CIVILIAN RADIOACTIVE WASTE MANAGEMENT SYSTEM

Management and Operating Contractor

Contract #: DE-AC01-91-RW00134
LV.PA.CEB.5/93-059

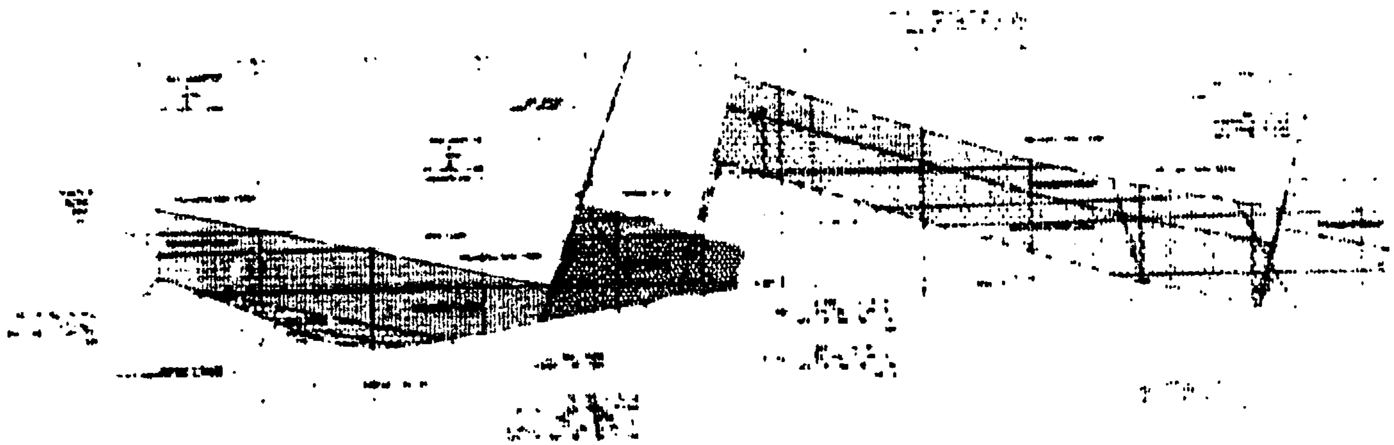
WASTE ISOLATION EVALUATION

LARGE BLOCK EXPERIMENT

by

Carl E. Bruch

June 9, 1993



WBS: 1.2.5.4.7
QA: QA

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Prepared by:

Carl E. Bruch — Carl Bruch — 9 June 1993
Project Consultant, Performance Assessment and Modeling Department — Date

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Evan K. Paleologos — 6/9/93
Senior Staff Consultant, Performance Assessment and Modeling Department — Date

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Manager, Performance Assessment and Modeling Department — Date

Approved by:

Jean L. Younker — Jean L. Younker — 6/9/93
Systems Manager — Date

This waste isolation evaluation was prepared in accordance with M&O QAP-3-5. The large block experiment and associated components have not been assigned a QA classification

WASTE ISOLATION EVALUATION

LARGE BLOCK EXPERIMENT

1. INTRODUCTION

1.1 Purpose of Evaluation

Los Alamos National Laboratory has requested a waste isolation evaluation of the proposed large block experiment (Oliver, 1993). This evaluation addresses potential effects of this activity on the ability of the current conceptual repository and potential repository expansion areas to isolate waste.

1.2 Proposed Activities

The large block test will be undertaken to understand coupled thermal-mechanical-hydrological-chemical processes in order to develop models that will predict the performance of a nuclear waste repository. It will also provide preliminary data for development of models that will predict the quality and quantity of water in the near-field environment of a repository. The techniques and measurement systems developed and used in this activity will be evaluated for later use in other activities, including the Engineered Barrier System Field Tests (Lin, 1993).

