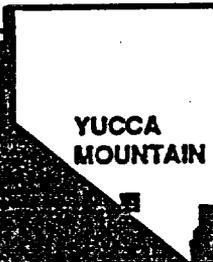


Sandia National Laboratories

U.S. DEPARTMENT OF ENERGY



**YUCCA
MOUNTAIN
PROJECT**

**Yucca Mountain
Site Characterization Project**

**MONTHLY HIGHLIGHTS
AND STATUS REPORT**

October 1991

9112110159 911204
PDR WASTE PDR
WM-11

ENCLOSURE 1

OCTOBER 1991



DISCLAIMER

Quality assurance checks on data contained in this report have been performed only to determine that the data have been obtained and documented properly. The SNL Project Department cautions that any information is preliminary and subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly. Milestones have not been baselined and are included only to show status.

TABLE OF CONTENTS

WBS 1.2.1	Systems	1
WBS 1.2.1.1	Management and Integration (Klamerus)	1
WBS 1.2.1.2.1	System Requirements and Description (Klamerus)	1
WBS 1.2.1.2.2	System Studies (Klamerus)	1
WBS 1.2.1.2.4	Systems Engineering Implementation (Klamerus)	1
WBS 1.2.1.2.5	Configuration Management and Plans and Procedures Control (Barr) ...	1
WBS 1.2.1.2.6	Yucca Mountain Site Characterization Project (YMP) support to the Management Systems Improvement Strategy (MSIS) (Schelling)	1
WBS 1.2.1.3.1	Site and Engineering Properties Data Base (Tipton)	2
WBS 1.2.1.3.2	Interactive Graphics Information System (Jones)	2
WBS 1.2.1.3.3	Reference Information Base (Schelling)	3
WBS 1.2.1.3.4	Technical Data Base Management Computer Support (Romero)	3
WBS 1.2.1.3.5	Technical Data Base Input (Schelling)	3
WBS 1.2.1.4.1	Total System Performance Assessment (Dockery)	4
WBS 1.2.1.4.3.1	Postclosure Repository Design Analysis (Ryder)	4
WBS 1.2.1.4.3.2	Preclosure Radiological Safety Analyses (Klamerus)	4
WBS 1.2.1.4.3.4	Seal Performance Requirements and Analyses (Fernandez)	5
WBS 1.2.1.4.4.1	Pre-Waste-Emplacement Ground-Water Travel Time (Dockery)	5
WBS 1.2.1.4.6	Development and Validation of Flow and Transport Models (Siegel)	5
WBS 1.2.1.4.7	Supporting Calculations for Postclosure Performance Analyses (Fewell)	8
WBS 1.2.1.4.9	Development and Verification of Flow and Transport Codes (Dockery) ..	8
WBS 1.2.3	Site Investigations	10
WBS 1.2.3.1	Site Management and Integration (Nimick)	10
WBS 1.2.3.2.2.2.1	Systematic Acquisition of Site-Specific Subsurface Information (Rautman)	10
WBS 1.2.3.2.2.2.2	Three-Dimensional Rock Characteristics Models (Rautman)	11
WBS 1.2.3.2.7.1.1	Laboratory Thermal Properties (Nimick)	11
WBS 1.2.3.2.7.1.2	Laboratory Thermal Expansion Testing (Nimick)	12
WBS 1.2.3.2.7.1.3	Laboratory Determination of Mechanical Properties of Intact Rock (Price)	12
WBS 1.2.3.2.7.1.4	Laboratory Determination of the Mechanical Properties of Fractures (Price)	13
WBS 1.2.3.2.8.3.3	Ground Motion from Regional Earthquakes and Underground Nuclear Explosions (Nimick)	13
WBS 1.2.3.6.2.1.6	Future Regional Climate/Environments (Behl)	14
WBS 1.2.4	Repository Investigations	15
WBS 1.2.4.1.1	Repository Management and Integration (Dennis)	15
WBS 1.2.4.1.1.1	Excavation Investigations (Costin)	15
WBS 1.2.4.2.1.1.2	In Situ Thermomechanical Properties (Costin)	15
WBS 1.2.4.2.1.1.3	In Situ Mechanical Properties (Costin)	15
WBS 1.2.4.2.1.1.4	In Situ Design Verification (Costin)	15
WBS 1.2.4.2.1.2	Rock Mass Analysis (Bauer)	16
WBS 1.2.4.2.3.1	Certification of Design Methods (Bauer)	16
WBS 1.2.4.2.3.2	Design Analysis (Ryder)	17
WBS 1.2.4.6.1	Seal Design and Design Requirements (Fernandez)	17
WBS 1.2.4.6.2	Sealing Testing (Fernandez)	17



TABLE OF CONTENTS

WBS 1.2.5	Regulatory and Institutional	19
WBS 1.2.5.1	Management and Integration (Barr)	19
WBS 1.2.5.2.1	NRC and NWTRB Interaction Support (Barr)	19
WBS 1.2.5.2.2	Site Characterization Program (Barr)	19
WBS 1.2.5.2.3	Regulatory Review (Barr).....	19
WBS 1.2.5.2.5	Study Plan Coordination (Price)	19
WBS 1.2.5.2.6	Semi-Annual Progress Reports (Cheek-Martin).....	20
WBS 1.2.6	Exploratory Shaft Investigations	21
WBS 1.2.6.1.1	Exploratory Shaft Management, Planning, and Technical Assessment (Gruer).....	21
WBS 1.2.9	Project Management.....	22
WBS 1.2.9.1.1	Management (Tang)	22
WBS 1.2.9.1.4	Records Management (Hotchkiss).....	22
WBS 1.2.9.1.5	YMP Support for the Training Mission (Cheek-Martin)	22
WBS 1.2.9.2	Project Control (Mathis).....	22
WBS 1.2.9.3	Quality Assurance Program (Richards).....	23
APPENDIX A:	Technical Data Base Input (Schelling)	24
APPENDIX B:	Reference Information Base (Schelling).....	25

1.2.1 SYSTEMS

The objective of the Systems element is to provide the focal point for the Yucca Mountain Project (YMP) activities concerned with the integrated perspective of the entire radioactive waste disposal system. The Systems element is comprised of four individual tasks: Systems Management and Integration (1.2.1.1), Systems Engineering (1.2.1.2), Technical Data Base Management (1.2.1.3), and Total System Performance Assessment (1.2.1.4).

1.2.1.1 MANAGEMENT AND INTEGRATION

Significant Meetings Attended

On October 24, 1991, R. Sandoval, L. Klamerus, and R. Kalinski attended a meeting at the Yucca Mountain Site Characterization Project Office (YMPO) to discuss a new effort by Sandia National Laboratories (SNL) to develop a Q List of Items Important to Safety and Waste Isolation.

1.2.1.2.1 SYSTEM REQUIREMENTS AND DESCRIPTION

No significant activity to report this period.

1.2.1.2.2 SYSTEM STUDIES

Status Report on Ongoing Activities

SNL is awaiting a response from the YMPO on the proposed Systems Studies Plan submitted on September 23, 1991.

1.2.1.2.4 SYSTEMS ENGINEERING IMPLEMENTATION

No significant activity to report.

1.2.1.2.5 CONFIGURATION MANAGEMENT AND PLANS AND PROCEDURES CONTROL

Major Accomplishments

A cost/schedule change request was submitted to the YMPO to remove SNL as a participant from WBS elements 1.2.4.3.3, 1.2.4.3.4, and 1.2.4.3.5 and to add several tasks to the statement of work.

1.2.1.2.6 YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT (YMP) SUPPORT TO THE MANAGEMENT SYSTEMS IMPROVEMENT STRATEGY (MSIS)

Status Report on Ongoing Activities

Current MSIS work has been completed. No new work is anticipated, pending further Office of Civilian Radioactive Waste Management (OCRWM/YMP) direction.



1.2.1.3.1 SITE AND ENGINEERING PROPERTIES DATA BASE

Status Report on Ongoing Activities

The Site and Engineering Properties Data Base (SEPDB) staff continued to enter, verify, and prepare return packages for all data submitted in FY91 which has either not yet been entered into the data base or has not had records completed. Nineteen outstanding data submittals are being processed. The forecast for completion is November 30, 1991.

The following SEPDB product was issued:

- SEP0106: Density, porosity, and thermal conductivity data issued to C. Chocas (SNL).

Staff reviewed and edited SNL data to be included in the first issue of the Technical Data Catalog.

Major Activities Upcoming Next Three Months

Data entry for outstanding data submittals will continue.

1.2.1.3.2 INTERACTIVE GRAPHICS INFORMATION SYSTEM

Status Report on Ongoing Activities

The following jobs were completed this month:

<u>Job</u>	<u>Requestor</u>	<u>Description</u>	<u>Status/Comments</u>
371	B. Lawrence	Tsw1/Tsw2 profiles	Completed
372	J. Fernandez	Isometric drawing	Cancelled
374	R. Barnard	Contour maps	Completed

Major Activities Upcoming Next Three Months

Work will continue to integrate the new Tsw1/Tsw2 contact model into the Interactive Graphics Information System (IGIS) model set and to develop mapping capabilities for performance assessment on ARC/INFO, using data received from the Project data base. Solid models of thermal/mechanical units will be developed using AVS software. Techniques to transfer data between various graphics software now in use (ARC/INFO, AVS, LYNX, CALMA) will also be developed by IGIS staff.

