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

Reviewed by:

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

Abraham E. Van Luik — *Abraham E. Van Luik* — 6/9/93
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

DOE, 1990. "Characterization of the Site Saturated-Zone Ground-Water Flow System, " YMP-USGS-SP 8.3.1.2.3.1, R0, May 1990.

EG&G, 1992a. "Topographic Map Showing Nearest Proposed Boreholes; Excavation and Fracture Mapping at Fran Ridge; Test Pit #1," Map 92-094.2.

EG&G, 1992b. "Potentially Useable Areas," Map 92-239.1, November 1992.

EG&G, 1992c. "Flood Prone Areas," Map 92-252.0, November 1992.

Fernandez, J.A., and J.B. Case, 1992. "Evaluation of ther Performance of UZ-16," SNL memo to S. R. Sobolik, SNL, January 31, 1992.

Lin, W., 1993. "Scientific Investigation Plan For Large Block Testing of Coupled Thermal-Mechanical-Hydrological-Chemical Processes," SIP-NF-2, R0. March 26, 1993.

Oliver, R., 1993. "Supplemental Input for Wate Isolation and Test Interference Evaluations Fran Ridge Test Planning Support for the Engineered Barrier - Large Block Experiment - TPP T-93-3," LANL memorandum to L. Foust, CRWMS M&O, April 22, 1993.

Robison, J.H., D.M. Stephens, R.R. Luckey, and D.A. Baldwin, 1988. "Water Levels in Periodically Measured Wells in the Yucca Mountain Area, Nevada, 1981-87," USGS OFR-88-468.

Ross, B., S. Amter, and N. Lu, 1992. "Numerical Studies of Rock-Gas Flow in Yucca Mountain," SAND91-7034, February 1992.

Scott, R.B., and J. Bonk, 1984. "Preliminary Geologic Map of Yucca Mountain, Nye County, Nevada, with Geologic Sections," USGS-OFR-84-494; Sheet 1 -- Preliminary Geologic Map; Sheet 2 -- Geologic Sections.

YMP, 1990. "Q-List," YMP/90-55, July, 1990.

Younker, J.L., 1993. "Waste Isolation Evaluations of Surface and Underground Design, Construction, Testing, and Related Activities," CRWMS M&O interoffice correspondence to distribution, April 18, 1993.

