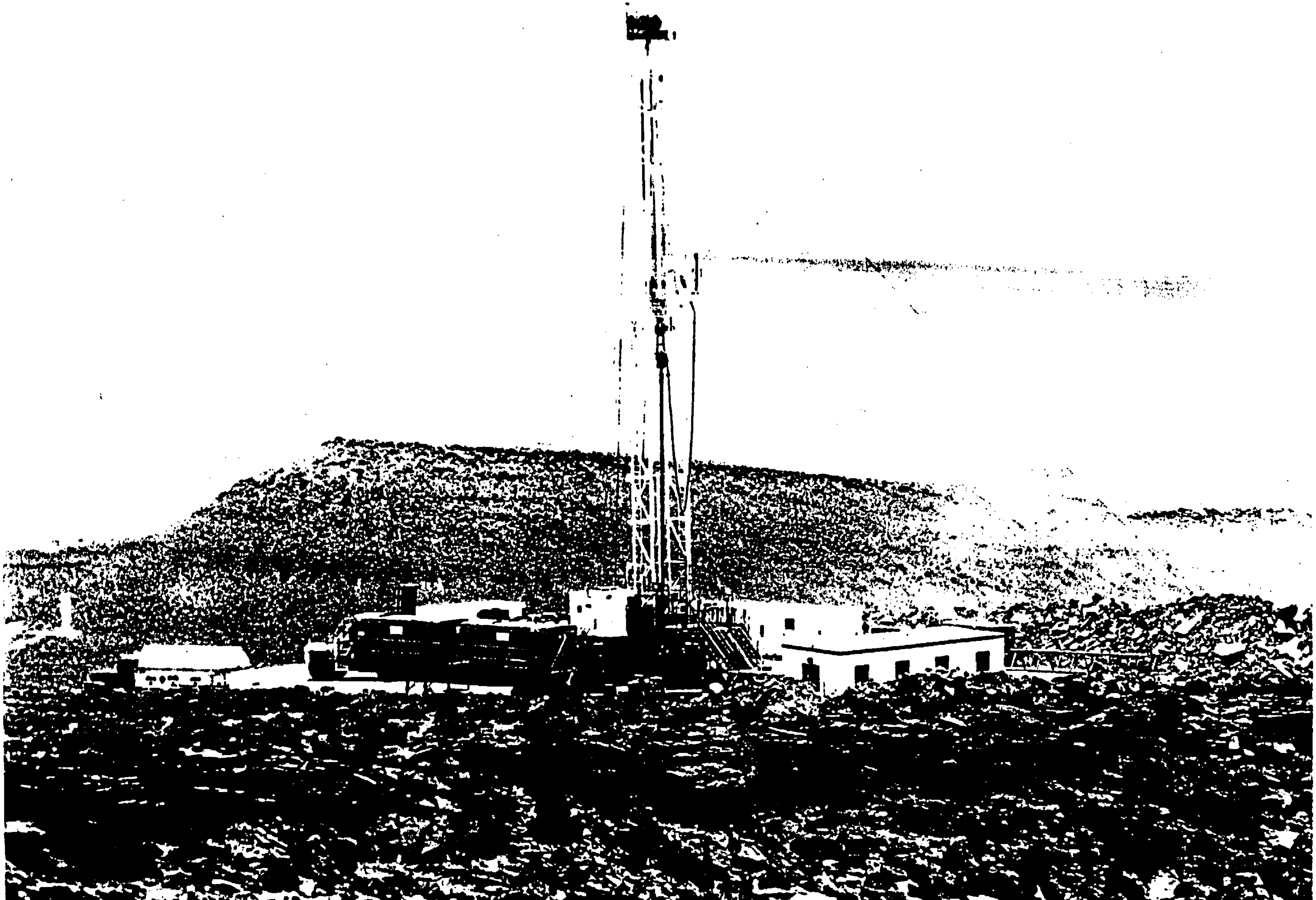
WT-24

WT-24



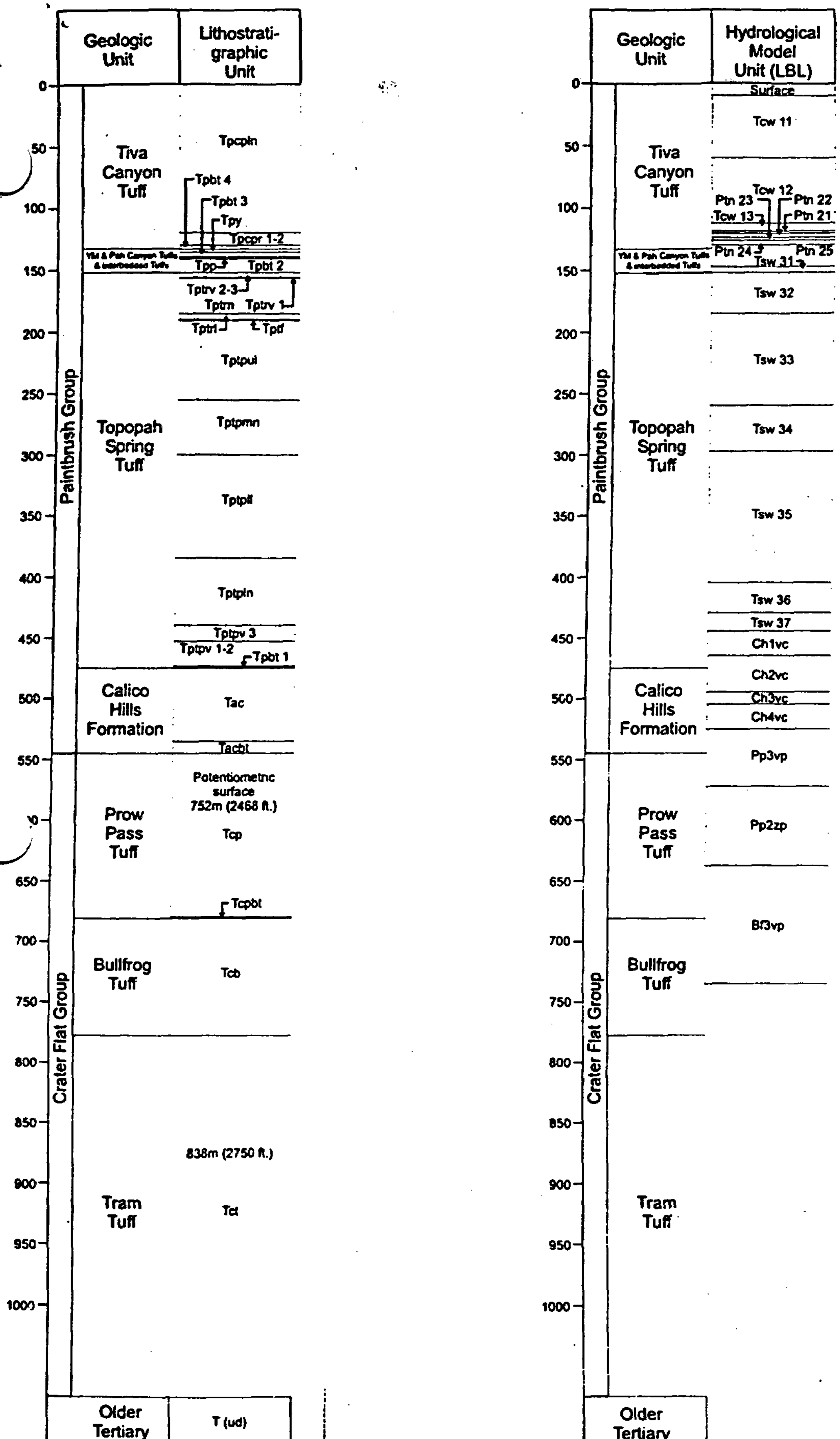
TOTAL DEPTH DRILLED 1734

ISM 2.1 Model   Actuals

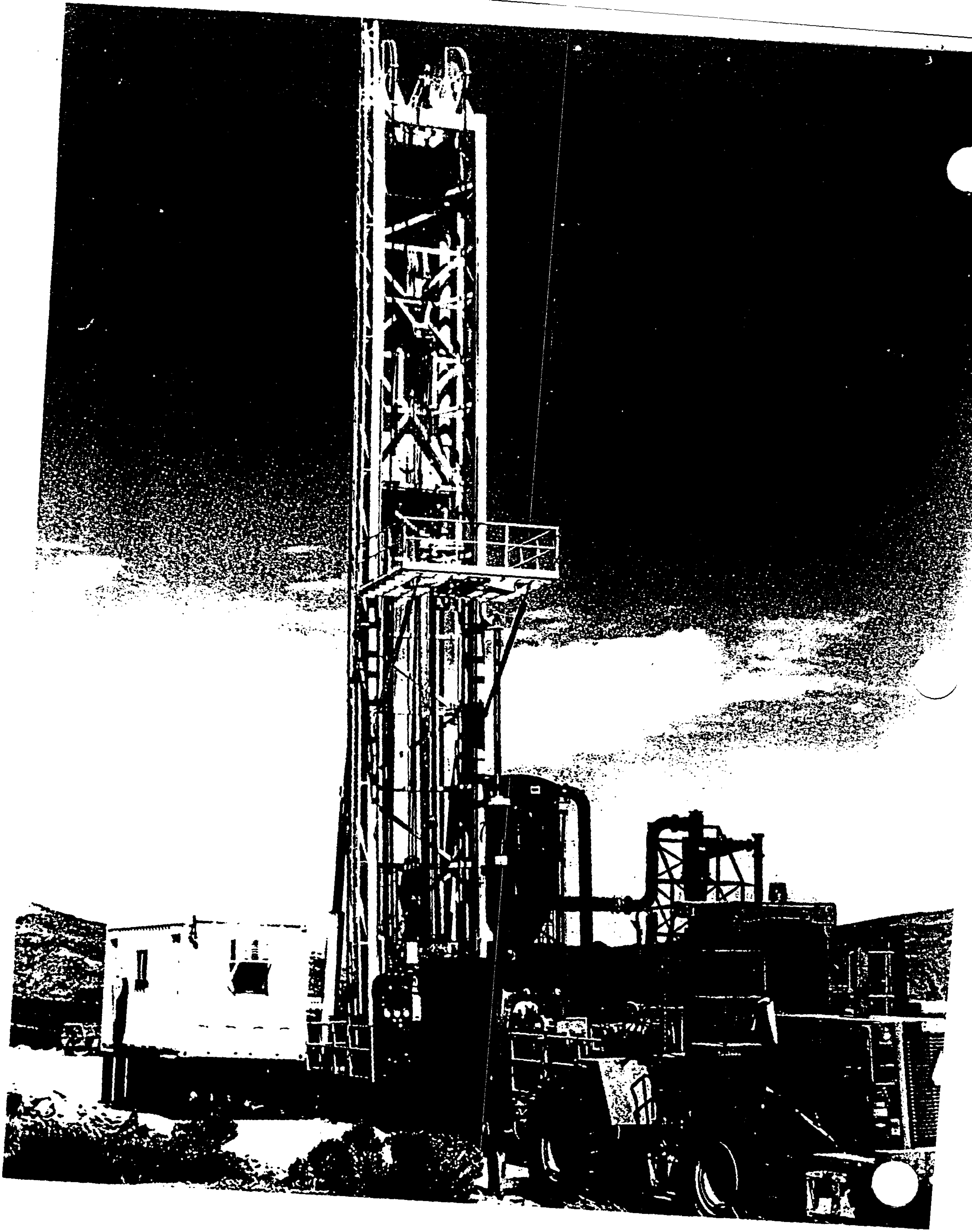


SD-6 Progress

- LM 300 moved to pad on 10/23/97
- Began drilling on 11/19/97
- Currently drilling a 12 ¼" hole using air reverse circulation
- Depth was 360' as of 12/10/97 (casing to 58')
- Began "potential erionite" zone 12/10/97, began coring


Geologic Unit
Lithostratigraphic Unit
Hydrological Model Unit (LBL)
Paintbrush Group
Crater Flat Group
Tiva Canyon Tuff
Topopah Spring Tuff
Calico Hills Formation
Prow Pass Tuff
Bullfrog Tuff
Tram Tuff
Older Tertiary
Tpcpln
Tpbt 4
Tpbt 3
Tpy
Tpcpr 1-2
Tpp
Tpbt 2
Tptrv 2-3
Tptrn
Tptrv 1
Tptrl
Tptf
Tptpul
Tptpmn
Tptpll
Tptpln
Tptpv 3
Tptpv 1-2
Tpbt 1
Tac
Tacbt
Potentiometric surface 752m (2468 ft.)
Tcp
Tcpbt
Tcb
838m (2750 ft.)
Tct
T (ud)
Surface
Tcw 11
Tcw 12
Ptn 23
Ptn 22
Tcw 13
Ptn 21
Ptn 24
Ptn 25
Tsw 31
Tsw 32
Tsw 33
Tsw 34
Tsw 35
Tsw 36
Tsw 37
Ch1vc
Ch2vc
Ch3vc
Ch4vc
Pp3vp
Pp2zp
Bf3vp

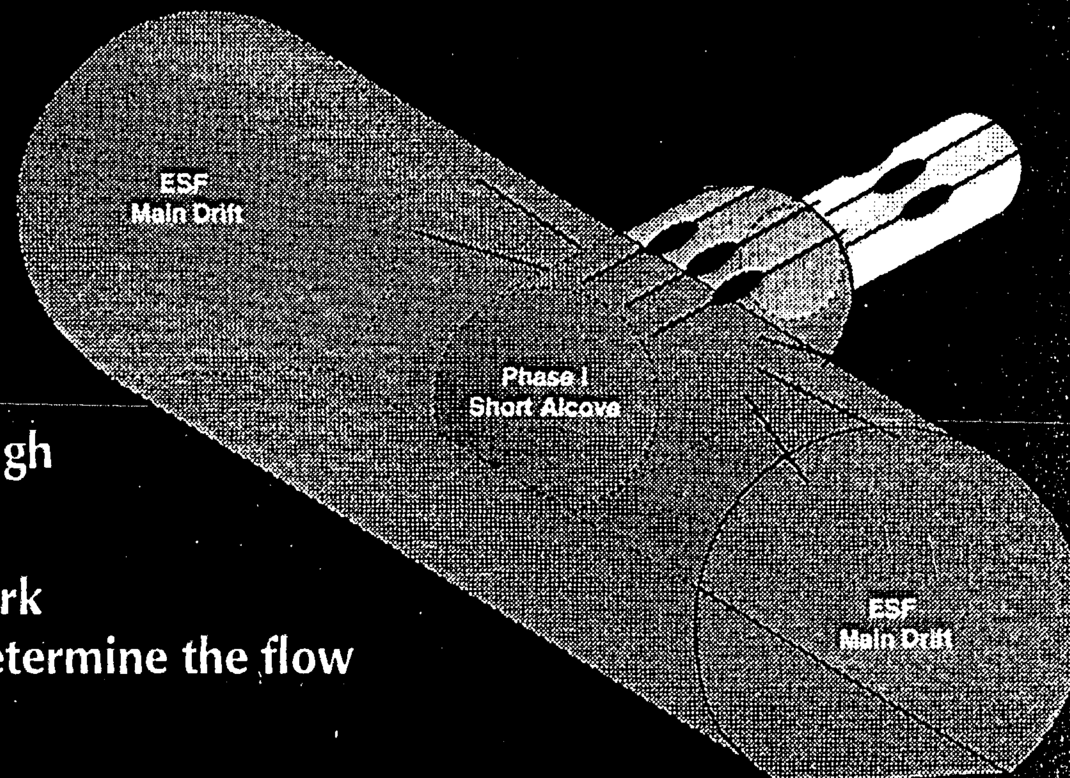
SD-6



C-well Complex Workover

- Turned off pump at 1600 11/12/97 ending tracer testing in the Bullfrog zone
- Began monitoring recovery
- Initiated removing packers / sensors / 2 ⅞" tubing from borehole c#2 on 12/9/97
- Packers / sensors / 2 ⅞" tubing will be removed from borehole c#3 before the end of 1997

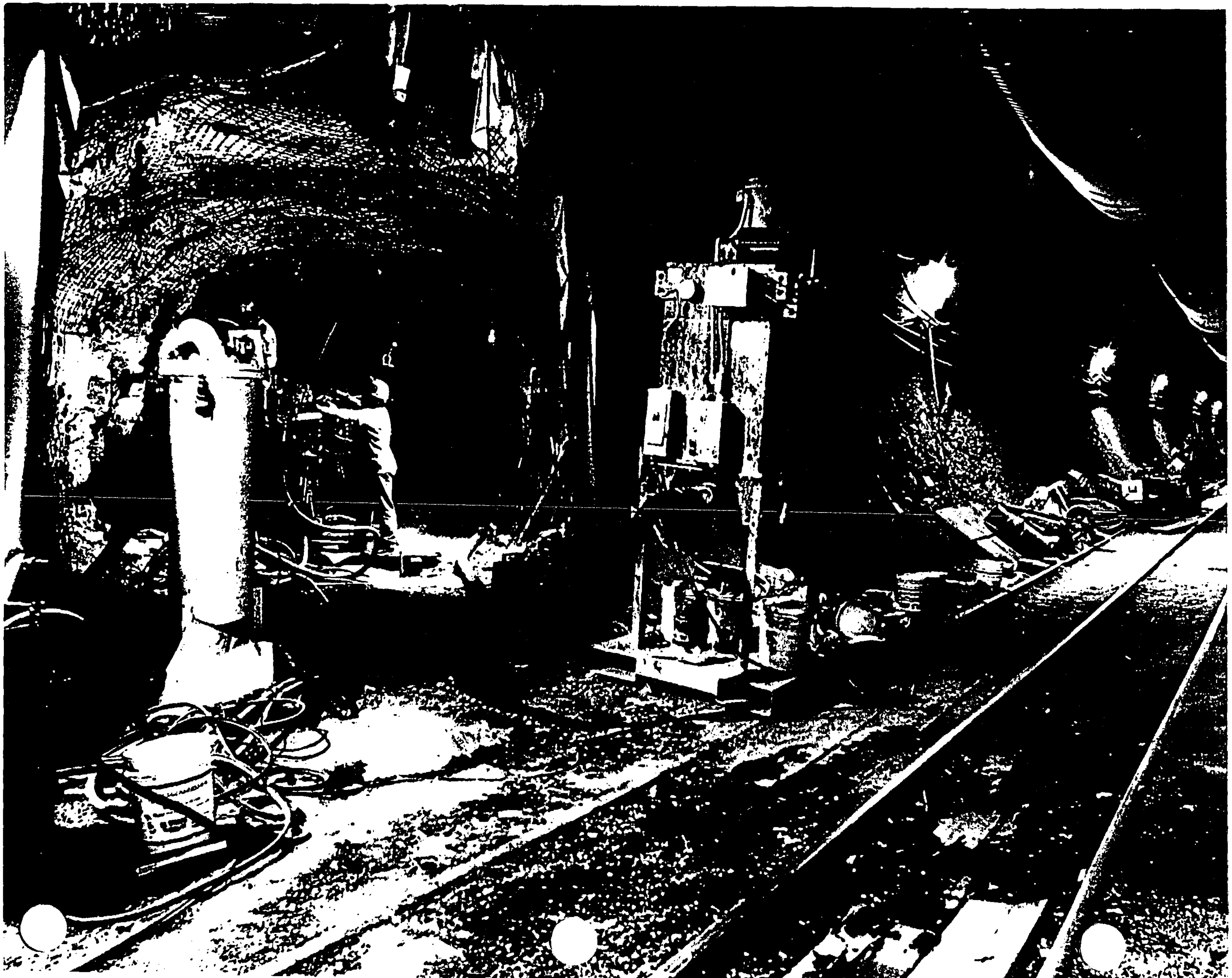
Niche study determines seepage into drifts
(infiltration ≠ percolation ≠ seepage)

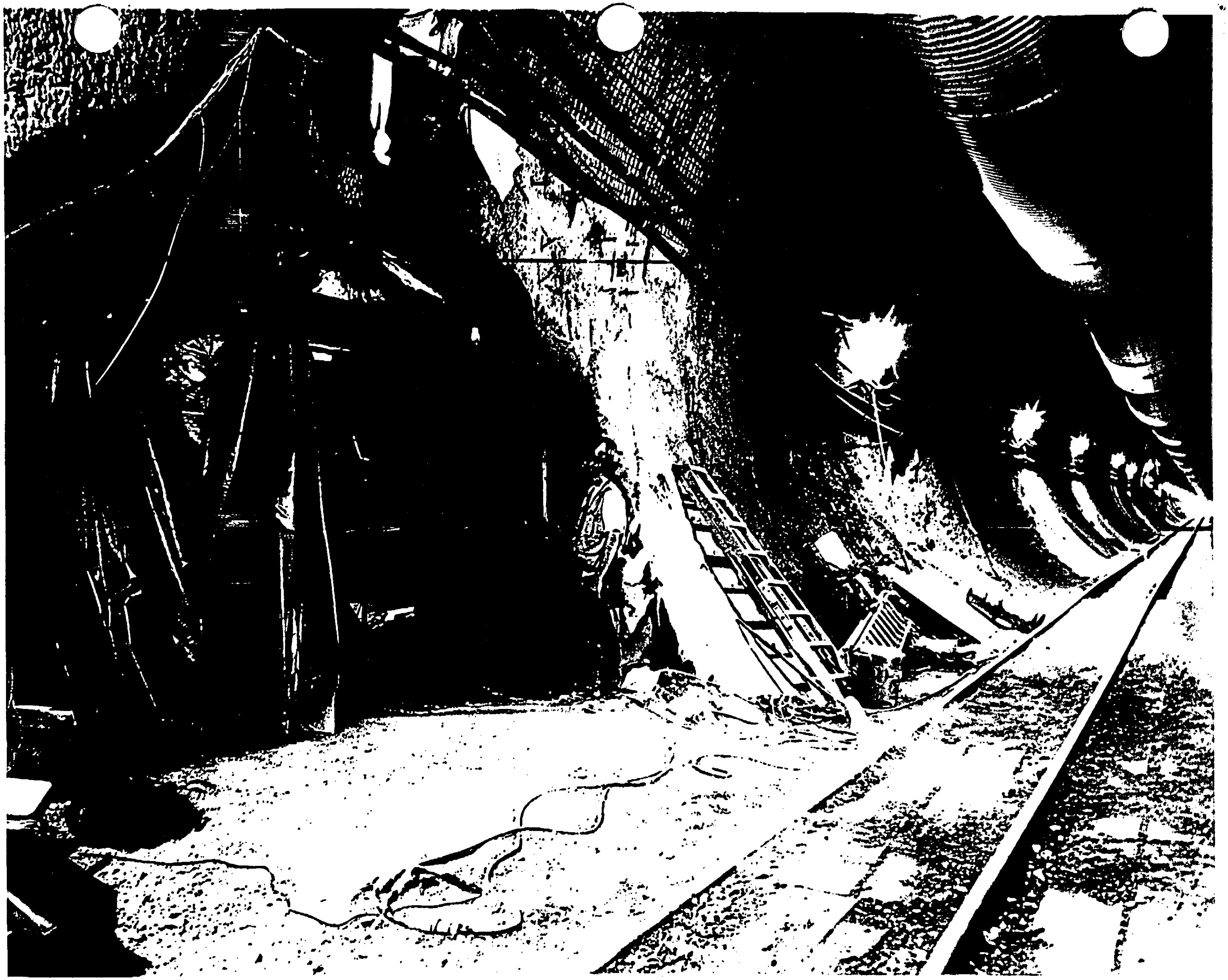


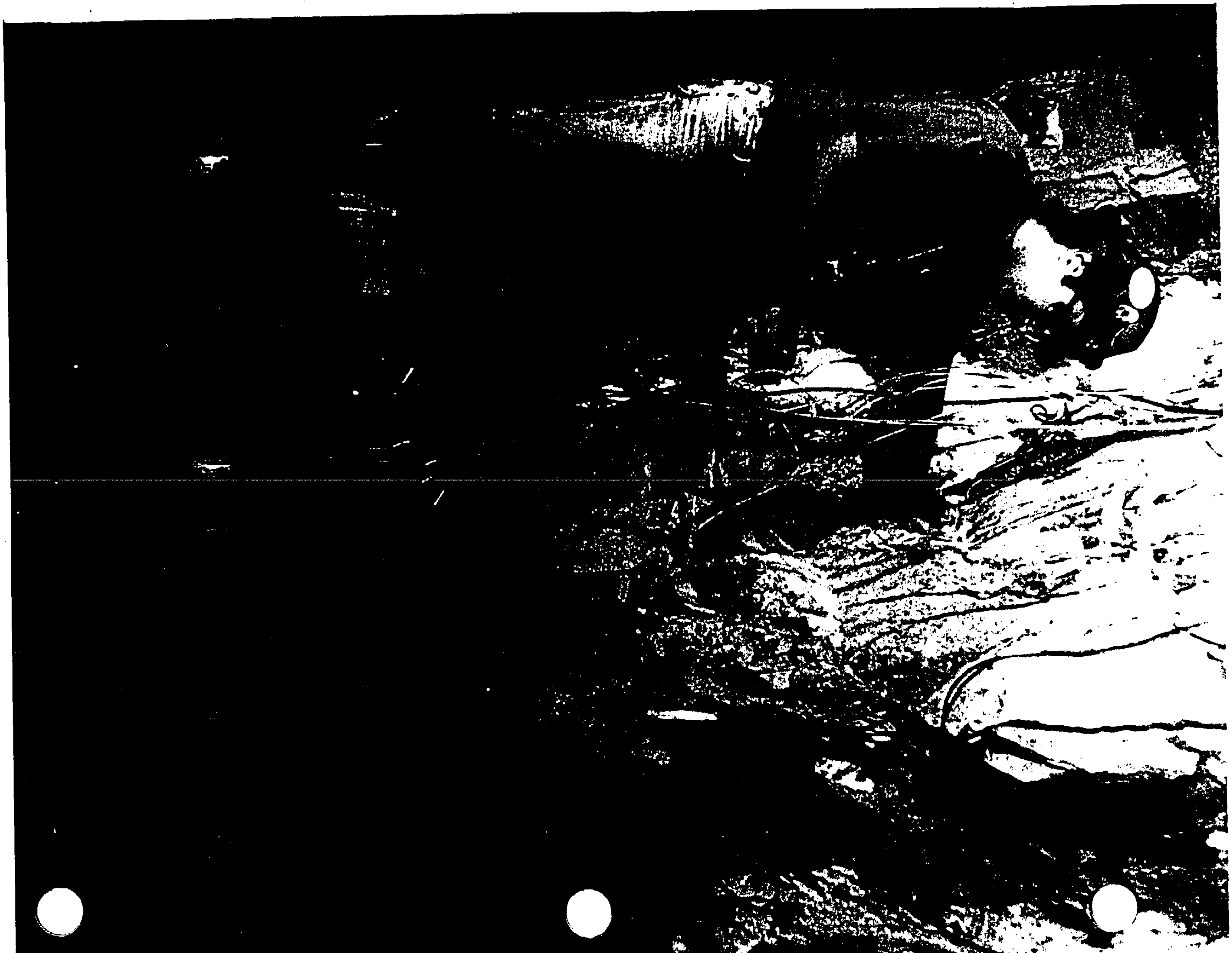
- Diversion of liquid release above the crown minimizes drips
- Isolation from main drift provides post-emplacement high humidity conditions
- Local fracture network and heterogeneity determine the flow paths to the drift
- Niche monitoring captures potential fast-flow pulses
- Niche alcove and drift-drift studies lead to better representation of multi-drift repository

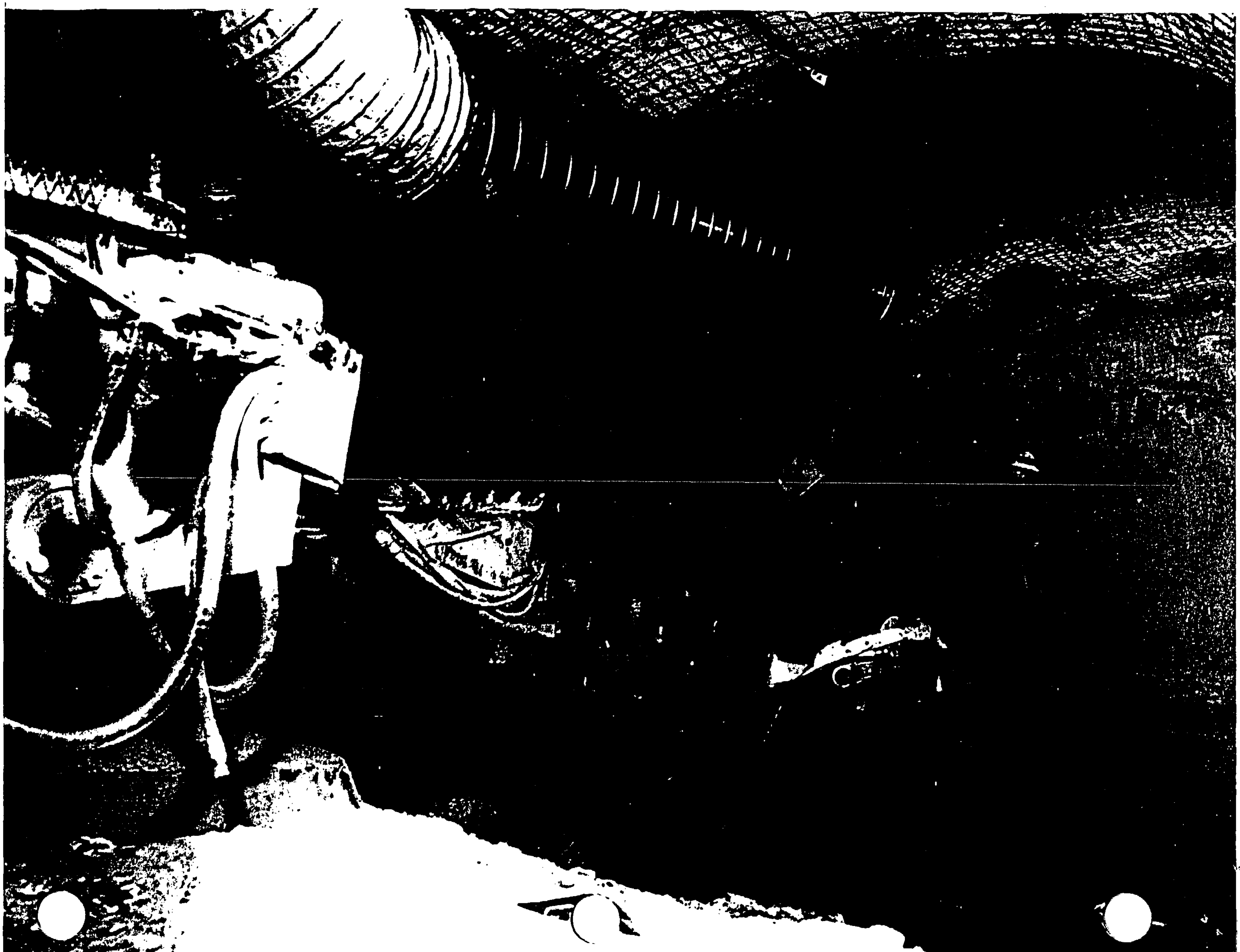
Seepage Into Drifts: Niche Studies

- Niche 1 at ESF Station 35+66
  - Completed excavation, pneumatic testing, and installation of temperature and humidity sensors and heat dissipation probes
  - Bulkhead sealed and shut-in monitoring began
- Niche 2 at ESF Station 36+50
  - Water injection test underway
  - Installed temperature and humidity sensors
  - Begin installation of heat dissipation probes in 3 to 5 weeks







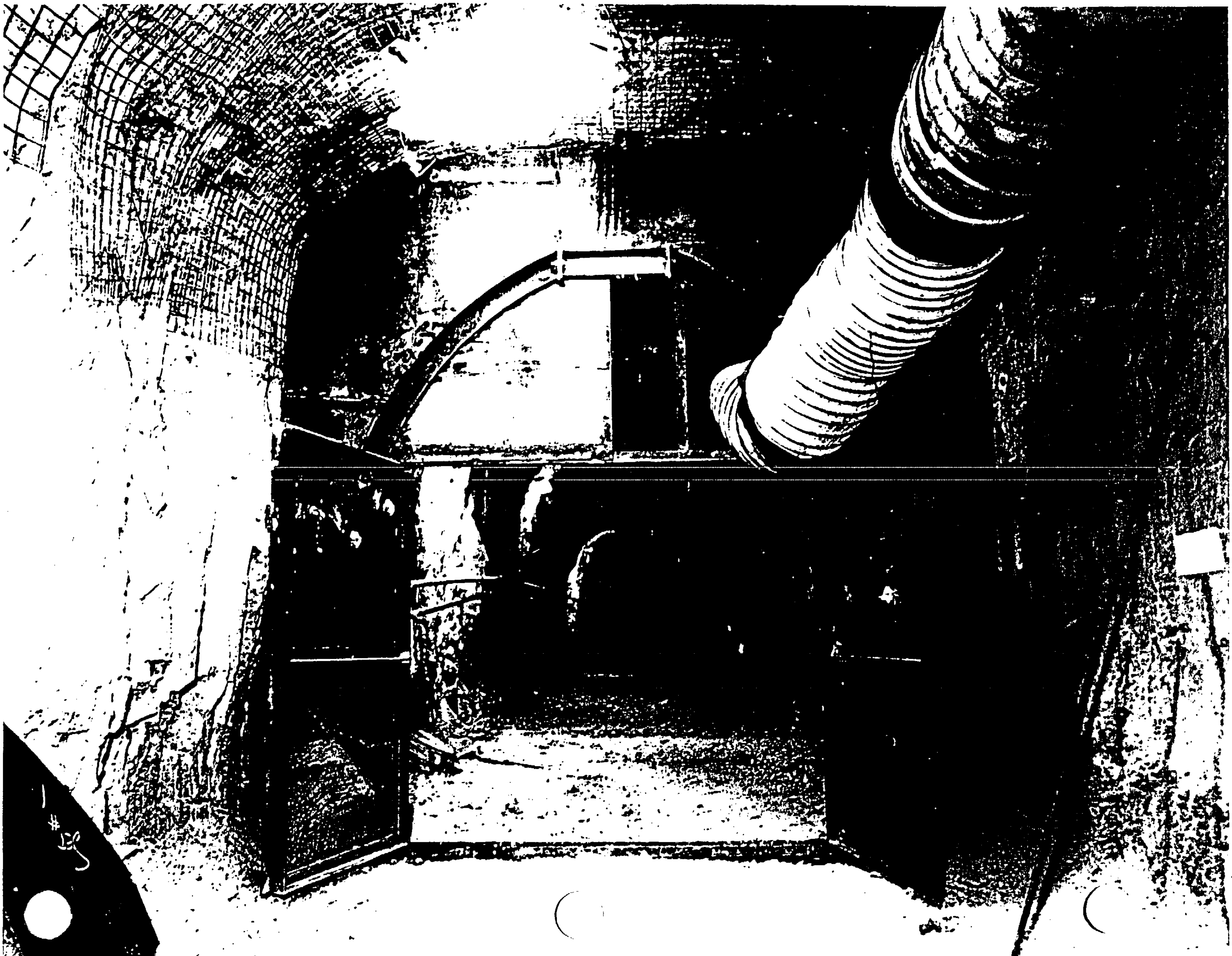


Seepage Into Drifts: Niche Studies

- **Niche 3 at ESF Station 31+05**
  - Drilling pre-construction boreholes
- **Niche 4 at ESF Station 47+85**
  - USGS and LBNL marked borehole locations