The following jobs are in progress:

<u>Job</u>	<u>Requestor</u>	<u>Description</u>	<u>Status/Comments</u>
363	C. Rautman	Tsw1/Tsw2 contact	Continuing
368	M. Jones	Drillhole data reference file	Continuing
369	K. Anderson	New PTn data models	Continuing
373	L. Costin	GTM intersections	Continuing
375	D. Guerin	Contour maps	Continuing

1.2.1.3.3 REFERENCE INFORMATION BASE

Status Report on Ongoing Activities

Development and technical review of proposed RIB information items continued to expand the Reference Information Base (RIB) and make it a more comprehensive document. A total of 22 new information items are now being written and reviewed. It is anticipated that the first information items will be submitted to the Change Control Board (CCB) for consideration by the end of November.

Development and technical review continued of four RIB information items requested by Raytheon Services of Nevada (RSN) to support Exploratory Studies Facility (ESF) design. The four items are CR41, Topographic maps; CR67, Thermal/mechanical cross-sections; CR68, Existing roads; and CR77, Rock mass and Q ratings.

Major Activities Upcoming Next Three Months

Development and review of the information items requested by RSN and those included in the expanded RIB effort will be completed.

1.2.1.3.4 TECHNICAL DATA BASE MANAGEMENT COMPUTER SUPPORT

Status Report on Ongoing Activities

The 622 mb hard disk and extra 14 mb of system memory was successfully installed on the DEC VAX RDBS system in October. With 28 mb of system memory, user response should improve considerably.

A 1.3 gb disk was installed on the Sun SparcStation in October. An additional 337 mb disk was acquired and will be installed. The 's' bus expander box and controllers arrived and will be installed by the first of November.

The Hewlett-Packard (HP) 9000/730 compute server has still not been delivered as of the end of October. The model is in high demand; SNL is on a waiting/priority list.

Network development continues in conjunction with Department 6600 for 'E' mail capabilities for each secretary. A "micronetwork" is currently being built for testing. The Network Process Management Team (PMT) is currently evaluating the feasibility of setting up 6300's own network partition. This should facilitate better organization of the users and easier network administration activities.

Major Activities Upcoming Next Three Months

As soon as the HP 9000/730 arrives, an effort will be launched to set the system up and test it.

The backup system will be setup and tested in November. When completed, 6310 network users will have 10 gb of DAT tape backup capability.

Testing and evaluation of the AVS, Lynx, and ARC/INFO modeling systems will continue. Network testing and improvement will also be an ongoing project for the next few months.

The RS/1 version 4.3.1 will be loaded on the IGIS system in November.

1.2.1.3.5 TECHNICAL DATA BASE INPUT

No significant activity to report this period.



1.2.1.4.1 TOTAL SYSTEM PERFORMANCE ASSESSMENT

Significant Meetings Attended

SNL met with Pacific Northwest Laboratory (PNL) staff to coordinate the November YMP review of the Total System Performance Assessment (TSPA) analyses.

H. Dockery participated in the International High Level Radioactive Waste Conference paper review in Arlington, VA on October 7 and 8, 1991. She organized and will in April chair a session on Performance Assessment Case Studies.

Status Report on Ongoing Activities

The majority of the analyses and sensitivity studies that will provide the basis for the Total System Performance Assessment (TSPA) task have been completed for human intrusion, basaltic volcanism, and nominal flow. The nominal-flow case includes representations of both fracture and matrix flow. Studies of groundwater flow and transport include representations of both the unsaturated and the saturated zones. The analyses are currently being documented and are expected to enter technical review in December. The analyses and their results are being prepared for presentation at the TSPA review in November. (SCP Subactivity 1.1.5.1.1)

Work has been completed on a two-dimensional numerical analysis of the Yucca Mountain region extending from drillholes USW H-5 to UE25a. Offset along the Ghost Dance fault was included. NORIA-SP was used to generate a time-dependent flow field. Results show that water infiltrating through the upper boundary tends to saturate regions immediately upstream of the fault and also at the down-dip boundary. However, only a moderate amount of lateral flow was computed as a result of the difference in the geologic unit conductivities and the discontinuity along the fault. (SCP Subactivity 1.1.5.1.1)

Some initial comments from Los Alamos National Laboratory (LANL) coauthors on the scenario selection document for basaltic volcanism were received. In mid-December, a major review session will be held with LANL and SNL authors in attendance. At that time, there will be an attempt to complete the document for internal technical review. (SCP Subactivity 1.1.2.1.1)

Work continues on preparation of the scenario-selection document for nominal flow. (SCP Subactivity 1.1.2.1.1)

1.2.1.4.3.1 POSTCLOSURE REPOSITORY DESIGN ANALYSIS

Major Accomplishments

A consistent set of three-dimensional calculations of near- and far-field temperature responses to design-basis areal power densities of 80, 57, 48, 30, and 22 kW/acre have been completed. Results were obtained using an analytical model based on a modified version of the potential repository design published in the Site Characterization Plan-Conceptual Design Report (SCP-CDR). Model assumptions include fully stepped emplacement of spent fuel, segregated emplacement of defense high level waste, and a levelized waste receipt schedule. For APDs of 80, 57, and 48 kW/acre, a 2010 start date was assumed. For loadings of 30 and 22 kW/acre, the emplacement start date was delayed until 2040 and 2070, respectively. These results were presented to the Nuclear Waste Technology Review Board (NWTB) in Las Vegas, NV on October 8, 1991. Formal documentation of these results has also been initiated.

1.2.1.4.3.2 PRECLOSURE RADIOLOGICAL SAFETY ANALYSES

This WBS element is no longer funded at Sandia National Laboratories.



1.2.1.4.3.4 SEAL PERFORMANCE REQUIREMENTS AND ANALYSES

Status Report on Ongoing Activities

As part of the planning for field tests, numerical analyses were completed on flow through backfill drifts. Two discrete analyses were performed. The first analysis, involving flow through a drift backfilled with a material simulating a coarse rockfill, will determine the lateral extent of flow in a drift assuming that only a coarse material is in the drift. The second analysis involved water flow through a backfilled drift having two different materials. Flow first occurs through a coarse backfill and then through a finer backfill. This analysis provides an estimate of how effective the contrast of materials would be on reducing the lateral extent of water flow.

The result for the first analysis was that lateral migration is predicted to occur over a distance of 220 m. The results of the second analysis indicated that a simple material contrast from a material having a saturated hydraulic conductivity (K_{SAT}) of 10^{-1} cm/s to a material having a K_{SAT} of about 10^{-4} cm/s could reduce the lateral migration of flow from 220 m to about 20 m. This effort is completed, and the results will be reported in the field test planning document.

1.2.1.4.4.1 PRE-WASTE-EMPLACEMENT GROUND-WATER TRAVEL TIME

Significant Meetings Attended

P. Kaplan participated in the International High Level Radioactive Waste Conference paper review in Arlington, VA on October 7 and 8, 1991. He organized and will in April chair a session of invited papers on Application of Probability Methods to Performance Assessment.

Staff accompanied a designated site suitability peer reviewer of the Postclosure Geohydrology Guideline on a field trip to the Yucca Mountain site to provide input on technical issues.

Status Report on Ongoing Activities

A memo was distributed outlining detailed plans to initiate the transfer of RS1 LLUVIA ground water travel time simulations to a personal computer (PC) environment. The work has begun, and the projected completion date is early 1992.

Preparation for the Total System Performance Assessment Review Meeting in November at the Project Office was initiated. Staff also participated in the extensive peer review the Post-closure Geohydrology Guideline is currently undergoing and in organizing and preparing presentations for the upcoming Saturated Zone Modeling Workshop in Tucson in November.

Documentation of the geohydrologic parameter set used for the Early Site Suitability Evaluation Calculations and for the Total System Performance Assessment continued.

1.2.1.4.6 DEVELOPMENT AND VALIDATION OF FLOW AND TRANSPORT MODELS

Status Report on Ongoing Activities

Unsaturated flow through single fractures

Experimentation into gravity-driven fingering in unsaturated fractures continued. Writing continued on SAND91-1985C, "Gravity-Driven Fingering in Unsaturated Fractures," by M. Nicholl and R. Glass, for presentation at the International High Level Radioactive Waste Management (IHLRWM) conference in April 1992.



Fracture-matrix interaction

Writing continued on SAND91-2030C, "Wetted Region Structure in Horizontal Fractures," by R. Glass and D. Norton, for presentation at the IHLRWM conference in April 1992.