The experiment will be undertaken at Nevada State Central Zone Coordinates of approximately N748500 and E574800 (Attachment to Oliver, 1993; Figure 1), on the south east side of Fran Ridge (EG&G, 1992a and 1992b; Figure 2). A block of minimum dimensions 3 m by 3 m and 4.5 m tall that contains "appropriate" fractures will be cut from the Topopah Spring welded unit TSw2, so that it is free on all four sides and the top. The bottom will not be cut, so that the block will be left in situ. The rock outside of the block will be "removed by any method that will cause minimal disturbance to the block. These methods include cutting with the belt saw, blasting with small charges, splitting with a swelling agent, and mechanical splitting" (Lin, 1993). Instrument and heater holes will be drilled into the block. Cutting of faces and drilling of instrument and heater holes may be done using water. Once the block is cut, additional water may be added to the block prior to testing, if deemed appropriate by the principle investigator (PI). Smaller blocks will be collected for laboratory testing of thermal-mechanical properties.

After characterizing the matrix and fracture properties of the large block, testing will commence. Some of the candidate waste package materials will be used to make the heater assembly(s) in order to study the responses of the materials to an environment similar to that expected of the near field of a nuclear waste repository. If it is not practical to use the waste package material to make the heater assembly, then a piece of the material will be put near, but not in contact with, the heater. Once the instruments and heaters have been emplaced, the holes will be sealed with "a sealant that will have minimal chemical impact on the water and gas in the block." Subsequently, "Thermal and moisture barriers will be installed around the outside of the block. A load retaining frame will be assembled around the block that will allow loading with a stress similar to the in situ principal stress" (Lin, 1993). Also, a temperature controlling device and water/vapor collection device will be installed on the top block surface.

Data from the sensors will be collected at ambient conditions for at least one week before the block is loaded with predetermined stress. Data acquisition will continue at ambient temperatures for another week before the heaters are energized. The block will be heated and then allowed to cool down. The data will continue to be collected throughout the heating and cool-down periods. This sequence may be repeated for different temperatures and stresses, but it is expected to last for at least three years (personal communication, B. Distel, M&O/WCFS, 28 May 1993). After the test or series of tests is completed, the block will be dismantled so that the fracture surfaces and some of the matrix can be examined for evidence of chemical processes and alterations due to the heating and cooling. Subsequent analysis and model development will be done in a laboratory environment.

1.3 Quality Assurance

The proposed activity will affect the welded Topopah Spring unit at the Yucca Mountain site which is listed in Appendix A of the Q-List (YMP, 1990). Accordingly, this report was prepared as a quality-affecting activity according to CRWMS M&O Quality Administrative Procedure QAP-3-5 "Development of Technical Documents." No calculations were performed in this calculation. Some of the referenced data may not have been approved for quality-affecting activities, and the referenced analyses may not have been performed as quality-affecting activities or under software QA requirements. The extent and possible effects of non-qualified data and analyses on the evaluations, conclusions and recommendations of this report were not determined but are not expected to be significant.

2. EVALUATION

2.1 Evaluation Approach

This is a qualitative evaluation of the proposed large block experiment based on the best available information in the referenced documents and supplemented by personal communications. A checklist (see last page) was used as guidance to ensure that no potential activities and impacts were overlooked. General guidance for the format and content of waste isolation evaluations was provided by Younker (1993), so that all possible waste isolation impacts would be considered.

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2.2 Relative Locations and Elevations

The large block experiment will be sited near the Fran Ridge borrow pit on the southeastern flank of Fran Ridge, Nye County, Nevada, about 5.2 km (3.2 mi) outside the nearest point on the conceptual perimeter drift boundary (CPDB) in a SE direction; about 140 m (460 ft) outside the conceptual controlled area boundary (CCAB) in a SE direction; and about 2.7 km (1.7 mi) ESE of the nearest repository expansion area boundary, potentially useable area #6 (EG&G, 1992b). All activities will occur in the upper 10 m (30 ft) of the surface at Fran Ridge, at an approximate elevation of 1030 m (3400 ft) above mean sea level (m.s.l.). The ground-water table elevation in the vicinity of the Fran Ridge borrow pit is approximately 730 m (2400 ft) above m.s.l. (Robison et al., 1988).

2.3 Relevant Hydrology and Hydrogeology

The unsaturated zone is approximately 300 m (1000 ft) thick at the site of the large block experiment and consists of the following stratigraphic units: the alluvium and colluvium, the welded Topopah Spring Member of the Paintbrush Tuff, and a nonwelded tuff (Scott and Bonk, 1984). The formations dip downward in an easterly direction, away from the conceptual repository and potentially useable areas. The large block experiment lies within 400 m (1300 ft) of three known and inferred faults, east of the Fran Ridge Fault, west of an unnamed fault, and within 300 m (1000 ft) of three fractures and five fracture sets (Scott and Bonk, 1988). The saturated ground-water flow at Fran Ridge is in a southerly direction (DOE, 1990), away from the current conceptual repository and potentially useable areas. The experiment is located 0.6 km (0.4 mi) from the nearest region of probably maximum flood (EG&G, 1992c).