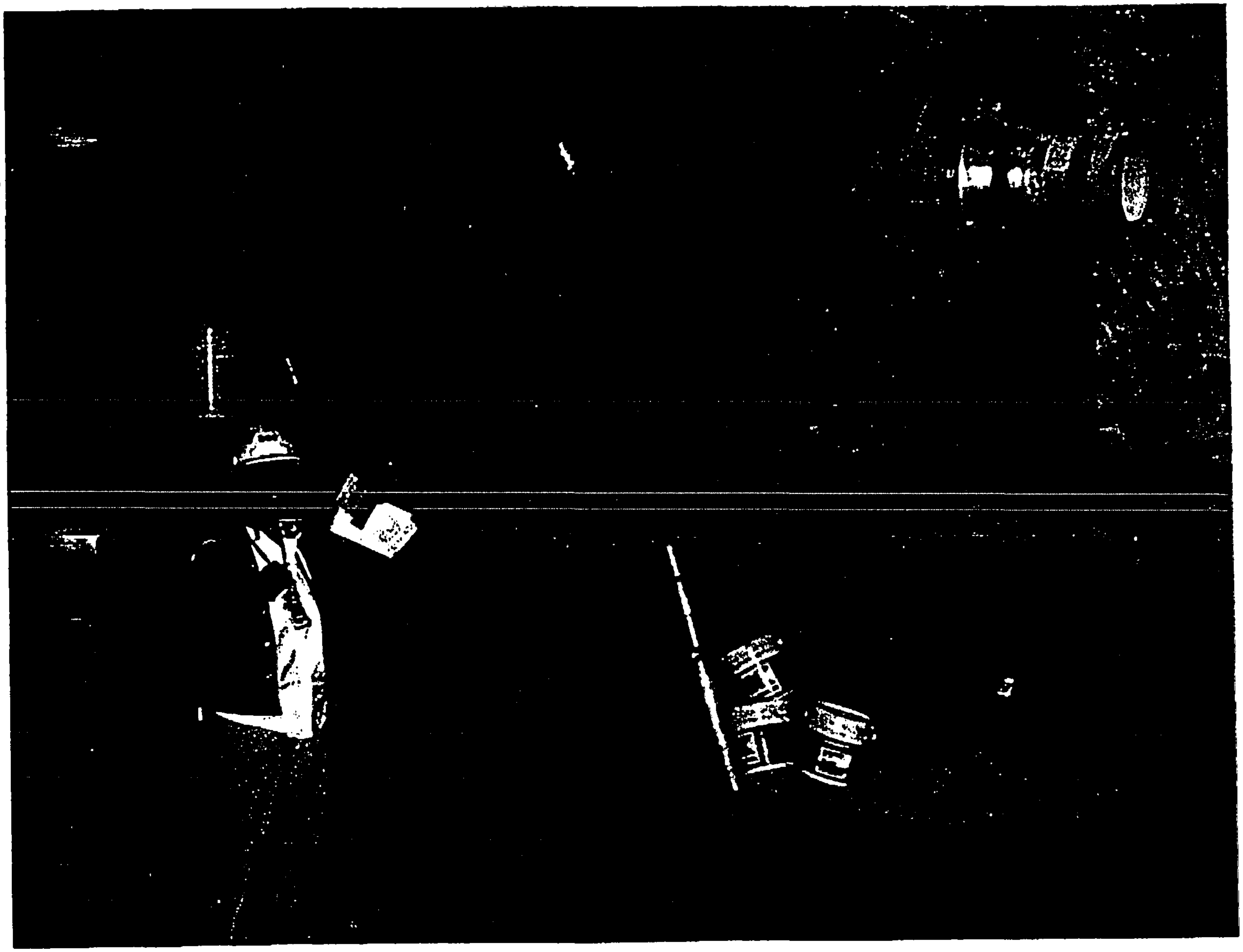
Seepage Into Drifts: Alcove Studies

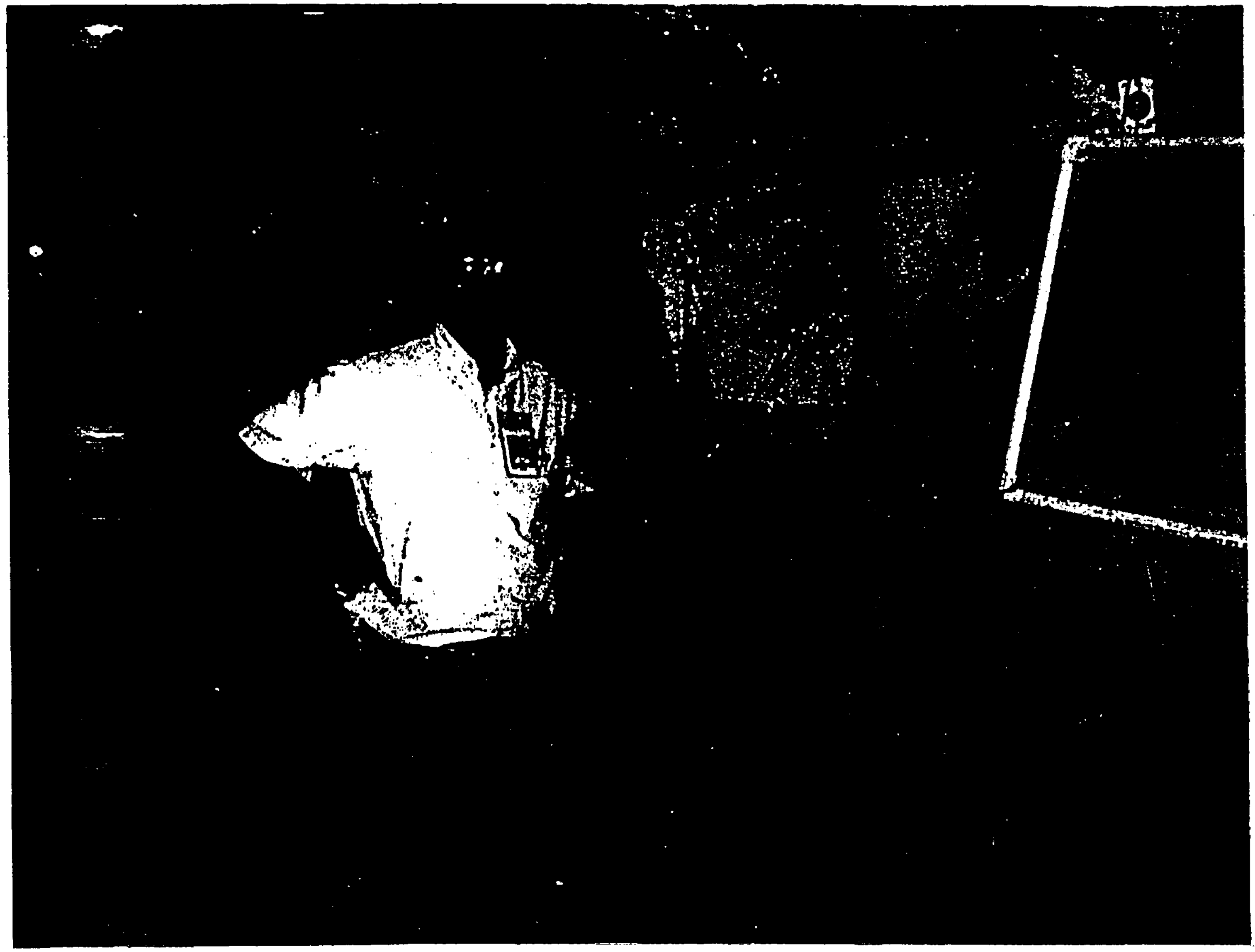
- **Alcove 1 at ESF North Portal (Artificial Infiltration Test)**
  - Bulkhead installed (not yet sealed)
  - Installation of moisture sensors almost complete
  - LBNL installing moisture sensing packer assemblies in existing boreholes
  - Developing surface-based infiltration equipment

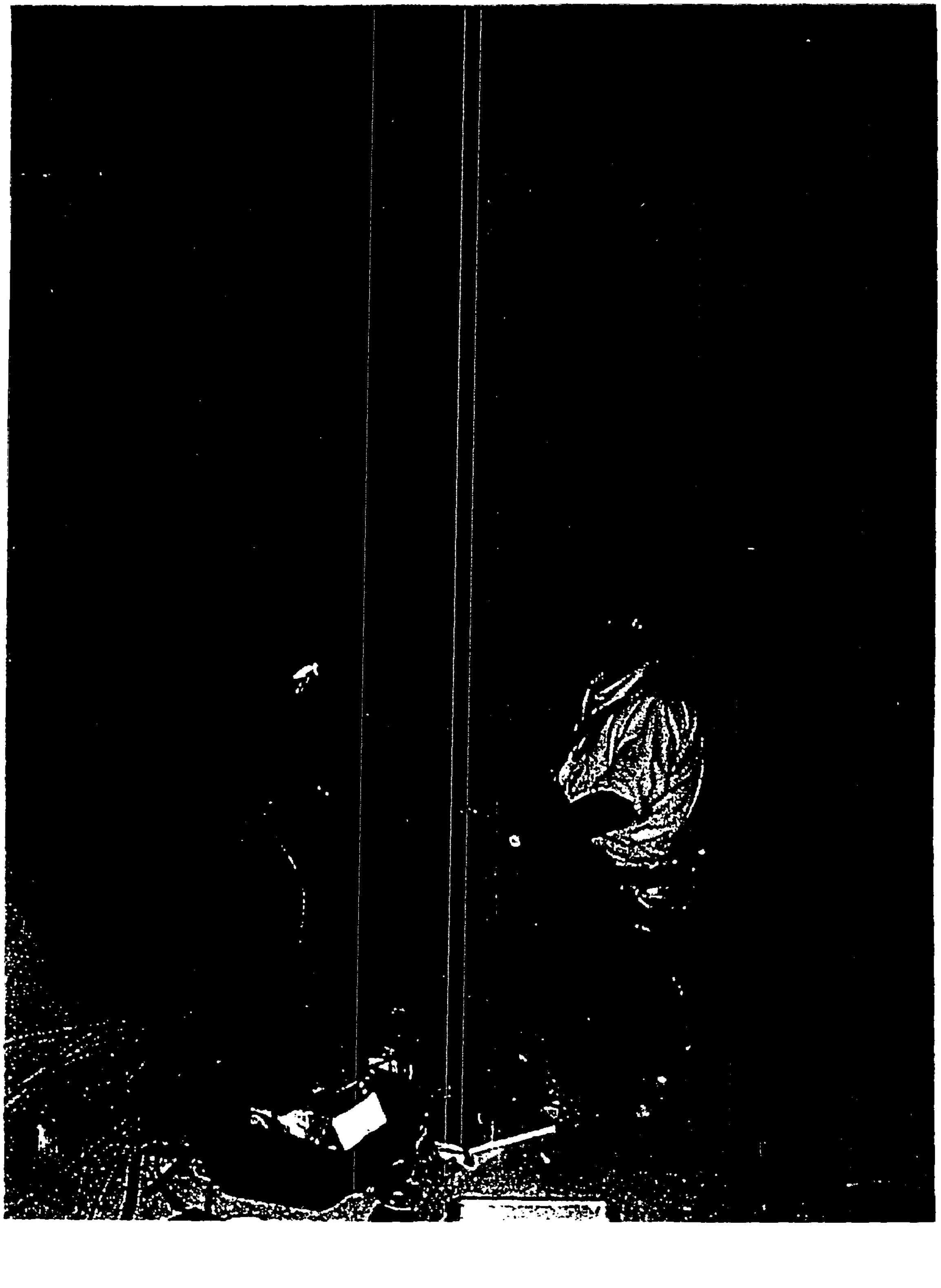


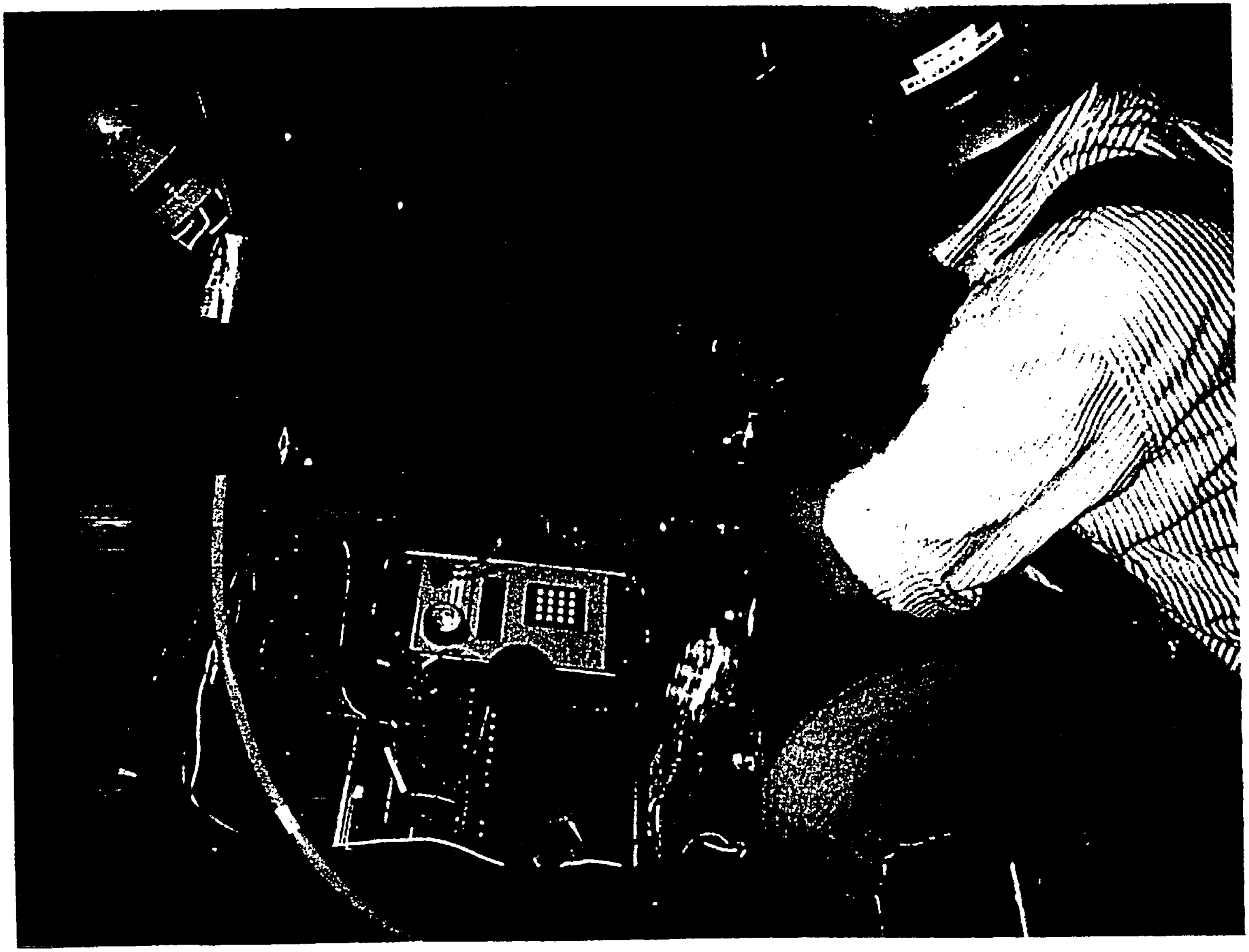
Seepage Into Drifts: Alcove Studies

- Alcove 7 at ESF Station 50+64 (Ghost Dance Fault)
  - Completing bulkhead construction
  - Completed detailed line survey fracture mapping
  - Installing moisture sensors, begin data collection on 12/8/97
  - Installed surface monitoring sensors over the Ghost Dance Fault on 12/9/97









PTn Lateral Diversion Study

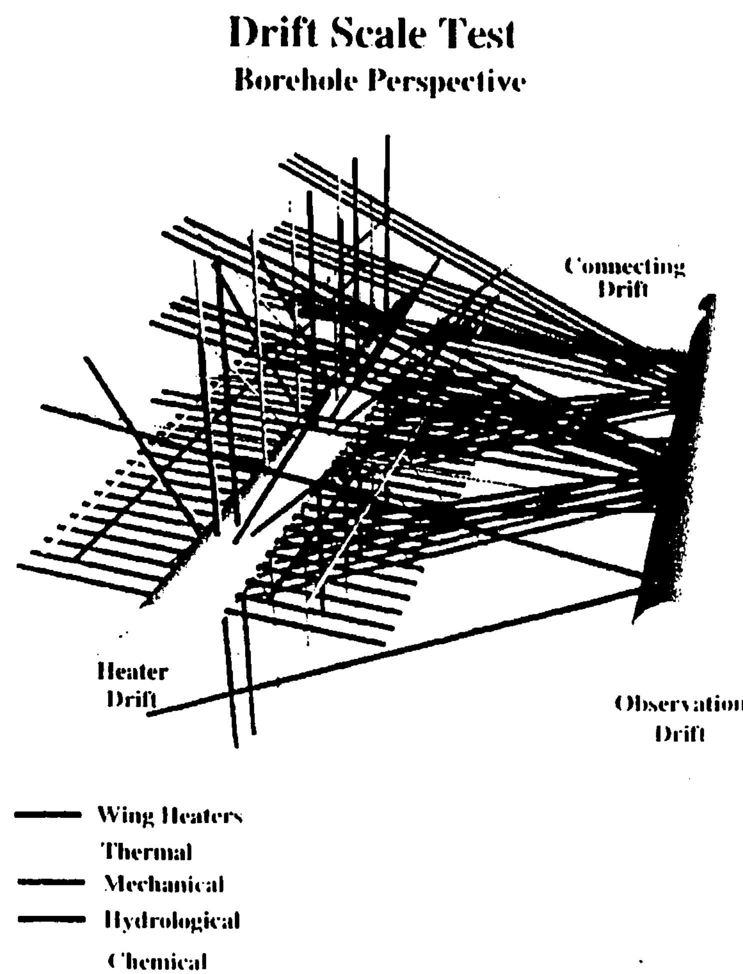
- Alcove 3
  - Plan to drill a 60 m downlook borehole for matrix properties from ESF construction (early 98)
- Alcove 4
  - Plan to drill a 40 m uplook and a 60 m downlook borehole for matrix properties from ESF construction (early 98)
- North Ramp and South Ramp Boreholes
  - Evaluating cores for stratigraphy, matrix properties, Cl-36 and chloride mass balance

Thermal Testing: Drift Scale Test

Induce Accelerated Near-Field Processes

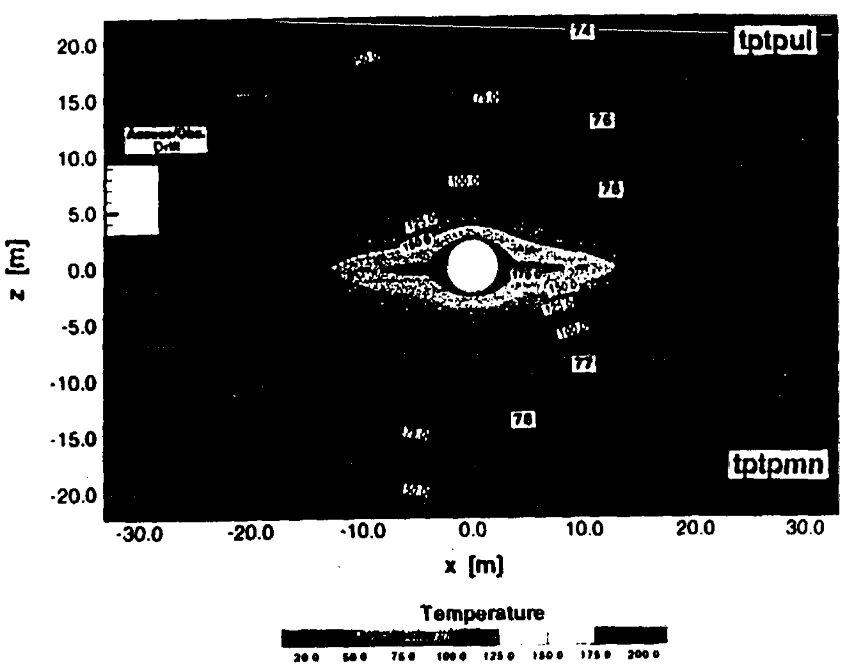
- Heated Drift: 47.5 m long, 5 m diameter
- 147 holes, total length: 3,300 m
- 9 canister heaters: 7.5 kW each
- 50 wing heaters: Inner Segments 1150 watts ea
  Outer Segments 1720 watts ea
- Heating duration: up to 4 yrs
- Rock heated volume: >200,000 m^3
- Rock heated above 100° C:>10,000 m^3
- Total sensors: 3,500
- Data collection system: approx 5,000 channels
- Limited data will be available to support VA, but LA and performance confirmation are the primary customers

	Upper Lith	Middle Non-Lith	Lower Lith
Porosity	0.15	0.11	0.13
Initial Saturation	0.8	0.9	0.8
Thermal Conductivity w(m°k)	1.7(wet) 1.2(dry)	2.0(wet) 1.7(dry)	2.3(wet) 1.6(dry)
Permeability (Darcies)	0.02D	0.01D	0.005D

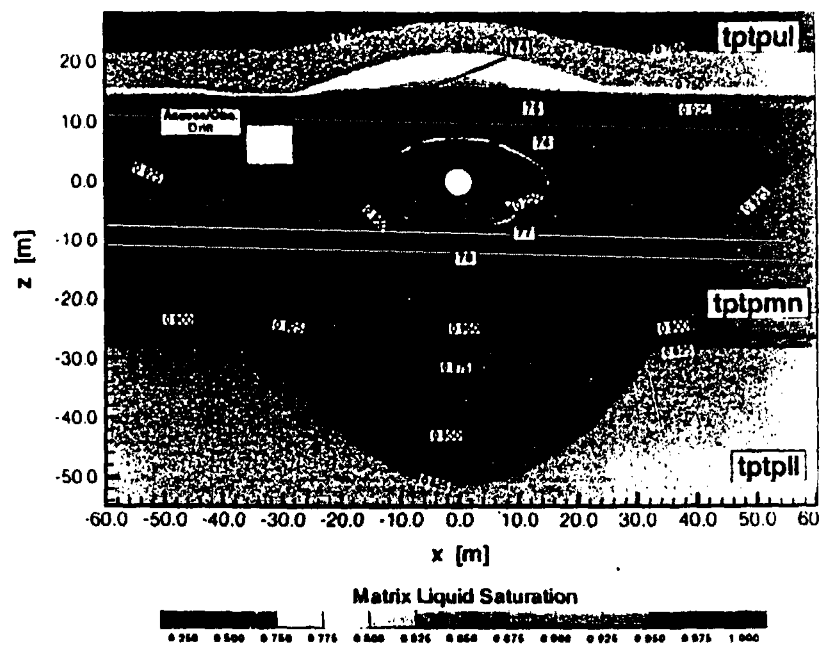


Thermal Testing: Drift Scale Test Near-Field Performance Predictions

Thermal - Hydrological Situation after 4 Years of Heating
(3.6 mm/yr infiltration, 100%/50% heating schedule, ECM, uniform heat input along drift wall)

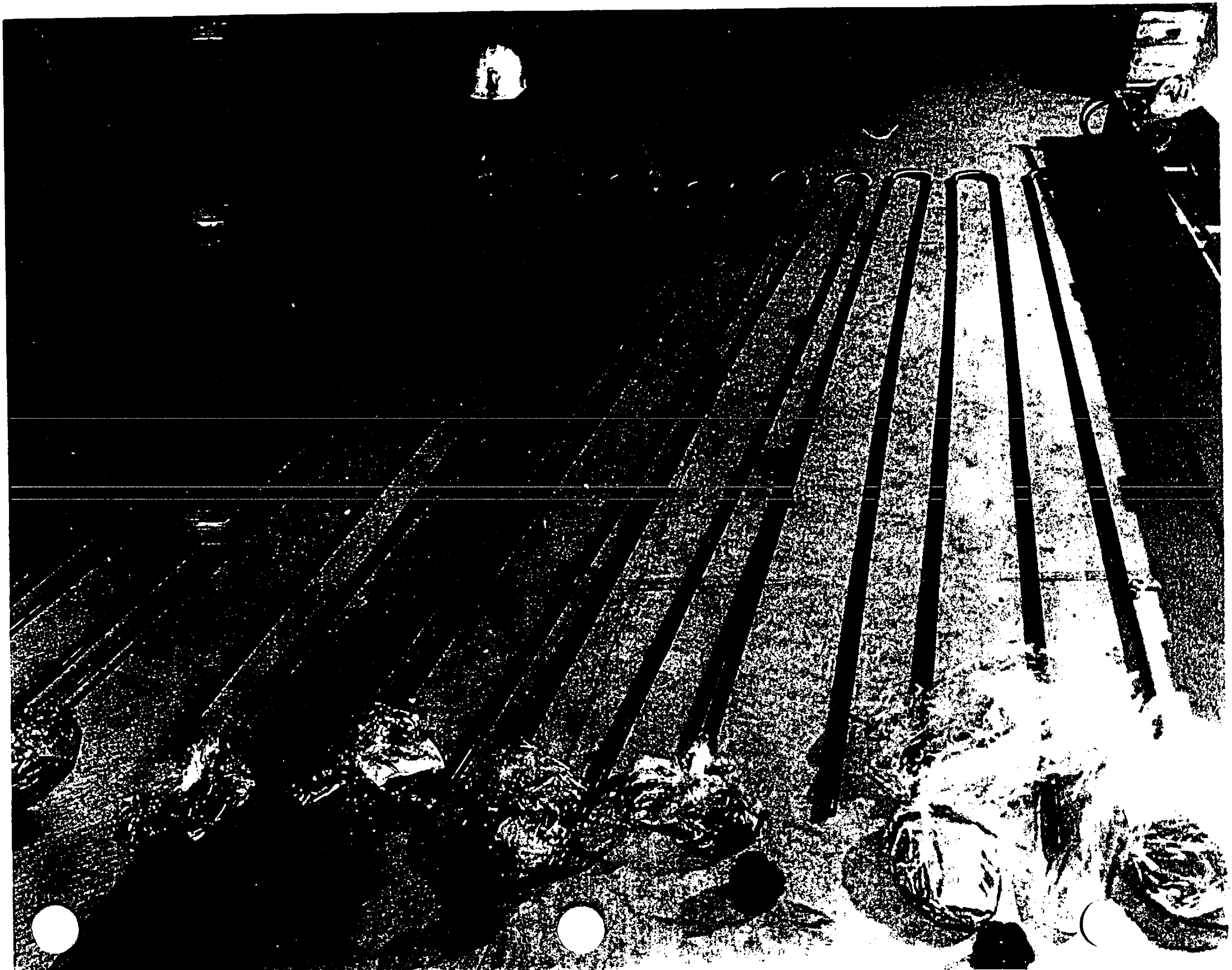


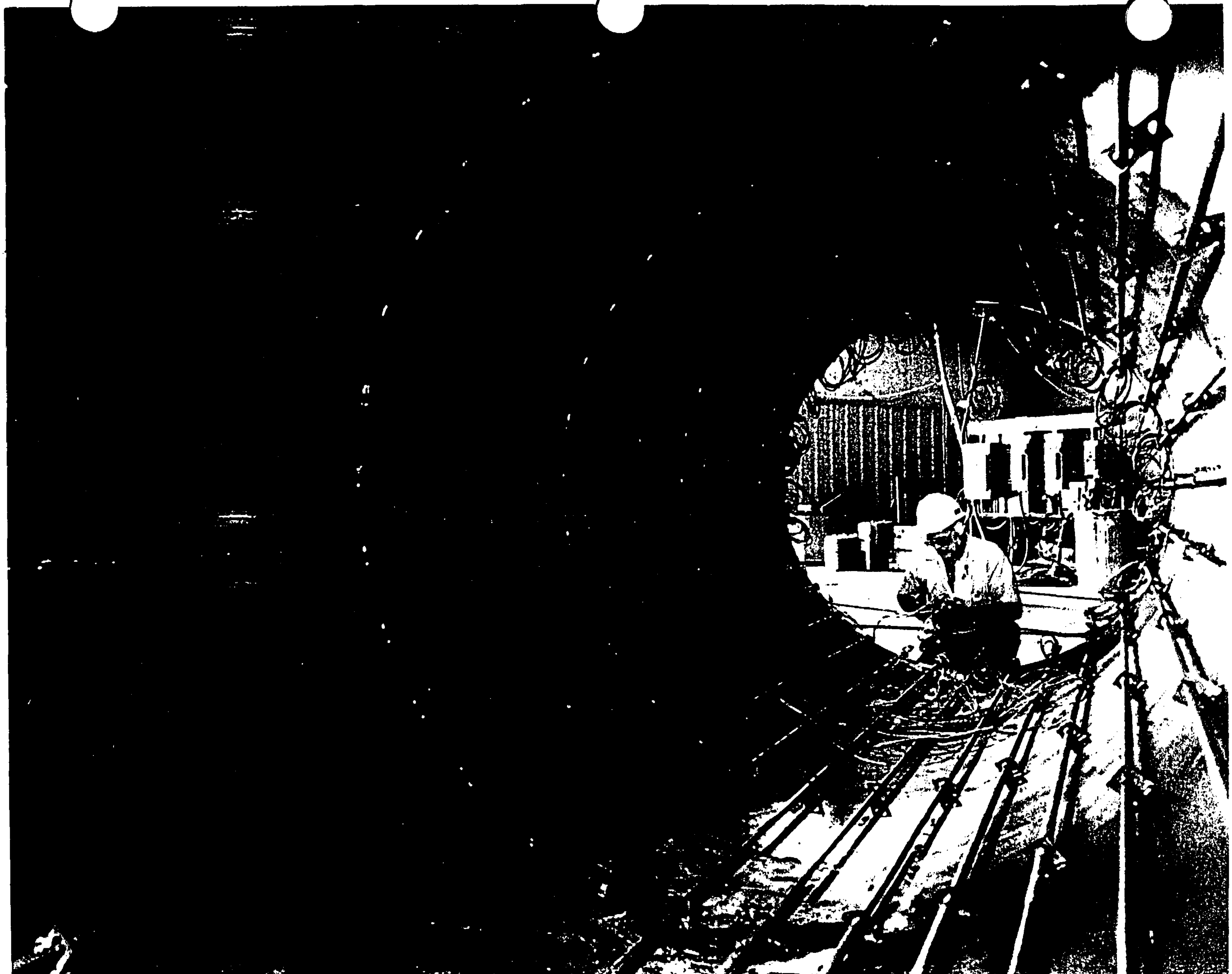
Thermal - Hydrological Situation after 4 Years of Heating
(3.6 mm/yr infiltration, 100%/50% heating schedule, ECM, uniform heat input along drift wall)

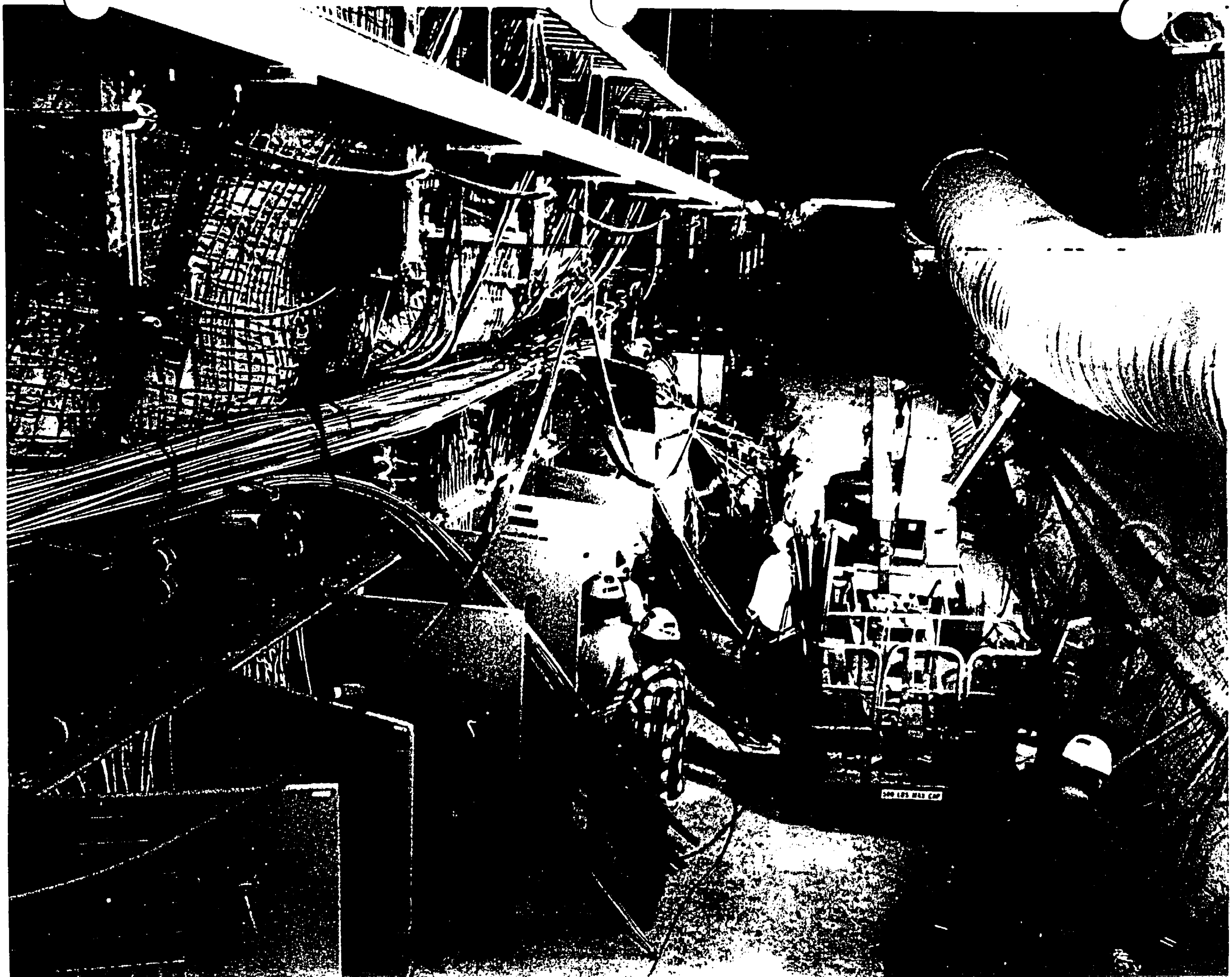


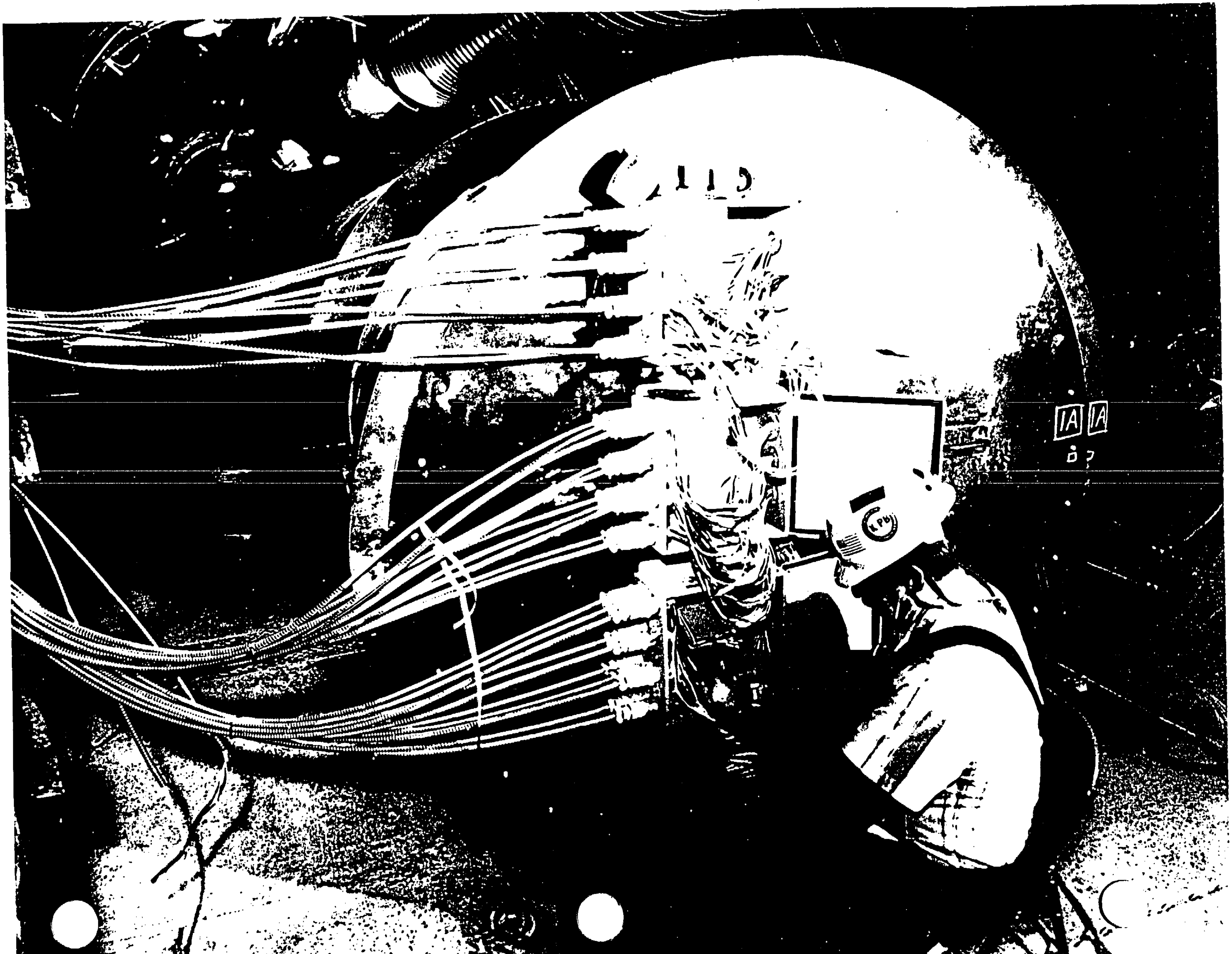
Highlights : Drift Scale Test

- Alcove mining completed 2/97 -- drilling, instrumentation, characterization and baseline data collection from 2/97 to 11/97
- Integrated Data Collection : Completed instrumentation of 139 monitoring boreholes including strain gauges, bulkhead thermocouples, and installed SEAMIST liners in 10 hydrochemistry boreholes
- Individual Event Data Collection : Collecting baseline data, including neutron logging, electrical resistivity tomography, ground-penetrating radar, air-injection testing, gas sampling, and video imaging
- Heater turn-on began at 10:35 AM on 12/3/97
- Heat up phase (200 kW power input) for 4 years