Field, lab, and numerical experimentation to determine scaling laws for effective media properties in heterogeneous media

Work has continued on the gas permeameter, which is to be used to collect data for challenging effective media property models. Data collection efforts were initiated. Approximately 300 air permeability measurements were made on a single tuff slab using a one-inch-diameter permeameter/rock seal. Characterization of the same slab using half-inch-, two-inch-, and four-inch-diameter permeameter/rock seals will be completed this month. These data will be used to evaluate the gas permeameter measurement technique as well as to provide information on the scaling properties of air permeability measurements. Results of this study will be presented at the American Geophysical Union (AGU) Fall Conference in San Francisco, CA in December 1991.

Development of experimental capabilities

Efforts have continued in the comparison of x-ray absorption and transmitted light as techniques for measuring moisture content in porous media. Activities have centered primarily around data-reduction and data-analysis tasks. Results of the analysis will be documented in a paper to be written over the course of the next two months for presentation at the IHLRWM conference.

Preparation of activity-specific technical procedures for tracer sorption studies continued.

Caisson experiment

Reactive-tracer studies focused on design of the intermediate-scale (caisson) flow and transport validation experiment that is being carried out in collaboration with LANL YMP staff. This experiment differs from previous intermediate-scale transport studies in its use of mechanistic geochemical and transport models to guide the experimental design. The experiment is being designed to develop a model validation strategy that integrates a variety of hydrological and geochemical conceptual models, field measurements, and experimental approaches. The study involves the detection and prediction of the migration of fluid and tracers through unsaturated porous media in a 6-m-long caisson.

The caisson experiment is being designed to ensure that the system will be simple enough to model from the pretest characterization data, yet contains chemical and hydrological phenomena that are relevant to Yucca Mountain. In addition, the caisson is being designed to ensure that the travel time for the water and conservative tracers are long enough to allow sufficient resolution for the models (approximately four days) and that the reactive tracer travel time is short enough to allow tracer detection before winter weather makes monitoring impossible (approximately 4 months).

The current design includes a 0.5-m-thick sorbing layer in the middle of two 2.75-m-thick quartz sand layers. The sorbing layer will be composed of the quartz sand doped with minor amounts of highly sorbent minerals. It is intended that the hydraulic properties of the filling material will be uniform throughout the caisson. This will be accomplished by matching the grain size distribution of the sorbing layer to that of the quartz sand layers. During October, experimental studies and scoping calculations were carried out to determine the types and amounts of candidate sorbents required to achieve the desired tracer velocities.

Saturated hydraulic properties of the sand and sand mixed with candidate sorbents (clinoptilolite and limonite) were measured. Preliminary sorption studies for nickel were carried out in the proposed background electrolyte (0.01 M NaCl) with candidate sorbents. Technique development for analysis of Ni by graphite furnace atomic absorption spectrophotometry at very low concentrations (1-5 ppb) was successfully completed during October. The development of this capability will allow the conduct of sorption experiments at low concentrations; sorption rather than precipitation will be the dominant control on the concentration of Ni in solution. During this month, surface areas of the sorbents were measured with the BET method as a function of particle size distribution. Surface-based sorption distribution coefficients (K_d 's) will be calculated from these data and used to estimate the weight and particle size of sorbent needed to achieve the desired retardation factor and tracer travel times.

The pretest characterization data will be used as input to the LLUVIA-II and LEHGC codes to predict the fluid flow and tracer migration. For preliminary design calculations, the hydraulic properties of a variety of candidate sands were estimated from particle size distribution and bulk density. The applied flux and suction at the lower boundary that results in the desired fluid travel time (four days) were calculated using these estimated materials properties with the LLUVIA-II code.

The moisture content and Darcy velocities computed by LLUVIA-II are written to an external data file for use in solution of the transport problem by the LEHGC code. This finite-element code solves a system of transport and geochemical equilibrium equations. The transport mechanisms include advection, dispersion/diffusion, and sources/sinks. The original version of LEHGC, however, does not handle the axisymmetric problem suggested by the caisson design. During October, the modifications to LEHGC required for the caisson experiment were completed.

Four columns were constructed for the measurement of unsaturated flow and transport properties of the three proposed caisson materials: silica sand and silica sand mixed with zeolite or limonite. The properties will support the design of the caisson experiment as well as contributing to pre-experiment calculations which will be part of the validation exercise.

Major Activities Upcoming Next Three Months

Collaboration with LANL YMP staff in an intermediate-scale (caisson) flow and transport validation experiment will continue. After the tracer/sorbent combination for the caisson has been chosen, more systematic sorption experiments will be carried out. These measurements will be designed to obtain surface complexation constants for tracer sorption by surface hydrolysis sites and ion exchange constants for fixed charged sites. Surface hydrolysis constants will be obtained by potentiometric titrations; specific adsorption constants for the reactive tracers and background electrolytes will be obtained by batch and column techniques.

The next step in hydraulic characterization involves measurement of the hydraulic and transport properties of a homogeneous mixture of the sand in 5-cm-diameter columns and 30-cm x 1-cm slab chambers, where two-dimensional full-field measurement techniques can be used. These preliminary experiments will be used to refine the parameter values predicted from the material textural properties. In succeeding studies, the effect of small-scale heterogeneities (0.001-0.3-m layering) that influence hydraulic and dispersion processes will be examined in order to define effective properties at a larger scale (0.3-1 m). This will be accomplished through a series of column and slab experiments wherein the flow path length and the frequency and strength of the microlayering are varied systematically and the hydraulic and dispersion properties measured. (Subactivity 1.6.2.1.1, SCP Section 8.3.5.12.2.1, and Subactivity 1.6.2.2.2, SCP Section 8.3.5.12.2.2)

Over the next three months, data collected and presented last spring validating Miller scaling theory applied to finger properties will be reviewed. Additional experiments will be conducted as required to finish the validation study and a journal article will be written.

Other Items to Report

The following abstract was written for presentation at the Fall 1991 AGU meeting: SAND91-2095A, "Comparison of Measured and Calculated Permeability for a Saturated, Rough-Walled Fracture," by R. Glass, M. Nicholl and M. Thompson.

Tours of the SNL-YMP Flow and Contaminant Transport Model Validation Laboratory were given to DOE WM/ER fellowship students and program representatives on October 1, 1991, and to M&O representatives on October 24, 1991, by R. Glass and V. Tidwell. During the tours, the approach to model development and validation was discussed and the integrated physical and numerical experimental efforts in flow and transport through single fractures and fracture/matrix interaction were demonstrated.

The abstract for the paper entitled "An Integrated Intermediate-Scale Caisson Experiment to Validate Models of Fluid Flow and Contaminant Transport in the Unsaturated Zone," by M. Siegel (SNL) and E. Springer (LANL), was accepted for presentation at the 1991 Fall meeting of the AGU.

An abstract for the paper entitled "Development and Validation of a Multi-Site Model for Adsorption of Metals by Mixtures of Minerals," SAND91-2314A, by M. Siegel (SNL), M. G. Rao (Howard University), V. Tripathi (Science Applications International, Inc.) and D. Ward (University of New Mexico), was submitted to the 7th International Symposium on Water-Rock Interaction, to be held in Park City, UT on July 13 through 22, 1992.

1.2.1.4.7 SUPPORTING CALCULATIONS FOR POSTCLOSURE PERFORMANCE ANALYSES

Status Report on Ongoing Activities

SAND91-0791, "Movement of Shaft and Drift Construction Water in Yucca Mountain, Nevada-An Extended Study," has completed technical and SNL management review and has completed the YMP review process and is awaiting publication.

SAND91-0790, "Estimation of the Performance Assessment Limitations for Surficial Water Addition Above a Potential High Level Radioactive Waste Repository at Yucca Mountain, NV," has been completed in technical review, management review, and is in the YMP review process.

SAND91-0792, "Determination of the Effects of the Location of Sewage and Settling Ponds Near a Potential High Level Radioactive Waste Repository in Yucca Mountain, NV," is in management review.

Following interactions with T&MSS, the September 1991 version of Appendix I of the ESF-DR was revised and transmitted to the T&MSS.

Rationale for applying PA analyses to the Title II, Modified Option 30, ESF design were developed and transmitted to the T&MSS.

Major Activities Upcoming Next Three Months

The document describing the PA plan for ESF Title II design support will be completed and the plan described in the document will be further developed and will be implemented.

Performance Assessments of the test planning packages of ESF alignment drillholes will be performed.

1.2.1.4.9 DEVELOPMENT AND VERIFICATION OF FLOW AND TRANSPORT CODES

Significant Meetings Attended

SNL staff from 6312 and 1511 met with S. Pahwa and B. Nelson of INTERA on October 22, 1991 to discuss the technical content of the current Planning and Control System (PACS) accounts. Proposed future directions for code development was discussed in detail.

Status Report on Ongoing Activities

Code development

A memo describing the evaluation of JACQ3D, a code developed outside the Yucca Mountain Project, on one-dimensional unsaturated infiltration problems was completed and distributed. The memo also discussed modifications to JACQ3D that enabled the solution of more severely nonlinear test problems. Evaluation of two-dimensional problems is in progress.