2.4 Specific Evaluations and Conclusions

2.4.1 Water Flowing to Conceptual Repository/Expansion Areas Wet cutting of the block faces and drilling of instrument/heater holes is proposed. Additional water may be added to the block prior to testing if the PI deems it necessary to increase the saturation of the rock (Lin, 1993). Because of the relatively small volume of rock, it is expected that an insignificant volume of water will be used. Furthermore, the experiment is located outside the conceptual controlled area boundary. Thus, the cutting and testing activities are not expected to significantly affect the water flowing to the conceptual repository and potential expansion areas.

2.4.2 Saturated Zone Ground-Water Travel Time For the same reasons given in section 2.4.1, the cutting and testing of the large block experiment are not expected to significantly affect the saturated zone ground-water travel time.

2.4.3 Aqueous Radionuclide Transport Fernandez and Case (1992) considered flow from a flooded drift. Using conservative assumptions, they found that "flow would develop below the drift at an approximate angle of 20° from the vertical direction." This corresponds to a lateral extent of less than 150 m (500 ft), much less than the 5.2 km (3.2 mi) distance from the test to the proposed repository boundary. Thus, the activities associated with the large block experiment are not expected to significantly affect aqueous radionuclide transport.

2.4.4 Gaseous Radionuclide Transport Fernandez and Case (1992) considered the advection-dispersion of gaseous flow above the proposed repository. They found that the lateral spreading of the gaseous radionuclides would be limited to several hundred meters from the edge of the repository. "This is a conservative estimate because the dominance of the vertical fracture system would force flow to be more narrowly confined around the perimeter of the repository" (Fernandez and Case, 1992). Ross et al. (1992) presented results that are consistent with these conclusions. However, as noted above, the lateral extent of the radionuclide transport is much less than the 5.2 km (3.2 mi) distance from the repository to the test area. Thus, the activities associated with the large block experiment are not expected to significantly affect gaseous radionuclide transport.

2.4.5 Thermo-Mechanical Effects The thermo-mechanical effects of cutting the block and clearing the neighboring rock will be limited to the immediate vicinity of the block. During the heating and subsequent cooling of the block, the sides of the block will be thermally insulated. The heaters will be in contact with the host rock of the site. However, because of the small scale of the experiment, the thermal effects are expected to be of limited extent. Due to its distance from the conceptual repository and the potential expansion areas and its limited extent, the thermo-mechanical effects of the large block test are expected to be insignificant to waste isolation.

2.4.6 Tracers, Fluids, and Materials (TFMs) (other than water) No tracers will be used, and no significant amount of fluids will be used. Sealant will be utilized to hold the sensors and heaters in place, but the quantity will be small. Due to the small quantities of TFMs and the large distance from the conceptual repository, the planned TFMs are not expected to significantly affect waste isolation.

3. CONCLUSIONS AND RECOMMENDATIONS

This qualitative evaluation indicates that the proposed activities associated with the large block experiment will not have a significant effect on the ability of the conceptual repository and the potential repository expansion areas to isolate waste. No new controls are needed in addition to the controls already existing for water use, spill control, spill cleanup, recording of actual use of tracers, fluids and materials, and land reclamation.