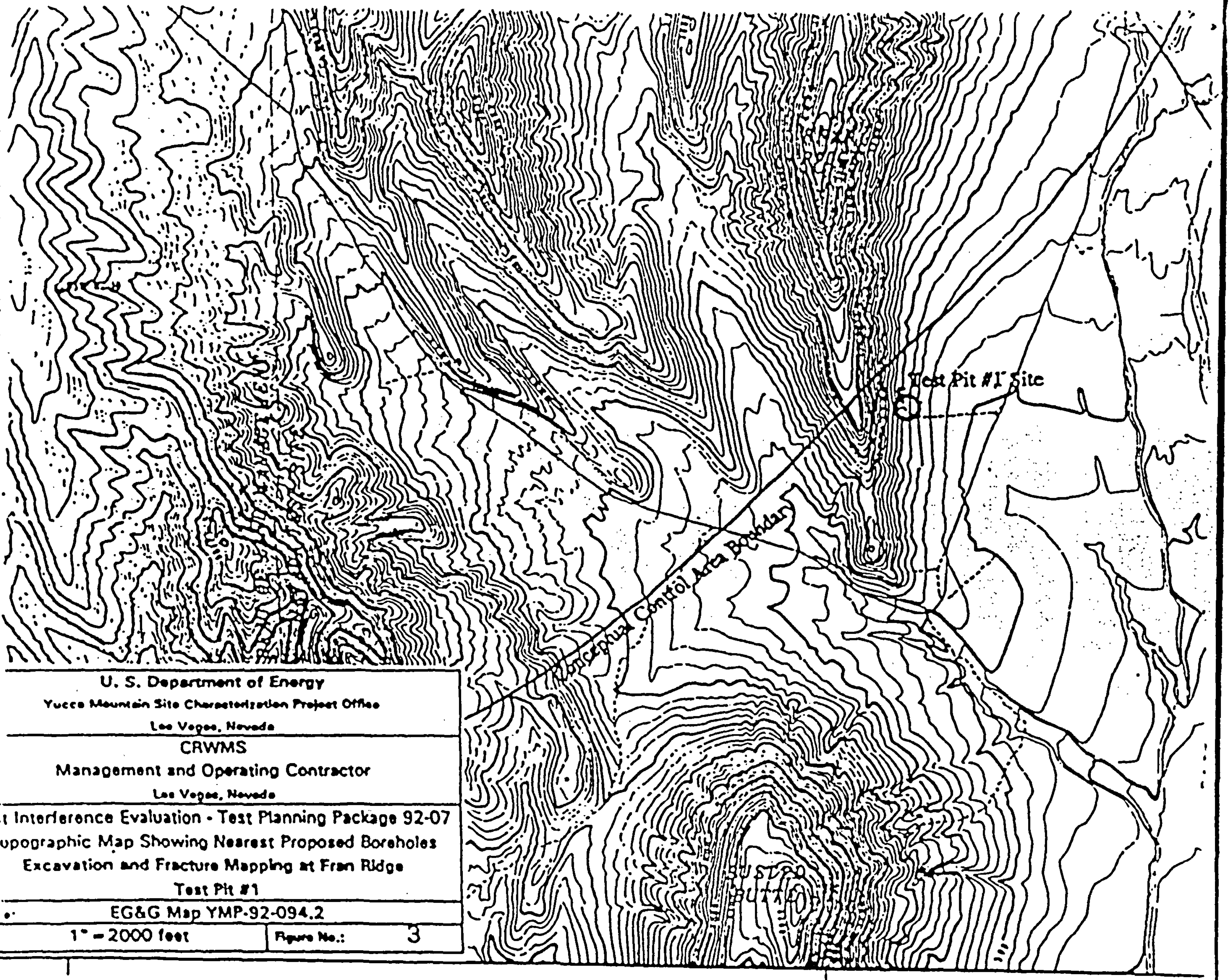