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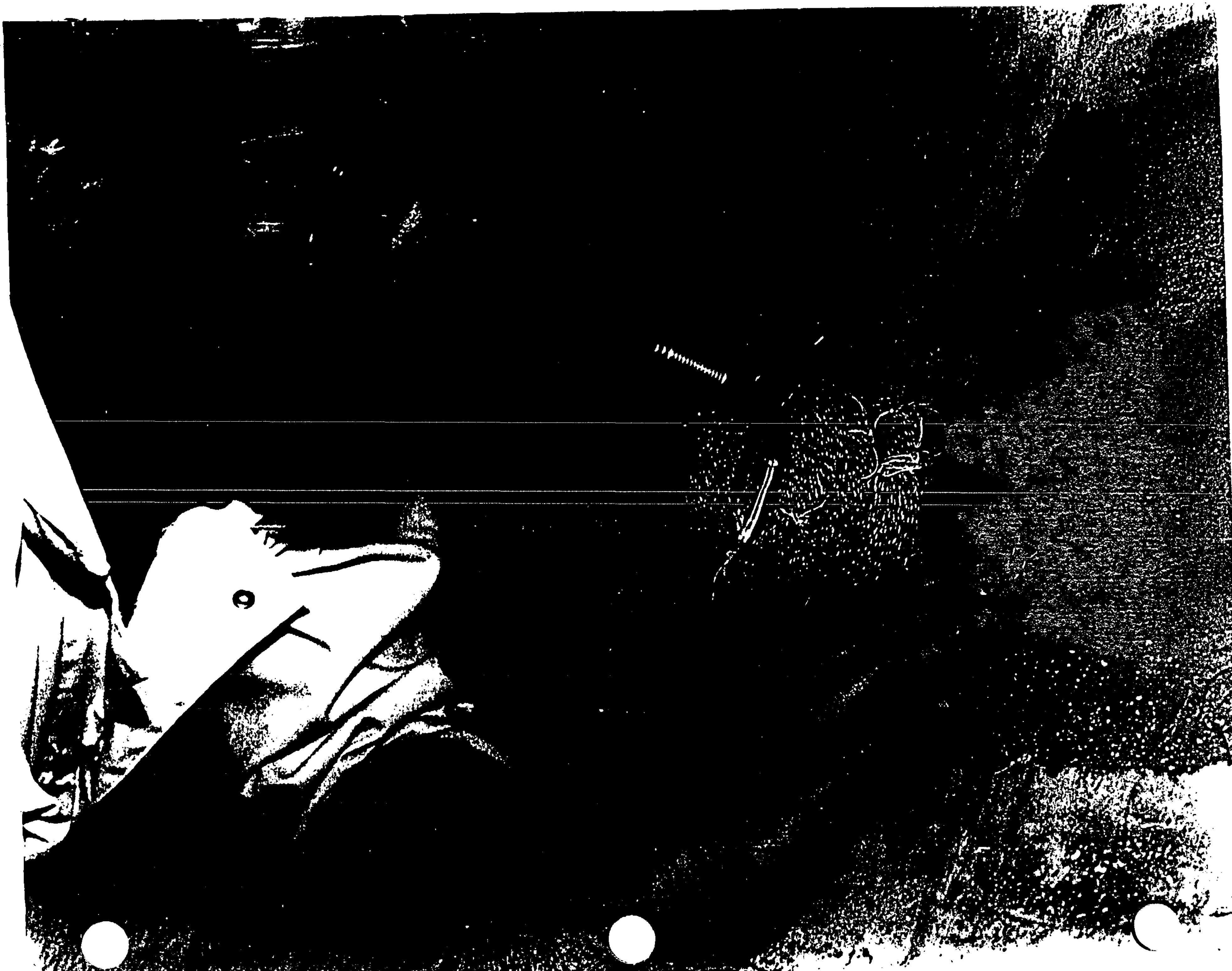


FACT SHEET
for
DRIFT SCALE TEST
(November 25, 1997)

Boreholes:

Number: 147
Length: ≈3300 meters (2 miles)
- Access Drift: ≈1500 meters
- Connecting Drift: ≈240 meters
- Heated Drift: ≈1560 meters

Volume: ≈18 cubic meters (635 cubic feet)

Costs (estimated):

Construction, Drilling, A/E:≈ $8 Million
Procurement, Design, Installation, Amb. Char., Baseline Data:≈ $11 Million
Annual Operation (Conduct, Analyze, Report):≈ $5 Million
Total Annual Cost:≈ $5.9 Million
Total:≈ $59 Million

Data Collection System:

Channels: ≈6000
Type: Hewlett Packard VXI Mainframes in NEMA-12 Enclosures
Mass Storage: ≈70 Gigabytes
Communications: Fiber Optic Cable to Surface
Length of Wiring: ≈0.2 million meters (125 miles)
Number of Wire Connections: ≈30,000

Data Service System:

Features: Restricted Network, Electronic Diagnostics, Data Tracking Numbers, Query Logic, Downsizing, Interpolation, Graphical, Maintenance, and Special
Hardware: Silicon Graphics, Inc - O2 Unix System
Primary Database Language: Oracle - Version 7.3.2
Mass Storage: ≈40 Gigabytes

Duration (years):

Total: 10
Installation & Construction : 1
Heating: 4 (2 years mandatory-minimum, 4 years planned-maximum)
Cooling: 4 (approximately equivalent to heating duration)
Analyses & Reports : 1

Heated Drift:

Length: 47.5 meters
Diameter: 5 meters
Volume (without invert): ≈1000 cubic meters
Invert: Max. Thickness-1.3 meters; Vol.-≈300 cubic meters; Std.Concrete
Ground Support Systems:

- Rockbolts and Welded-Wire Mesh (for stability and safety only)
  - Location: Throughout Roof of Heated Drift
- Cast-in-Place Concrete (test component)
  - Length: 12 meters
  - Diameter (outside): 5.4 meters
  - Thickness (minimum): 0.2 meters
  - Type: Regular (8m Section) and Fiber-Reinforced (4m Section)
  - Strength: 5,000 pounds per square inch
  - Location: West End of Heated Drift

Heater Power:

Total: 212 kW (designed use); 300kW(maximum available)
Wing (50): 144 kW
Floor (9): 68 kW
Power Controller: 0 to 100%
Initial Power: 100% - Wing; 80% - Floor; 200 kW - Total
Maximum Drift Wall Temperature: 200 C
Energy: ≈ 1.8 Million kWH per Year

Heaters:

- Wing (Inner and Outer):
  - Number: 50
  - Length: 11.5 meters
  - Diameter: ≈5 centimeters
  - Elements: Primary and Backup
  - Kilowatts: Inner - 1.145; Outer - 1.719
- Floor (Canister):
  - Number: 9
  - Length: 4.6 meters
  - Diameter: 1.7 meters
  - Elements: Primary and Backup
  - Kilowatts: 7.5 (designed use)

Instrument Arrays:

Number: 9 (Observation Drift); 9 (Heated Drift)

Type (primary):

- Thermal: 5.5
- Mechanical: 3
- Hydrological: 7.5
- Chemical: 2

Total Array-Boreholes: 85

Measurement Devices:

Data Collection System (Integrated):

- Total: ≈3500
- Thermal (thermocouples, RTDs, thermistors): ≈2900
- Mechanical (MPBX anchors): 110
- Hydrological (humidity, pressure, pore fluid, ERTs): ≈450
- Chemical: 30

Data Collection System(Non-Integrated):

- Air-Permeability
- REKA [Rapid Evaluation of Thermal Conductivity (K) and Thermal Diffusivity (Alpha)]
- Plate Loading
- Ground Penetrating Radar
- Neutron Logging
- Electrical Resistivity Tomography
- Bulkhead Vapor Pressure
- Remote Camera (video and infrared)
- Acoustic Emissions/Seismic Tomography
- Borehole Video Logging

Numerical Analyses:

Type (Computer Programs):

- Thermal (V-TOUGH, NUFT, TOUGH2, COYOTE, FEHM, ANSYS)
- Mechanical (FLAC, UDEC, DDA, ANSYS, JAC)
- Hydrological (FEHM, NUFT, V-TOUGH, TOUGH2, FEMTRAN)
- Chemical (EQ3/6, OS3D, GIMRT, FEHM, NUFT, TOUGH2)

Phases: Scoping, Pre-Test, and Mid-Test (multiple)

Scope Comparison

(See Table 1)

Thermal Test Team (Primary/Secondary Contributors)

Consultants: 5/50
DOE: 2/10
M&O (non laboratory): 6/40
LANL: 5/15
LBNL: 7/15
LLNL: 10/30
SNL: 10/20

Total Contributors: 225 (45 Primary and 180 Secondary)

Volume (cubic meters):

Rock Heated Above Ambient: >200,000
Dryout Zone (<46% saturation): >10,000

Table 1. Scope Comparison Between the Drift Scale Test and Sixteen Other Thermal Tests

Thermal Test	Power (kW)	Total Test Duration (Years)	Processes T-Thermal M-Mechanical H- Hydrological C-Chemical
Yucca Mountain (Drift Scale Test)	**200**	**8.0**	**TMHC**
Yucca Mountain (Single Heater Test)	4	1.5	TMHC
Yucca Mountain (Large Block Test)	2.3	0.8	TMHC
G-Tunnel (Small Diameter Experiment)	2.1	0.3	TMH
G-Tunnel (Heated Block Experiment)	0.8	1.0	TM
G-Tunnel (TH Experiment)	3.3	1.0	TH
Climax (Spent Fuel Test)	19.5	3.0	TM
Waste Isolation Pilot Plant (Room A)	57.3	4.0	TM
Waste Isolation Pilot Plant (Room B)	58.6	4.0	TM
Waste Isolation Pilot Plant (Room H)	81.6	9.0	TM
Underground Research Laboratory-Canada (Buffer Container Experiment)	1.2	2.5	TMH
Underground Research Laboratory-Canada (Heated Failure Tests)	1.2	2.5	TMH
Underground Research Laboratory (Thermal Hydraulic Experiment)	1.0	1.0	TMH
Basalt Waste Isolation Plant (Test-1 No. 1)	5.0	2.0	TM
Basalt Waste Isolation Plant (Test-2 No. 2)	5.0	4.5	TM
Stripa - Sweden (3 Experiments)	6.1	4.5	TM
Avery Island (Site A)	6.0	1.5	TM

Paul Dixon, Ph.D.
Technical Lead for Geochemistry
Natural Environment Program Organization
M&O / LANL

Colloidal Facilitated Transport: Plutonium Migration at the Nevada Test Site (NTS)

- Plutonium measured in groundwater at the NTS at a maximum level of 0.63 pCi/L
- Pu detected associated with the colloidal fraction
- Colloidal material isolated consisted mainly of clays, zeolites, and silica
- Isotopic analyses indicate that Pu originated at the nuclear test -- BENHAM
- Minimum distance for Pu migration at NTS is 1.3 km in 28 years

Possible Mechanisms for Pu Migration at the NTS

- Plutonium transported along fractures during the early time of the detonation - Not likely
- Colloid Transport – Most likely explanation
- Soluble Pu migrated in fast flow paths - Not likely

Implication of Pu Migration at NTS to the Yucca Mountain Project

- Volcanic units at the YMP SZ (fractured welded tuffs) are similar to those at NTS showing Pu associated with colloids
- Radiocolloids (from the waste) and natural colloids (from the EBS) are expected to be generated in the drift
- Colloid transport should be considered in performance assessment base case calculations for radionuclide releases at Yucca Mountain

Colloid Model Framework for the TSPA-VA

- Information provided to PA for Base Case TSPA-VA (12/97)
  - Constraints on colloid concentrations in suspension as a function of water chemistry (pH and ionic strength) based on stability arguments
  - Rates of sorption / desorption of Pu onto iron oxide and clay colloids
  - Elution of colloids through saturated fractures under unsaturated & saturated conditions
- Use expert opinion to address transport of Pu via colloids

Current FY-98 Colloidal Studies

- Sorption/desorption rates of radionuclides onto natural colloids (clays and calcite, LANL)
- Sorption/desorption rates of radionuclides onto NFE and EBS generated colloids (LLNL)
- Reactive and neutral colloid migration in the natural environment (C-wells, LBT, and UZ field test, LANL, LLNL)
- Laboratory colloid migration studies in fractured tuffs (LANL with UFA)
- Sampling of natural colloids at SZ wells

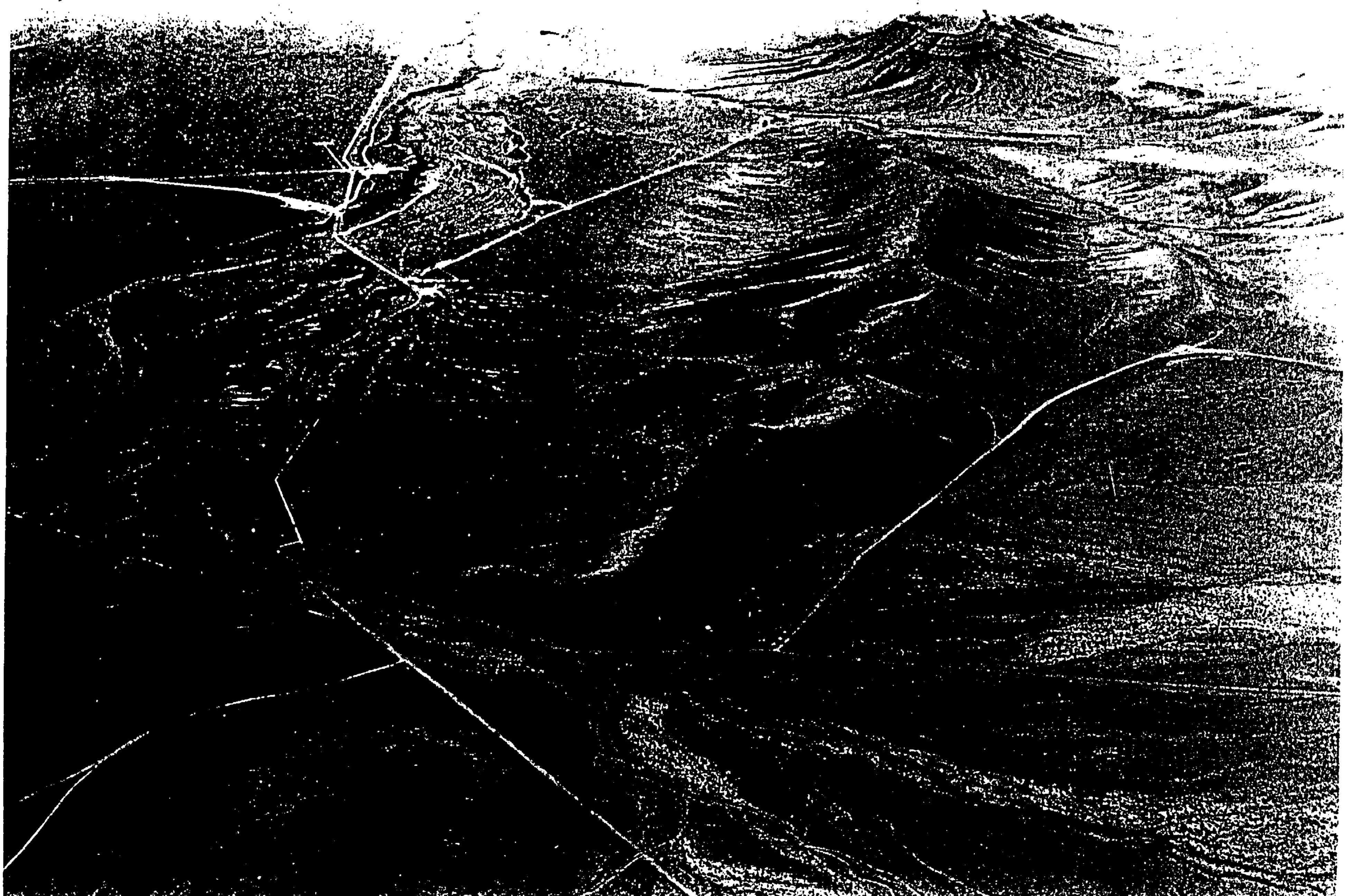
UZ Transport Test At Busted Butte

Purpose of the Busted Butte Field Test

- Validate lab data on radionuclide migration
- Validate conceptual UZ flow an transport models
- Reduce uncertainty in the transport of key radionuclides (Tc, I, Np and colloidal Pu)

Benefits of Siting the UZ Transport Test at Busted Butte

- The CHn at Busted Butte is the same section (but thinned) that exists under the repository
- Therefore all findings will directly applicable to Repository PA issues
- Test can be fielded and analyzed to produce results for TSPA-LA



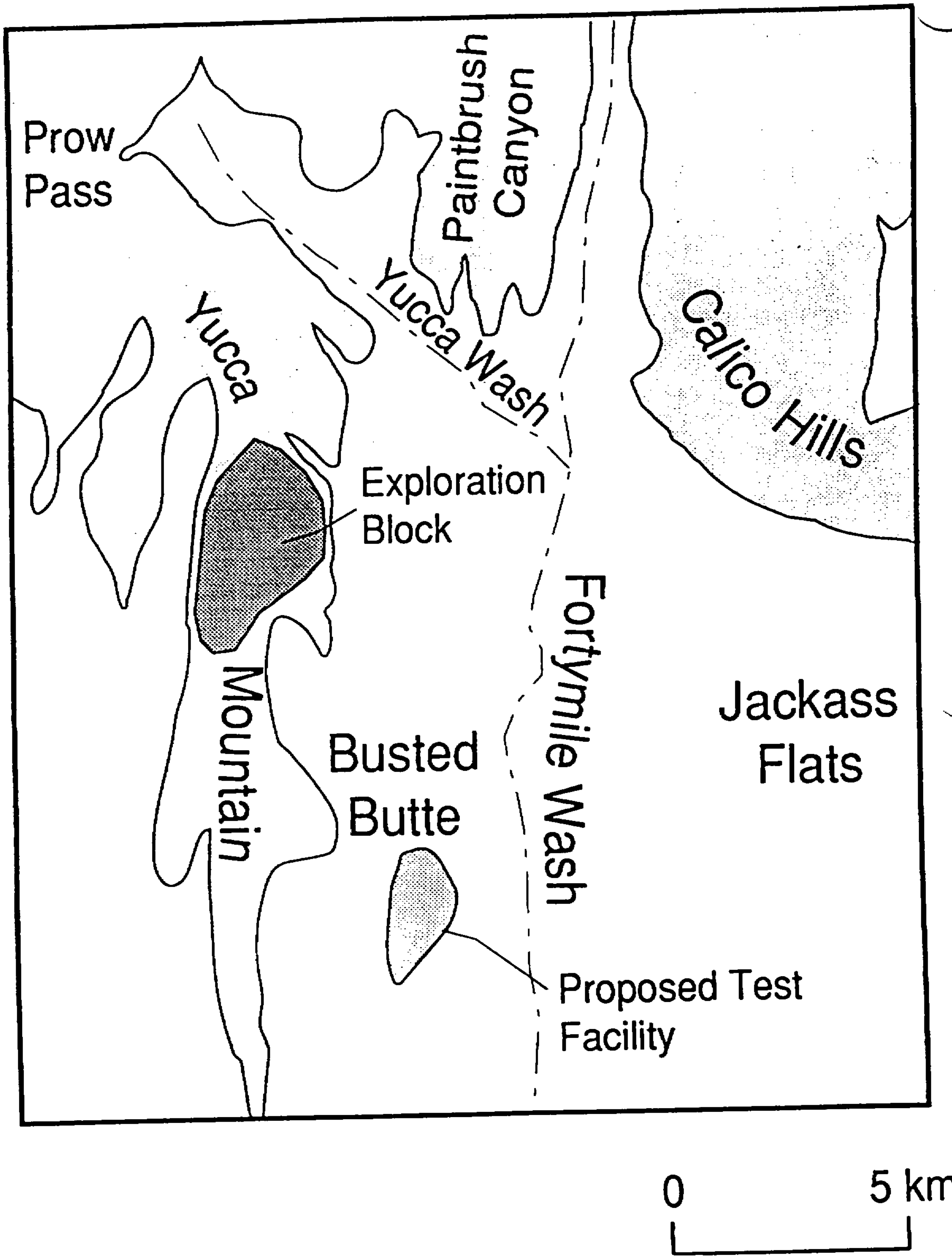
What TSPA-LA Issues will be Addressed by the UZ Transport Test

- Importance of colloid facilitated transport fractured welded and nonwelded tuffs
- Fracture/matrix interaction in the field
- Transport behavior in the CHn vitric and zeolitic rocks
- Validation of the dual-permeability UZ transport models
- Validate laboratory databases on sorption and matrix diffusion
- Validate scaling of the minimum Kd approach

Busted Butte UZ Transport Test

- Location
  - Proximity to Yucca Mountain
  - Location of test at Busted Butte
- Comparison of H-5 and Busted Butte Section
- Layout
  - Diagram of test bed
  - Configuration of the test bed

Figure 1



Prow Pass
Paintbrush Canyon
Yucca Wash
Yucca
Calico Hills
Exploration Block
Fortymile Wash
Jackass Flats
Mountain
Busted Butte
Proposed Test Facility
0
5 km

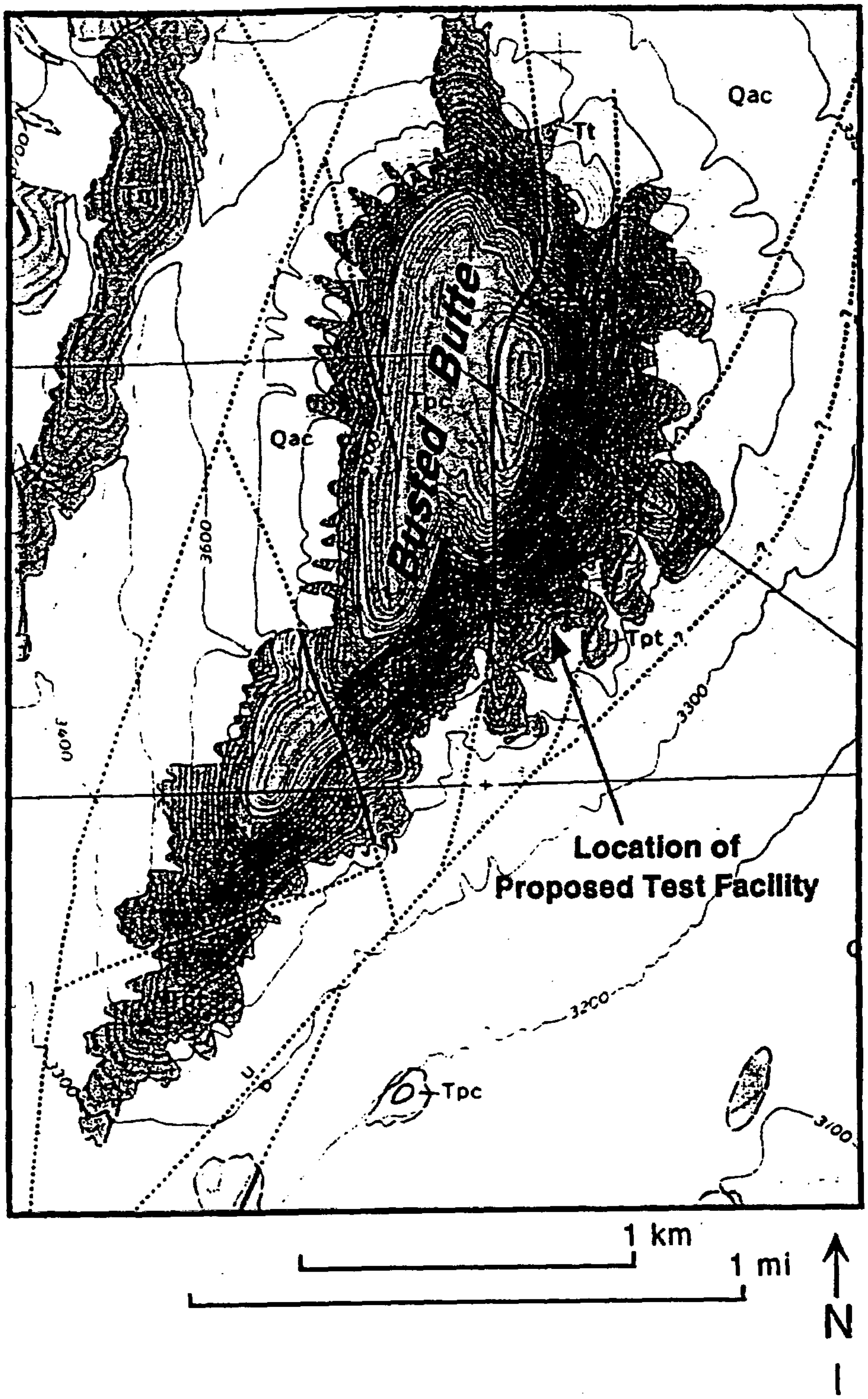
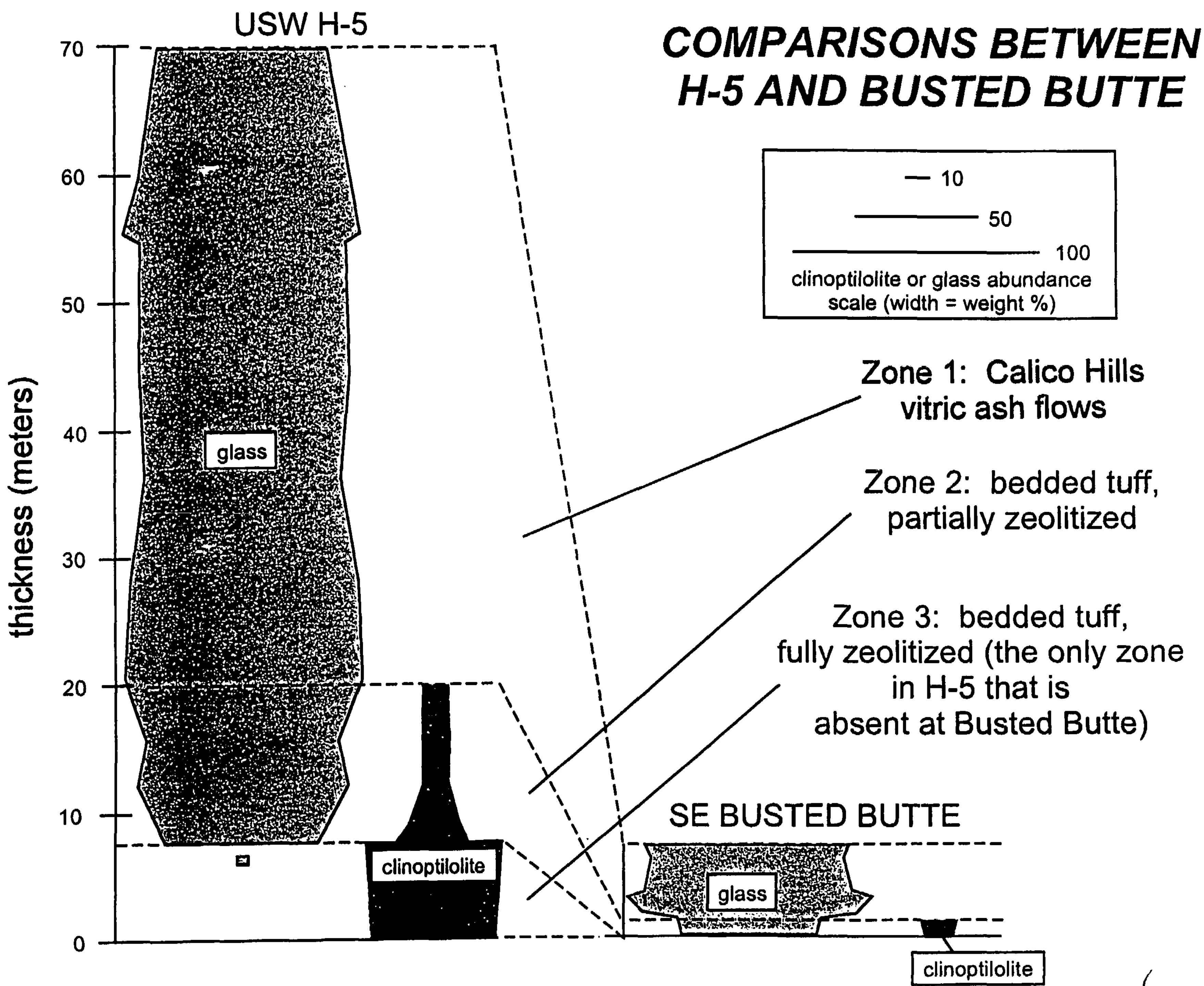


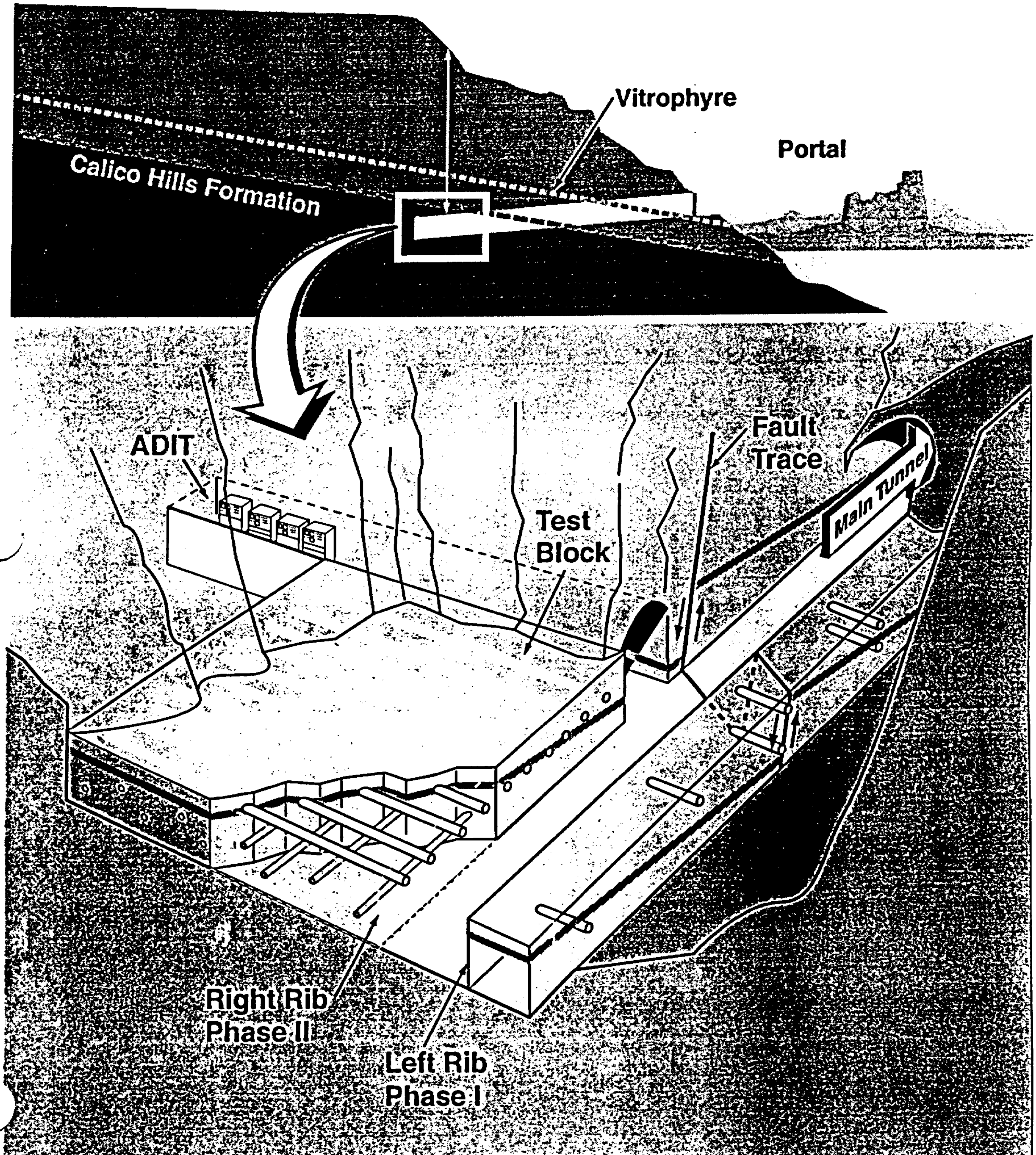
Figure 2. Geologic Map of Busted Butte showing locations of Calico Hill outcrops.
From Lipman and McKay (1965)

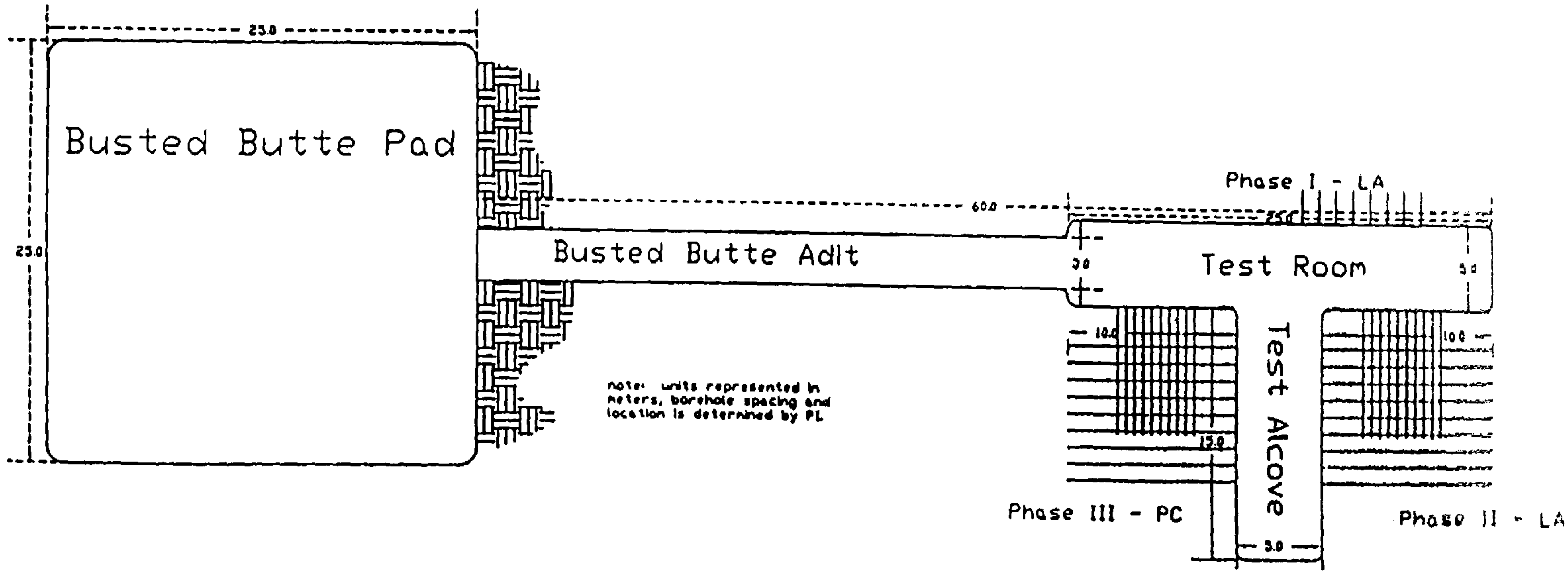


COMPARISONS BETWEEN
H-5 AND BUSTED BUTTE
USW H-5
thickness (meters)
70
60
50
40
30
20
10
0
glass
clinoptilolite
10
50
100
clinoptilolite or glass abundance
scale (width = weight %)
Zone 1: Calico Hills
vitric ash flows
Zone 2: bedded tuff,
partially zeolitized
Zone 3: bedded tuff,
fully zeolitized (the only zone
in H-5 that is
absent at Busted Butte)
SE BUSTED BUTTE
glass
clinoptilolite