4. REFERENCES

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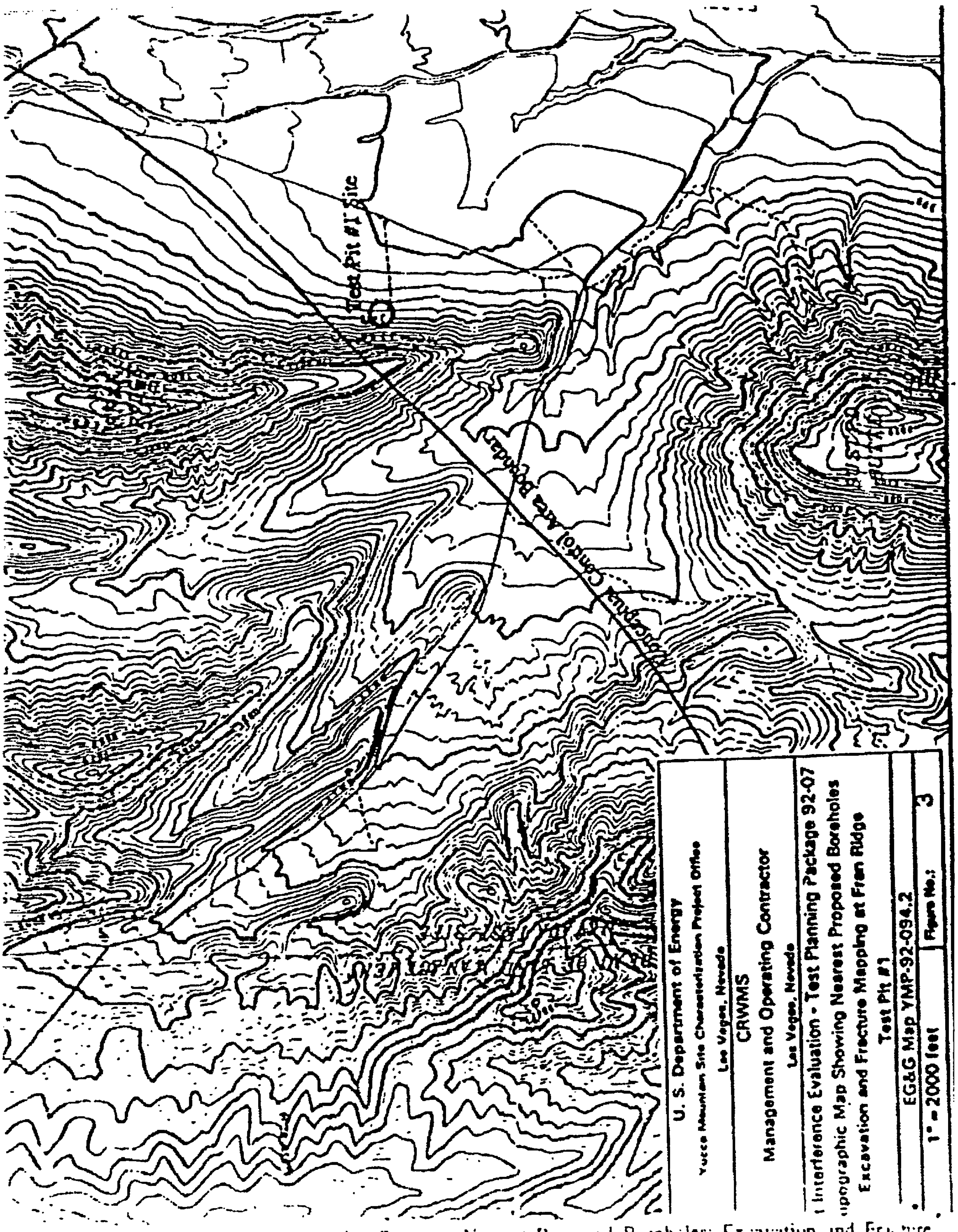
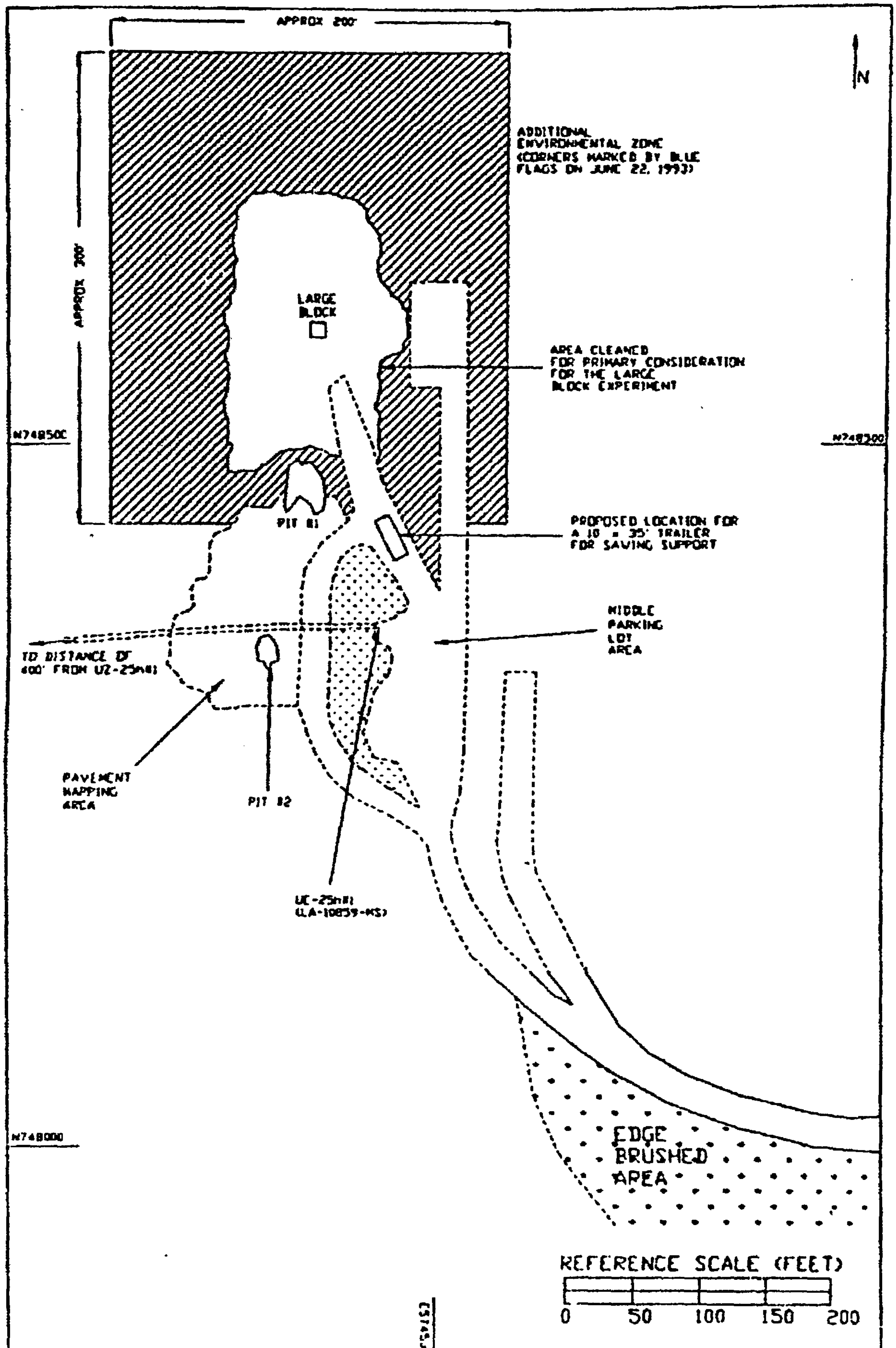