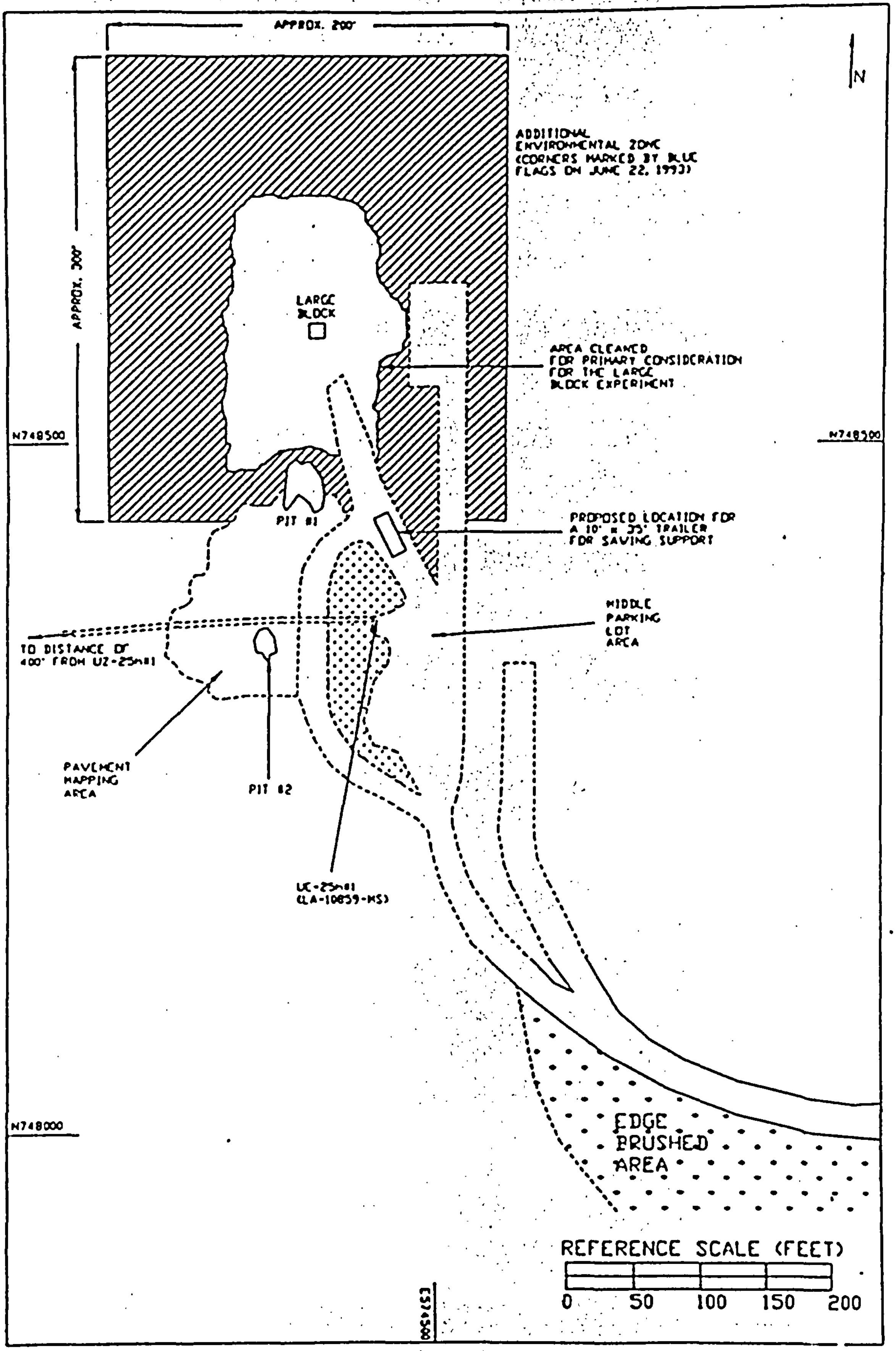