YMPO review comments on the NORIA-SP SAND document were addressed. A memo correcting known discrepancies in the NORIA manual was distributed, detailing updated sample calculations. NORIA-SP was successfully modified to operate on the SUN workstations. Some of these modifications have also been incorporated in the CRAY version of NORIA-SP, resulting in significant increases in efficiency.

Staff from 6310 have been working with staff from 1400 to develop versions of FASTQ and BLOT that work on SUN workstations.

The Quality Action Team formed to address code development for Department 6310 met first on October 18. Subteams were formed on the basis of the three different aspects of code development identified by the group. The three teams were Model Development and Validation, led by F. Lauffer; Numerical Techniques, led by M. Martinez; and Pre- and Post-Processing, led by A. Treadway. The initial reports from the three teams on areas needing research will be made in mid-November. Final reports with the recommendations of the QAT for 6310 management are targeted for mid-February.

Software QA (SCP Subactivity 1.6.2.1.2)

The NCAR audit report was prepared and reviewed. Rewrites of QAIP 3-2 using QAIP 5-1 were developed. Desktop procedures for the master log use were prepared. Work continued on QA forms for FASTQ, COYOTEII, JAC, and BLOT.

1.2.3 SITE INVESTIGATIONS

The objective of the Site Investigation element is to determine repository site suitability in terms of DOE siting guidelines (10 CFR 960), Nuclear Regulatory Commission (NRC) criteria (10 CFR 60), and Environmental Protection Agency (EPA) standards (40 CFR 191).

1.2.3.1 SITE MANAGEMENT AND INTEGRATION

Status Report on Ongoing Activities

Updates were performed for all SNL WBSs within 123 for PACS. Three large reports and an abstract were reviewed for management concerns. An Affected Document Notice was completed for CR 91/111, Technical Requirements Document for Surface-Based Testing.

The Project Sample Overview Committee met on October 16 at the Sample Management Facility in Area 25. The principal items of business were several specimen removal requests, including two somewhat controversial requests by State of Nevada investigators from the Nevada Bureau of Mines and Geology and the University of Nevada-Reno, who sought samples of altered and mineralized intervals of core. All requests were approved, with the proviso that the Project retain a half-core split (or other appropriate replicate sample) of each state specimen for corroborating analyses if needed.

Major Activities Upcoming Next Three Months

Support for activities in the WBSs within 123, as well as the Sample Overview Committee, will continue.

1.2.3.2.2.1 SYSTEMATIC ACQUISITION OF SITE-SPECIFIC SUBSURFACE INFORMATION

Major Accomplishments

A paper entitled "Microstratigraphic Units and Spatial Correlation of Hydrologic Properties in Tuff, Yucca Mountain, Nevada," SAND91-1450A, by C. A. Rautman (SNL), A. L. Flint and M. P. Chornack (USGS), and M. P. McGraw (PNL) was presented at a special session on Yucca Mountain at the 1991 Annual Meeting of the Geological Society of America (GSA) in San Diego, CA on October 21, 1991. The summary entitled "Deterministic Geologic Processes and Stochastic Modeling," SAND91-1925, by C. A. Rautman (SNL) and A. L. Flint (USGS), has been accepted for presentation at the 1992 International High-Level Radioactive Waste Management Conference in Las Vegas, NV on April 12 through 16, 1992. Both papers involve the results of previously reported outcrop sampling activities. Other presentations at the GSA meetings indicate that numerous, independent researchers are beginning to use geostatistically oriented outcrop studies as a means of addressing spatial variability of materials for a variety of hydrologic problems. (SCP Activities 8.3.1.4.3.1.1 and 8.3.1.2.2.3.1)

Status Report on Ongoing Activities

The 82 samples of existing core and cuttings requested in August from the Sample Management Facility were received mid-month at the USGS Hydrologic Research Facility in Area 25. Determination of hydrologic properties for these samples, which supplement previous outcrop specimens to provide a composite profile through the entire unsaturated zone interval, will commence. (SCP Activity 8.3.1.4.3.1.1)

Major Activities Upcoming Next Three Months

Analysis of the matrix-properties data will continue. Additional information on permeability and imbibition as well as bulk properties data for the new samples will be incorporated as appropriate. The time required for permeability measurements is a prominent factor in this work.



Comment resolution for the Study Plan for this activity will resume with the goal of submitting a revised draft by year end. Text for the High-Level Radioactive Waste Management conference paper will be prepared for final submission by December 20. (SCP Activity 8.3.1.4.3.1.1)

1.2.3.2.2.2.2 THREE-DIMENSIONAL ROCK CHARACTERISTICS MODELS

Major Accomplishments

The Geotechnical Modeling System (GMS) by Lynx Geosystems, Inc., has been received and installed on a new Sun Sparc-2 workstation. Staff are being trained to use the new system, which offers the potential for greatly enhanced three-dimensional capabilities and the integration of this modeling work with geostatistical analysis of material properties. Initial indications are favorable, but the learning curve for this sophisticated software package promises to be steep, resulting in a substantial period of low productivity. (SCP Activity 8.3.1.4.3.2.1)

Status Report on Ongoing Activities

USGS personnel participated in initial training for the Lynx GMS software system. Although access to the software package by USGS personnel will be through SNL staff, it is believed that close interaction between principal investigators involved in both modeling and site characterization is required to utilize fully the capabilities of the new system and to ensure that field data are appropriately collected. (SCP Activity 8.3.1.4.3.2.1 and SCP Studies 8.3.1.2.3.1 and 8.3.1.2.3.3)

Major Activities Upcoming Next Three Months

The new modeling software will be "exercised" by attempting to recreate several existing computer models and observing the differences in technique and results. The first model of Yucca Mountain to be constructed using the GMS may utilize existing data from the C-Hole complex of three drill holes in close proximity. Modeling of units in different fault blocks, a particularly difficult problem for the existing geometric modeling system, will also be of early interest. (SCP Activity 8.3.1.4.3.2.1)

1.2.3.2.7.1.1 LABORATORY THERMAL PROPERTIES

Status Report on Ongoing Activities

Data from the SEPDB for thermal conductivity (SCP Activity 8.3.1.15.1.1.3) and density and porosity (SCP Activity 8.3.1.15.1.1.1) are being converted into files for use in data analysis and to evaluate equations for empirical correlations between thermal conductivity and porosity. In addition, the data will be used to compare two statistical packages (SYSTAT and RS-1) for comparability of results and user-friendliness.

Major Activities Upcoming Next Three Months

The relocation of the testing laboratory has continued to delay initiation of the scoping study on the effects of saturation on thermal conductivity. However, it is anticipated that this study will be initiated and completed in the next three months. (SCP Activity 8.3.1.15.1.1.3) A comparison of calculated heat capacities with data obtained during development of technical procedures for measurement of heat capacity will be completed and documented (SCP Activity 8.3.1.15.1.1.2)



1.2.3.2.7.1.2 LABORATORY THERMAL EXPANSION TESTING

Status Report on Ongoing Activities

SAND88-1581, "Linear-Thermal-Expansion Data for Tuffs From the Unsaturated Zone at Yucca Mountain Nevada," completed technical review and is in the process of comment resolution. Data documented in this report also are being converted into files for use in statistical data analysis. (SCP Activity 8.3.1.15.1.2.1)

Major Activities Upcoming Next Three Months

Once the testing laboratory is operational in its new location, the dilatometer modifications will be completed, the relevant procedures will be approved, and a scoping study on the effects of sample size on thermal expansion will be initiated. (SCP Activity 8.3.1.15.1.2.1)

1.2.3.2.7.1.3 LABORATORY DETERMINATION OF MECHANICAL PROPERTIES OF INTACT ROCK

Major Accomplishments

SAND91-1898, "Modulus Dispersion and Attenuation in Tuff, Sandstone, and Granite," by R. Haupt and R. Martin III (NER), R. Price (SNL), and W. Dupree and X. Tang (NER), has been accepted for presentation and publication at the 33rd U.S. Symposium on Rock Mechanics. The conference will be held on June 8 through 10, 1992 in Santa Fe, NM. (SCP Activity 8.3.1.15.1.3.2)

Status Report on Ongoing Activities

A data report, SAND91-7031, "Mineralogy, Petrology, and Whole-Rock Chemistry Data Compilation for Selected Samples of Yucca Mountain Tuffs," by J. Connolly (UNM), is in management review. (SCP Activity 8.3.1.15.1.3)

SAND91-0894, "Anisotropy of Topopah Spring Member Welded Tuff," by R. Martin III, R. Price, P. Boyd, and R. Haupt, is being revised in response to comments generated during management review. (SCP Activity 8.3.1.15.1.3.2)

Testing of several rock types is being conducted at SNL Division 6232 and at New England Research, Inc. (NER) in support of the American Society for Testing and Materials/Institute for Standards Research (ASTM/ISR) Steering Committee for the Interlaboratory Testing Program for Rock Properties. The experiments for Phase I testing have been completed at NER and the report was submitted to the committee chairman during October. The samples are being prepared for testing by Division 6232 and the experiments should be completed by the end of calendar year 1991. These resulting data will be analyzed along with the data from at least eight other laboratories to establish measures of precision for published rock-property standard ASTM test methods. (No SCP Activity)

Discussions among R. Price (SNL) and R. Martin and P. Boyd (NER) were held in Albuquerque on October 3 and 4, 1991 concerning progress on a contract for running high temperature experiments at creep and low strain rate conditions. The fifth experiment run at a nominal strain rate of 10^{-9} s^{-1} was being performed during October. In addition, the status of two SAND reports and two abstracts for submittal to the 1992 U.S. Rock Mechanics Symposium were discussed. (SCP Activities 8.3.1.15.1.1.1 and 8.3.1.15.1.3.2)

Major Activities Upcoming Next Three Months

The series of six experiments at 10^{-9} s^{-1} being performed at NER should be completed within the next three months. Data analysis and reporting will begin at that time.