...aphic Map Showing Nearest Proposed Boreholes: Excavation and Fracture ... Ridge, Test Pit #1 (EG&G, 1992a)

ENGINEERED BARRIER LARGE BLOCK
SITE PREPARATION ILLUSTRATION
FRAN RIDGE SITE



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DRN BY
D J WEAVER

FRLBENV2.DWG
6/25/93

Definition of Test

The Large Block Testing (LBT) of Coupled Thermal-Mechanical-Hydrological-Chemical (TMH Processes is described in Section 8.3.4.2.4.4 of the Site Characterization Program Baseline (SCF and in the Scientific Investigation Plan for the Large Block Test, SIP-NF-2, Rev. 0.

A series of heater and infiltration tests are planned using the nonlithophysal, densely weld fractured Topopah Spring tuff found at the Fran Ridge Test Site. Testing and validation of so model concepts on small blocks in the laboratory, and an integrated demonstration of the coup TMHC processes in a larger block are planned at the site.

For the larger-block testing, a block will be chosen that contains appropriate fractures and t measures at least 3 m on each side and at least 4.5 m tall. Smaller blocks measuring a few ten: centimeters on each side and of the same material as the larger block will be tested at Lawre Livermore National Laboratory. Both types of block will be used to investigate the therm mechanical properties of the rock and to validate model concepts of thermal-hydrological : geochemical processes.