Figure 1: Topographic Map Showing Nearest Proposed Boreholes; Excavation and Fracture Mapping at Fran Ridge; Test Pit #1 (EG&G, 1992a).

ENGINEERED BARRIER LARGE BLOCK
SITE PREPARATION ILLUSTRATION
FRAN RIDGE SITE



ADMINISTRATIVE USE ONLY

DRN. BY
D.J. WEAVER

FRLBENV2.DWG
6/25/93

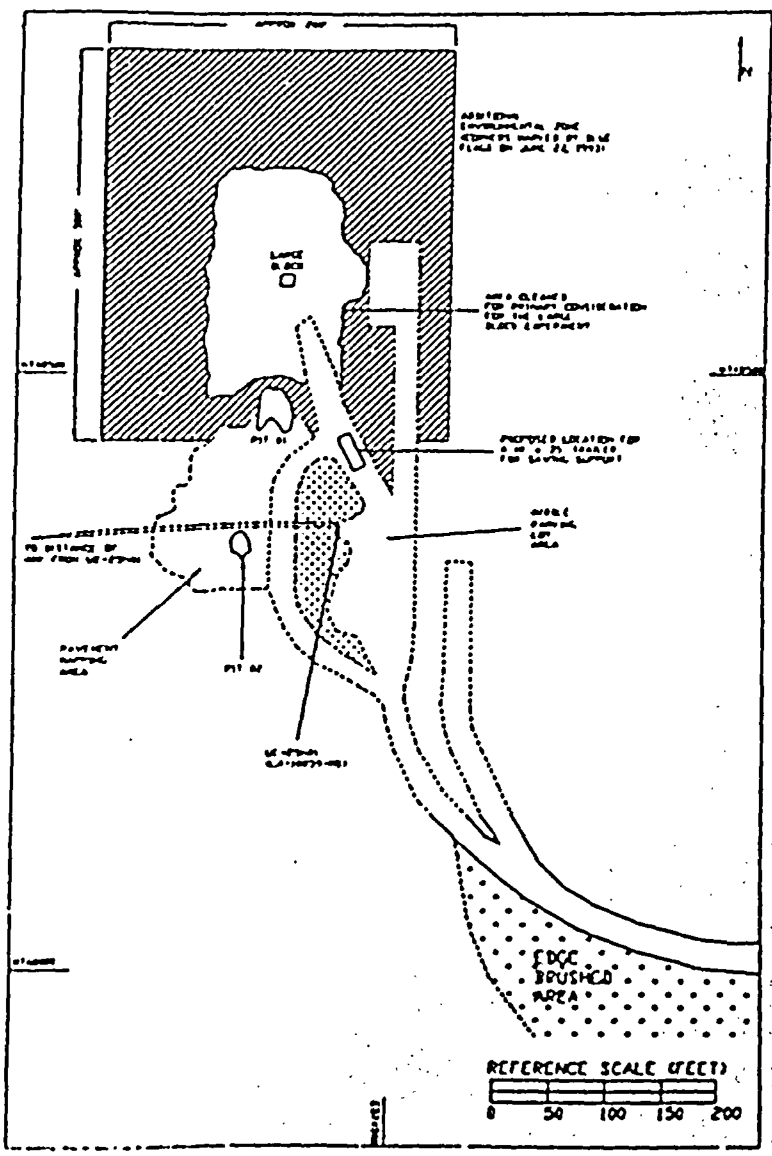
Definition of Test

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

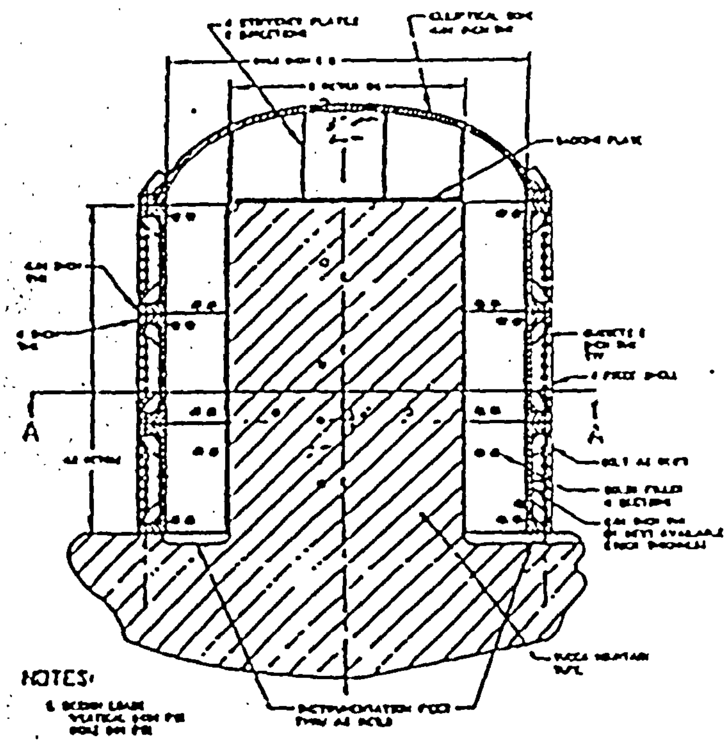
A series of heater and infiltration tests are planned using the nonlithophysal, densely welded, fractured Topopah Spring tuff found at the Fran Ridge Test Site. Testing and validation of some model concepts on small blocks in the laboratory, and an integrated demonstration of the coupled TMHC processes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

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

ENGINEERED BARRIER - LARGE BLOCK EXPERIMENT
SITE PREPARATION ILLUSTRATION
FRAN RIDGE SITE



ADMINISTRATIVE USE ONLY   DRN BY D.J. WEAVER   FRLECNV2.DWG 6/25/93



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

WEAVER1
5-28-93

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 Environmental
Safety Systems Inc.