1.2.3.2.7.1.4 LABORATORY DETERMINATION OF THE MECHANICAL PROPERTIES OF FRACTURES

Major Accomplishments

Study Plan 8.3.1.15.1.4, "Laboratory Determination of the Mechanical Properties of Fractures," has completed SNL review and was submitted to the Project Office on October 24, 1991. This submittal satisfied Milestone P570. (SCP Activities 8.3.1.15.1 and 8.3.1.15.1.4.2)

Status Report on Ongoing Activities

A meeting of the Fracture Properties Working Group was held on October 18, 1991 to discuss testing plans and the status of Study Plan 8.3.1.15.1.4, "Laboratory Determination of the Mechanical Properties of Fractures." The working group consists of W. A. Olsson (SNL, 6232), S. Brown (SNL, 6232), and R. Price (SNL, 6315). (SCP Activities 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)

The development of a data base consisting of the topographies of natural fractures from various rock types is continuing. These data will be compiled, included in a report on a simple mathematical model of rough fractures, and maintained for future analysis. (SCP Activity 8.3.1.15.1.4.2)

A series of scoping experiments designed to begin an investigation of the creep behavior of fractures has been initiated. While there are very few data in the general literature on creep of fractures, some information exists on time- or rate-dependent behavior. Unfortunately, the effect of changes in deformation rate is drastically different for laboratory-produced (so-called 'artificial'), relatively smooth fractures than for natural, relatively rough fractures. This is also true for changes in other parameters (e.g., water). This work will continue. (SCP Activity 8.3.1.15.1.4.2)

Major Activities Upcoming Next Three Months

The scoping study on time-dependent fracture properties should continue during the next three months. Following the study, an evaluation will be made as to the approach and depth the quality-affecting investigation should take.

1.2.3.2.8.3.3 GROUND MOTION FROM REGIONAL EARTHQUAKES AND UNDERGROUND NUCLEAR EXPLOSIONS

Status Report on Ongoing Activities

The software QA process is under way for the finite-difference, synthetic-seismogram code package required for modeling travel paths. In anticipation of successful completion of the software QA requirements, a grid of velocity points has been constructed for the PM1 path from Area 20 of the Nevada Test Site (NTS) to Yucca Mountain for use in the finite-difference code. The grid includes the actual topography along the profile. This grid is a combination of 26 constant velocity polygons; the next step (in progress) is to construct a grid that incorporates velocity gradients, specified as 3- or 4-sided polygons with velocities specified at each vertex.

In the statistical-analysis area, software QA also is of concern and the process is ongoing. Meanwhile, the input data set has been examined critically; it appears that some data are missing, and efforts are being made to find the information. Preliminary analyses have been run with the incomplete data set to evaluate the probable results from this study. All indications are that, once the software QA process is complete, the analysis will proceed rapidly and successfully.

Machining work on the accelerometer canisters is nearly complete and should be finished in November.

Major Activities Upcoming Next Three Months

Software QA and ensuing analyses will be the focus for the next three months. The QA portion should be completed by January.

1.2.3.6.2.1.6 FUTURE REGIONAL CLIMATE/ENVIRONMENTS

Status Report on Ongoing Activities

In a parallel version of MM4BAT, the Holstlag boundary layer scheme was implemented to help validate the current version. The scheme, which should allow better vertical transport of heat and water vapor than the scheme currently used in the climate version of the MM4, has now been implemented and a number of 3-day summertime and wintertime runs have been performed to test the model prediction of boundary layer height and vertical diffusion coefficients. A number of parameter values have been tested and a suitable model configuration has been reached. With this model configuration, 30-day January and July simulations are being run to evaluate the effect of the new parameterization on the climatology of the model. For these longer runs, the temperature and precipitation predictions will be compared with that of similar runs performed with the old model. Following established QA procedures, this new parameterization will be included in the next version of the regional climate model.

The present-day and 2XCO₂ climate runs with the MM4 driven over the U.S. by boundary conditions from the Genesis GCM are being continued. Two years for the control run and one year for the 2XCO₂ run are completed. Within the next month, 3 1/2 years for both control and 2XCO₂ runs will be completed and analyzed.

A multiyear regional climate run for the western U.S., with the model driven by the output of a currently available and documented CCM1 run at T42 resolution, is being planned. This run will be part of Phase II (validation of the coupled GCM-MM4 modeling system) of the National Center for Atmospheric Research (NCAR) YMP project.

The audit report for the SNL QA audit of the NCAR has been completed.

An informal review of the journal article summarizing the results of the present climate validation, Phase I, was completed and forwarded to the authors.

A review of two RIB items, CR73 and CR74, was completed.

Major Activities Upcoming Next Three Months

A response will be prepared to the QA audit report.

Work will continue in qualifying the models in use at NCAR. The complexity of the meteorological code will result in this task taking several months to complete. Also, the meteorological data bases already in common use within the community will be qualified.

An informal review of the journal article summarizing the results of the present climate validation, Phase I, will be completed.



1.2.4 REPOSITORY INVESTIGATIONS

The objectives of the Repository element are to design a repository compatible with the host rock that meets the engineered barrier performance objectives of 10 CFR 60 and 40 CFR 191; to develop the required instrumentation and equipment for the repository; to obtain the necessary geoengineering data through laboratory and field tests; and to identify repository operation, closure, and decommissioning requirements.

1.2.4.1.1 REPOSITORY MANAGEMENT AND INTEGRATION

Status Report on Ongoing Activities

PACS activity and budgets for WBS 1.2.4 were revised to be consistent with Project Guidance. Task definition statements for direct work for other SNL organizations were drafted and are being reviewed. Discussions were held with several key staff of the M&O to initiate better integration of thermal and mechanical preclosure performance analyses for the ESF.

Other Items to Report

Comment responses to the DAA recommendations were prepared.

1.2.4.2.1.1.1 EXCAVATION INVESTIGATIONS

Status Report on Ongoing Activities

Activities associated with the revision of Appendix B of the current Exploratory Studies Facility Design Requirements and the Test Planning Package 91-5 were completed.

1.2.4.2.1.1.2 IN SITU THERMOMECHANICAL PROPERTIES

Status Report on Ongoing Activities

Final activities associated with the revision of Appendix B of the current Exploratory Studies Facility Design Requirements and the Test Planning Package 91-5 were completed.

1.2.4.2.1.1.3 IN SITU MECHANICAL PROPERTIES

Status Report on Ongoing Activities

Work associated with the revision of Appendix B of the current Exploratory Studies Facility Design Requirements and the Test Planning Package 91-5 was completed.

1.2.4.2.1.1.4 IN SITU DESIGN VERIFICATION

No significant activity to report this period.



1.2.4.2.1.2 ROCK MASS ANALYSIS

Major Accomplishments

RIB Item CR77, rock-mass quality designations for certain of the units at Yucca Mountain, was reviewed in detail and revised to support incorporation of this RIB item into the RIB.

Status Report on Ongoing Activities

SAND91-1982A, "Fault Stress Analysis for the Yucca Mountain Site Characterization Project," by S. Bauer (SNL) and M. Hardy, R. Goodrich, and M. Lin of Agapito and Associates, was accepted by the American Nuclear Society for the IHLWC meeting in April 1992. A paper will be developed in the next month by the authors. (SCP Activity 8.3.2.4.1.4)

Design Investigation Memo (DIM) 260, "Rock Mass Property Assessment-I, Fracture Analysis," was completed, reviewed and submitted for controlled distribution. The DIM defines a parcel of work in which "raw" sources of fracture data will be reviewed to look for and define fracture spatial orientations and relative abundances. From this information, rock qualities and rock mass ratings will be determined for input to the RIB. The work on this DIM will continue for about a year.

DIM 261, "Rock Mass Property Assessment-II, Rock Mass Strength, Modulus, etc.," was completed, reviewed, and submitted for controlled distribution. The DIM defines a parcel of work in which data sources, such as the RIB and the output from DIM 260, will be evaluated using primarily empirical methods described in SAND89-0837. The results of applying the methods will then be used to provide much-needed input to the RIB in the areas of rock mass strength and rock mass modulus. The work on this DIM will continue for about a year.