ENGINEERED BARRIER - LARGE BLOCK EXPERIMENT
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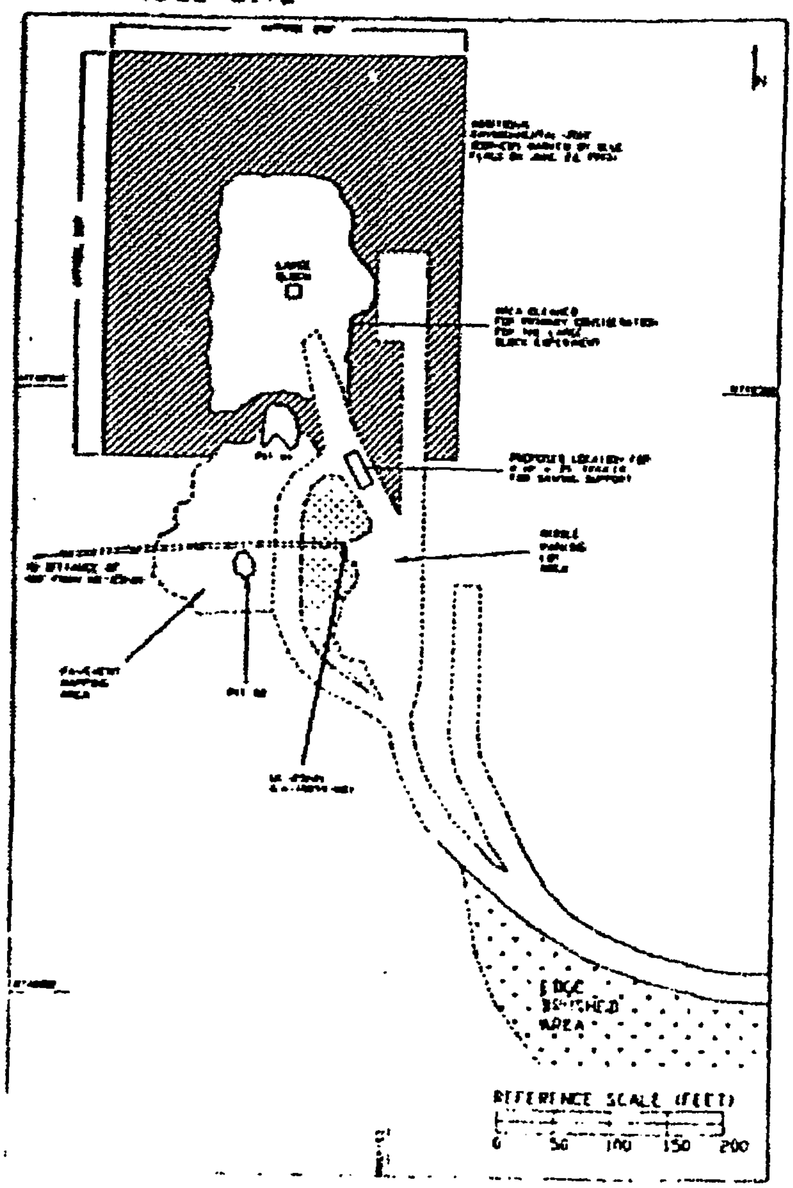
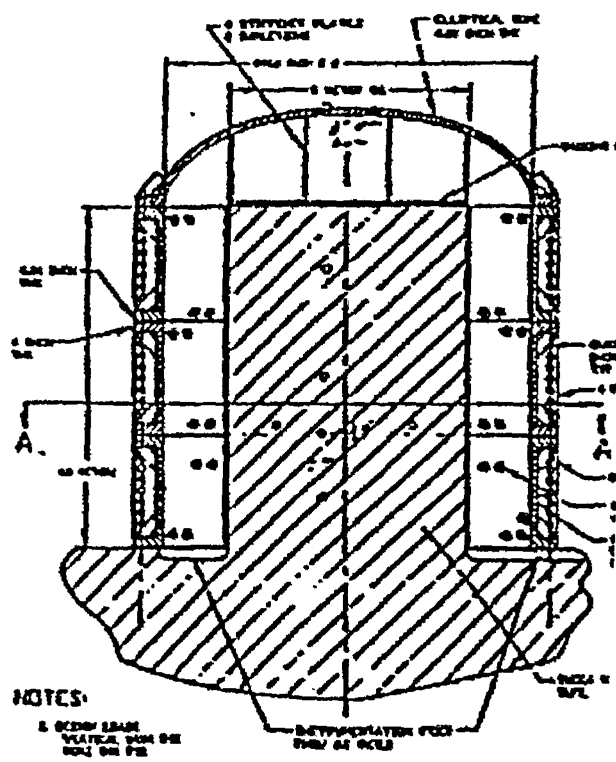
FRAN RIDGE SITE