CIC-1/97-1476 (7-97)

Southern Busted Butte UZ Transport Test





CONFIGURATION OF THE UZ TRANSPORT TEST AT BUSTED BUTTE

Phased Implementation of UZ Transport Test

- Test designed in three phases. Phases 1 and 2 have hard LA data feeds (9/99) and Phase 3 has longer term ambient and thermal tests for performance confirmation

- Phase 1: Three month long tunnel bore hole tests and over coring completed during construction of the main test block construction

- Phase 2: Thirteen month long test (LA data feed) in 5 meter squared test block as shown

- Phase 3: Continued ambient (Phase 2) testing and implementation of a new 5 meter test block for evaluating thermal effects and partially saturated conditions

ATTACHMENT 4

YUCCA MOUNTAIN PROJECT

Studies

Anticipated Status of Design Products at Viability Assessment

Presented to:
Nuclear Regulatory Commission
Technical Exchange

Presented by:
Paul G. Harrington
U.S. Department of Energy
Yucca Mountain Site Characterization Office

December 15, 1997

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

Design Products at VA

- Twenty-one (21) sets of Design Products consistent with System Description Documents are identified
- Presentation on 10/22/97 to NWTRB identified these as Design Packages

Design Products at VA

PRODUCT DESCRIPTION	BIN #	SIGNIFICANT LEVEL 4 PRODUCTS
Site		
1. Geologic Repository (Drawings)		
Operations Area	1	Partial
2. MGDS Site Layout	1	Partial
3. Site Security & Safeguards Systems		
- Security & Safeguards System	2	Partial
- Emergency Response System	2	Not started
- Health Safety System	1	Not started
- Environmental Monitoring	2	Not started

Status of the Design Products at VA

PRODUCT DESCRIPTION	BIN #	SIGNIFICANT LEVEL 4 PRODUCTS
Site		
4. Access (Offsite) Group		
- General Site Transportation System	1	Not started
- Off-site Rail & Road System	1	Not started
- Subsurface Dvlp. Trans. System	1	Not started
5. Utilities Systems Group		
- Site Electrical Power System	2	Not started
- Site Water System	2	Not started
- Site Communications System	2	Not started
- Off-site Utilities System	1	Not started
- Site Compressed Air System	1	Not started
6. Site Control Systems Group	2	Not started

Status of the Design Products at VA

PRODUCT DESCRIPTION	BIN #	SIGNIFICANT LEVEL 4 PRODUCTS
Surface Facilities		
1. Controlled Area Plot Development	2	Partial
2. Carrier/Cask Shipping & Receiving	2	Partial
3. Waste Preparation Systems Group	2	Partial
4. Waste Treatment Systems Group	2	Partial
5. Uncontrolled Area Plot Development	1	Not started
6. Management & Administration Systems Group	1	Not started

Status of the Design Products at VA

PRODUCT DESCRIPTION	BIN #	SIGNIFICANT LEVEL 4 PRODUCTS
Subsurface Facilities		
1. Subsurface Development Plan	2	Not started
2. Shafts and Ramps	2	Not started
3. Subsurface Drainage System	2	Not started
4. Waste Emplace. & Retrieval Systems	3	Partial
- Subsurface Facility System	2	Partial
- Subsurface Elect. Distrib. System	2	Partial
- Subsurface Water Collect./Removal System	1	Not started
- Subsurface Fire Suppression System	2	Partial
- Subsurface Safety & Monitoring System	2	Partial
- Ground Control System	3	Partial

Status of the Design Products at VA

PRODUCT DESCRIPTION	BIN #	SIGNIFICANT LEVEL 4 PRODUCTS
Subsurface Facilities (cont'd)		
Waste Emplacement System (cont'd)		
- Subsurface Ventilation System	3	Partial
- Backfill Emplacement System	3	Partial
- Waste Retrieval System	3	Partial
- Subsurface Emplace. Transport. System	2	Not started
- Subsurface Closure and Seal System	3	Not started
- Subsurface Water Distribution System	1	Not started
- Subsurface Compressed Air System	1	Not started
5. Radiological Control Systems	2	Not started

Status of the Design Products at VA

PRODUCT DESCRIPTION	BIN #	SIGNIFICANT LEVEL 4 PRODUCTS
Waste Isolation System		
1. Engineered Barrier System (includes Waste Packages, Inverts, Pedestal, Backfill Option, Dripshield Option)	3	Partial
2. Natural Barrier System (Ref.)	3	Partial
3. Performance Confirmation System	3	Partial
4. Waste Emplacement & Retrieval Systems	3	Partial

CRWMS
Engineering & Integration Product Summary
Design Product Planning Guidelines (By Bin Numer)

BIN ①

No DBE Involvement,

Little or no radiological safety significance, and

Little or no radiological safety interaction, and limited (Non-NRC) regulatory significance

Design Products/Documents	VA	SR	LA	CA	RFC
General Arrangement			◆ Partial	◆	
P&ID/PFDs			◆ Partial	◆	
Electrical one lines			◆ Partial	◆	
Control Logics			◆ Partial	◆	
Handling Drawings				◆ Partial	◆
Equipment Outlines				◆ Partial	◆
Analyses				◆ Partial	◆
Calculations			◆ Partial	◆ Partial	◆
Specifications				◆ Partial	◆
Commodity Design Guides				◆ Partial	
System Design Guides				◆ Partial	

◆
- 40% complete at CA (site arrangement & early infrastructure packages 100%; misc. support 0%)
- 15% complete at LA (site arrangement 100%; others 0%)
- 10% complete at SR (site arrangement 67%; others 0%)
- 5% complete at VA (site arrangement 33%; others 0%)

Bin 1 is estimated to be 20% of the total design

CRWMS
Engineering & Integration Product Summary
Design Product Planning Guidelines (By Bin Numer)

BIN ② (2A, 2B, 2C)

Has radiological safety significance, or

Has significant radiological safety system interaction, and

Has regulatory precedent

Design Products/Documents	VA	SR	LA	CA	RFC
General Arrangement	◆ Partial	◆ Partial	◆ Partial	◆	
P&ID/PFDs		◆ Partial	◆ Partial	◆	
Electrical one lines		◆ Partial	◆ Partial	◆	
Control Logics		◆ Partial	◆ Partial	◆	
Handling Drawings			◆ Partial	◆ Partial	
Equipment Outlines			◆ Partial	◆ Partial	
Analyses			◆ Partial	◆	
Calculations			◆ Partial	◆ Partial	◆
Specifications			◆ Partial	◆ Partial	◆
Commodity Design Guides			◆ Partial	◆ Partial	
System Design Guides			◆ Partial	◆ Partial	

◆
- 60% complete at CA (major safety systems & early construction packages 100%; others 20%)
- 35% complete at LA (major safety systems & early construction packages 50%; others 15%)
- 30% complete at SR (major safety systems & early construction pakcages 40%; others 10%)
- 5% complete at VA (major safety systems & early construction packages 10%; others 0%)

Bin 2 is estimated to be 60% of the total design

CRWMS
Engineering & Integration Product Summary
Design Product Planning Guidelines (By Bin Numer)

BIN ③

Has radiological safety significance, or

Has significant radiological safety system interaction, and

Has no regulatory precedent, or

Has been identified as impacting other regulatory submittals

Design Products/Documents	VA	SR	LA	CA	RFC
General Arrangement	◆ Partial	◆ Partial	◆		
P&ID/PFDs	◆ Partial	◆ Partial	◆		
Electrical one lines	◆ Partial	◆ Partial	◆		
Control Logics	◆ Partial	◆ Partial	◆		
Handling Drawings	◆ Partial	◆ Partial	◆ Partial	◆ Partial	◆
Equipment Outlines		◆ Partial	◆ Partial	◆ Partial	◆
Analyses	◆ Partial	◆ Partial	◆		
Calculations	◆ Partial	◆ Partial	◆		
Specifications	◆ Partial	◆ Partial	◆ Partial		◆
Commodity Design Guides		◆ Partial	◆ Partial	◆ Partial	◆
System Design Guides		◆ Partial	◆ Partial	◆ Partial	◆

◆

- 95% complete at CA (early construction packages 100%)
- 70% complete at LA (3/02) (critical performance elements 90%)
- 60% complete at SR (critical performance elements 80%)
- 40% complete at VA (critical performance elements 60%)

Bin 3 is estimated to be 20% of the total design

ATTACHMENT 5

YUCCA
MOUNTAIN
PROJECT

Studies

Repository Subsurface Design Overview

Presented to:
DOE/NRC Quarterly Technical Meeting

Presented by:
Dan McKenzie
Repository Subsurface Design Supervisor
CRWMS Management & Operating Contractor

December 15, 1997

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

Briefing Topics

- Design Drivers
- Site Geology
- Thermal Considerations
- Construction Sequence
- Ventilation
- Waste Emplacement

Design Drivers

Major Design Drivers

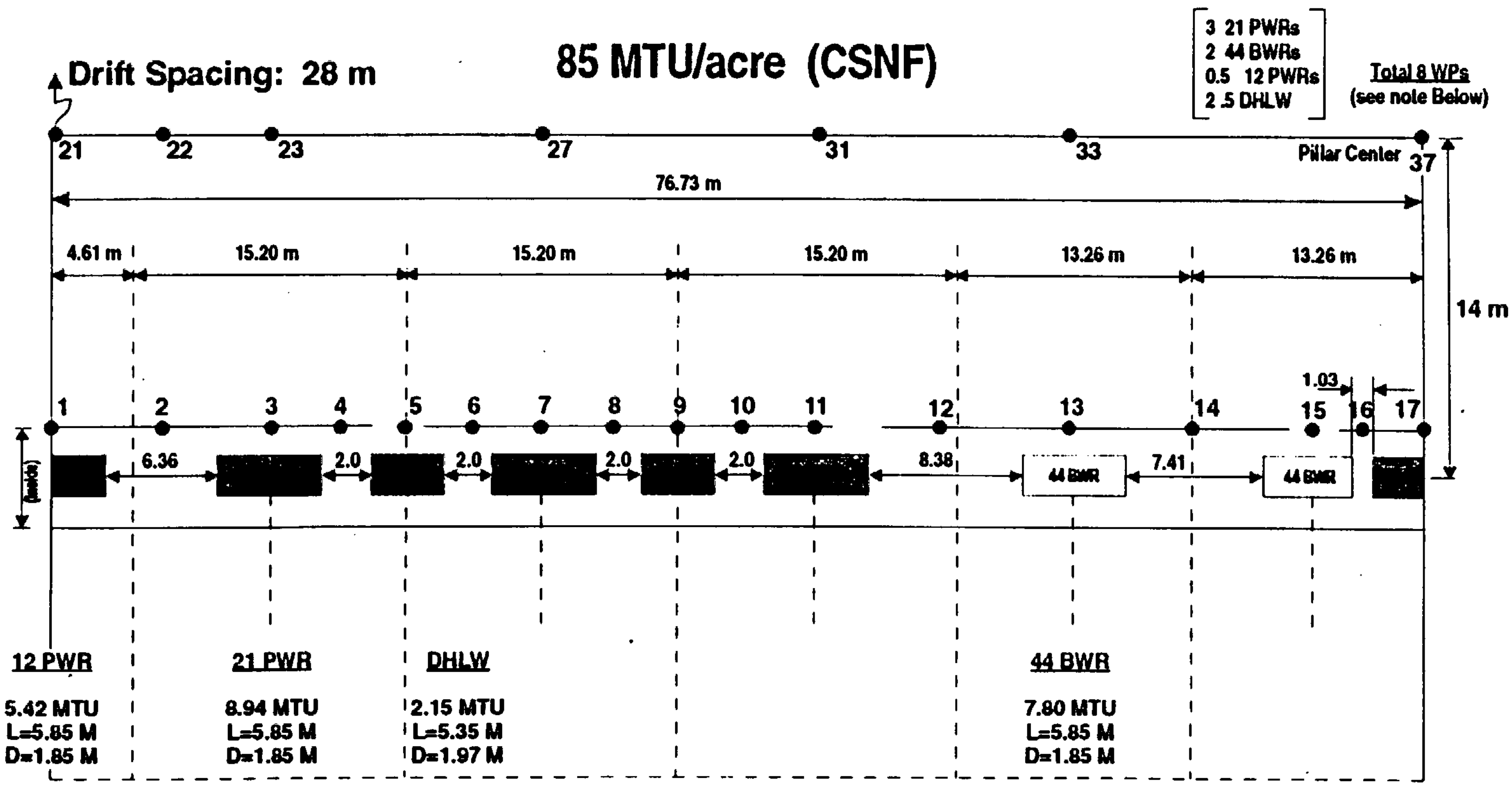
Factors influencing the subsurface design include:

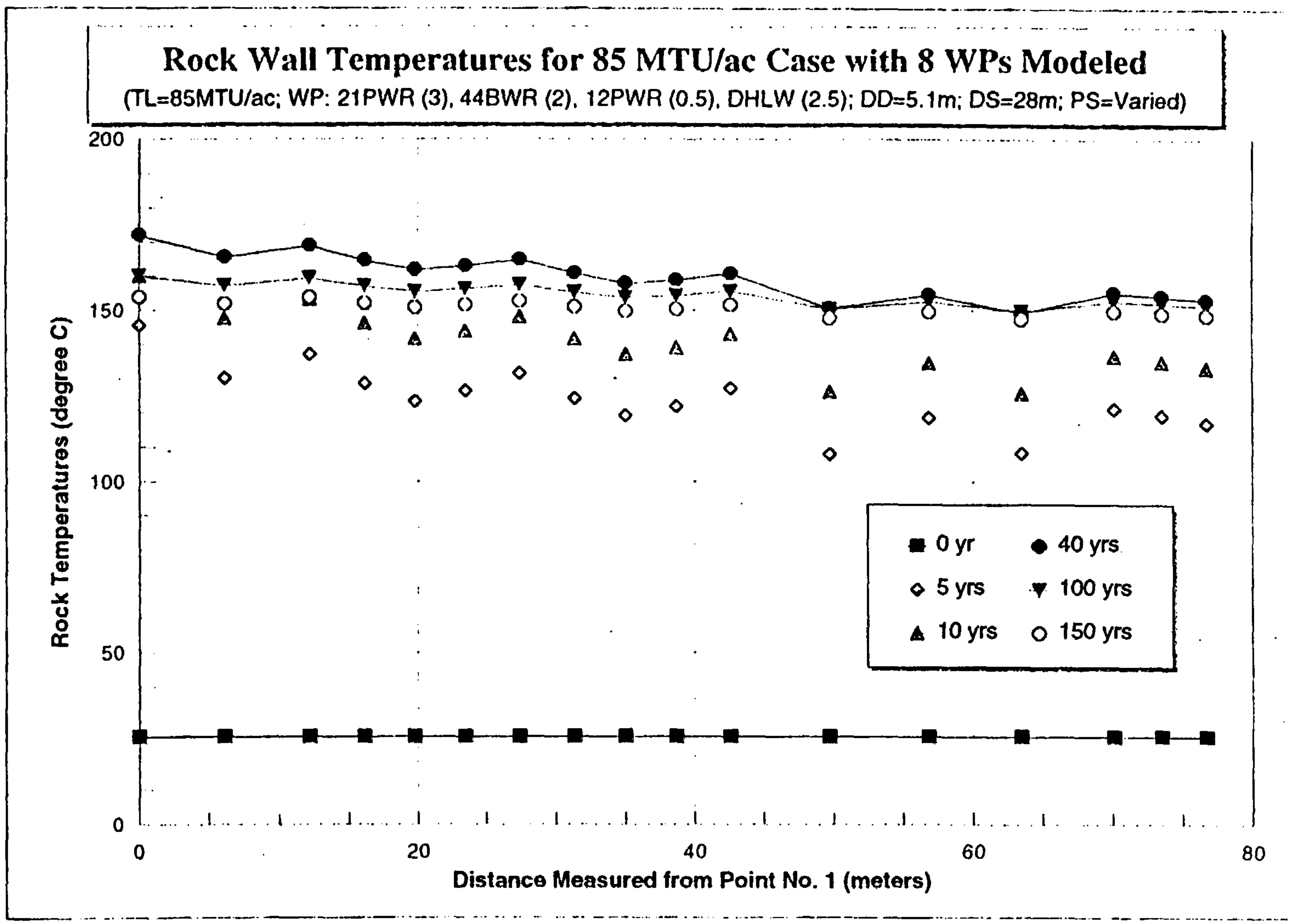
- Geologic setting
- Waste inventory heat output, and areal thermal loading
- Waste package physical characteristics
- Transportation system
- Desire to maximize use of mechanical excavation methods
- Post-closure drainage control
- Performance confirmation program requirements
- Retrievability requirements

Drift Spacing

- Once the AML is set, drift spacing is maximized within the following constraints:
  - Maximum Drift wall temperature <200^0 C
  - DHLW packages must physically fit between adjacent CSNF packages emplaced at 85 MTU/acre, with 1 meter of open space between adjacent packages
- The widest spacing which satisfied the above is 28 meters (center-to-center)

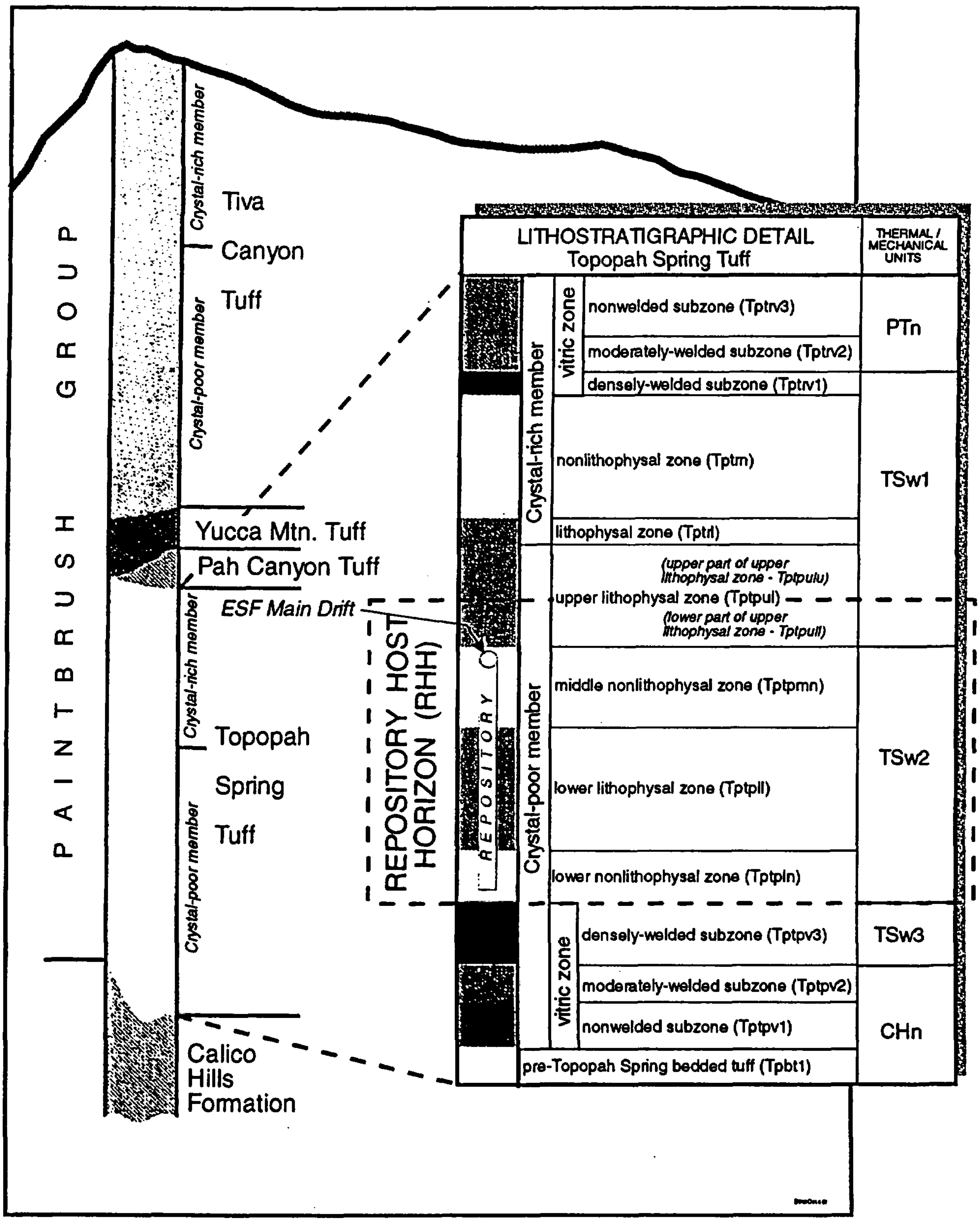
A Typical Emplacement Drift Segment





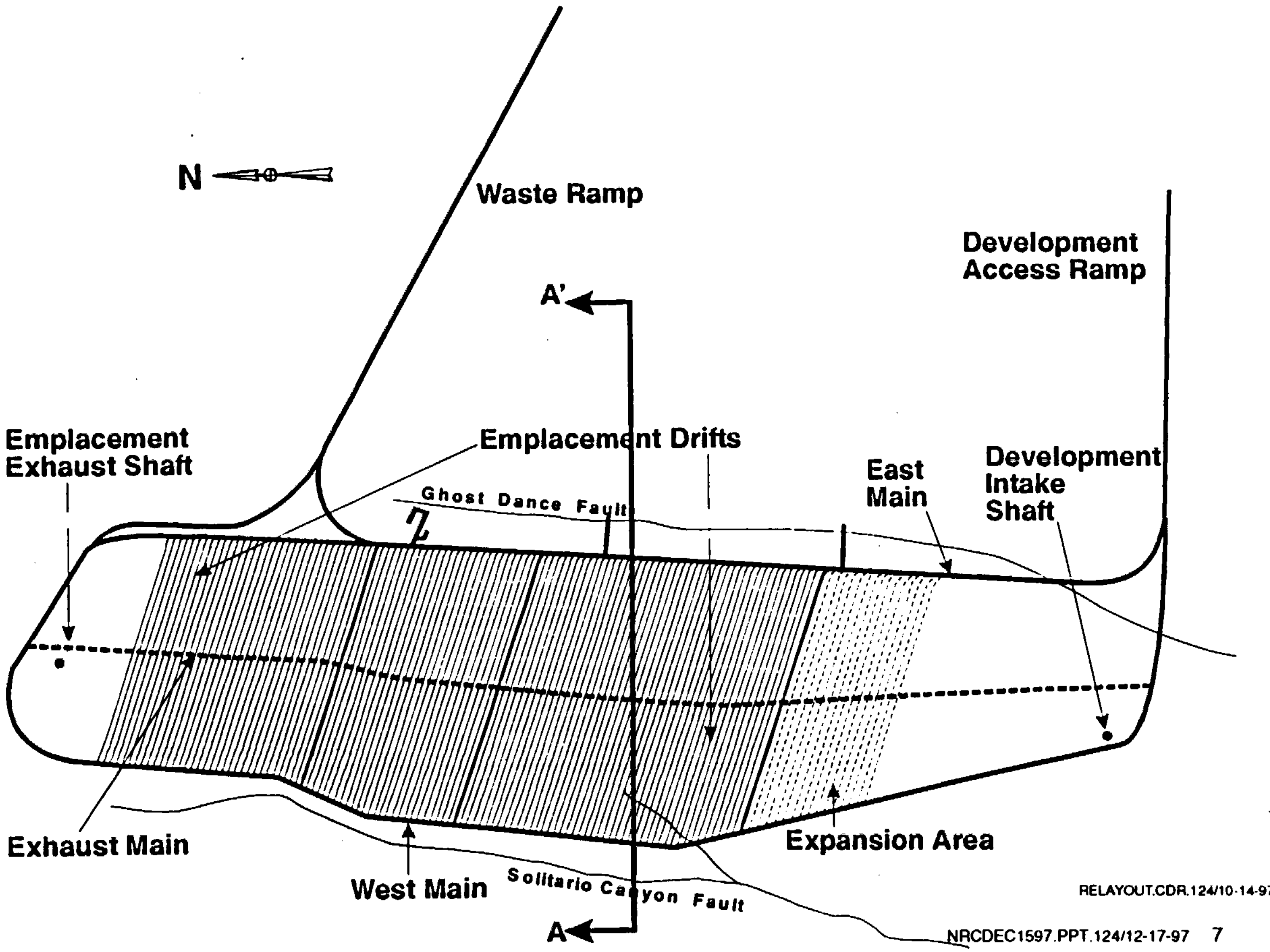
Rock Wall Temperatures for 85 MTU/ac Case with 8 WPs Modeled
(TL=85MTU/ac; WP: 21PWR (3), 44BWR (2), 12PWR (0.5), DHLW (2.5); DD=5.1m; DS=28m; PS=Varied)
Rock Temperatures (degree C)
200
150
100
50
0
0
20
40
60
80
Distance Measured from Point No. 1 (meters)
0 yr
40 yrs
5 yrs
100 yrs
10 yrs
150 yrs

Site Geology

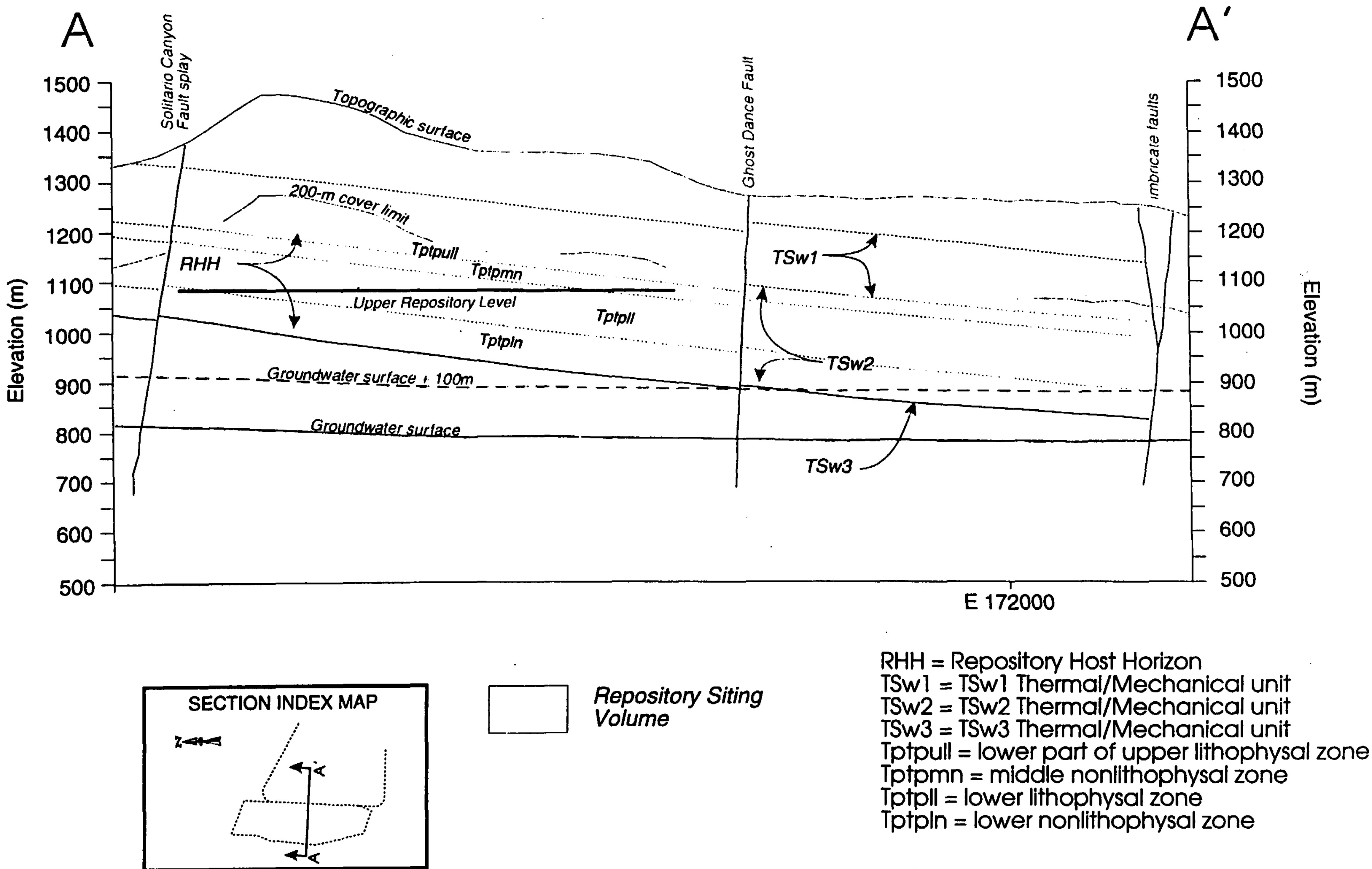


General Stratigraphic Column

Preliminary Repository Layout



RELAYOUT.CDR.124/10-14-97



West-East Cross Section Through Repository Siting Volume

Thermal Considerations

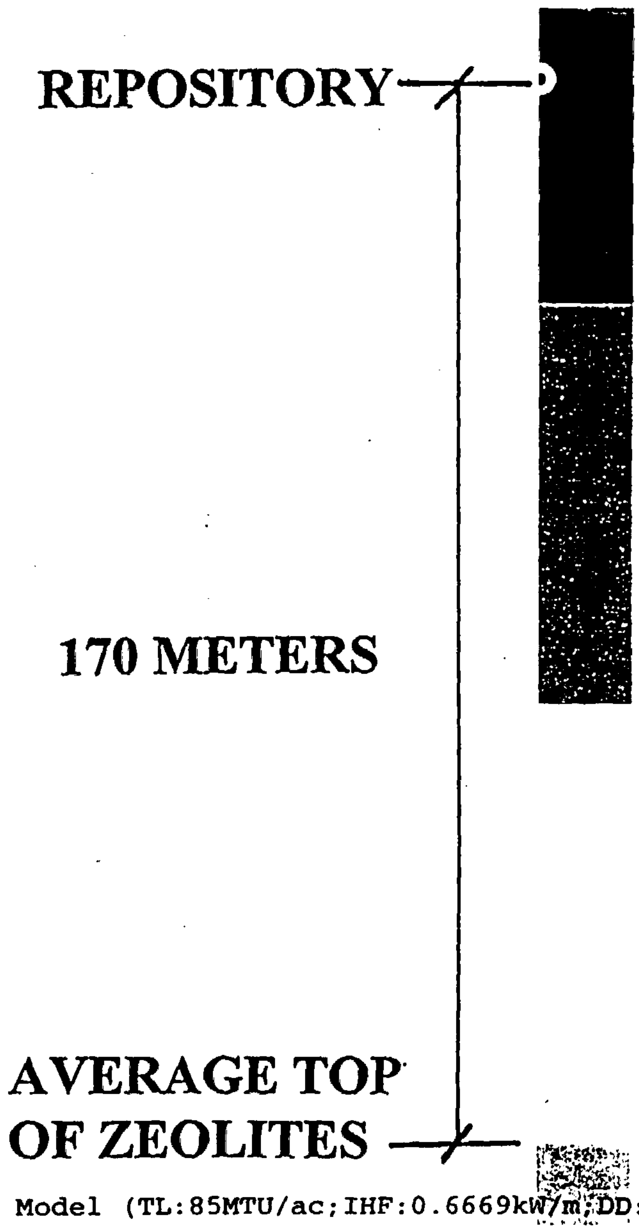
Determination of Areal Mass Loading

- Thermal goals are used as surrogates for repository performance

- The design thermal load is established by increasing the thermal load until any of the thermal goals reach their limit

Areal Mass Load Determination
(continued)

- The goal of 90^0 C at the average top of the underlying zeolite layer (170 meters below the repository) is the limiting goal
- 85 MTU/acre AML results in 90^0 C zeolite temperature
- VA design has been developed based on an AML of 85 MTU/acre
- Only Commercial Spent Nuclear Fuel (CSNF) is used in the determination of AML
- DHLW packages are assumed to be emplaced between CSNF packages



ANSYS 5.2
MAR 3 1997
17:19:04
PLOT NO. 1
NODAL SOLUTION
TIME=5000 YEARS
TEMPERATURE - C
MIN =18.7
MAX =107.469

18.7
60
70
80
90
95
100
105
110

5000 Years after Emplacement

Thermal Load: 85 MTU/acre

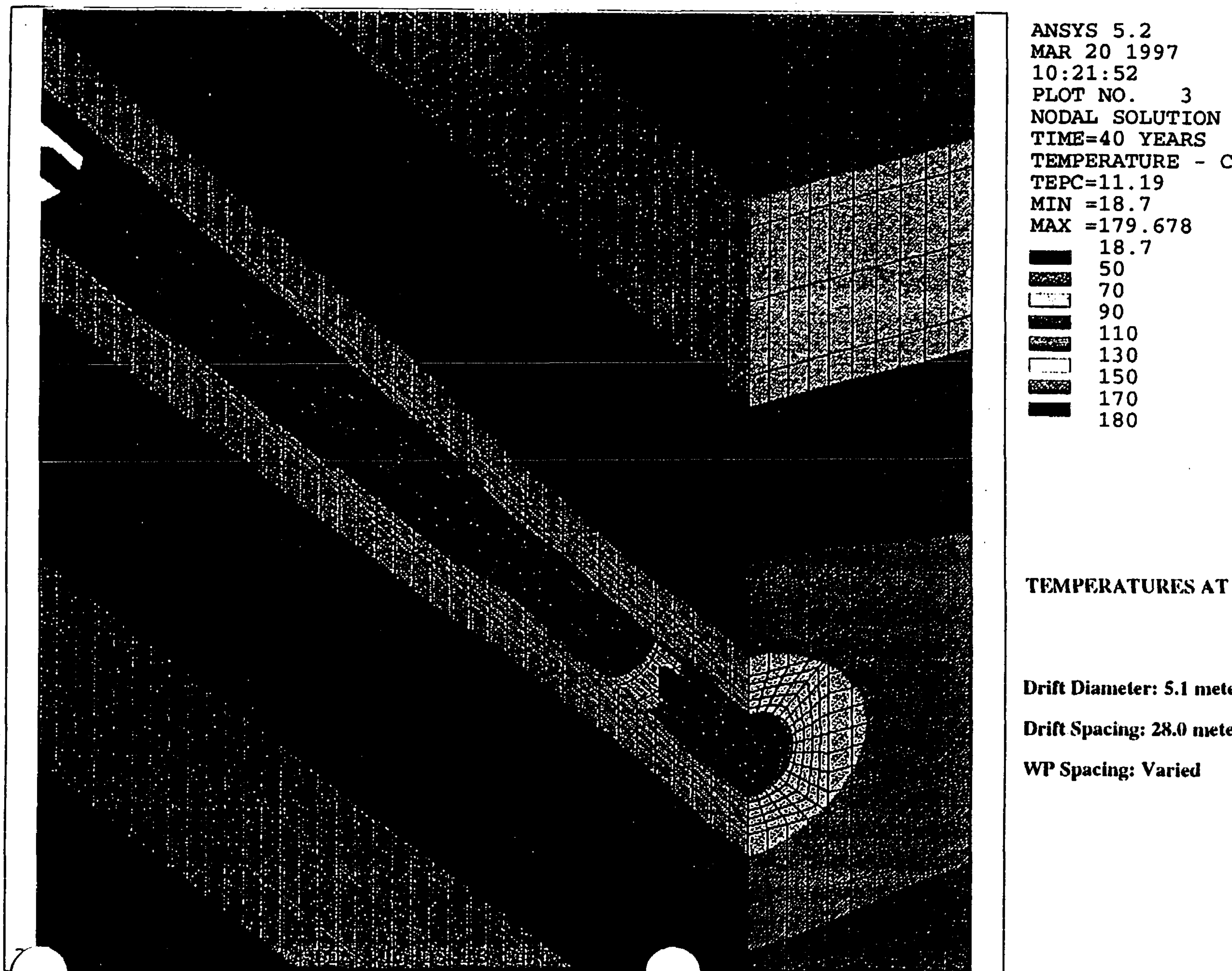
WP Initial Heat Output: 0.6669 kW/m

Drift Spacing: 28.0 meters

Drift Diameter: 5.1 meters

Package Diameter: 1.85 meters

2D Model (TL:85MTU/ac;IHF:0.6669kW/m;DD:5.1m;DS:28m;WPD:1.85m;CID)