WBS:1.2.5.2.1
QA:NA

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

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

From
Mike Lugo

To
C.T. Statton

cc
B.W. Distel
J. Houseworth

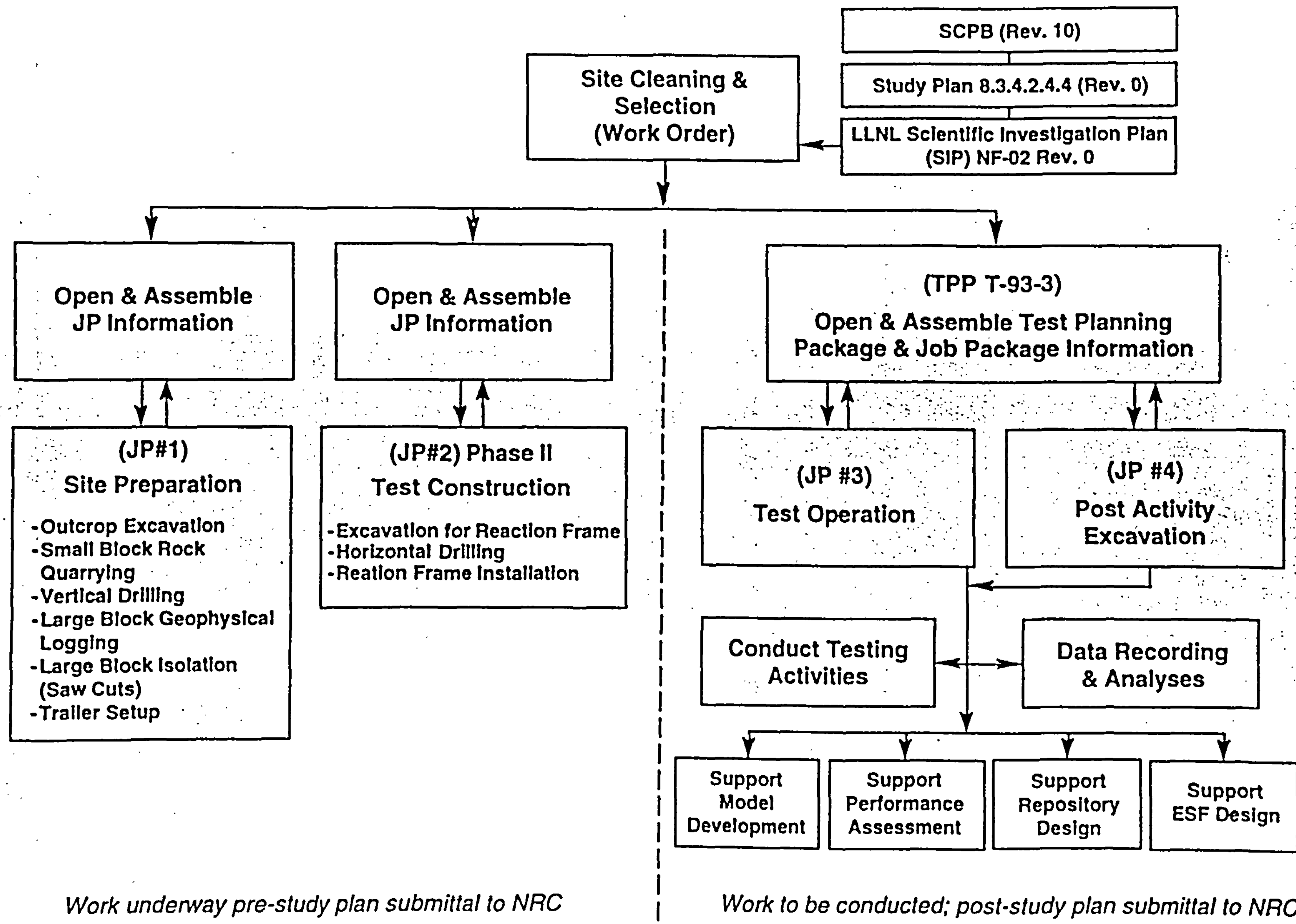
Location/Phone
TES3/1100-12
(702) 794-7830

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. 4-1859.

TEST LOGIC DIAGRAM

ENGINEERED BARRIER-LARGE BLOCK EXPERIMENT



ENCLOSURE 5

TLDLBE1.PM4.125/1-25-94

Site Preparation - Fran Ridge (JP 93-10)
EBS Large Block Test (TPP T-93-3)
ADMINISTRATIVE USE ONLY