PHASES OF THE ACTIVITY		
1)	Site Cleaning	(Work Ord
2)	Site Preparation	(JP #1 Onl
3)	Test Construction	(JP #2 and
4)	Test Operation	(JP #3 anc
5)	Post Activity Excavation	(JP #4 anc

CHECKLIST OF GENERAL CONCERNS REGARDING IMPACTS ON WASTE ISOLATION

CONCERNS				COMMENTS
I. Water				
	A. Surface Sources			
		1. Road watering for dust control		Not applicable
		2. Drillpad dust control		Not applicable
		3. Equipment washdown		Not applicable
		4. Natural surface runoff		Not applicable
		5. Accidental water spillage		Not applicable
		6. Used in testing		See sections 2.4.1 and 2.4.2
	B. Underground			
		1. Water loss during drilling		
			a) Normal	Not applicable
			b) Fishing	Not applicable
			c) Unexpected	Not applicable
		2. Recovered or produced during drilling		
			a) Perched water	Not applicable
			b) Water table	Not applicable
		3. Used in testing		Not applicable
II. Tracers, Fluids and Materials (other than water)				
	A. Used in surface construction			
		1. Building materials		See section 2.4.6
		2. Leachates from rock & muck piles		Not applicable
	B. Used in borehole construction and/or sealing			
		1. Grout for surface casings		Not applicable
		2. Drilling fluids		Not applicable
		3. Other materials left in boreholes		Not applicable
	C. Used in testing			Not applicable
III. Other considerations				
	A. Physical and chemical characteristics of seals			Not applicable
	B Seals may not achieve design objectives			Not applicable
	C Cut-and fill for roads, pads, trenches & pits			Not applicable
	D Blasting			See section 2.4.5

Interoffice Correspondence
Civilian Radioactive Waste Management System
Management & Operating Contractor

TRW

TRW Environment
Safety Systems In

WBS:1.2.5.2.1
QA:NA

Subject
Evaluation for Constraints and Commitments Made in Regard to the Fran Ridge Heater Block Tests

To
C.T. Statton

Date
May 26, 1993
LV.RL.CJG.5/93.093

cc
B.W. Distel
J. Houseworth

From
Mike Lugo

Location/Phone
TES3/1100-12
(702) 794-7830

The NRC SCA comments to the Site Characterization Plan, comments on studies plans, DOE responses to comments, and any subsequent or related interactions were examined to identify any constraints or commitments made during the response process that relate to the proposed large block thermal testing at Fran Ridge. No constraints or commitments were made in the DOE responses or related interactions. NRC SCA Objection 1 and Question 59 did express concern over the thermal tests. However, the NRC concerns are related to the duration of the thermal tests. The NRC wants the DOE to make sure the tests are conducted a sufficient length of time. In the response to the concern, DOE stated that each test would be evaluated individually to determine the length of the test.

Should you have any questions, please call me or Clem Goewert at ext. 4-1659.

ENGINEERED BARRIER - LARGE BLOCK ...