TEMPERATURES AT 40 YEARS

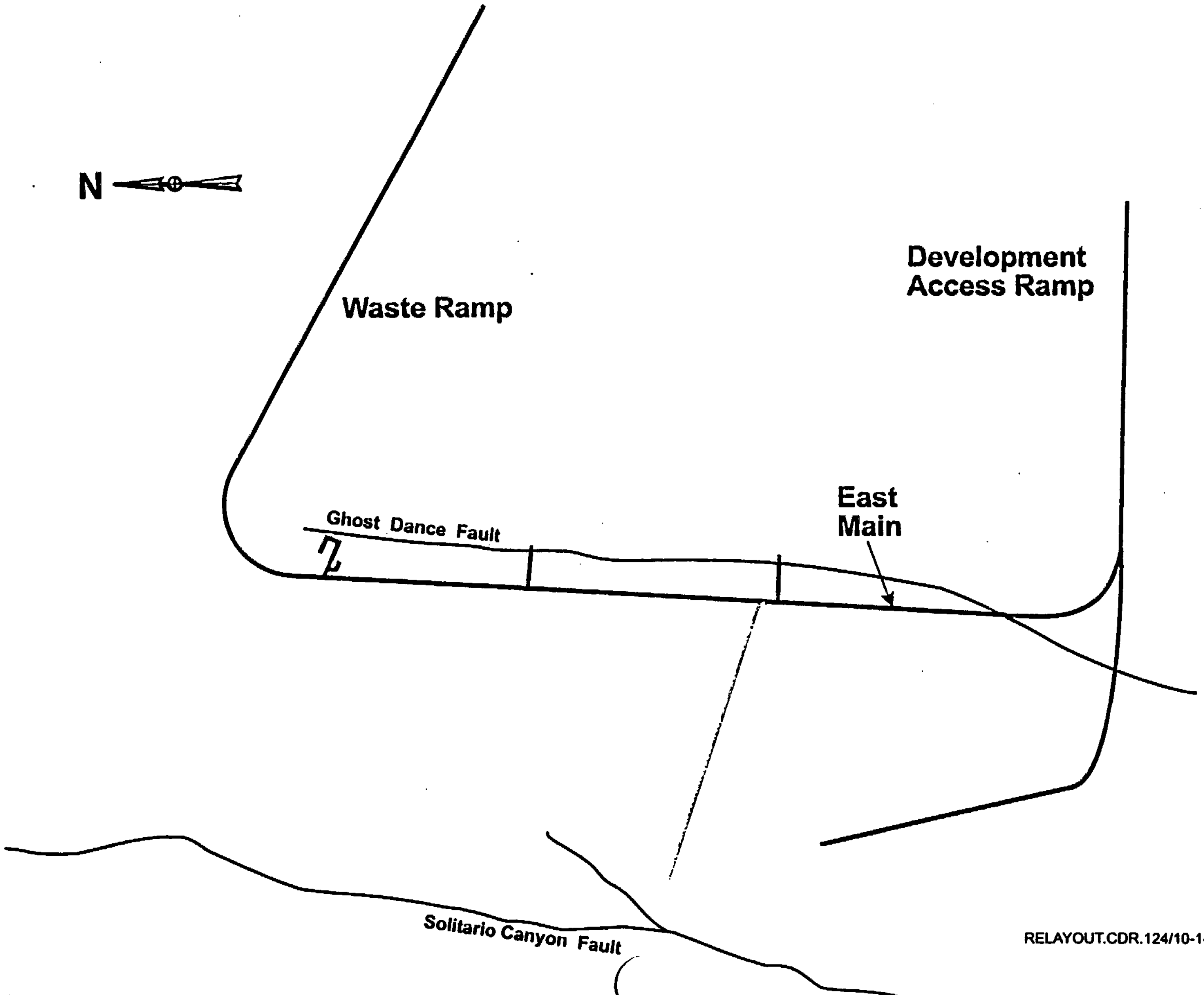
Drift Diameter: 5.1 meters

Drift Spacing: 28.0 meters

WP Spacing: Varied

Construction Sequence

Pre-Emplacement Development



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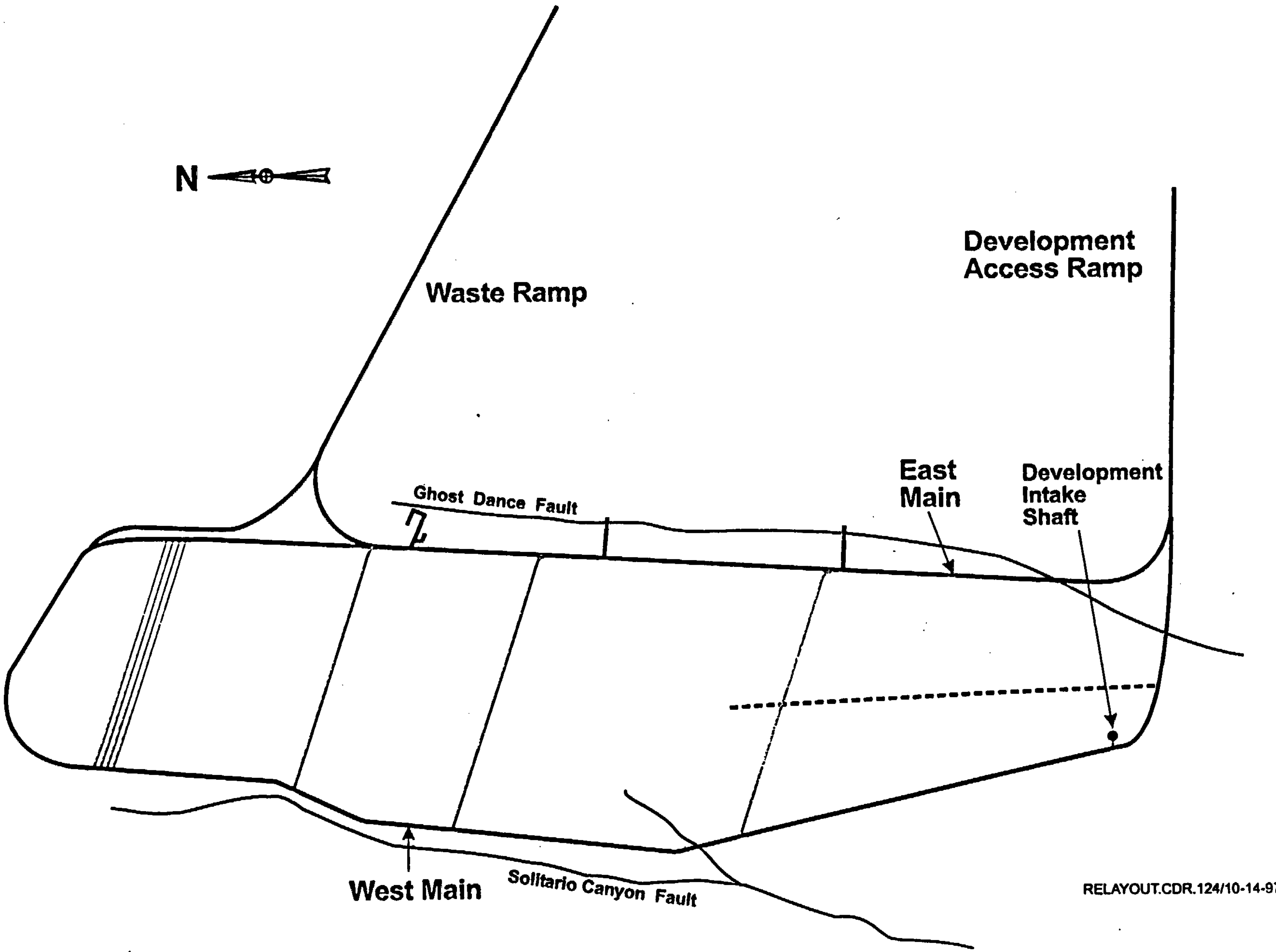
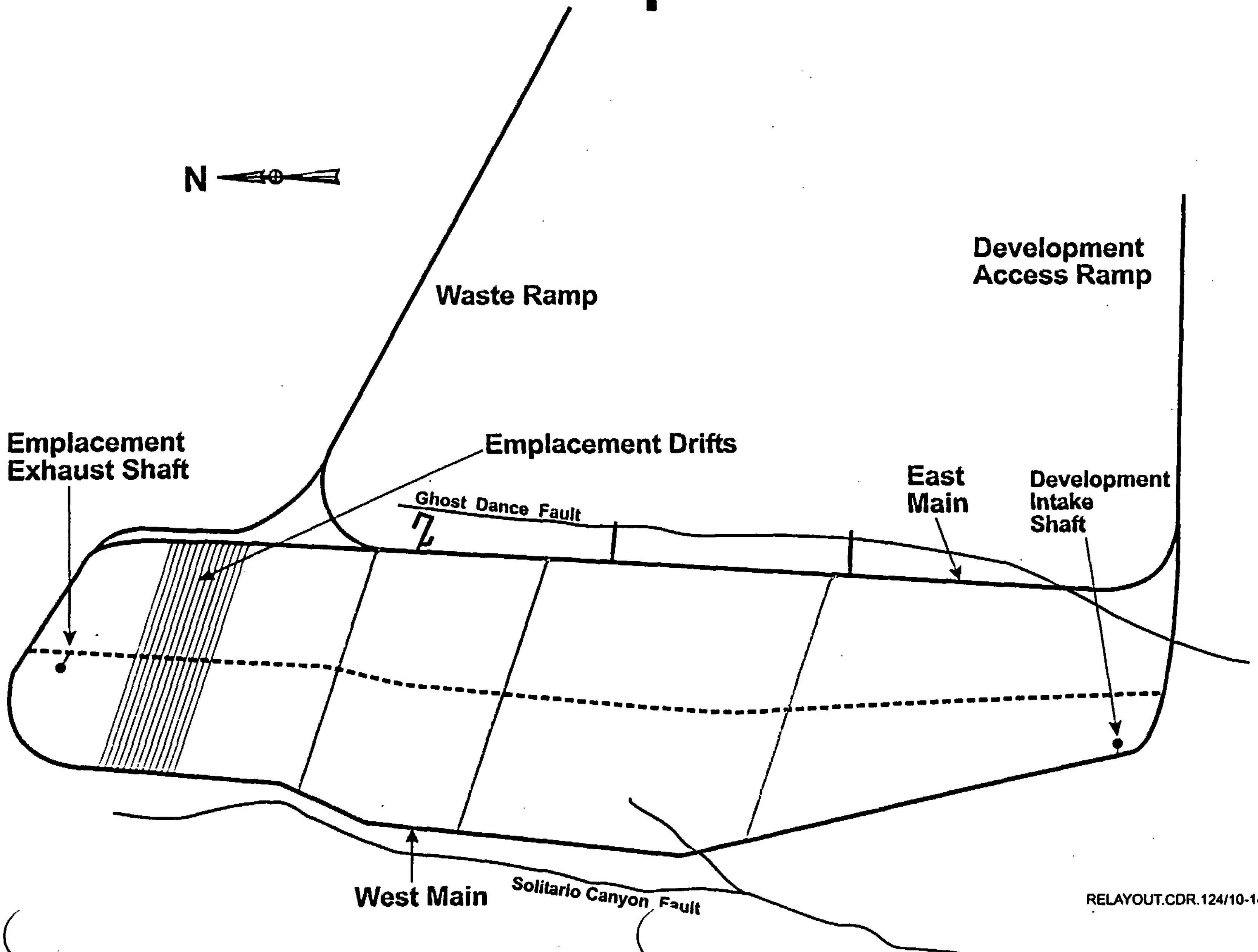
Pre-Emplacement Development



Start of Simultaneous Emplacement & Development



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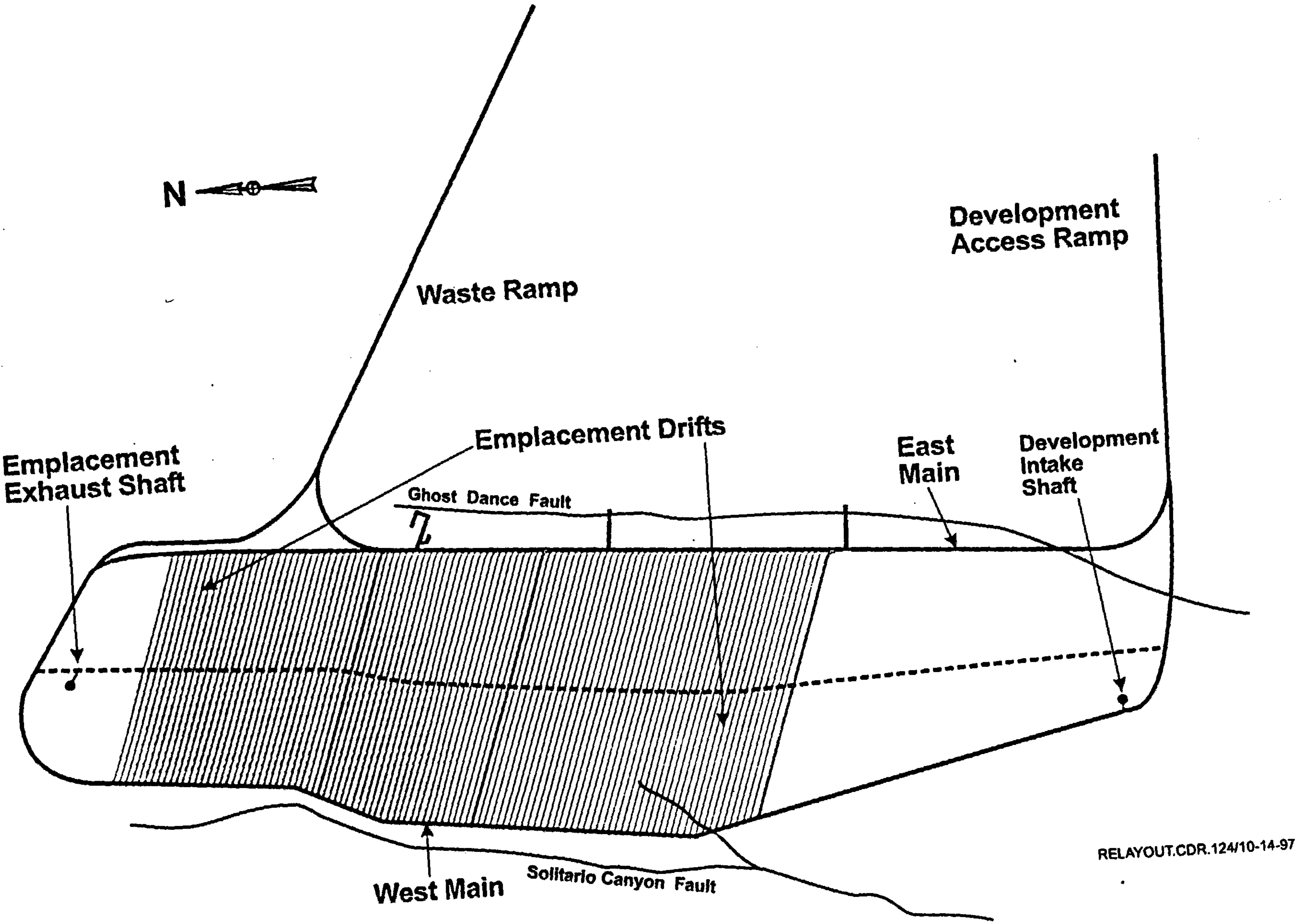
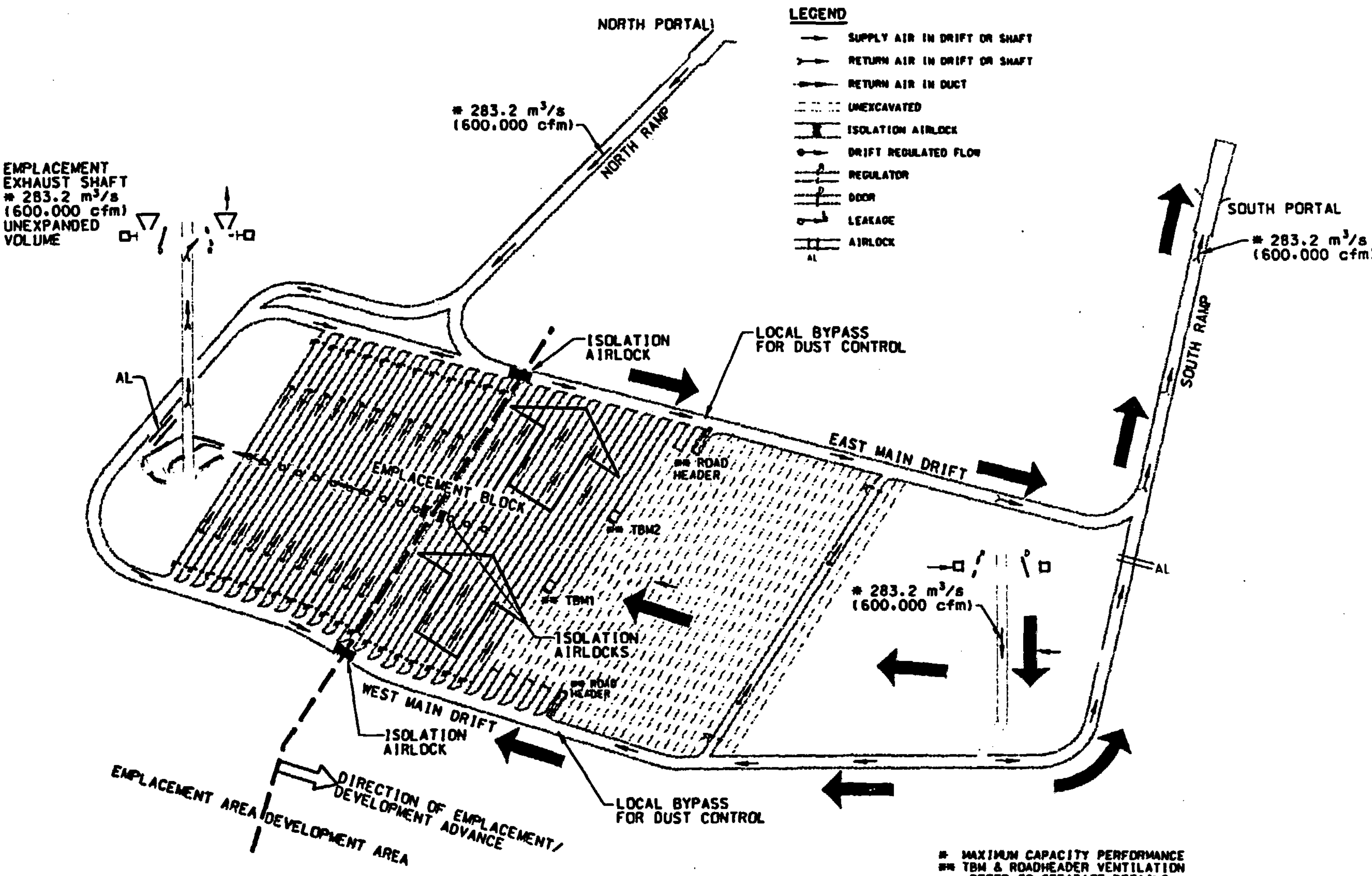
Caretaker

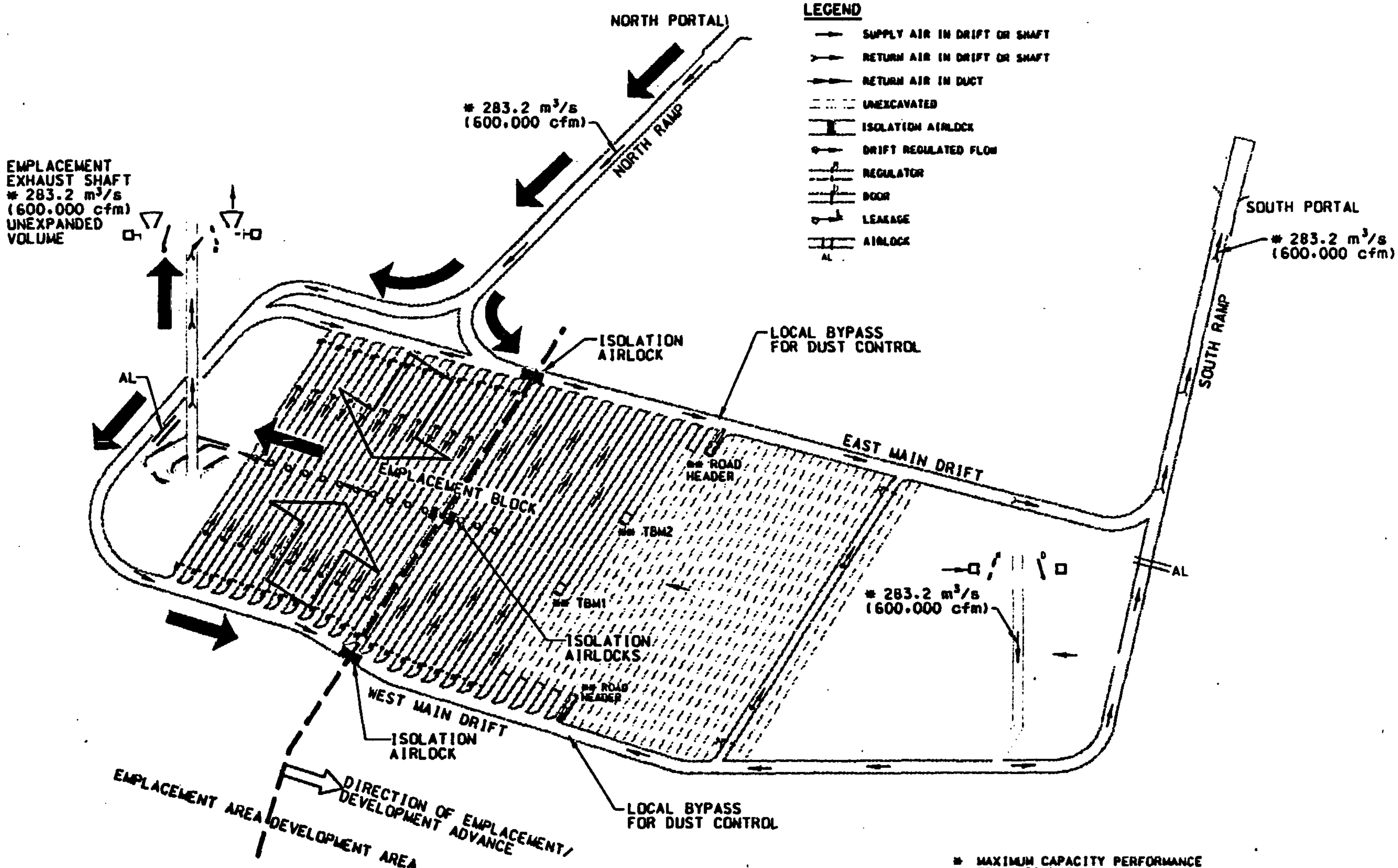


N
Waste Ramp
Development
Access Ramp
Emplacement Drifts
Emplacement
Exhaust Shaft
Ghost Dance Fault
East
Main
Development
Intake
Shaft
West Main
Solitario Canyon Fault
RELAYOUT.CDR.124/10-14-97

Ventilation



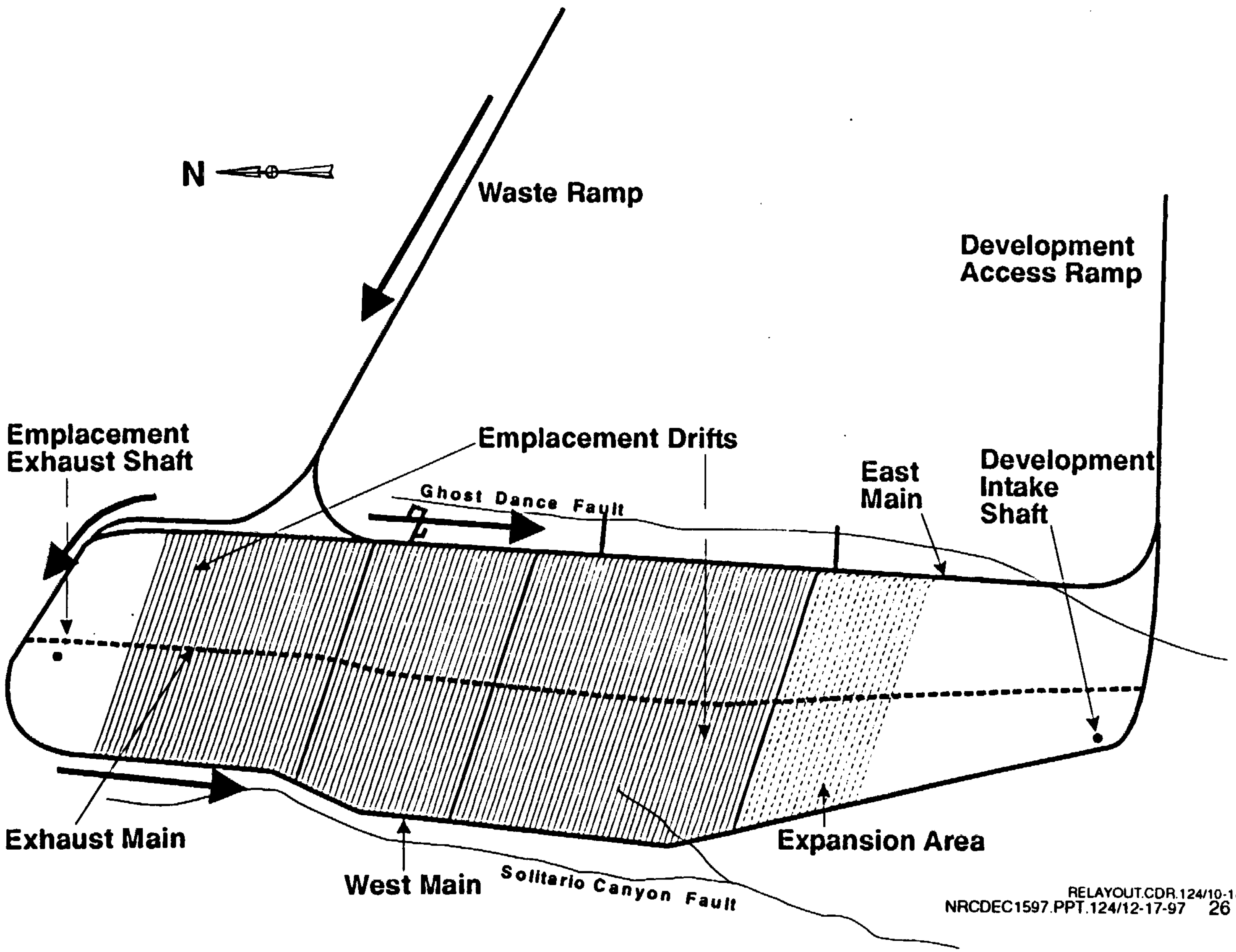
TYPICAL VENTILATION BALANCE OF EMPLACEMENT/DEVELOPMENT ACTIVITIES



TYPICAL VENTILATION BALANCE OF EMPLACEMENT/DEVELOPMENT ACTIVITIES

Waste Emplacement

Preliminary Repository Layout



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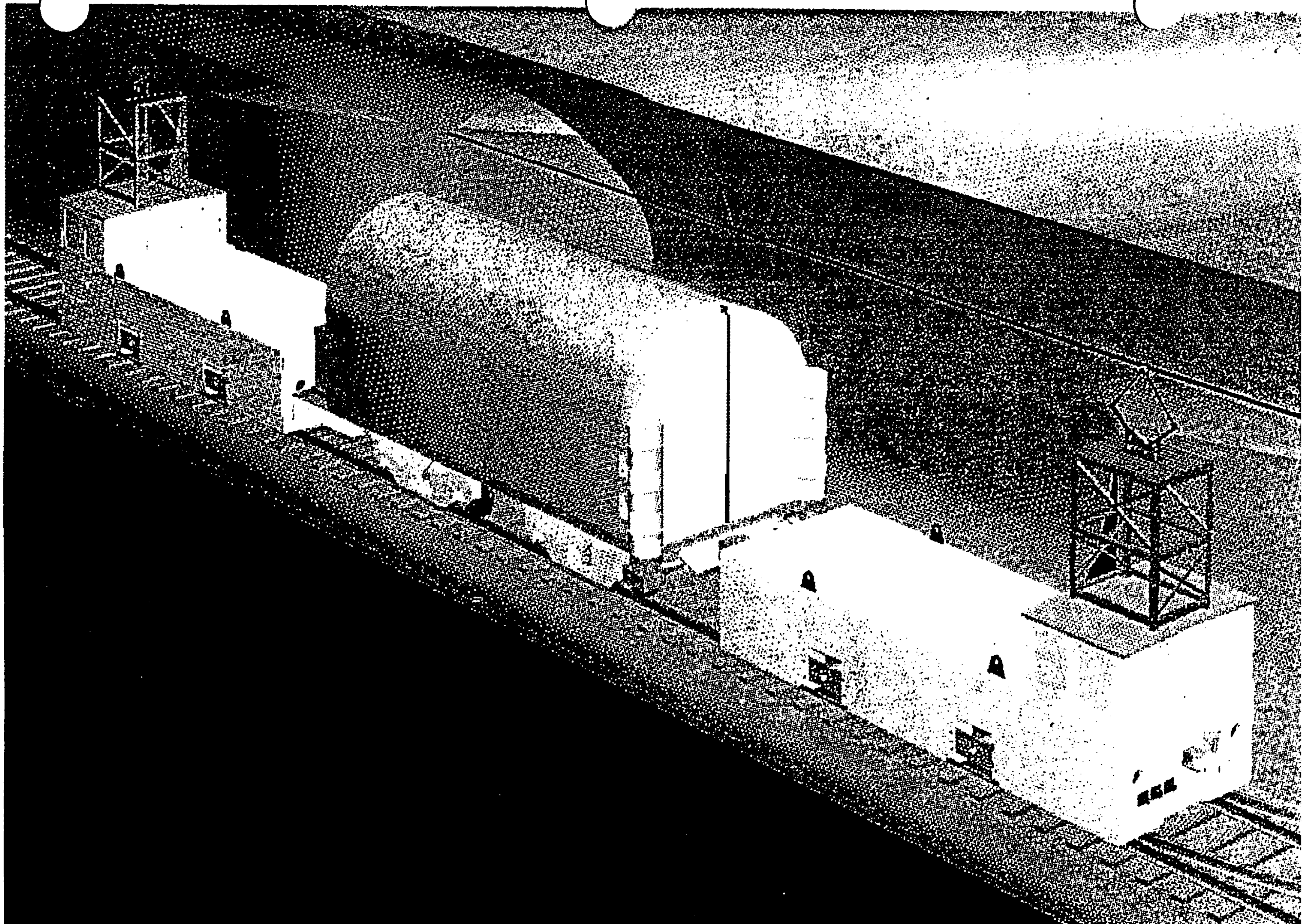
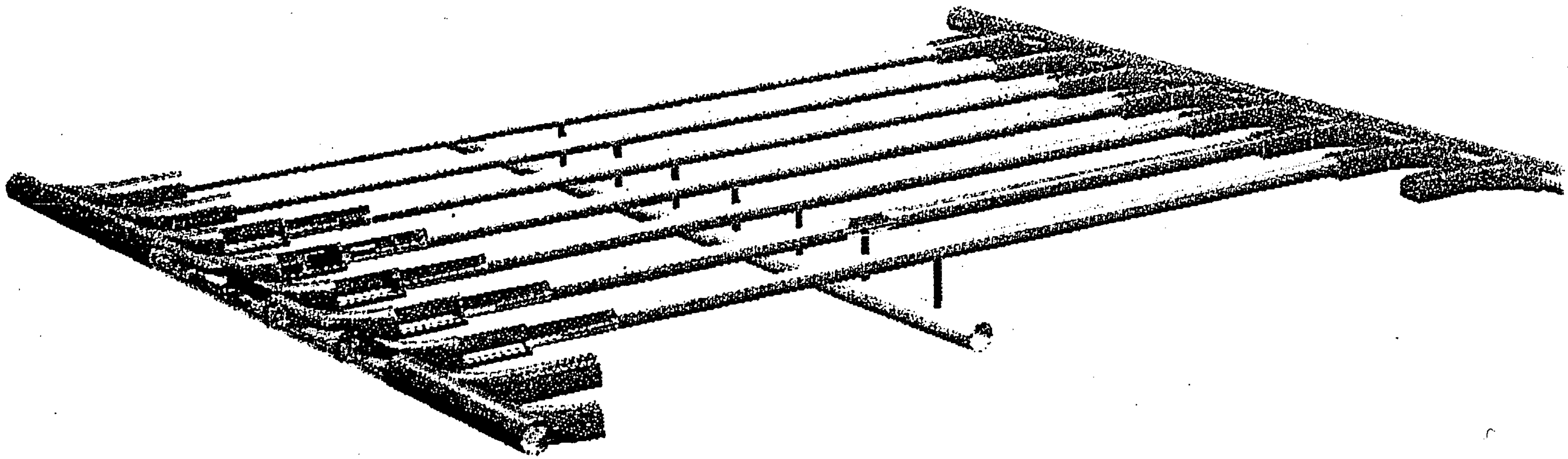
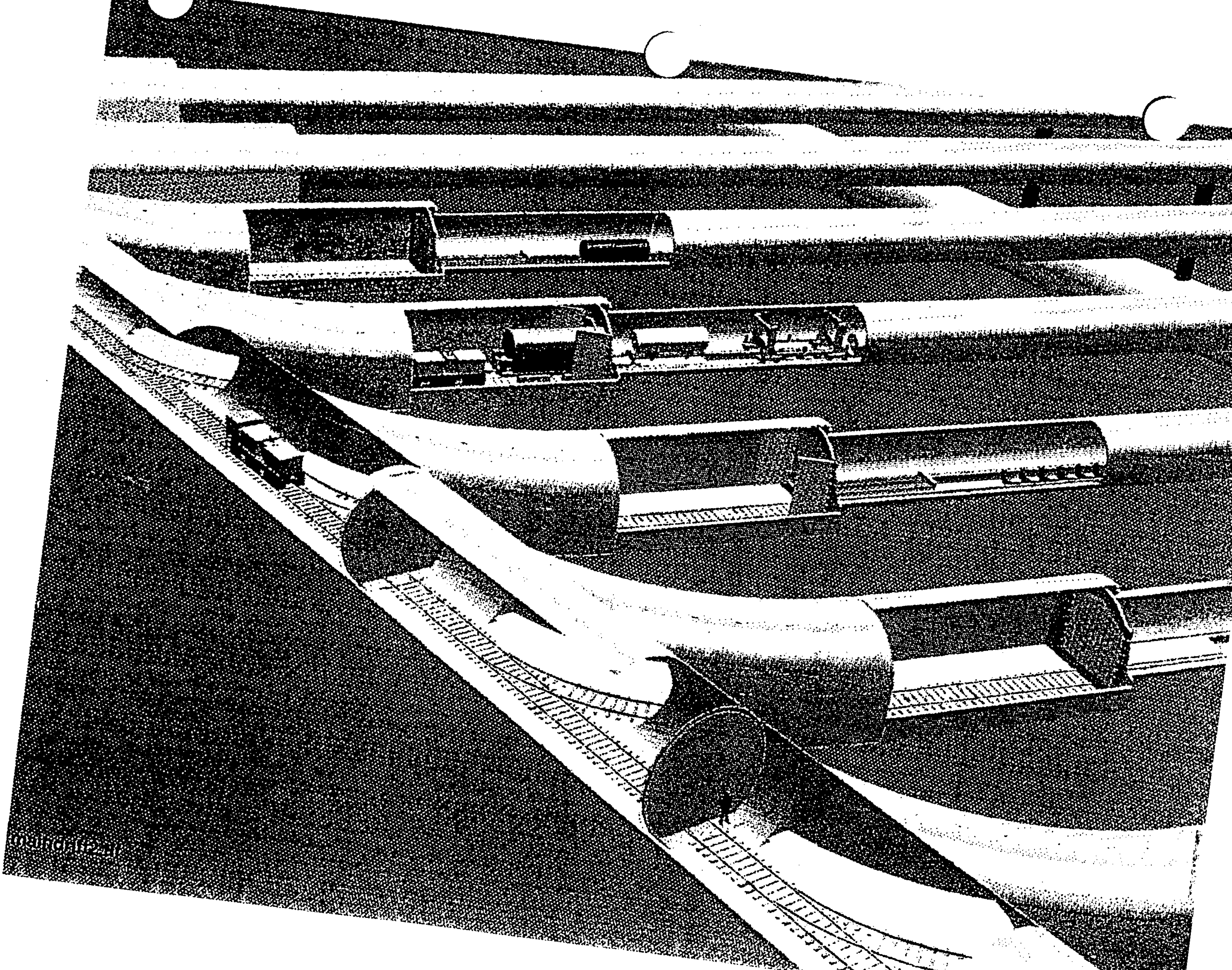
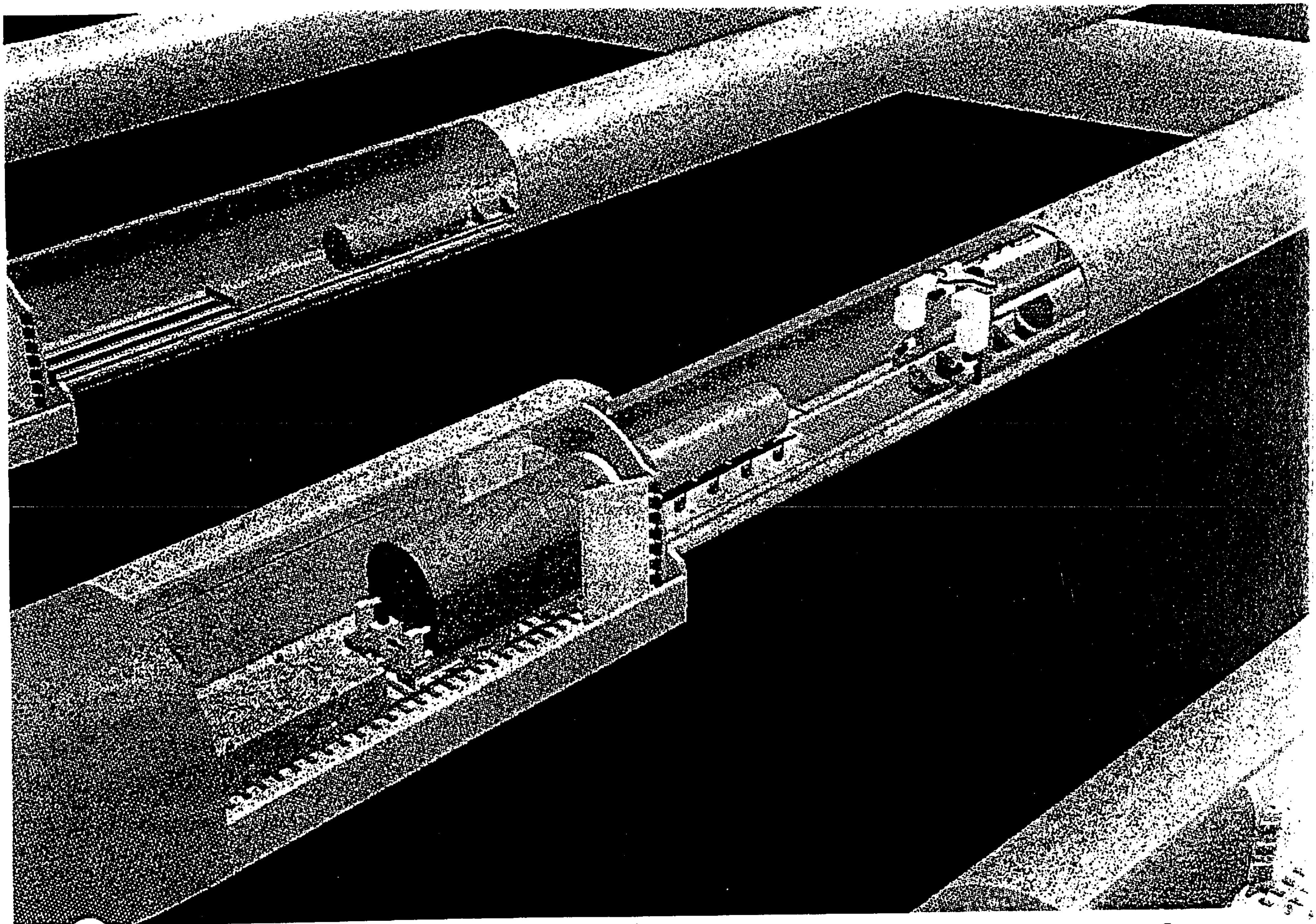
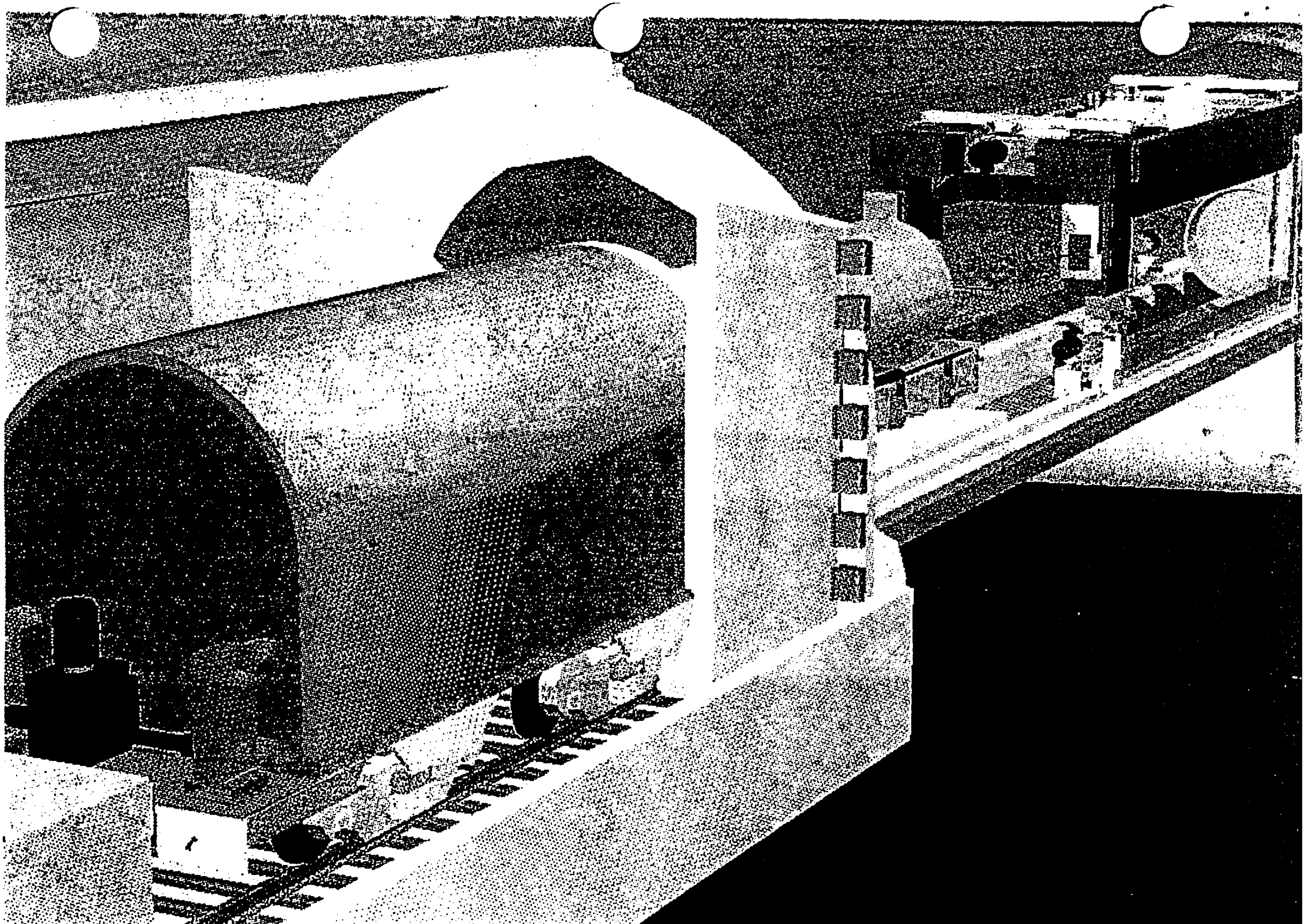
NRCDEC1597.PPT.124/12-17-97 26