7/22/93

ID	DESCRIPTION	START DATE	P&S ACCOUNT NUMBER	SUMMARY ACCOUNT NUMBER	FUNDING WORK ($K)	FUNDING SUMMARY ($K)	CAPITAL DOLLARS ($K)	FIELD COST ESTIMATE	DEVELOP COST ESTIMATE
01.	EBS - LARGE BLOCK TEST, FRAN RIDGE	17MAR93							
02.	Test Planning Milestones	17MAR93							
03	Initiation of TPP T-93-3	17MAR93							
04.	Initiation of JP 93-10	18JUN93							
05	Initiation of Site Preparation	27JUL93							
06.	Phase I - Site Selection, EBS - Large Block Test	28MAY93							
07.	Project Manager Authorization Letter	28MAY93							
08	Environmental Clearance for Site Confirmed	28MAY93							
09.	Clean Site North of Pits	28MAY93	DR224						
10	Select Large Block Location	14JUN93	DL224	DL224KGB	9	522		10	
11.	Phase IA - Saw Cuts Demonstration	21JUN93							
12.	Project Manager Authorization Letter	07JUL93							
13	Start Large Block Saw Demonstration Cuts	16AUG93							
14	Saw Shipped to Site	21JUN93	DL224	DL224KGB	9	522		9	
15	Construction Support	15JUL93	DR224	DR224L3	74	100		50	
16	Demonstration block Cuts - Prototype Saw	15JUL93	DL224	DL224KGB	141	522		30	
17.	Demonstration Cuts - Large Block Saw	16AUG93	DL224	DL224KGB	178	622		37	
Pre-JOB PACKAGE TOTAL					411	622		136	
18	JOB PACKAGE PREPARATION - EBS LARGE BLOCK TEST	07APR93							
19	Job Package Preparation - Discrete	22APR93							
20.	LLNL Test Planning	22APR93	DL224	DL224HXC	10	60			10
21.	Engineering Dsgn/Spec Development & Procurements	05MAY93	RS224						0
22	REECo Test Construction Planning & Procurement	18JUN93	DR224	DR224L3	28	100			5
23	Job Package Preparation - Matrix Support	07APR93							
24.	Los Alamos TCO Coord & Plan (TPP/JP Development)	26MAY93	DA31	DA310BL3	145	420			20
25	LLNL Coordination & Planning (TPP/JP Review)	12JUL93	DL224	DL224HXC	6	60			2
26	Engineering Coord & Plan (Work Plan Development)	01JUN93	RS611	RS611P92	118	689			5
27	REECo ESF Test Mgmt (JP Review & Support Plan)	16JUN93	DR611	DR611L3	146	730			5
28.	CRWMS M&O Waste Isolation Eval (TPP/JP Develop)	22APR93	TR547	TR547BA1	121	616			5
29.	CRWMS M&O Test Interfere Eval (TPP/JP Dev & TFM)	22APR93	TR522	TR5223BA	124	344			5
30	CRWMS M&O N/W-BSL Plan Support (TPP/JP Develop)	07APR93	TR921	TR921BA1	780	2026			3
31.	SITE PREPARATION - EBS LARGE BLOCK TEST	28JUL93							
32	Site Preparation - Discrete	28JUL93							
33.	LLNL Site Preparation Monitoring	28JUL93	DL224	DL224KGB	356	522		241	
				(FY94)				20	
34	Engr Field Survey & Processing	28JUL93	RS224					40	
35	REECo Test Construction & Procurement	28JUL93	DR224	DR224L3	74	100		300	
				(FY94)				120	
36	Construction Implementation - Matrix Support	28JUL93							
37.	Los Alamos TCO Coord & Plan (Field Test Coord)	28JUL93	DA31	DA310CL3	100	223		10	
				DA310CL4	41	493		5	
38	Los Alamos TCO Test Mgmt (Project Engr Support)	28JUL93	DA616	DA616AL3	265	695		5	
				DA616AL4	72	863		2	
39	T&MSS Sample Management Facility	28JUL93	DT351	DT351DL	246	3094		2	
40	Engr Survey Support/Capital Procurement-Intm WBS	28JUL93	RS614	RS614P92	176	404		6	
				RS614L92	21	750		0	
41.	CRWMS M&O N/W-BSL Plan Support (Mo Cost/Progress)	28JUL93	TR921	TR921BA1	663	2026		6	
				TR921CA1	322	3796		2	
42	JC Photography & Process (Interim WBS)	28JUL93	DP3522	DP3522L93	17	200		3	
JOB PACKAGE TOTAL					3728	15202	0	762	60

() AFP Change

NOTES AND ASSUMPTIONS

1. This Integrated Network excludes participant efforts expended on:
   1) Study Plan/Site Investigation Plan
   2) Quality Assurance
   3) Environmental, Safety and Health
   4) Technical Procedure Department
   5) Data Processing

   and is expressly limited to test planning and job package document and record development for Yucca Mountain Project.
2. The Network task dates and estimated durations are based on review of Job Package Schedule and current construction strategies. These tasks, dates and durations are subject to change.
3. Field implementation cost estimates are subject to revision based on construction methodologies and assessments of the constructed facility.
4. "Funding Work" figures represent total monthly distributed budget dollars by summary account for the scheduled period of performance.