Major Activities Upcoming Next Three Months

Work is to begin on a series of laboratory experiments to help evaluate and validate the joint models. The initial experiments involve a stack of plates of Lexan with a centrally located hole. The plates are to be loaded perpendicular to the stacking and displacements are to be tracked and measured using Moire grid techniques. Experimental methods and details are being developed. Experimental results will be input to WBS 1.2.4.2.3.1.

1.2.4.2.3.1 CERTIFICATION OF DESIGN METHODS

Status Report on Ongoing Activities

An important component of the Project involves the development of constitutive models capable of analyzing the responses of jointed rock masses, which is a representative geologic feature of the potential waste repository site at Yucca Mountain, NV. Current compliant joint models represent state-of-the-art analysis capabilities. These models were incorporated into computationally efficient computer codes providing a unique capability for simulation of large-scale field problems. Efforts to improve both the capability and efficiency of the models and codes is ongoing.

SAND87-1305, "JAC3D-A Three Dimensional Finite Element Computer Program for the Nonlinear Quasi-Static Response of Solids with the Conjugate Gradient Method," by J. Biffie, completed technical review within SNL and is being revised in accordance with reviewer comments. It is expected that this code will form the backbone of the structural analyses to be performed for the Project in the upcoming years in support of Title II design. The program is vectorized to perform efficiently on the CRAY-YMP. The work on this report will continue for at least the next year.

Major Activities Upcoming Next Three Months

Work is to begin on numerical analysis of a series of laboratory experiments being performed (WBS 1.2.4.2.1.2). The analyses will help evaluate and validate the joint models. Both continuum and

discontinuum analysis methods are to be employed. In attempting to use the discontinuum methods, it became necessary to modify the code (UDEEC) to run on the CRAY and to modify the joint behavior portion of the code to make it more like the one implemented in JAC (Chen's compliant joint model).

Preliminary work has begun to plan the work to be initiated to develop a linked boundary element-finite element computer model for analyzing thermomechanical problems associated with design and performance of a potential nuclear waste repository. The linkage with an infinite boundary element domain will allow for the finite element portion of the analysis to focus on the near-field (detailed) aspects of a given problem, while ensuring that more realistic far-field effects are accounted for using the boundary element code. The work this next FY will be devoted to an investigation of key technical issues for the two-dimensional case, with a view toward extension of this work to three dimensions in the following two years.

An error was detected in the contact algorithm in JAC2D. The error was fixed and a check problem was run and examined for certain characteristics of the contact algorithm. Because no quality-affecting analyses have been run using JAC, this error detection and fix will be used as part of the current and future documentation for the code. No back-tracking will be done to determine "effects" of the error.

1.2.4.2.3.2 DESIGN ANALYSIS

Major Accomplishments

An abstract entitled "Drift Design Methodology and Preliminary Application for the Yucca Mountain Project," by S. Bauer and M. Hardy (Agapito and Associates) was accepted by the organizing committee of the 33rd U.S. Rock Mechanics Symposium. The paper is being developed based on SAND89-0837. The paper will be part of a workshop on "Design Methodologies" which is being organized by S. Bauer, M. Hardy and Z. Bienawzki.

1.2.4.6.1 SEAL DESIGN AND DESIGN REQUIREMENTS

Other Items to Report

No work was performed under this WBS due to the heavy involvement in preparing for the NWTRB meeting in Seattle on November 12 and 13, 1991.

1.2.4.6.2 SEALING TESTING

Status Report on Ongoing Activities

Activities performed during this month included preparation of the field test plans and laboratory analyses of a grout together with supporting analyses. Field tests were divided into seal component tests and a second, more complex group of tests called seal system tests. The simple (seal component) tests include small-scale seal performance tests, intermediate-scale seal performance tests, fracture grouting experiments, the surface backfill test, and the heated block test.

The more complex (seal component) experiments include the filter/single embankment test in welded tuff, large-scale seal and shaftfill performance tests, the Calico Hills backfill test, the Calico Hills bulkhead test, and the remote borehole sealing test.

The tests would be performed in one surface and four underground facilities. The underground facilities include the Tiva Canyon Welded Tuff Shaft Facility and the Paintbrush Nonwelded Tuff Shaft Facility. The test areas also include an alcove in the welded tuff of the Topopah Spring Unit, and a dedicated drift in the Calico Hills nonwelded tuff. A plan is under development for fielding each experiment including the equipment needed to emplace the seals, backfill materials, or other special

structures, the appropriateness of fielding the test, and the required services including drilling, electrical, compressed air, and lighting.

Final checking of the structural hydration calculations SHAFT.SEAL code was performed during the month. Plugs modeled at 1-ft, 2-ft, and 10-ft diameters were evaluated for changes in stress and temperature.

The second activity involved laboratory analyses of the chemical stability of a specific grout and supporting numerical analysis. SNL is performing two experiments: a single-point experiment that involves reacting cement and ground water at 200°C and analyzing the contents and a second experiment that involves the same reaction in a Dickson rocking autoclave device that allows periodic sampling of the fluid during the test duration.

The single-point experiment was simulated using the solubility/speciation code EQ3, which calculated the speciation of the fluid, based on a standard chemical analysis, and the degree of fluid saturation with respect to a list of relevant minerals. The rocking autoclave experiments were simulated using the reaction-path code EQ6. The objectives of the simulations were to evaluate the extent of water/cement equilibrium existing at the end of the experiment, determine the dominant forms of elements dissolved in the fluid, identify the final assemblage of minerals that should be present if all reactions are allowed to proceed to a state of equilibrium, calculate the mass and composition of reaction products, and contrast the numerical analyses with laboratory results.

During the last month significant progress was made in the experimental program. An on-line sampling autoclave has been operating at 200°C and has yielded high-quality data on the solutions that arise when the 84-12R1 grout interacts with water. In parallel, small sealed autoclave experiments were performed so that the solid products produced during the interaction could be identified. These reaction products were found to consist of a mixture of well-crystallized 11-angstrom tobermorite and gyrolite - both zeolite minerals.

The data also were used as a test case for the geochemical computer code EQ3NR/EQ6, which has been used to model the course of cement-groundwater interactions. In general only poor agreement was found. The code correctly predicted that zeolite minerals would form, but incorrectly picked one of the zeolite minerals. Solution compositions were even farther off. For example, solution pH is predicted to fall in the range 6.8 to 8, while in actuality pH values between 9.5 and 10.5 were observed. This disagreement may arise from the fact that silicon metal (from the silica fume) reduced the sulfate in the system. This, in turn, precluded anhydrite precipitation and allowed high calcium values. As this interaction was not anticipated at the time the code was run, its effects could



1.2.5 REGULATORY AND INSTITUTIONAL

The objective of the Regulatory and Institutional element is to (1) conduct all activities involving licensing, environmental compliance, communication, and liaison with the State of Nevada, affected Indian tribes, and the public and (2) administer the grants mandated by the Nuclear Waste Policy Act (NWPA) of 1982.

1.2.5.1 MANAGEMENT AND INTEGRATION

Status Report on Ongoing Activities

Authorization to provide limited support for development of the license application outline has been received from the Yucca Mountain Project Office. This effort, which is being managed by the M&O, is expected to incorporate Project participant input over the next several months.

1.2.5.2.1 NRC and NWTRB INTERACTION SUPPORT

Status Report on Ongoing Activities

Presentations were made to the Technical Review Board that addressed the issue of hot versus cold waste. The presentations incorporated the results of a series of analyses to predict the long-term thermal history as a result of employing waste with varying areal power densities.

In preparation for the NWTRB presentation on sealing scheduled for mid-November, staff and management participated in a dry-run in Las Vegas, NV on October 29 and 30.

Major Activities Upcoming Next Three Months

An NWTRB meeting on sealing will convene November 12 and 13, in Seattle, WA. Preparation for the meeting is expected to consume a considerable percentage of budget allocated for annum within this WBS element.

1.2.5.2.2 SITE CHARACTERIZATION PROGRAM

No significant activities to report this month.

1.2.5.2.3 REGULATORY REVIEW

No significant activities to report this month.