ATTACHMENT 6

YUCCA MOUNTAIN PROJECT

Studies

Repository Surface Design

Presented to:
DOE/NRC Quarterly Technical Meeting

Presented by:
Steven Meyers
Repository Surface Design Manager
CRWMS Management & Operating Contractor

December 15, 1997

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

Presentation Outline

- Physical characteristics
- Program schedule
- Major design drivers
- Waste forms handled at the Repository
- North Portal site operations and surface facilities
- Waste Handling Building (WHB)
- Walkthrough of the waste handling operations

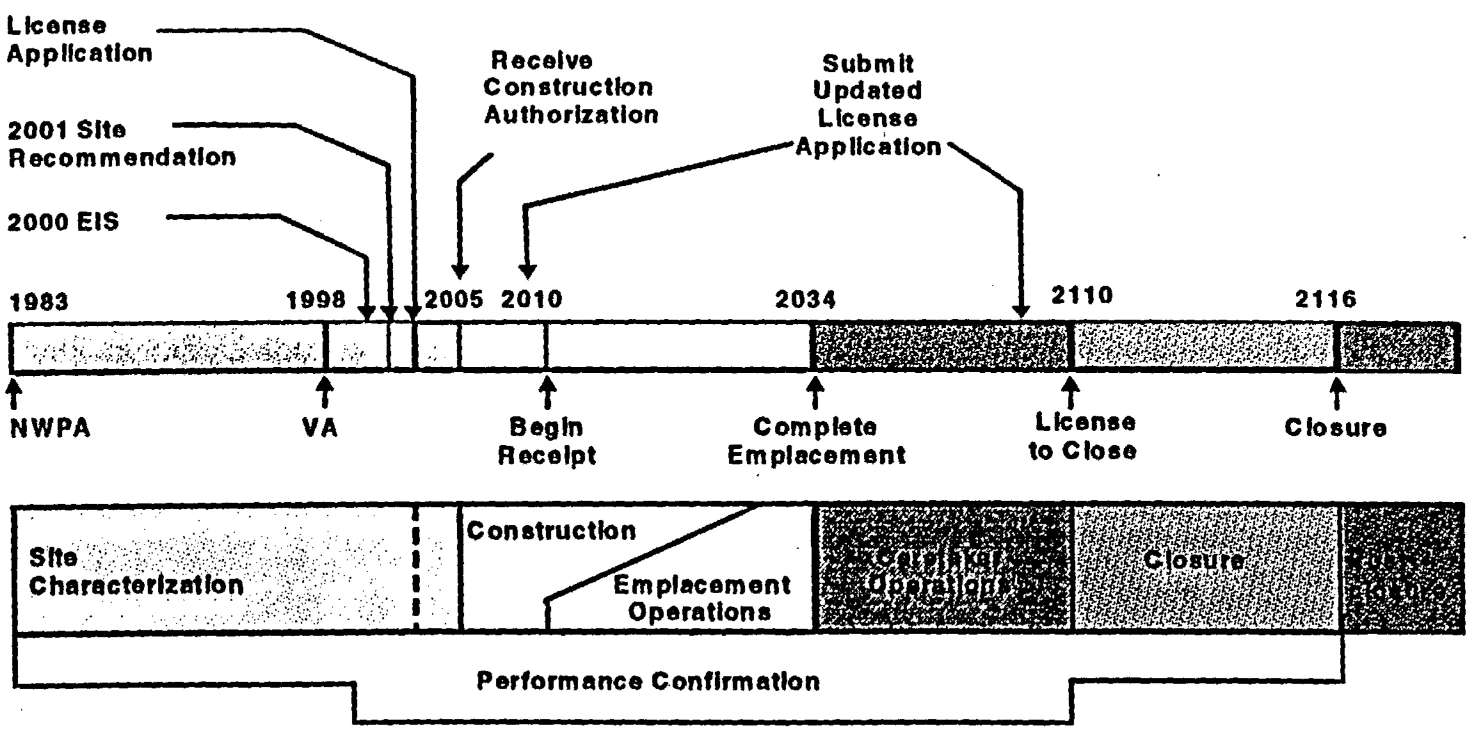
Major Design Drivers

- Peak annual receipt and emplacement rates
- Receipt and emplacement configurations (e.g., rail and truck transportation, commercial SNF in DPCs and disposable canisters, HLW and DOE SNF in disposable canisters, vast variety)
- Dry loading of disposal containers
- No integration with ISF, and no early receipt
- No rod consolidation or significant cask maintenance
- Off-site disposal of low-level waste
- Off-site recycle/disposal of empty DPCs
- Seismic load of 0.66g for waste handling building

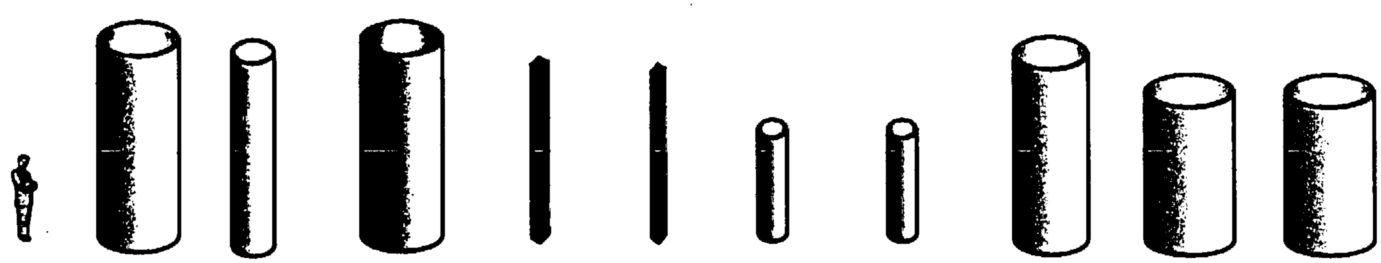
Physical Characteristics

- Disposal of 70,000 MTU
  - In 11,000 large waste packages, 5½ to 6 ft. Diameter
  - 70% SNF, 30% DHLW
- Horizontal Emplacement in Underground Drifts
  - 93 miles of 15 to 20 ft. diameter tunnels and drifts
  - 741 acres of emplacement area
  - 650 to 1,300 feet below the surface in welded tuff
- Surface Facilities
  - 17 buildings for emplacement and support
  - 800,000 ft^2 of floor space (18 football fields)
- Staffing: 700 for surface and subsurface operations
  450 for underground drift excavation

Program Schedule



Representative Waste Form Data



	Received		Transferred					Emplaced		
	Rail Cask	Truck Cask	SNF Canister	PWR Assy	BWR Assy	DOE SNF	DHLW Canister	SNF DC	DC 5	DOE SNF DC
Loaded Weight (tonnes)	105	25	31	0.9	0.4	2.0	1.1	53	39	40
Peak Units per Year	580	240	300	5,000	8,300	340	500	380	100	70

<u>KEY</u>

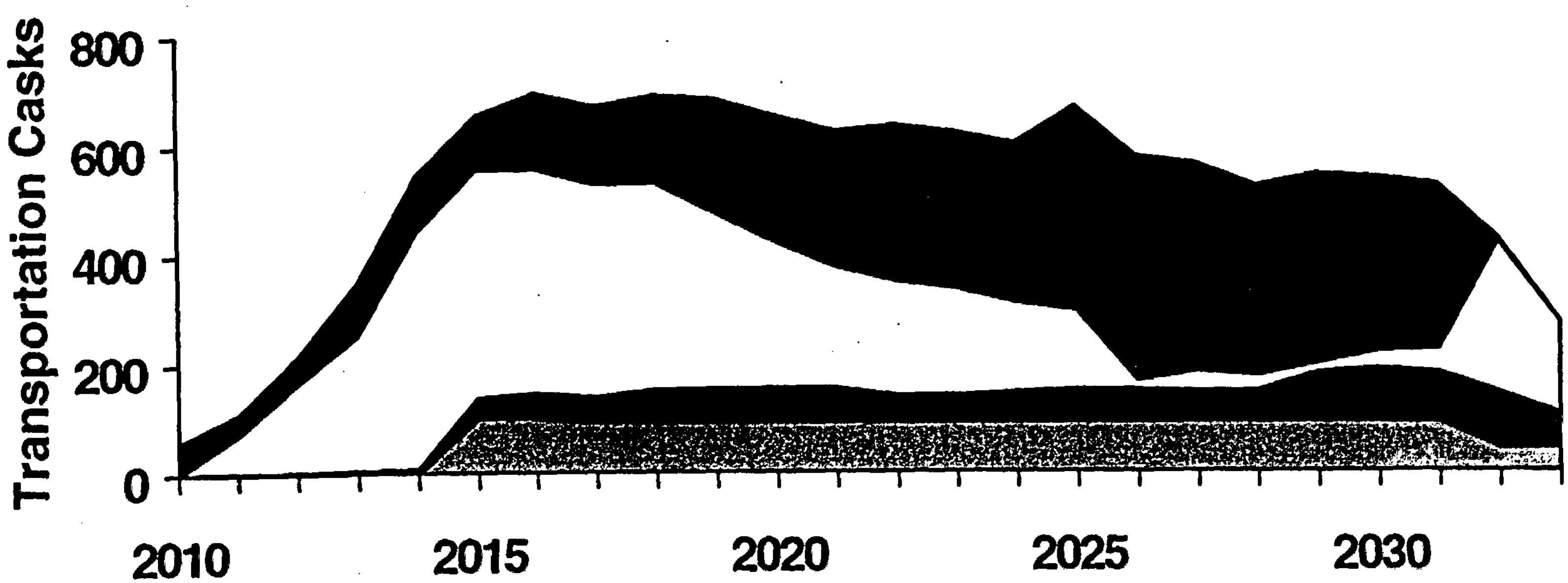
BWR	Boiling Water Reactor	DHLW	Defense High-Level Waste
DC	Disposal Container	PWR	Pressurized Water Reactor
DC 5	5 Pack with DOE SNF Center	SNF	Spent Nuclear Fuel

MEYERFIG.CDR.124/9-2-97

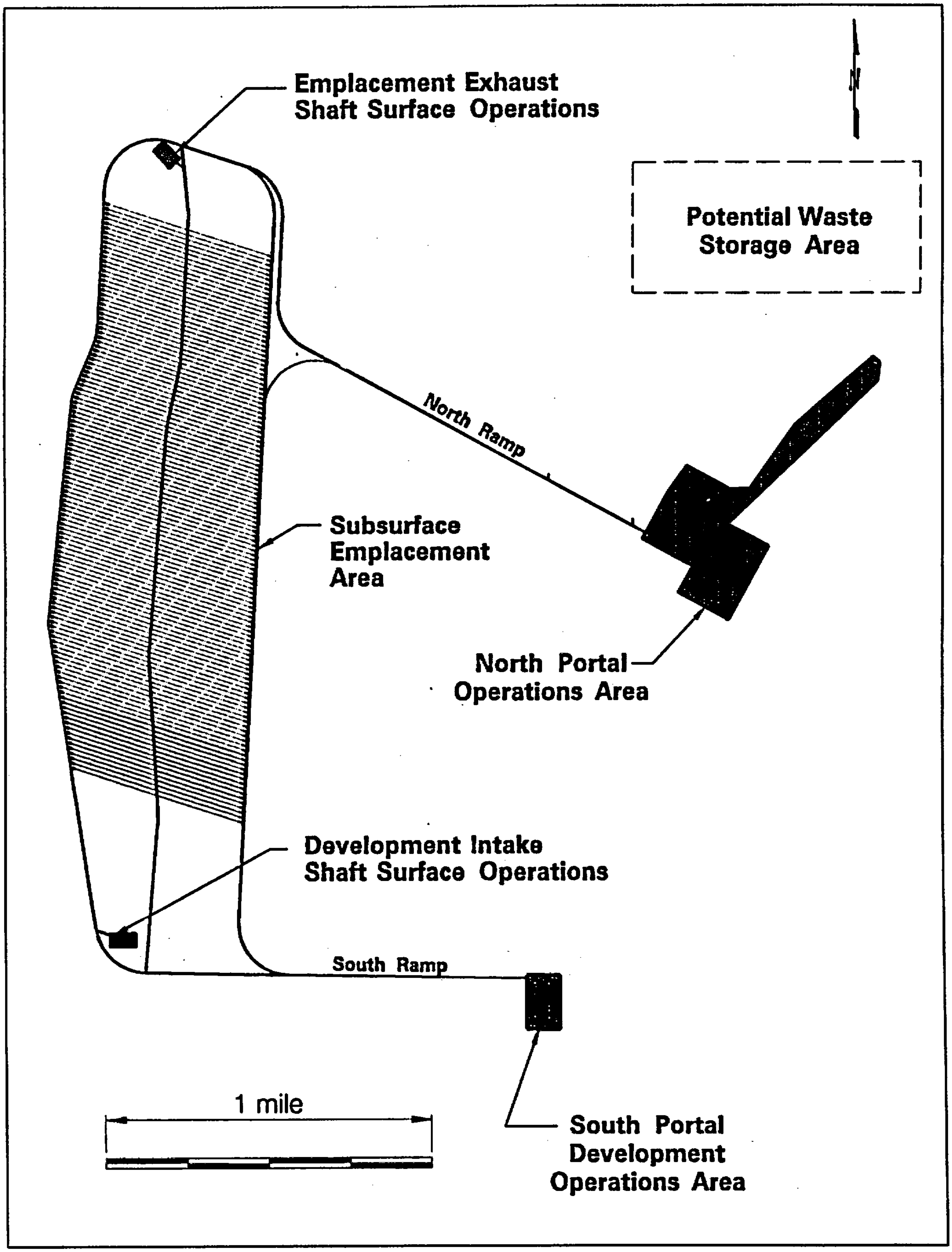
Cask Arrival Schedule (CDA)

- CSNF as UCF by Truck
- CSNF in DPCs by Rail
- CSNF as UCF by Rail
- DOE SNF in DISPCs by Rail
- HLW in DISPCs by Rail

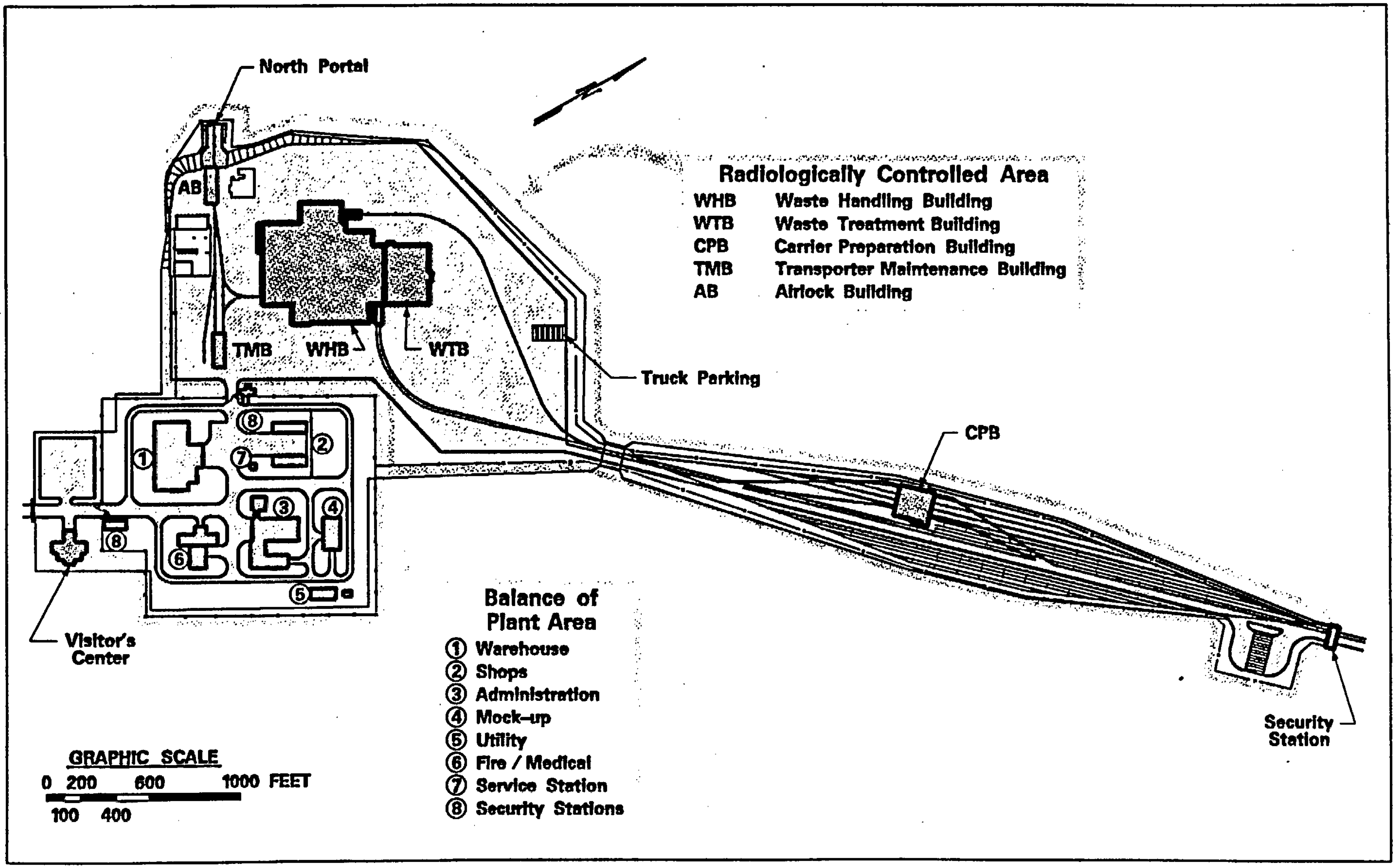
HLW - Vitrified High-Level Waste
CSNF - Commercial Spent Nuclear F
UCF - Uncanistered Fuel
DPC - Dual Purpose Canister
DISPC - Disposable Canister



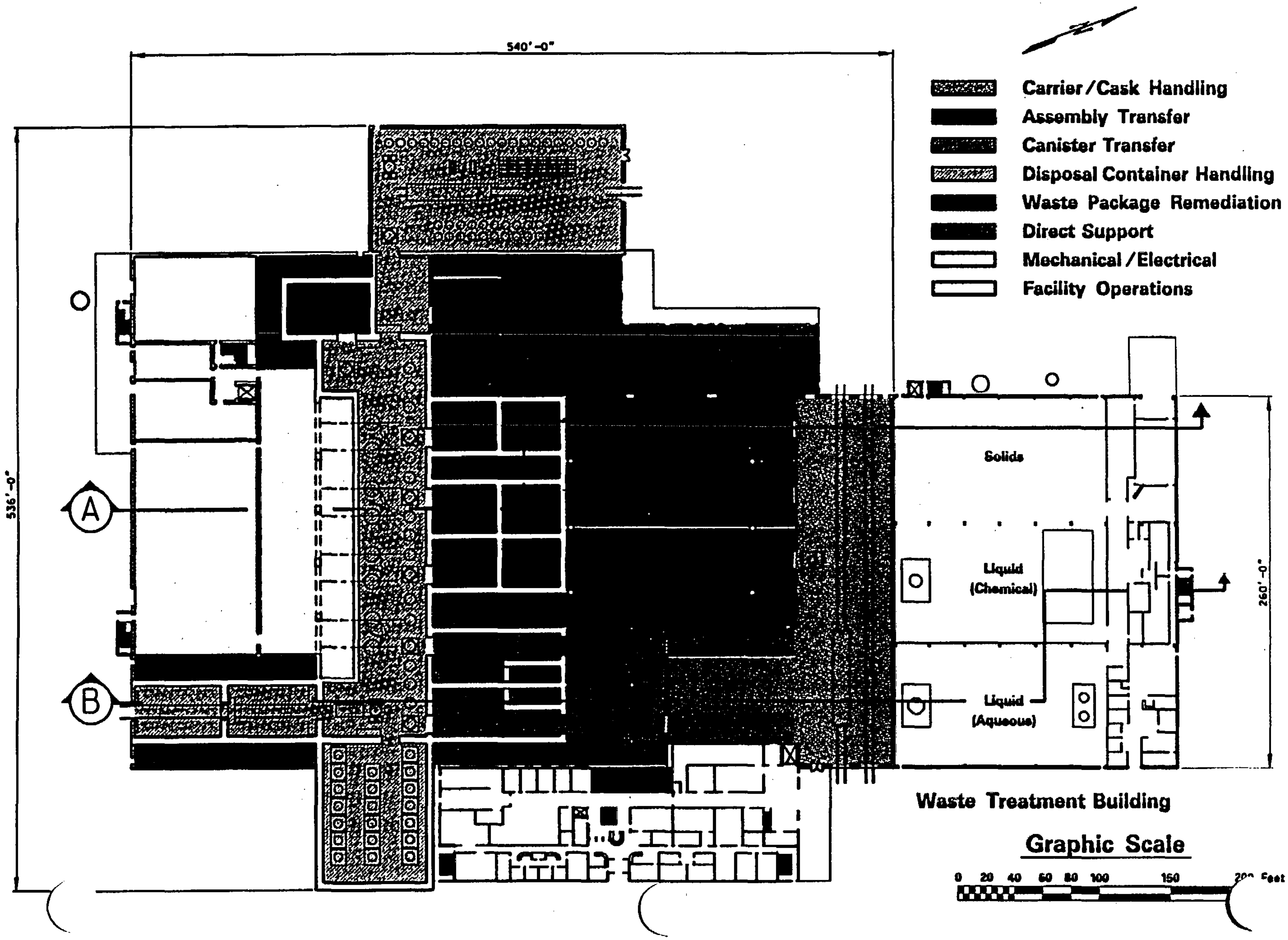
MGDS Operations Areas



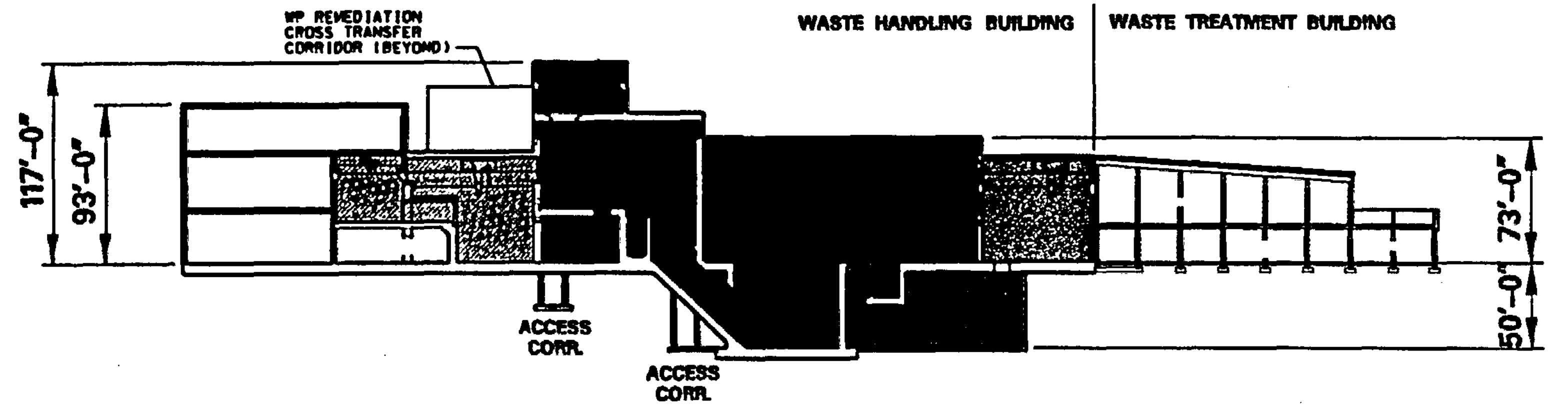
Repository North Portal Surface Facilities



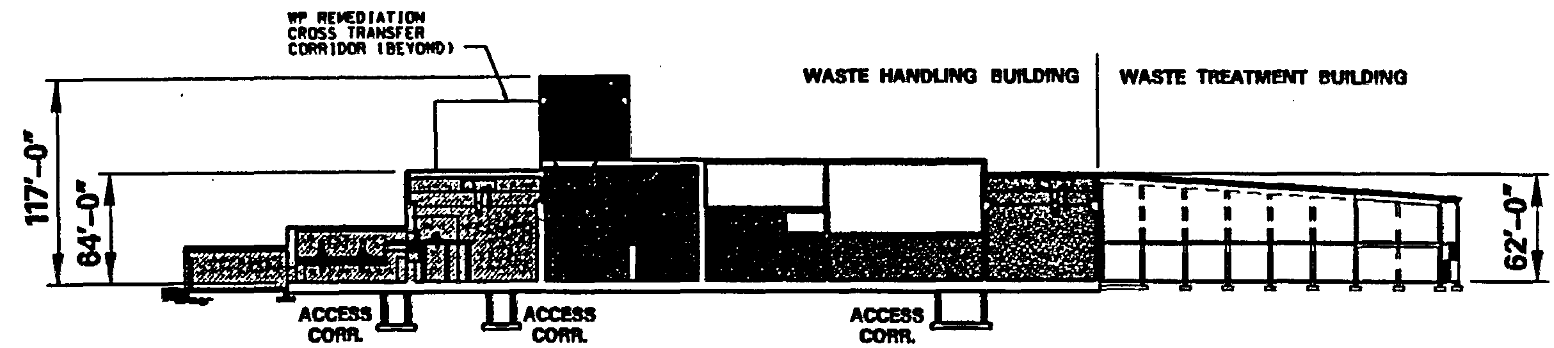
Waste Handling Building Floor Plan



Waste Handling Building Sections



Assembly Transfer (A)

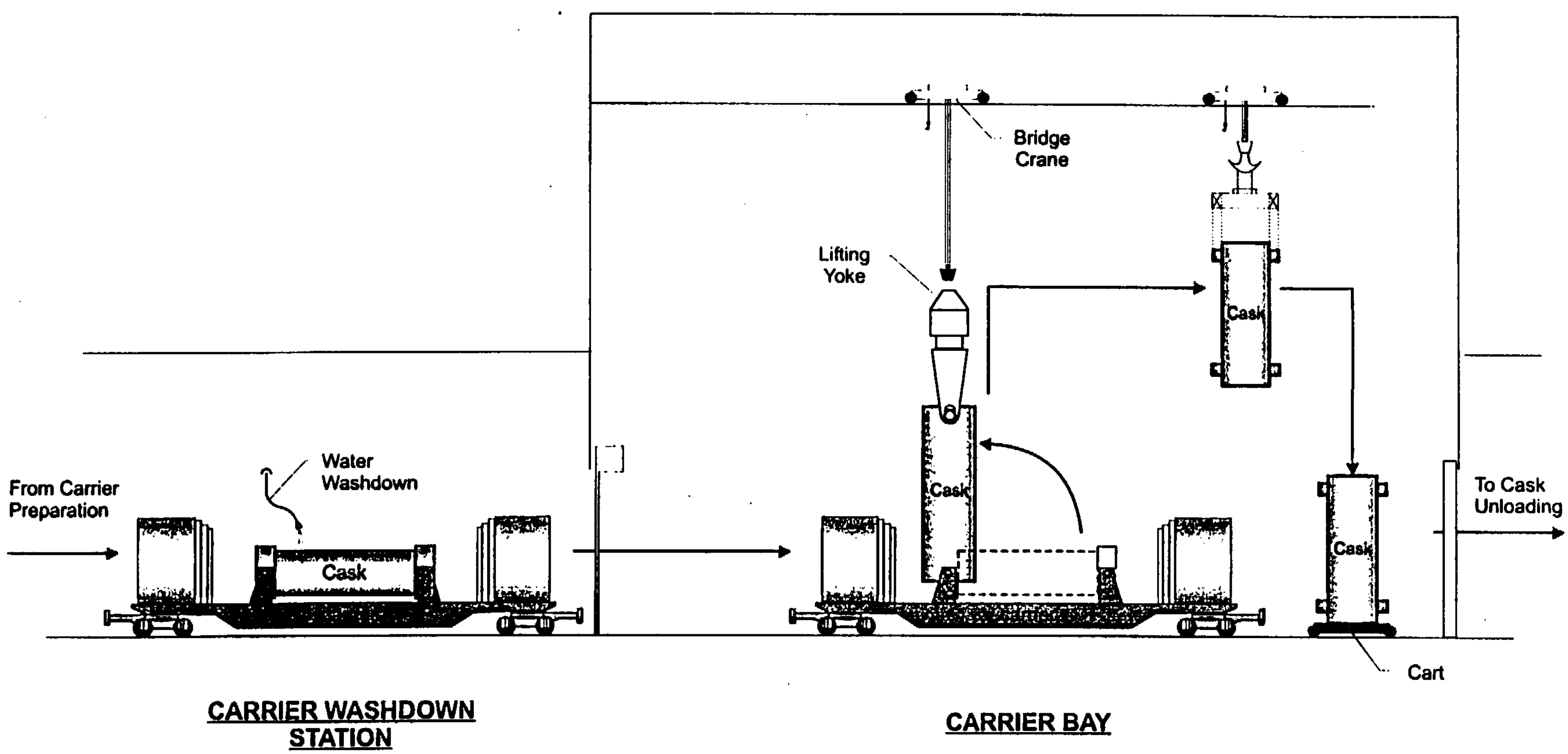


Canister Transfer (B)