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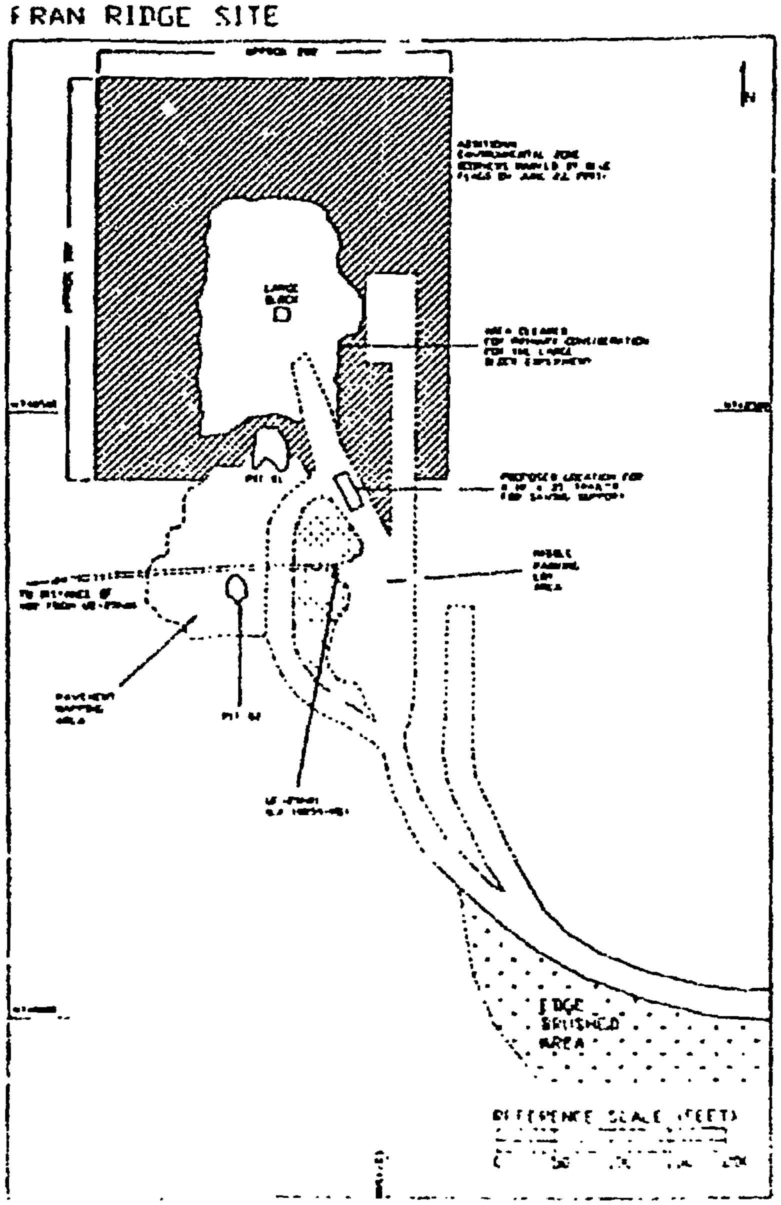

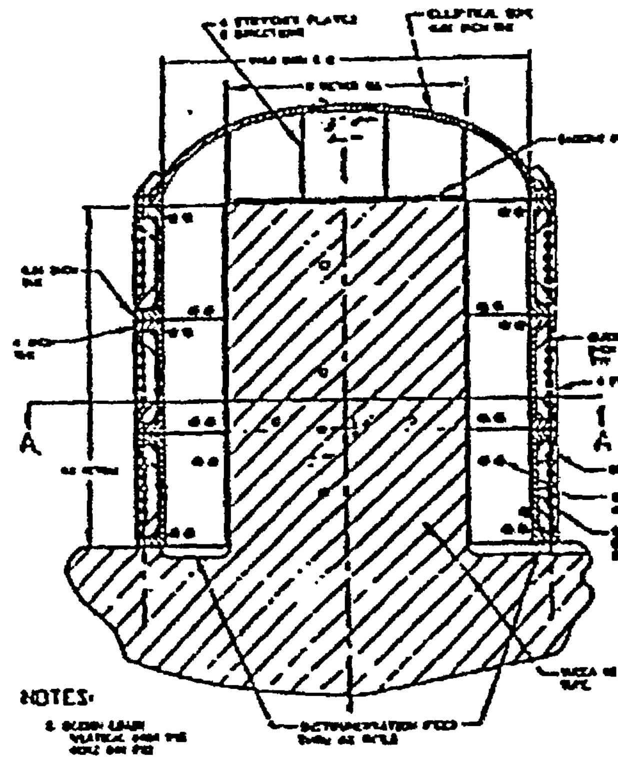

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Civilian Radioactive Waste Management System
Management & Operating Contractor

TRW Environmenta
Safety Systems Inc

WBS:1.2.5.2.1
QA:NA

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