1.2.5.2.5 STUDY PLAN COORDINATION

Major Accomplishments

Study Plan 8.3.1.15.1.4, "Laboratory Determination of the Mechanical Properties of Fractures," was submitted to the Project Office on October 23, 1991. (SCP Activity 8.3.1.15.1.4)

The responses to SNL review comments on Study Plan 8.3.1.2.2.5, "Diffusion Tests in the Exploratory Studies Facility," written by LANL staff, were accepted by G. Barr. The completed Comment Resolution Forms were returned to the Project Office on October 24, 1991. (No SCP activity)

Status Report on Ongoing Activities

The responses to SNL review comments on Study Plan 8.3.1.5.1.4, "Analysis of the Paleoenvironmental History of the Yucca Mountain Region," written by USGS staff, are being reviewed by D. Gibson. The completed Comment Resolution Forms will be returned to the Project Office on completion of the verification. (No SCP activity)

The responses to SNL review comments on Study Plan 8.3.1.4.2.2, "Characterization of Structural Features in the Site Area," written by USGS staff, are being reviewed by C. Rautman. The completed Comment Resolution Forms will be returned to the Project Office on completion of the verification. (No SCP activity)

Major Activities Upcoming Next Three Months

Study Plan 8.3.1.4.3.1.1, "Systematic Acquisition of Site-Specific Subsurface Information - Systematic Drilling Program," by C. Rautman, has been reviewed by other Project participants, YMPO, and HQ personnel. The review comments were received on October 3, 1990, and will be responded to in the next several months. (SCP Activity 8.3.1.4.3.1.1)

1.2.5.2.6 SEMI-ANNUAL PROGRESS REPORTS

Status Report on Ongoing Activities

The Site Characterization Plan Semiannual Report was prepared and submitted to the Project Office.



1.2.6 EXPLORATORY SHAFT INVESTIGATIONS

The objective of the Exploratory Shaft element is to develop, design, construct, operate, maintain, and decommission the exploratory shafts required for site characterization and to plan and implement the in situ testing program.

1.2.6.1.1 EXPLORATORY SHAFT MANAGEMENT, PLANNING, AND TECHNICAL ASSESSMENT

Status Report on Ongoing Activities

An Interaction Task Memo (ITM) is being prepared to cover the evaluations of the impact of surface-based testing on performance.

1.2.9 PROJECT MANAGEMENT

The objective of the Project Management element is to schedule, budget, perform, control, coordinate, and report Project management, Project control, and quality assurance work. This includes identifying and defining interfaces among Project elements and integrating those elements.

1.2.9.1.1 MANAGEMENT

Status Report on Ongoing Activities

Six SAND reports were submitted to the YMPO for programmatic review.

1.2.9.1.4 RECORDS MANAGEMENT

Significant Meetings Attended

On October 22, Records Center staff attended the "Quality Control in a Micrographics Environment" seminar sponsored by the Association for Records Managers and Administrators (ARMA).

Status Report on Ongoing Activities

Development of a records training program for records sources and Local Records Center (LRC) staff continued. A draft of QAIP 17-1, Rev. O was completed and is undergoing QA review. Desk guidance was revised for the Data Records Management System (DRMS). Informal training on the Records Information System (RIS) was provided by Report References staff to records technicians. Informal training was also provided to LRC staff in the special processing requirements of training records. The collection of baseline data to support LRC staff performance standards was completed.

Major Activities Upcoming Next Three Months

A training session on requirements of the Records Management Plan will be conducted at SNL in November for LRC personnel by T&MSS staff. Records Center staff will attend the 1991 DOE/Contractors Image and Information Management Association (CIIMA) Conference on November 13 through 15, 1991, in Albuquerque, NM. On-the-job training for LRC staff will be implemented. Standards for LRC job performance will be established.

1.2.9.1.5 YMP SUPPORT FOR THE TRAINING MISSION

Status Report on Ongoing Activities

Orientation manuals for Department 6310 were distributed to supervisors and selected employees for review.

YMP Performance-Based Training Specification and User's Manual is currently being reviewed by Department 6310 staff.

1.2.9.2 PROJECT CONTROL

Significant Meetings Attended

The YMP Planning and Control Steering Committee (PCSC) met in Albuquerque on October 23, 1991 and the Training Subcommittee met in Las Vegas on October 17, 1991.

Status Report on Ongoing Activities

FY92 and FY93 Scope of Work and Planning and Scheduling (P&S) header sheets for 1.2.3, 1.2.4 and 1.2.6 are being prepared for submission on November 22, 1991.

Planning packages were submitted to the YMPO for 1.2.1, 1.2.5 and 1.2.9 for FY92 and outyears.

The TCP/IP network communication software for the AIMS was upgraded. The SCO UNIX operating system for the AIMS network was also upgraded.

Major Activities Upcoming Next Three Months

A Planning and Control System (PACS) videotape will be designed and developed for the Project Control Steering Committee.

1.2.9.3 QUALITY ASSURANCE PROGRAM

Major Accomplishments

Audit Report NCAR-A91-1, concerning the SNL audit of the National Center for Atmospheric Research, was issued October 25, 1991. No SNL audits were performed during this reporting period.

One internal SNL surveillance was conducted during the month of October. Criteria 4, 7, 8, 12, and 13 were investigated with satisfactory results.

Quality Assurance Implementing Procedure (QAIP) 2-8, Conduct and Reporting of Management Assessments, was approved and issued.

Status Report on Ongoing Activities

A review of "final draft O" of the OCRWM Quality Assurance Requirements and Description (QARD) document was performed and comments developed. Concurrently, the Software Advisory Group is also reviewing Supplement I (Software) of the draft QARD.

The FY92 QA External Audit and the FY92 Surveillance Schedules are being developed.

Revisions to the following procedures are in process: QAIP 2-6, Qualification and Certification of Personnel, QAIP 16-1, Corrective Action, and QAIP 18-1, Quality Assurance Audits. These are major revisions updated to the QARD and QAIP 5-1 requirements. QAIP 2-6 is also being changed to respond to an internal audit observation.

The Process Management Team (PMT) focusing on QA Procedures, which was active earlier this year, reconvened with the objective of improving these procedures in terms of simplicity, conciseness, and user-friendliness.

Major Activities Upcoming Next Three Months

The Software Advisory Group will meet November 19, 20 and 21 in Las Vegas, NV to resolve comments on Supplement I to the draft QARD.

No contractor audits are currently scheduled during the next 3 months.

Three surveillances are scheduled during the next 3 months.

The QA Procedure PMT, mentioned above, will continue efforts to improve, shorten, and simplify SNL QA Implementing Procedures.

**APPENDIX A: TECHNICAL DATA BASE INPUT****1. CANDIDATE DATA FOR THE TECHNICAL DATA BASE**

Participant Description of Data

None.

2. DATA FORMALLY SUBMITTED TO THE TECHNICAL DATA BASE

Participant Description of Data SNL Data Auth. No.

LLNL Dissolution and Precipitation Kinetics
of Gibbsite at 80 °C and pH3 K. Nagey and
A. Lasaga

LLNL Spent Fuel Hardware Activities as a
Function of Time (to 1,000,000 years)

3. DATA FORMALLY ENTERED INTO THE TECHNICAL DATA BASE

Participant Description of Data SNL Data Auth. No.

None.



APPENDIX B: REFERENCE INFORMATION BASE

1. REFERENCE INFORMATION BASE (RIB) CHANGE REQUESTS SUBMITTED*

<u>RIBCR</u>	<u>Subject</u>	<u>Participant</u>	<u>Status</u>
None.			

2. INFORMATION BEING PROCESSED AS RIB CHANGE DEVELOPMENT FILES FOR CONSIDERATION AS INPUT TO THE RIB*

<u>RIBCR</u>	<u>Subject</u>	<u>Status</u>
CR41	Topographic Maps	Under Development
CR57	Calcite-Silica Vein Deposits	Under Development
CR58	Volcanic Features	Under Development
CR59	Subsurface Facility Configuration	Under Development
CR60	Vertical Emplacement of Spent Fuel	Under Development
CR61	Horizontal Emplacement of Spent Fuel	Under Development
CR62	Geomorphic Processes	Under Development
CR63	Water Requirements (onsite)	Under Development
CR64	Physiographic Divisions	Under Development
CR65	Tectonic Geomorphology	Under Development
CR66	Mechanical Excavator Evaluation	Under Development
CR67	Thermal/Mechanical Cross-sections	Under Development
CR68	Existing Roads	Under Development
CR70	Hydrogeologic Zones	Under Development
CR71	Potential Transportation Routes	Under Development
CR72	Material Specs for Surface Facilities	Under Development
CR73	Paleoclimatic Change	Under Development
CR74	Paleohydrologic Evidence of Climatic Change	Under Development
CR75	Regional Seismic History	Under Development
CR76	Seismicity and UNES	Under Development
CR77	Rock Mass and Q Ratings	Under Development
DR05	Yucca Mountain Stratigraphy	Under Development
ER32	ESF Alternatives Study	Under Development
ER39	Surface Construction Water Movement	Under Development
ER40	Thermal/Mechanical Surfaces	Under Development
ER41	Sewage and Settling Pond Water Movement	Under Development

3. INFORMATION ENTERED INTO THE RIB

None.

*Candidate information is identified by RIB Change Requests, which are prepared in accordance with Revision 0 of Yucca Mountain Project Administrative Procedure AP-5.3Q, "Information Flow Into the Reference Information Base," which is implemented at SNL as Department Operating Procedure (DOP) DOP 3-8.