- Carrier/Cask Handling
- Assembly Transfer
- Canister Transfer
- Disposal Container Handling
- Waste Package Remediation
- Direct Support
- Mechanical/Electrical
- Facility Operations

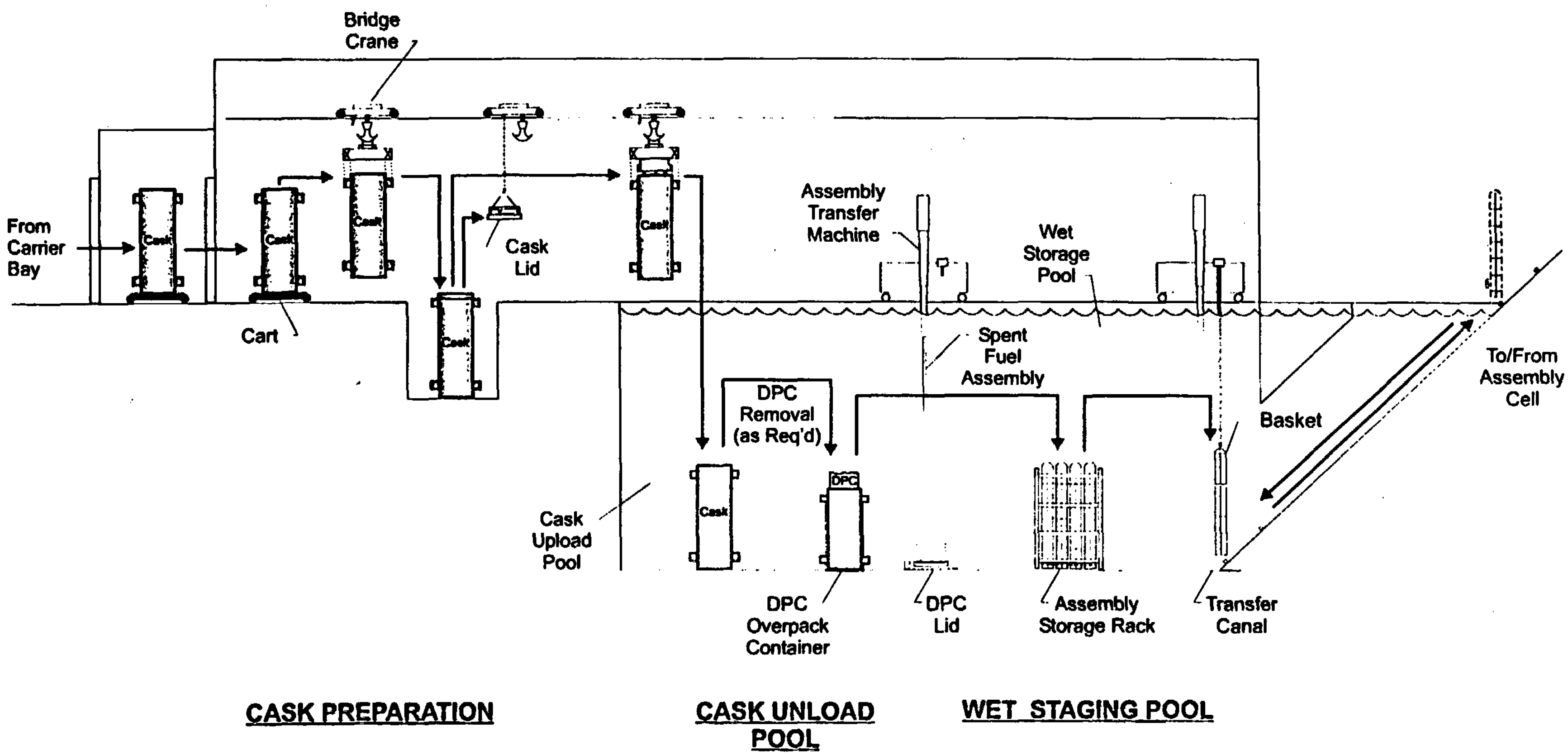
Graphic Scale

Carrier/Cask Handling System



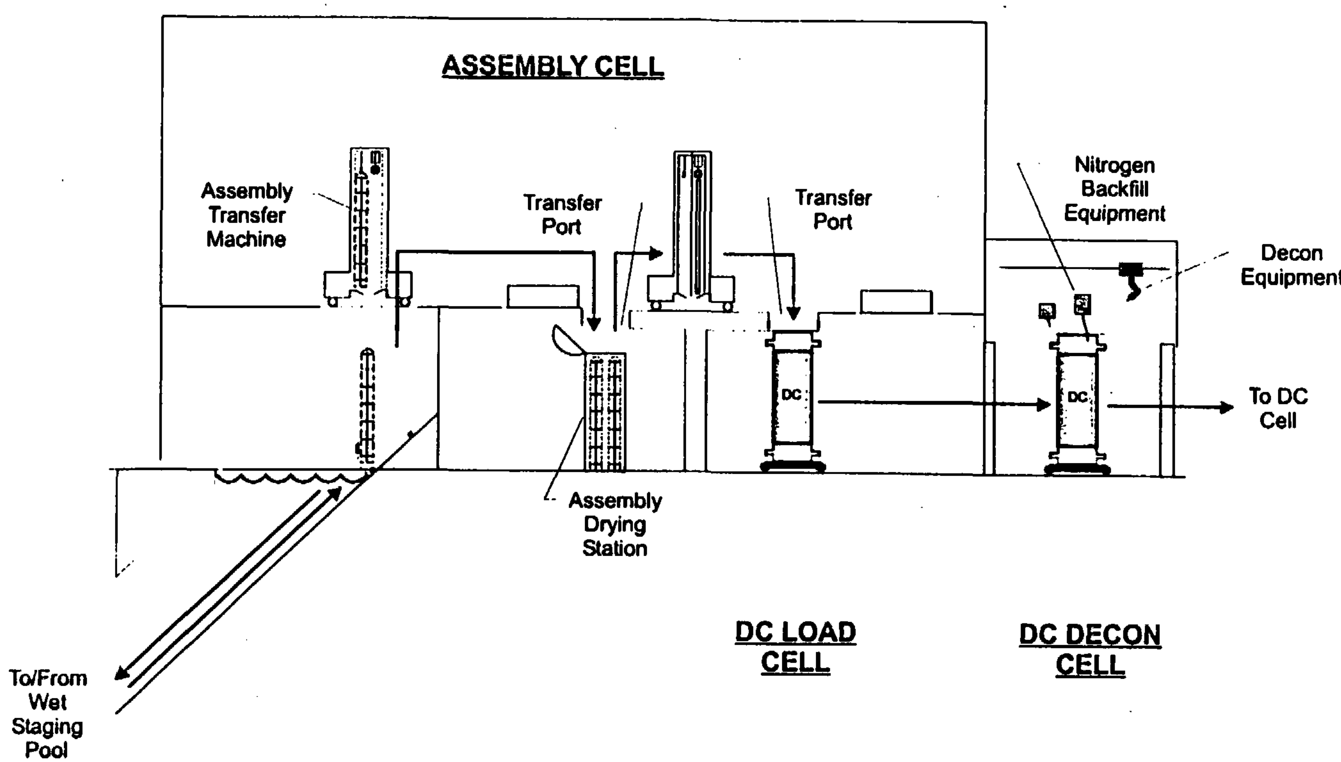
MEYERFIG.CDR.124/9-2-97

Assembly Transfer System



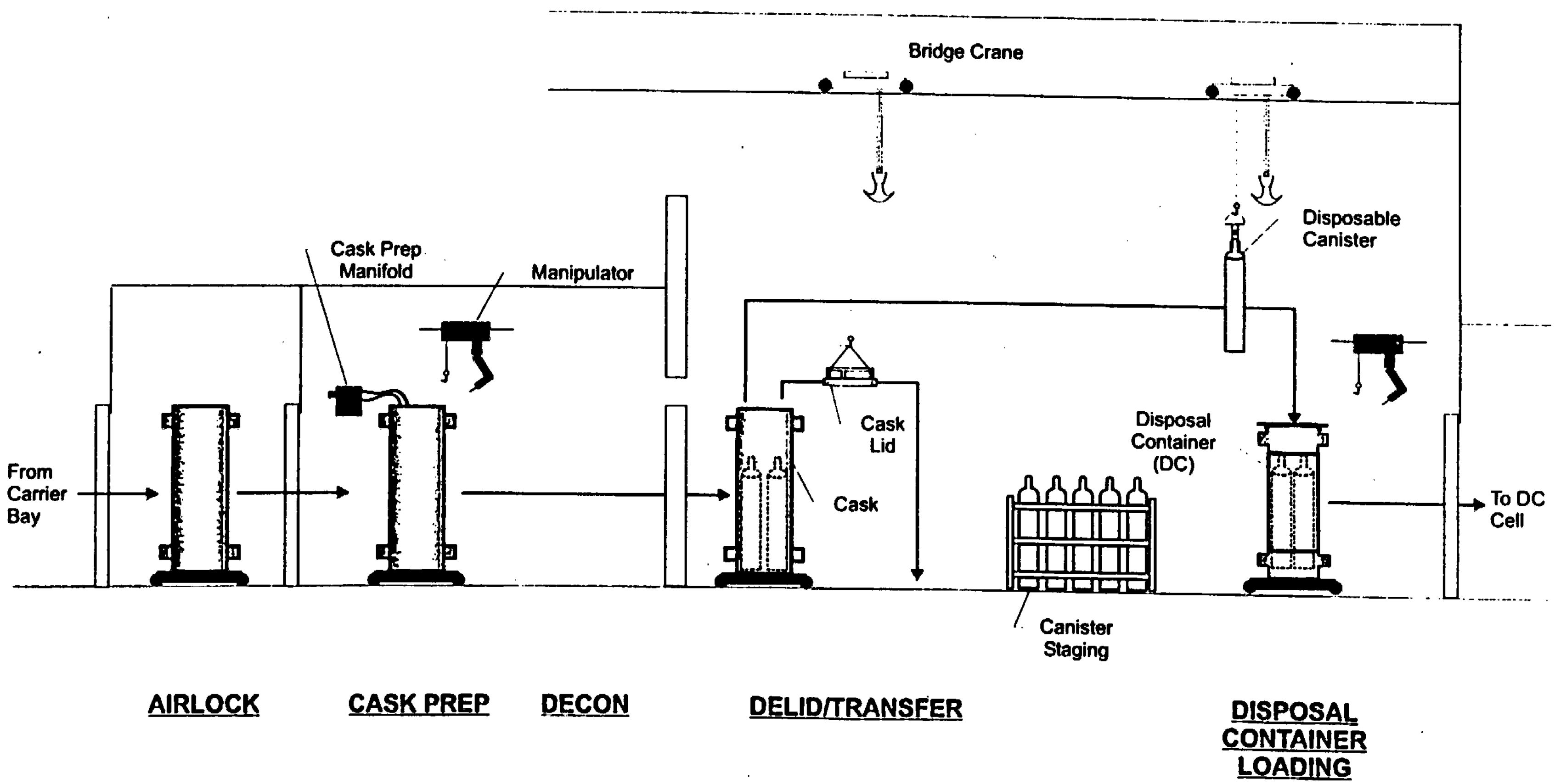
MEYERFIG.CDR.124/9-2-97

Assembly Transfer System
(continued)



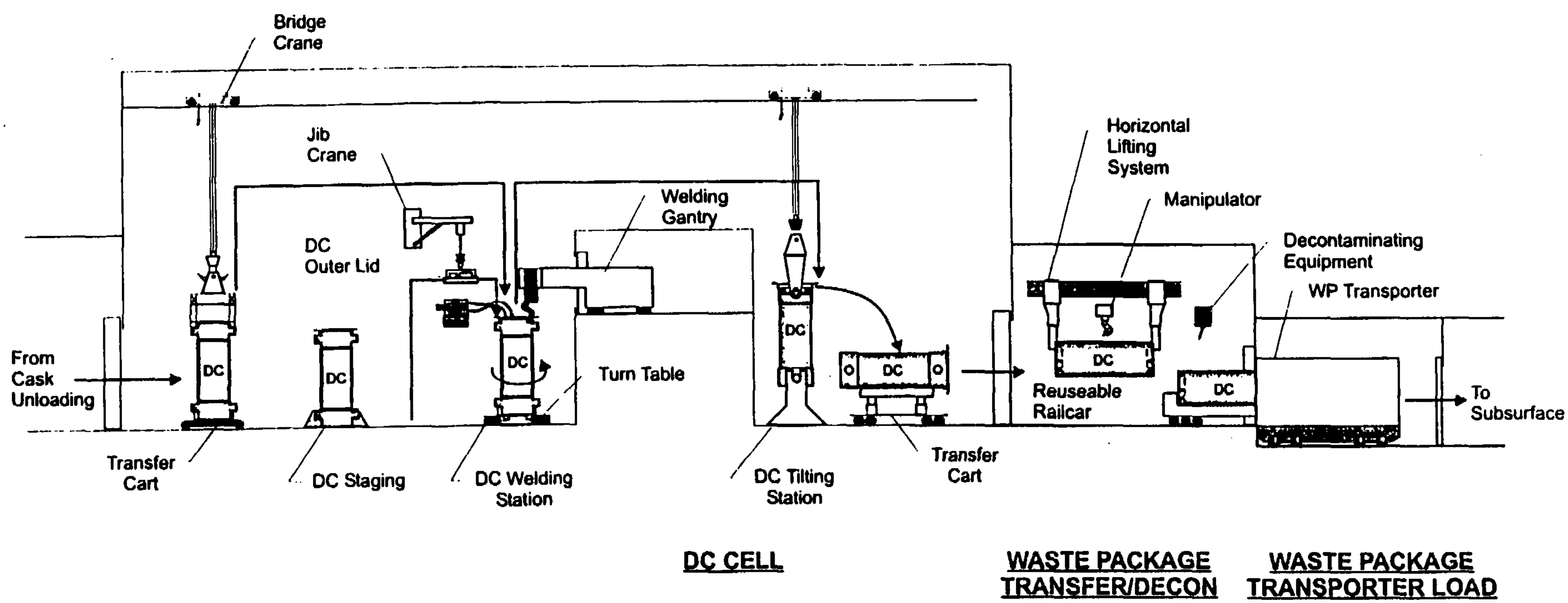
MEYERFIG.CDR.124/9-2-97

Canister Transfer System



MEYERFIG.CDR 124/9-2-97

Disposal Container Handling System



MEYERFIG.CDR.12-·,3-2-97

ATTACHMENT 7

YUCCA MOUNTAIN PROJECT

Studies

Waste Package

Presented to:
DOE - NRC Quarterly Technical Meeting

Presented by:
Hugh A. Benton
Waste Package Manager
CRWMS M&O

December 15, 1997

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

Outline

- Design goals
- Current Designs
- Thermal Analysis
- Structural Analysis
- Criticality Analysis
- Material Selection and Testing

Major Design Goals

- Preclosure, prevent criticality during operations
- Postclosure, design to ensure very low likelihood of criticality and insignificant consequences
- Maintain fuel rod cladding temperature below 350° C
- Shield to protect against radiation induced corrosion
- Contain waste for at least 3,000 years
- Post containment release <1 part in 10^5 per year of inventory of each radionuclide at 1000 years
- Protect waste form from seeping or dripping water for 10,000 years

Waste Package Designs

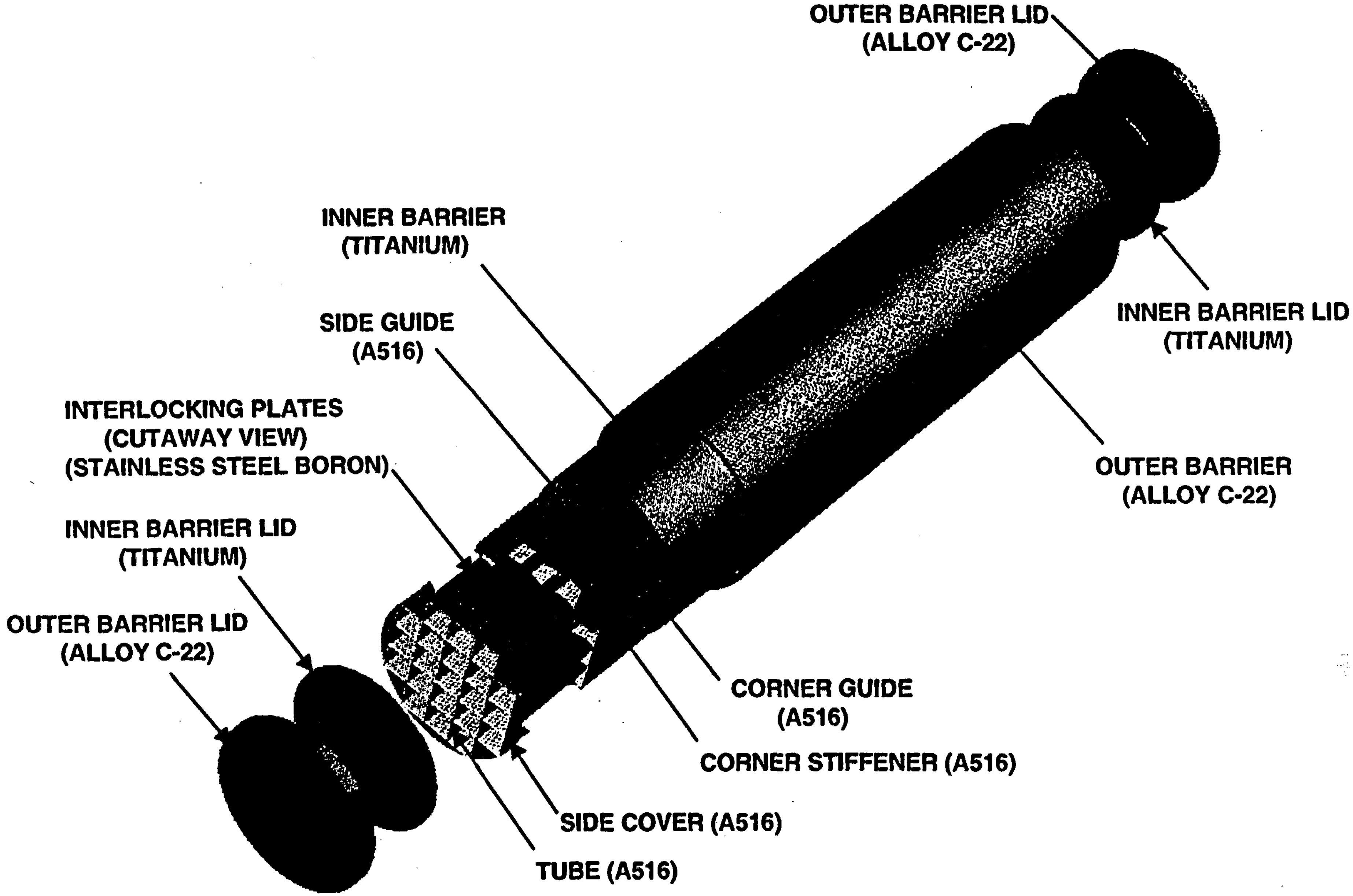
- Uncanistered commercial fuel
- Canistered commercial fuel
- Defense high level waste
- DOE-owned fuel
- Canistered Navy fuel

Commercial

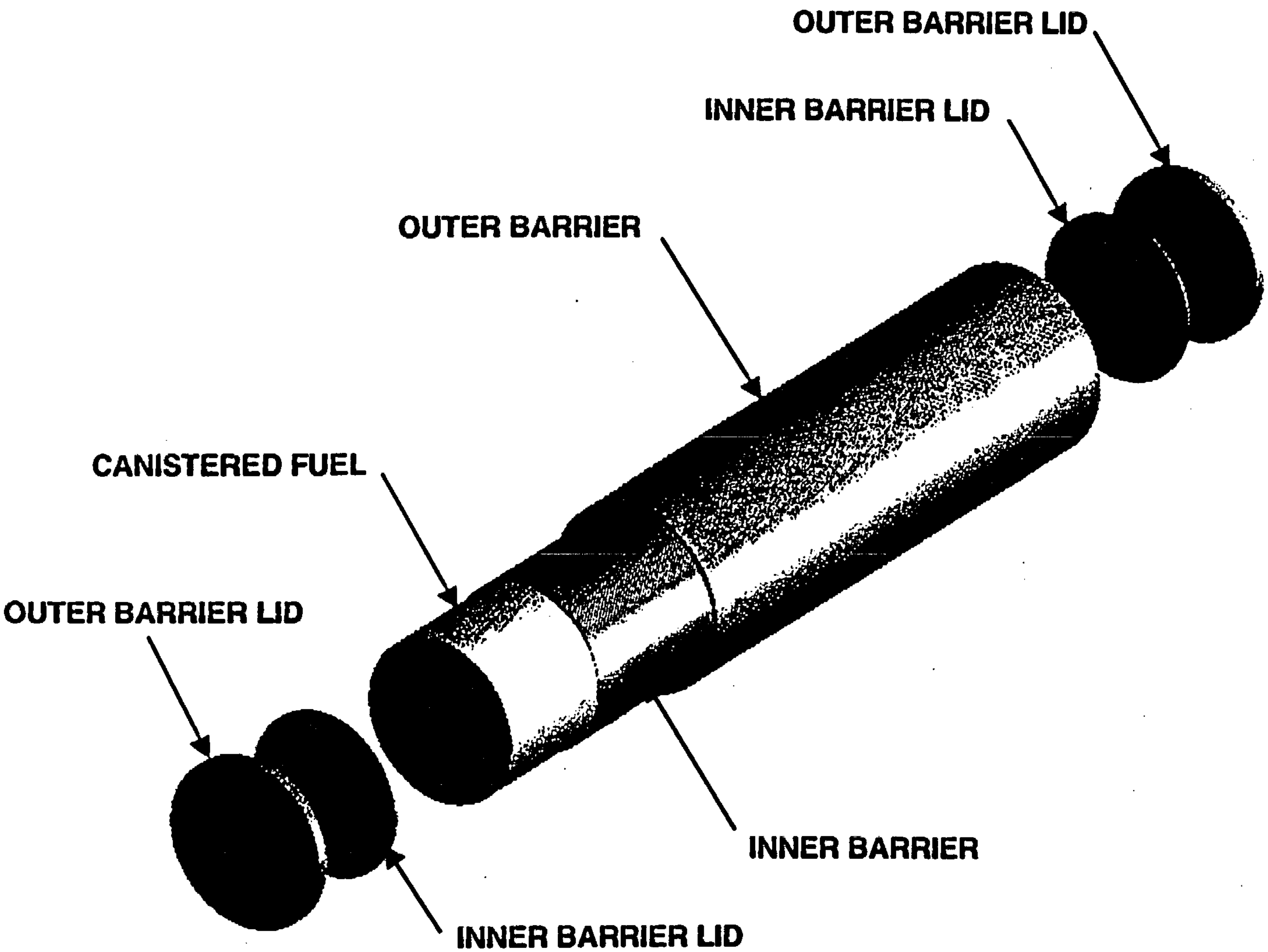
- 86,800 metric tons of heavy metal from 72 reactor sites
  - 131,500 PWR assemblies
  - 167,800 BWR assemblies
- Estimate <0.5% contain one or more leaking rods
- % of assemblies with following cladding material

  99% Zircaloy 2 or 4

  1% Stainless Steel



21-PWR UCF
WASTE PACKAGE ASSEMBLY



LENGTH = 5682 mm
DIAMETER = 1802 mm
TARE WEIGHT = 31,176 kg
LOADED WEIGHT = 65,900 kg (PWR)
LOADED WEIGHT = 65,463 kg (BWR)

CANISTERED FUEL-WASTE PACKAGE
21-PWR / 40-BWR

Defense High Level Waste

- 5944 canisters from Savannah River Plant

  61 cm O.D. x 300 cm long

- 276 canisters from West Valley

  61 cm O.D. x 300 cm long

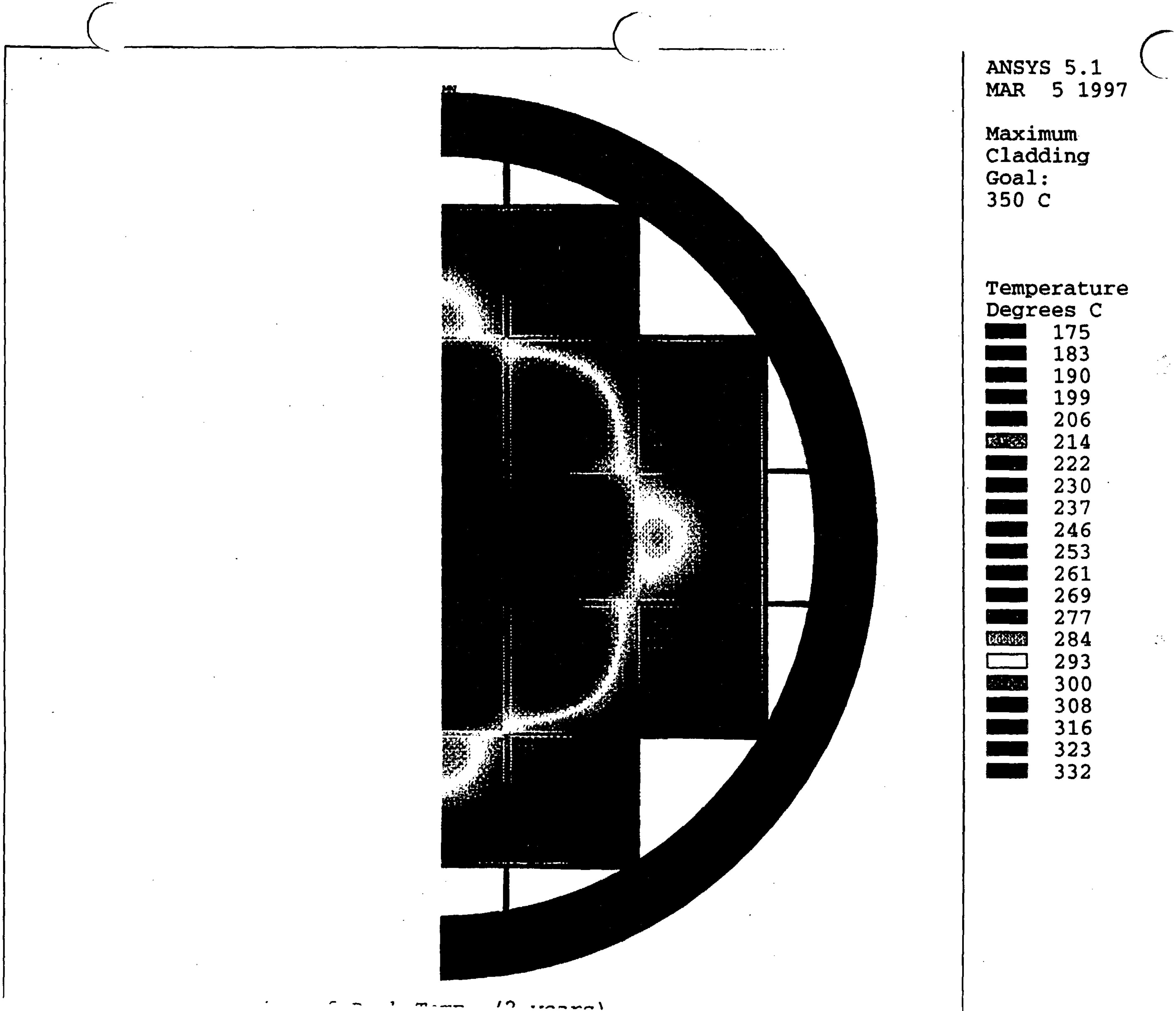
- 12,444 canisters from Hanford Site

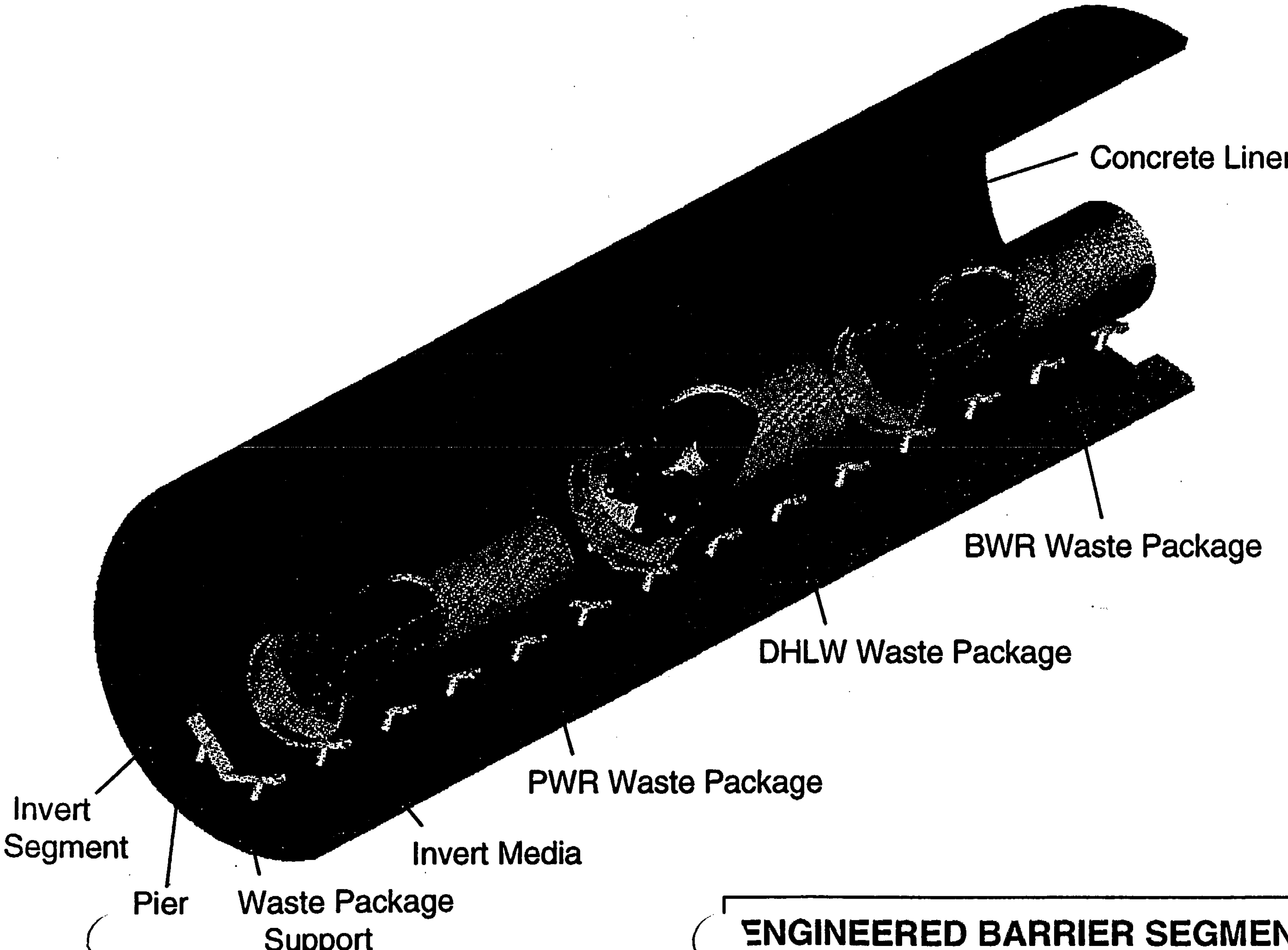
  68 cm O.D. x 457 cm long

- ~570 canisters from INEEL, size uncertain

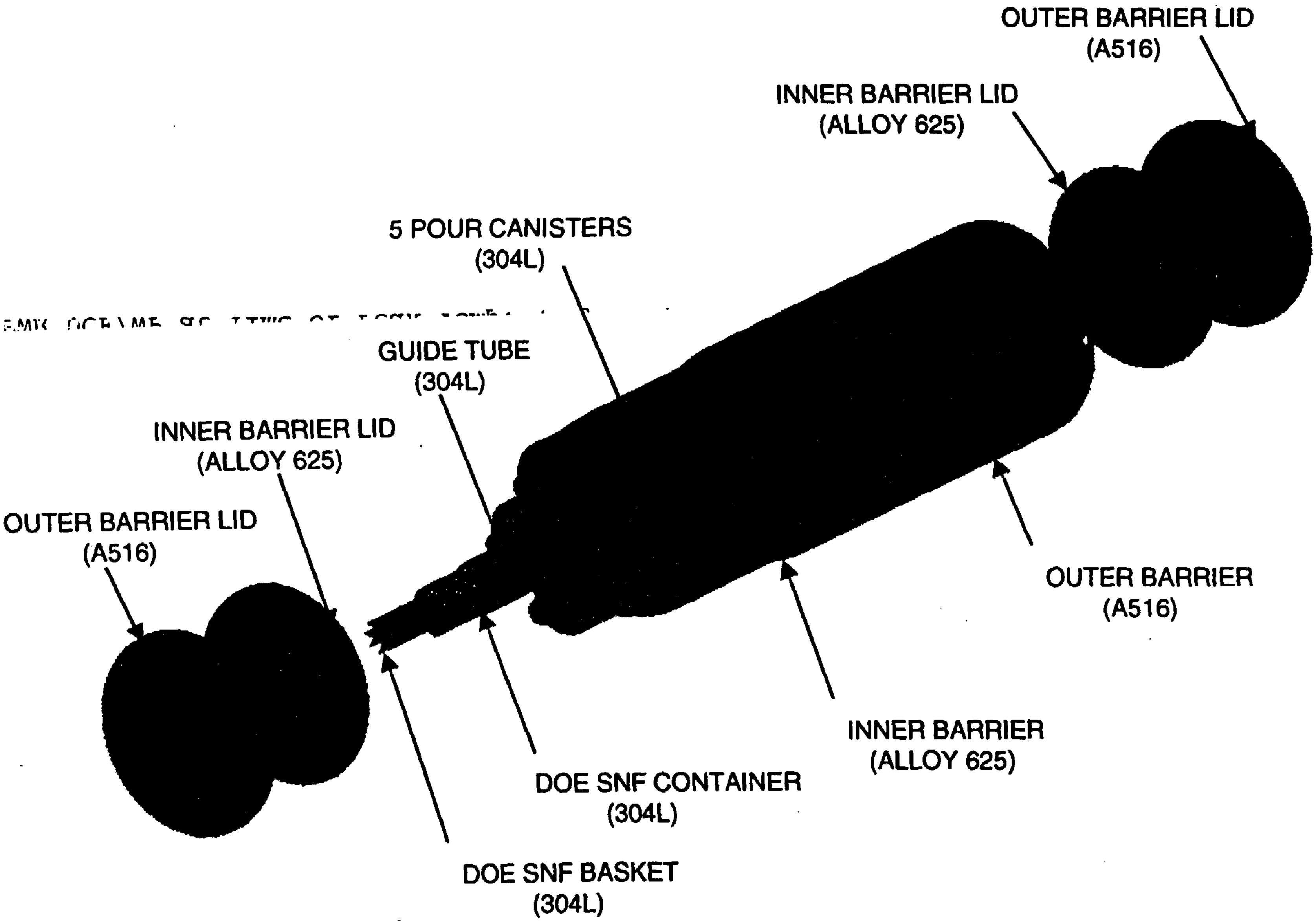
Amounts of DOE SNF

Major Categories of DOE SNF	MTHM	MT	cu. m
Naval Fuel	65	3,659	888
N-Reactor Fuel	2,105	2,276	206
Al- U Research Reactor Fuel	211	588	352
EBR-II & Fermi (Sodium Bonded)	76	316	259
Uranium Carbide (Ft St Vrain & PB-1)	28	352	293
Uranium Oxide (Commercial LWRs)	90	234	77
TMI- 2 Core Debris	82	325	129
Shipping port LWBR (Thorium Oxide)	43	84	31
FFTF (MOX)	11	56	17
Miscellaneous (Triga Zr-U-H, MSRE)	26	159	62
Totals:	2,735	8,047	2,315


ANSYS 5.1
MAR 5 1997
Maximum
Cladding
Goal:
350 C
Temperature
Degrees C
175
183
190
199
206
214
222
230
237
246
253
261
269
277
284
293
300
308
316
323
332

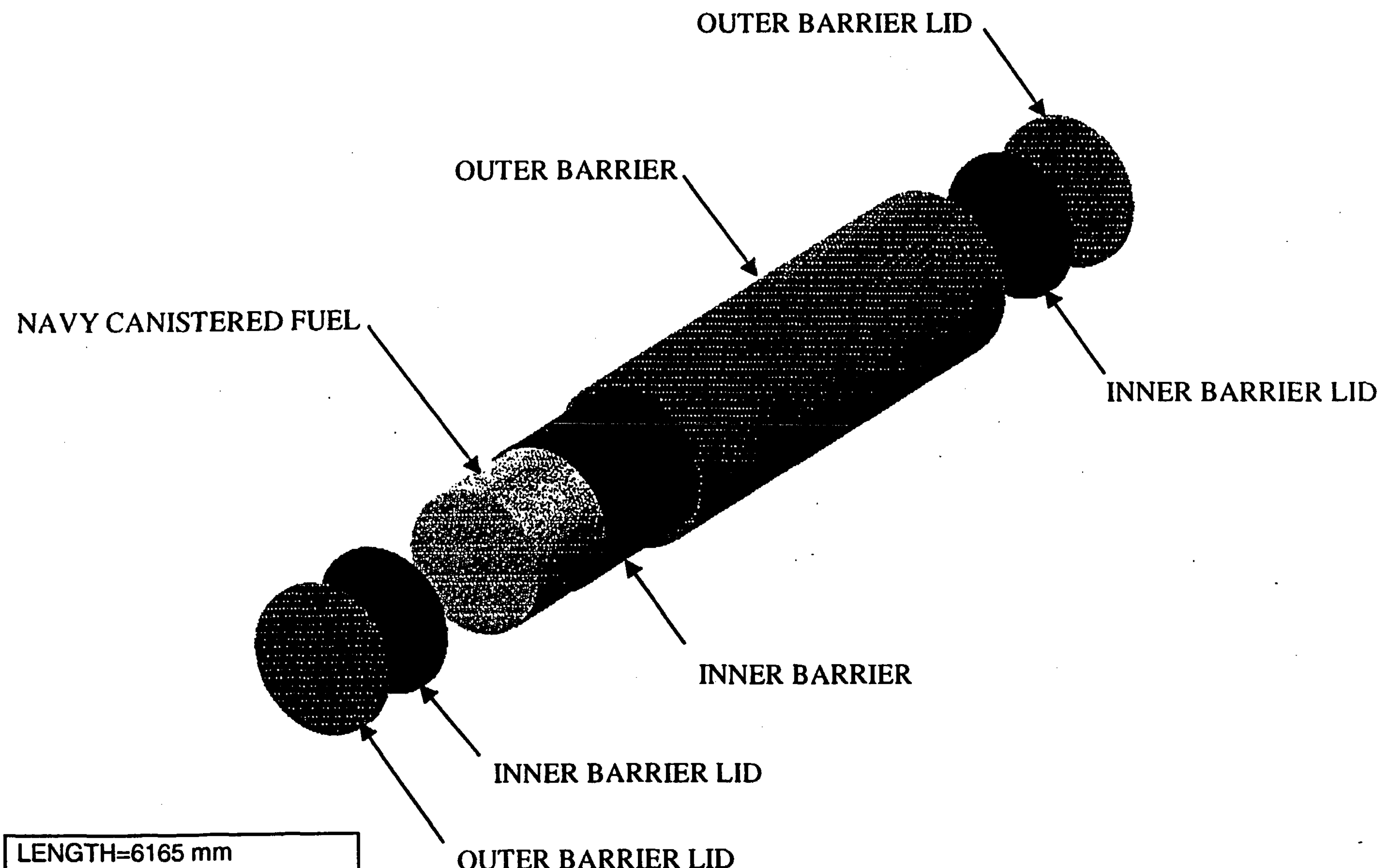


ENGINEERED BARRIER SEGMEN



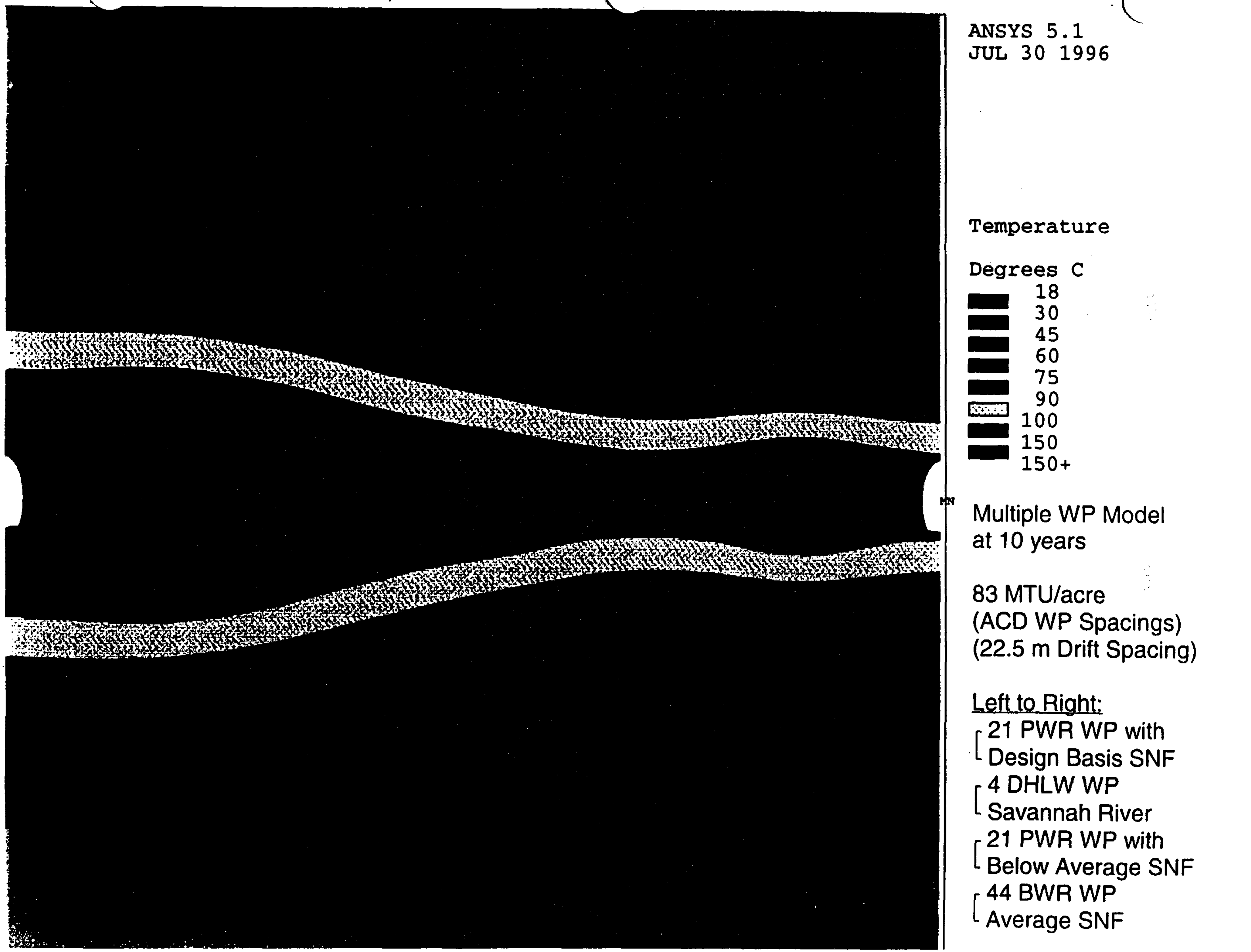
LENGTH = 3790 mm
DIAMETER = 1970 mm
TARE WEIGHT = 24,782 kg
LOADED WEIGHT = 35,692 kg
EXCLUDES DOE SNF, BASKET,
CONTAINER , AND GUIDE TUBE

5-DHLW/DOE
SPENT FUEL ASSEMBLY



LENGTH=6165 mm
DIAMETER=1959 mm
TARE WEIGHT=37,855 kg
LOADED WEIGHT=82,305 kg

NAVY CANISTERED FUEL-WASTE PACKAGE

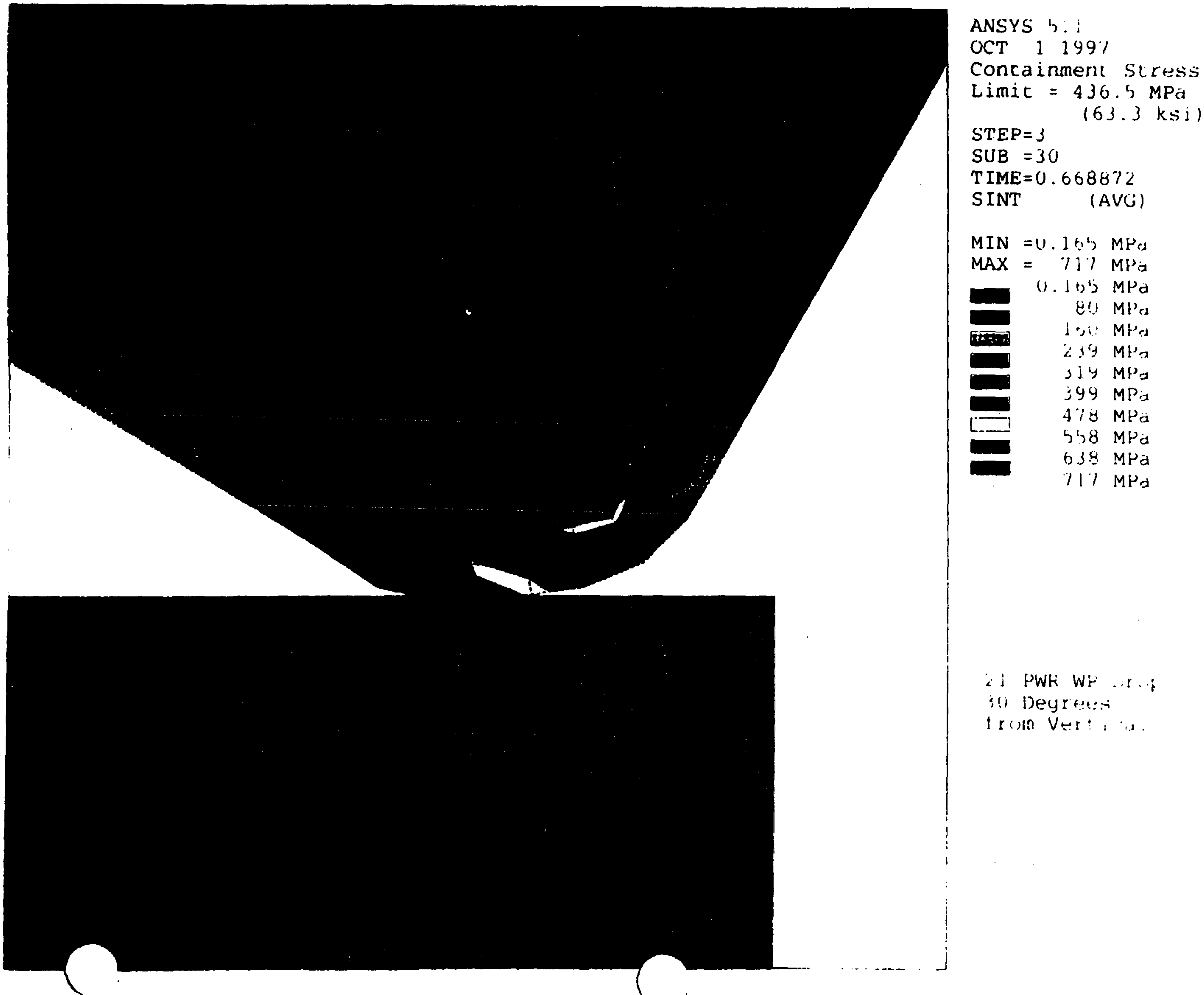

ANSYS 5.1
JUL 30 1996
Temperature
Degrees C
18
30
45
60
75
90
100
150
150+
MN
Multiple WP Model
at 10 years
83 MTU/acre
(ACD WP Spacings)
(22.5 m Drift Spacing)
Left to Right:
21 PWR WP with
Design Basis SNF
4 DHLW WP
Savannah River
21 PWR WP with
Below Average SNF
44 BWR WP
Average SNF

Structural Analysis

- Preclosure Analyses
  - Handling Loads
    - SNF loading and container closure
    - Disposal container lifting and moving
    - Emplacement and retrieval
  - Design Basis Events
    - Drops (vertical, horizontal, oblique)
    - Tip-over
    - Impacts (missile from failure of pressurized component, rock fall, etc.)

Structural Analysis

- Postclosure Analyses
  - Drift liner collapse
  - Rock fall
  - Seismic event



ANSYS
OCT 1 1997
Containment Stress
Limit = 436.5 MPa
(63.3 ksi)
STEP=3
SUB =30
TIME=0.668872
SINT (AVG)
MIN =0.165 MPa
MAX = 717 MPa
0.165 MPa
80 MPa
239 MPa
319 MPa
399 MPa
478 MPa
558 MPa
638 MPa
717 MPa
21 PWR WP
Degrees
from

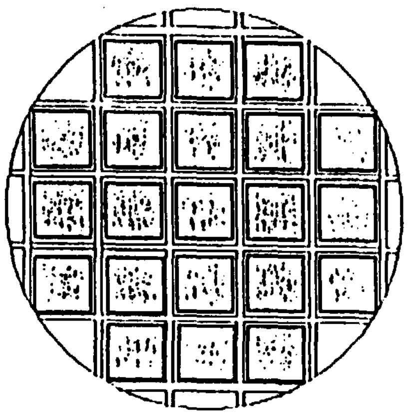
Criticality Analysis Methodology

- Disposal criticality analysis methodology
  - Risk-based
    - Probability of occurrence times consequence of criticality events
    - Risk in terms of dose to the public from criticality events
  - Accounts for spent commercial fuel burnup in criticality analysis (burnup credit)

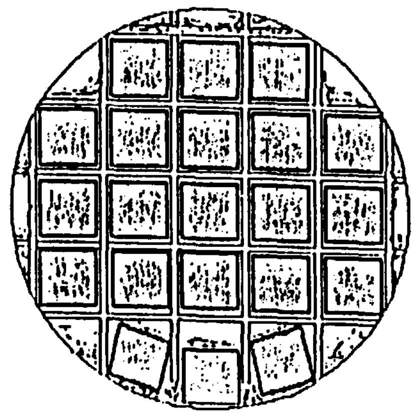
Technical Report, Revision 01

- Issued to DOE September 3, 1997
- Contains the latest revision of the disposal criticality analysis methodology
- References four main supporting reports:
  - Commercial Reactor Criticals
  - Laboratory Critical Experiments
  - Comparisons of Chemical Assays
  - Probabilistic Evaluations

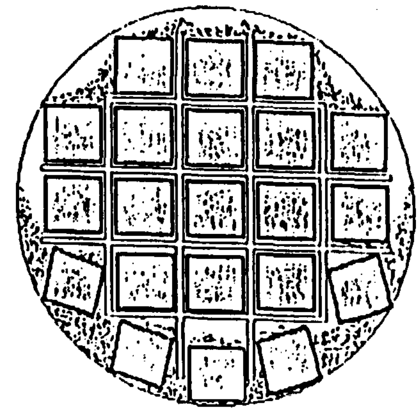
Waste Package Degraded Internal Configurations for Commercial PWR SNF (Schematic)



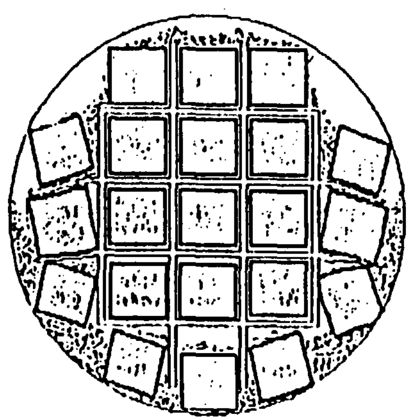
Initial Configuration



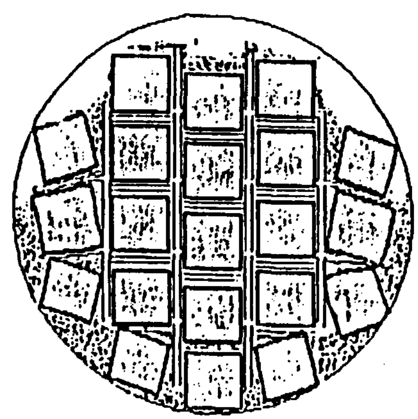
Side Guide Failure



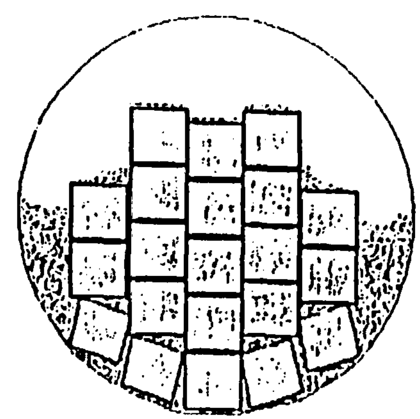
Corner Guide Failure



Long Criticality Control Plates Bend at Ends

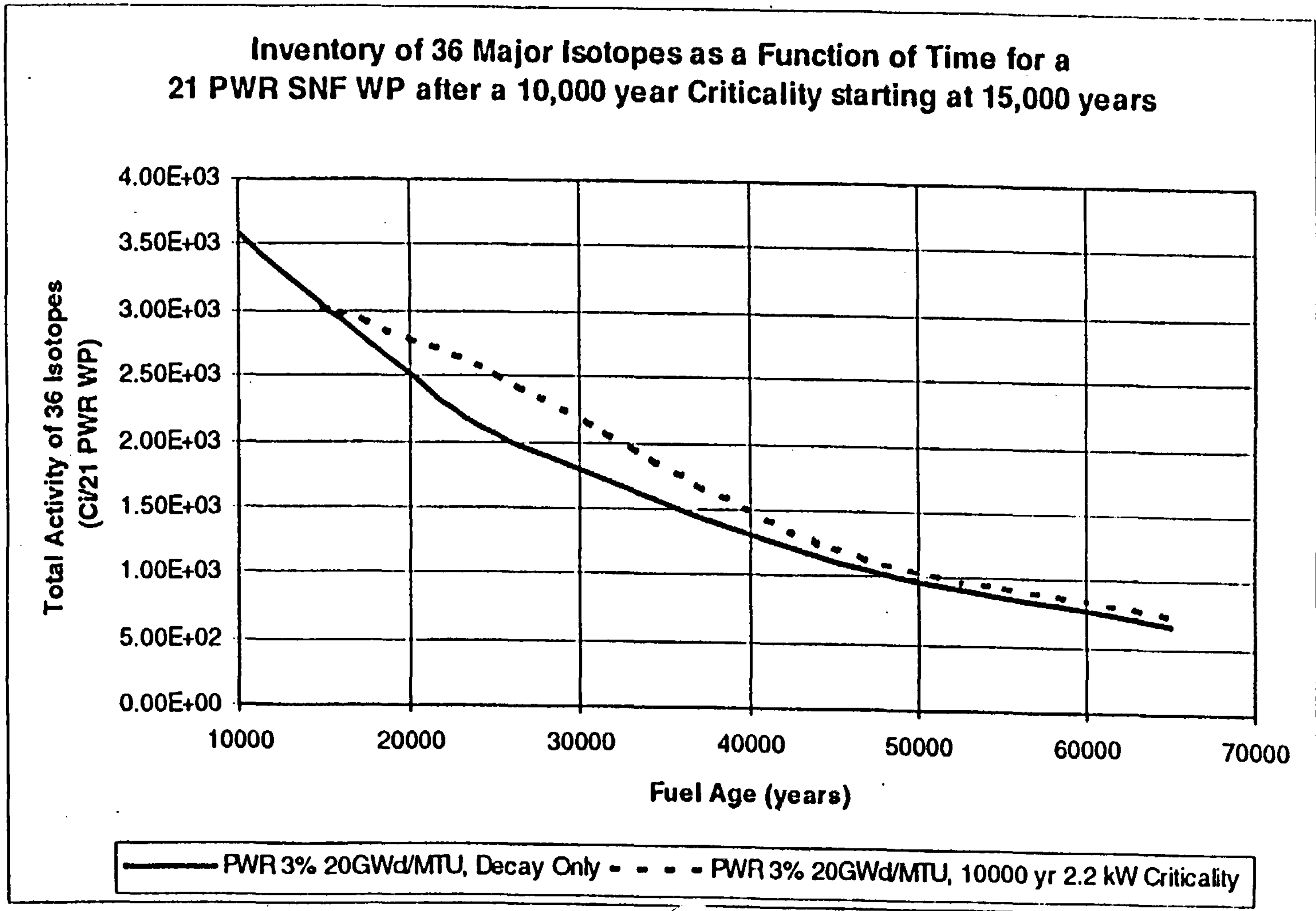


Fully Collapsed Basket with Partial Criticality Control Plate



Fully Degraded Basket

Steady State Criticality Consequence Analysis



Criticality Risk

- Probability of criticality occurrence
  - Fraction of waste packages with drips
  - Fraction of waste packages that are sequentially breached, filled, flushed, and remain filled
- Consequence of criticality
  - Increase in radionuclide inventory/activity
  - Transient effects on radionuclide containment

Material Selection Criteria

- Mechanical performance
- Chemical performance
- Predictability of performance
- Compatibility with other materials
- Fabricability
- Cost
- Previous experience
- Thermal and neutronic performance

The 1996 selection process resulted in the selection of the following materials:

Corrosion Allowance Material:	Carbon Steel, ASTM A 516, Grade 55 or 70
Corrosion Resistant Material:	Alloy 625, ATM B 443
Fuel Basket Tubes:	Carbon Steel, ASTM A 516, Grade 55 or 70
Fuel Basket Plates:	Boron Stainless Steel, Neutronit A 978
Waste Package Fill Gas:	Helium
Basket Guides:	Carbon Steel, ASTM A 516, Grade 55 or 70
Canister Guides for HLW Glass:	Carbon Steel, ASTM A 516, Grade 55 or 70

WP Material Selection Process Review

- A review of the 1996 materials selection analysis is underway. Reasons for review:
  - New waste package lifetime requirements
  - Revised environmental input conditions
  - New data/information from LLNL and expert elicitations

Container Materials in Corrosion Test Program

- Corrosion-Allowance Materials
  - Carbon steel - cast (ASTM A27) and wrought (ASTM A516)
  - Low alloy (2.25 Cr - 1 Mo) steel
- Intermediate Corrosion-Resistant Materials
  - Copper-nickel (70/30) alloy
  - Nickel-copper (70/30 - Monel 400) alloy

Container Materials in Corrosion Test Program (con't)

- Corrosion-Resistant Materials
  - Nickel-rich alloys (Alloy G-3, G-30, 825)
  - Nickel-base alloys (Alloy 625, C-4, C-22)
  - Titanium alloys (Ti-Grade 12, Ti-Grade 16)
- Other Materials
  - Type 304/316 stainless steel with and without boron
  - Zircaloy (to be added to support Navy testing)
  - Ceramic coatings (alumina, titania, alumina-magnesia, zirconia)

Summary

- Waste package designs are robust, multi-barrier
- Designs are compatible with environment
- Current designs will meet containment requirements
- Post-closure criticality analysis is probabilistic risk-based
- Material testing validating selections

ATTACHMENT 8

KEY FISCAL YEAR 1997 AND 1998 DELIVERABLES RELEVANT TO THE VIABILITY ASSESSMENT
U.S. Department of Energy - Yucca Mountain Site Characterization Office

I. VIABILITY ASSESSMENT DESIGN

Fiscal Year 1997

RP120MG1R1 — VA Design and Review Plan — 4/14/97

A description of the design-related topics and issues important to the VA and a description of the issue resolution strategy and planned progress.

RP120M3E — Subsurface EBS Design — 4/31/97

Includes underground portion of the engineered barrier segment design - integrated with performance assessment, seismic and testing needs, materials identification, structural needs and engineered barrier placement methods.

WP0035A3 — Waste Form Characteristics Report, Rev 1 — 5/7/97

Up-to-date information on waste form materials testing and modeling activities. Preliminary models will be presented for spent fuel oxidation, spent fuel and HLW glass dissolution, and release under both saturated and unsaturated conditions.

RP120M3 — Subsurface Development Design — 8/31/97

Depicts information on subsurface development design including layout and configuration of ramps, shafts, and drifts; alcoves and support areas. Will show the emplacement area, design basis maximum thermal load, and emplacement strategy.

WP220754 — EBS/WP Materials Selection Analysis — 9/15/97

Describes the materials selection process, selection criteria, results ratings, and the selected materials for components of the engineered barriers.

Fiscal Year 1998

SE9272M4 **Reference Design Description for a Geologic Repository, Rev 1** **10/30/97**

Describes the current design expectations for a potential repository that could be located at Yucca Mountain. Includes surface, subsurface, and disposal container design descriptions.

RP742BM3 **Site Layout Analysis** **4/2/98**

This analysis will be developed, as necessary, as a revision to an existing analysis to reflect changes to the site layout including: location of surface facilities, site infrastructure, site facilities, and major site features.

SE420M3 **Final VA Test and Evaluation Plan** **4/31/98**

Update the current revision of the VA T&EP to 1) incorporate the latest design information to be used for VA, and 2) refine to the extent possible the test identification and description sheets contained in the appendices of the draft VA T&EP.

SE422AM3 **MGDS-Requirements Document Update for Final VA Design** **7/1/98**

This Document will capture the applicable program and project requirement changes that have occurred since the last revision. Applicable laws and regulations identified in Appendix C of the CRWMS Requirements Document, Revision 3, will be evaluated for applicability to the MGDS and specifically included in the MGDS-RD.

WP20BM3 **Waste Form Characteristics Report Update** **7/31/98**

Preliminary degradation process models and up-to-date test data that describe the performance of commercial spent fuel, borosilicate glass waste, and the degradation behavior of additional waste forms (e.g., DOE SNF, Naval fuel, and surplus weapons-useable fissile materials). Also includes cladding degradation, colloid stability testing, and actinide solubility tests and parameters.

WP20AM3 **Engineered Materials Characteristics Report Update** **7/31/98**

Most recent test data and model development for humid air, aqueous film, dripping, microbial, and radiolytic environments. Also degradation due to pitting, stress corrosion cracking, oxidation, and hydrogen embrittlement. Corrosion-allowance and corrosion-resistant barriers; ceramic and zirconium outer layers; and galvanic protection also included.

RP240M3 **Subsurface HVAC** **8/31/98**

Preliminary design for the subsurface ventilation system to be used during construction of the mains, emplacement drifts, ventilation raises, shafts, and other openings.

RP237M3 **Waste Emplacement Design** **9/14/98**

Drawings that depict the latest information on waste emplacement design, showing changes and revisions in the waste package and thermal management strategy and design. The drawings will also depict and approach for utilizing several emplacement drifts to facilitate distribution of the waste packages to meet desired thermal loading goals.

II. TOTAL SYSTEM PERFORMANCE ASSESSMENT - VIABILITY ASSESSMENT

Fiscal Year 1997

SL5X4B1M **Unsaturated-Zone Flux Uncertainty Characterization Report** **6/30/97**

Expert Elicitation report to quantify uncertainties in the UZ flux estimates.

SP24BM3 **Unsaturated-Zone Site Flow Model** **7/9/97**

The unsaturated-zone three-dimensional, site-scale flow model, including model code, inputs and outputs, calibration results, possible uses and limitations, sensitivities and uncertainties.

SLSR500M | **First Interim Report - Total System Performance Assessment Peer Review Panel** | **7/20/97**

The TSPA-VA Peer Review provides interim reports on their comments, concerns, conclusions and recommendations at the conclusion of each of the first three phases of the review. The first phase of the review focuses on the an orientation for the review panel on the TSPAs completed to date (through TSPA-1995) and the project in general.

SL5X4E1M | **Waste Package Degradation Report** | **9/15/97**

Expert Elicitation Panel report on waste package degradation.

SP300M3 | **Near-Field Environmental Report, Vol 1, Rev 1** | **9/19/97**

The input to the Near-Field Environment Report (NFER) will include appropriate updates of the existing NFER Vol 1, Rev 0 chapters and new chapters as required.

SP25BM3 | **Final Unsaturated-Zone Transport Model** | **9/29/97**

Contains a conceptual model of the transport of radionuclides in the unsaturated zone, including 2- and 3-D integrated transport calculations and sensitivity analyses. Both equivalent continuum and dual permeability calculations will be made.

SP25CM3A | **Final Saturated-Zone Site Transport Model** | **9/29/97**

Includes a conceptual model of the transport of radionuclides in the saturated zone down-gradient from Yucca Mountain to the accessible environment, including 2- and 3-D integrated transport calculations and sensitivity analyses. Both equivalent continuum and dual permeability calculations will be made.

Fiscal Year 1998

SLX4AM3 | **Saturated-Zone Flow and Transport Expert Report** | **11/30/97**

Expert Elicitation Panel report on saturated-zone and transport.

SL230B1D **TSPA-VA Methods and Assumptions** **12/13/97**

Discusses the approach to be taken in TSPA-VA, the major assumptions adopted, a description of the software to be used, appropriate verification tests of the software. Also discusses the features, event, and processes (FEPs) to be evaluated, the rationales for FEPs not evaluated.

SR520M2 **Second Interim Report - Total System Performance Assessment Peer Review Panel** **1/15/98**

The TSPA-VA Peer Review provides interim reports on their comments, concerns, conclusions and recommendations at the conclusion of each of the first three phases of the review. The second phase of the review focuses on the modeling, scenarios, and abstractions that provide the bases for developing the TSPA-VA.

SL230GM3 **TSPA-VA Base Case Results** **2/28/98**

Presents the results of the TSPA-VA base case analyses. Includes a discussion of the final structure of the TSPA base case, with inputs and results, a preliminary list of sensitivities, and a discussion of the follow-up work needed to complete the TSPA-VA.

SP3100M3 **Near-Field Environment Models Report** **4/30/98**

The near-field models include: (1) thermomechanics; (2) thermohydrology; (3) thermochemistry; (4) near-field transport. These models describe the NFE and provide input to the TSPA-VA.

SLX41CM **Thermohydrology Expert Report** **6/29/98**

Expert Elicitation Panel report on thermohydrology.

SL5XDM3 **Waste Form Dissolution Expert Report** **6/29/98**

Expert Elicitation Panel report on waste form dissolution.

SR250M2	**Third Interim Report - Total System Performance Assessment Peer Review Panel**	**8/15/98**

The TSPA-VA Peer Review provides interim reports on their comments, concerns, conclusions and recommendations at the conclusion of each of the first three phases of the review. The third phase of the review focuses on the draft and final documentation of abstraction activities and the preliminary results of the TSPA-VA calculations.

SP39FBM3	**Site Description Document**	**8/31/98**

The Site Description Document will present information on the natural system at Yucca Mountain with an emphasis on those aspects that are relevant to waste containment and isolation, and that support design of a potential geologic repository and the assessment of its performance.

III. LICENSE APPLICATION PLAN

Fiscal Year 1998

SL300H	**Work Description for Multi-Year Planning Summary Schedule**	**10/30/97**

Describes the work planned between Viability Assessment and License Application, including the associated costs and schedules.

SL05X7A9	**Repository Safety Strategy: Strategy for Protecting Public Health and Safety after Permanent Closure, Rev 1 (Waste Containment and Isolation Strategy)**	**12/17/97**

Presents highlights of the DOE's SPPHS (WCIS), which is the process for iteratively developing the safety case for the postclosure repository system. This Document is updated as new site, design, and performance information dictates, or when regulatory changes provide impetus for rethinking aspects of the strategy.

[DOE/HQ]	**Strategic Plan and Program Plan Update**	**2/98**

OCRWM portion of DOE strategic plan to accompany FY99 Congressional budget submittal.

SL05X7B7	**Repository Safety Strategy: Strategy for Protecting Public Health and Safety after Permanent Closure, Rev 2 (Waste Containment and Isolation Strategy)**	**8/15/98**

Presents highlights of the DOE's SPPHS (WCIS), which is the process for iteratively developing the safety case for the postclosure repository system. This Document is updated as new site, design, and performance information dictates, or when regulatory changes provide impetus for rethinking aspects of the strategy.

IV. VIABILITY ASSESSMENT LIFE CYCLE COST ESTIMATE

The DOE understands that the NRC has no interest in the VA Cost Estimate and has no intention of reviewing this product. Therefore, no supporting deliverables are identified here.

V. VIABILITY ASSESSMENT MANAGEMENT PLAN

Fiscal Year 1998

[TBD]	**Annotated Outline for the Viability Assessment Product Management Plan**	**1/98**

The VA management plan provides a detailed road map of the M&O and DOE's development of the VA product elements.

Correlation Between Key Fiscal Year 1997 and 1998 Deliverables Relevant to the Viability Assessment and the U.S. Nuclear Regulatory Commission Key Technical Issues

Deliverable Identification	Title	Complete Date	NRC KTIs[1]									
			1	2	3	4	5	6	7	8	9	10
VIABILITY ASSESSMENT DESIGN												
RP120MG1R1	VA Design and Review Plan	4/14/97						x				
RP120M3E	Subsurface EBS Design	4/31/97						x	x			
WP0035A3	Waste Form Characteristics Report, Rev 1	5/7/97				x						
RP120M3	Subsurface Development Design	8/31/97						x				
WP220754	EBS/WP Materials Selection Analysis	9/15/97				x		x				
SE9272M4	Reference Design Description for a Geologic Repository, Rev 1	10/30/97				x		x	x			
RP742BM3	Site Layout Analysis	4/2/98						x				
SE420M3	Final VA Test and Evaluation Plan	4/31/98						x				
SE422AM3	MGDS-Requirements Design Document Update for Final VA Design	7/1/98						x				
WP20BM3	Waste Form Characteristics Report Update	7/31/98				x						
WP20AM3	Engineered Materials Characteristics Report Update	7/31/98				x		x				
RP240M3	Subsurface HVAC	8/31/98						x				
RP237M3	Waste Emplacement Design	9/14/98						x				
TOTAL SYSTEM PERFORMANCE ASSESSMENT - VIABILITY ASSESSMENT												
SL5X4B1M	Unsaturated-Zone Flux Uncertainty Characterization Report	6/30/97									x	
SP24BM3	Unsaturated-Zone Site Flow Model	7/9/97									x	
SLSR500M	First Interim Report - TSPA Peer Review Panel	7/20/97							x			
SL5X4E1M	Waste Package Degradation Report	9/15/97				x						
SP300M3	Near-Field Environment Report, Vol 1, Rev 1	9/19/97			x							
SP25BM3	Final Unsaturated-Zone Transport Model	9/29/97										x
SP25CM3A	Final Saturated-Zone Transport Model	9/29/97										x
SL230B1D	TSPA-VA Methods and Assumptions	12/13/97							x			

Deliverable Identification	Title	Complete Date	NRC KTIs[1]									
			1	2	3	4	5	6	7	8	9	10
SLX4AM3	Saturated-Zone Flow and Transport Expert Report	11/30/97									X	
SR520M2	Second Interim Report - TSPA-VA Peer Review Panel	1/15/97							X			
SL230GM3	TSPA-VA Base Case Results	2/28/98			X	X	X		X		X	X
SP3100M3	Near-Field Environment Models Report	4/30/98			X	X	X	X	X			
SLX41CM	Thermohydrology Expert Report	6/29/98			X		X					
SL5XDM3	Waste Form Dissolution Expert Report	6/29/98				X						
SR520M2	Third Interim Report - TSPA-VA Peer Review Panel	8/15/98							X			
SP39FBM3	Site Description Document	8/31/98	X	X	X				X		X	
LICENSE APPLICATION PLAN												
SL300H	Work Description for Multi-Year Project Summary Schedule	10/30/97							X			
SL05X7A9	Repository Safety Strategy: Strategy for Protecting Public Health and Safety after Permanent Closure (WCIS), Rev 1	12/17/97							X			
[DOE/HQ]	Strategic Plan and Program Plan Update	2/98							X	X		
SL05X7B7	Repository Safety Strategy: Strategy for Protecting Public Health and Safety after Permanent Closure (WCIS), Rev 2	8/15/98							X			
VIABILITY ASSESSMENT MANAGEMENT PLAN												
[TBD]	VA Management Plan Annotated Outline	1/98							X			

[1] U.S. Nuclear Regulatory Commission Key Technical Issues:

1 = Igneous activity
2 = Structural deformation and seismicity
3 = Evolution of the near-field environment
4 = Container life and source term
5 = Thermal effects on flow
6 = Repository design and thermomechanical effects
7 = Total system performance assessment and integration
8 = Activities related to development of EPA Yucca Mountain standard
9 = UZ and saturated flow under isothermal conditions
10 = Radionuclide transport