PROGRESS REPORT FOR EG&G/EM RSL SUPPORT TO YMP
October 01, 1991 Through October 31, 1991
Work Accomplished

WBS 1.2.1.3 TECHNICAL DATA BASE MANAGEMENT
EG&G/EM RSL YMP SUPPORT OFFICE

REPORT PERIOD: 10/01/91 - 10/31/91

REPORT DATE: 11/08/91

RESPONSIBLE INDIVIDUAL: C.E. Ezra

SUMMARY OF WORK ACCOMPLISHED DURING REPORT PERIOD:

1. Dave Brickey attended the Geological Society of America Annual Meeting in San Diego, California during the week of October 21 -24. Dave was invited to assist at the YMP exhibit to discuss on-going GIS and remote sensing activities.
2. An abstract entitled "Three Dimensional Visualization in Support of Yucca Mountain Site Characterization Activities" was prepared for presentation at the High Level Radioactive Waste Management Conference to be held in Las Vegas during April 12-16, 1992.
3. An FY92 Statement of Work and FY92 Planning and Control System (PACS) input was prepared.
4. Dave Brickey provided Dennis Grasso (USGS-WRD) with a tour of the RSL YMP Support Office on October 17. Grasso has extensive background in remote sensing.
5. Dave Brickey assisted with the Yucca Mountain Project exhibit at the Aerospace Education Conference at the Palace Station on October 18.

MAJOR PROBLEMS AND CORRECTIVE ACTION UNDERTAKEN: none.

ANTICIPATED SIGNIFICANT EVENTS PLANNED DURING NEXT REPORT PERIOD:

1. A briefing on the Remote Sensing Laboratories capabilities and demonstration of the GIS and 3-d modeling systems will be presented at the December Technical Project Officers meeting.

PROGRESS REPORT FOR EG&G/EM RSL SUPPORT TO YMP
October 01, 1991 Through October 31, 1991
Work Accomplished

**WBS 1.2.1.3 TECHNICAL DATA BASE MANAGEMENT
COMPUTER SUPPORT**

REPORT PERIOD: 10/01/91 - 10/31/91

REPORT DATE: 11/08/91

RESPONSIBLE INDIVIDUAL: C.W. Logan

SUMMARY OF WORK ACCOMPLISHED DURING REPORT PERIOD:

1. The SUN workstations were delivered and installed. The SUN systems have been configured and the INGRES database management system (DBMS) installed. ZEH Graphics Software, which will interface with the black and white thermal plotter, was installed. The ARC/INFO GIS software has not been received.
2. An internal meeting was held on October 29 to discuss the RSL YMP Support Office communications requirements. Four required links were addressed: 1) file transfers within the Support Office between the SUNs, Silicon Graphics and Personal Computers, 2) data entry from Support Office to SAIC Automated Technical Data Tracking System, 3) plot files from Support Office to SAIC Calcomp plotter, and 4) file transfer from the Support Office to the Remote Sensing Laboratory. A telecommunications plan will be prepared in accordance with DOE Order 5300.1 to address these requirements.

MAJOR PROBLEMS AND CORRECTIVE ACTION UNDERTAKEN: none.

ANTICIPATED SIGNIFICANT EVENTS PLANNED DURING NEXT REPORT PERIOD:

1. Input for the FY 1994 Information Technology Resources/Long Range Plan (ITR/LRP) will be prepared and submitted to Project Office.
2. ARC/INFO GIS software will be received and installed on the SUN workstations. The black-and-white thermal plotter, digitizing tablet and uninterruptible power supply will be received and installed at the Support Office.

PROGRESS REPORT FOR EG&G/EM RSL SUPPORT TO YMP
October 01, 1991 Through October 31, 1991
Work Accomplished

WBS 1.2.1.3 TECHNICAL DATA BASE MANAGEMENT
GIS COMPONENT OF THE TECHNICAL DATA BASE

REPORT PERIOD: 10/01/91 - 10/31/91

REPORT DATE: 11/08/91

RESPONSIBLE INDIVIDUAL: C.E. Ezra

SUMMARY OF WORK ACCOMPLISHED DURING REPORT PERIOD:

1. A meeting was held on October 4 at the RSN/YMP offices. Gene Ryder (DOE/YMP), Tom Pysto (SAIC), Doc McNeely, Brent Woolsey and Rick Remington (RSN) and Jim Beckett and Elaine Ezra (EG&G/EM) attended. The purpose of this meeting was to discuss the use of the GIS to produce maps showing environmental sampling locations which could be updated on a periodic basis. These maps would be provided to the surveyors.
2. Jim Beckett attended the Quarterly Technical Data Advisory Group Meeting held at the SAIC offices on October 17.
3. On October 29, Tom Bjerstedt met with Jim Beckett and Dave Brickey at the RSL YMP Support Office. The purpose of the meeting was to discuss the preparation of a set of basemaps to be used for a bi-annual report describing changes in the status of site characterization activities.
4. The first draft of the development plan for the GIS component of the TDB is complete. The development plan describes the approach and schedule for the database design phases, including: needs assessment, conceptual design, physical design, pilot study, implementation and operation.
5. Progress continues on the Site Atlas Map Portfolio. The most current version of the Geographic Names Information System (GNIS) files for California and Nevada has been received from USGS-Reston. The GNIS data requested includes feature name, coordinates, feature type, elevation, county location and USGS map name. The GNIS feature names will serve as the basis for the Site Atlas Gazetteer.

An effort is underway to obtain source data for the Site Atlas, including seismic, magnetic, gravity, magnetotelluric, magnetometric, resistivity and aeromagnetic surveys, paleoclimatic and vegetation studies.

6. Interpretation of the 1:12,000 scale surface disturbance features was completed. Photo verification of the 1:6,000 scale surface disturbance interpretation was initiated.
7. The digital twenty foot elevation contours processing has been initiated. The data has been reviewed, contours entered into the GIS, and the process for tagging elevation attributes identified.
8. A project with Chris Fridrich (YMPO) was initiated. The first phase of the project, which involved digitizing contact points from the Scott and Bonk geologic map, is complete. Attribute processing has been initiated.
9. Drillhole data from the SEPDB was reformatted and entered into the Dynamic Graphics system. 2-D grid models have been created for each thermal-mechanical unit. Contour models and perspectives have been generated for selected units. Work is proceeding on the development of thermal-mechanical stratigraphy model.
10. A mosaic of two geocoded, terrain corrected Landsat Thematic Mapper satellite images of Yucca Mountain were received. The imagery was acquired on October 10, 1990.
11. Miscellaneous GIS map products were generated to support project participants and are detailed in the "Deliverables" statement.
12. Other non-GIS products that were generated and provided include:
 - Two (2) blackline copies of the 1:6,000 scale orthophoto sheet # 16.
 - Four (4) slides each of YMP-91-046.1 (map and legend), YMP-91-046.1 (without legend), YMP-91-046.1 (legend only) for Greg Fasano/SAIC.

MAJOR PROBLEMS AND CORRECTIVE ACTION UNDERTAKEN: none.

ANTICIPATED SIGNIFICANT EVENTS PLANNED DURING NEXT REPORT PERIOD:

1. Development of the Site Atlas Map Portfolio will continue.

2. Photo verification will be completed; digitization will continue.
3. The digital hypsography data (20 foot elevation contours) entry to the GIS will be completed.
4. The INFO database for the GIS TDB has been updated. Upon receipt of the location data currently held in the SEPDB and ParaTrac databases, EG&G/EM will identify any discrepancies and provide the correct location coordinates.
5. Field checking of the 1:6,000 scale orthophoto disturbance mapping will be initiated.

PROGRESS REPORT FOR EG&G/EM RSL SUPPORT TO YMP
October 01, 1991 Through October 31, 1991
Work Accomplished

WBS 1.2.9

**ADMINISTRATIVE SUPPORT
PHOTO LABORATORY AND GRAPHICS SUPPORT**

REPORT PERIOD: 10/01/91 - 10/31/91

REPORT DATE: 11/08/91

RESPONSIBLE INDIVIDUAL: M.D. Pelan

SUMMARY OF WORK ACCOMPLISHED DURING REPORT PERIOD:

1. Diapositives, contact prints and the camera calibration report were provided to John Whitney, USGS/YMP, for the aerial photography collected of the three study sites.
2. Miscellaneous photo products were generated to support project participants and are detailed in the "Deliverables" statement.

MAJOR PROBLEMS AND CORRECTIVE ACTION UNDERTAKEN: none.

ANTICIPATED SIGNIFICANT EVENTS PLANNED DURING NEXT REPORT PERIOD:

1. Continued level-of-effort support

PROGRESS REPORT FOR EG&G/EM RSL SUPPORT TO YMP
October 01, 1991 Through October 31, 1991
Work Accomplished

WBS 1.2.9

**ADMINISTRATIVE SUPPORT
QUALITY ASSURANCE PROGRAM DESCRIPTION**

REPORT PERIOD: 10/01/91 - 10/31/91

REPORT DATE: 11/08/91

RESPONSIBLE INDIVIDUAL: C.E. Ezra

SUMMARY OF WORK ACCOMPLISHED DURING REPORT PERIOD:

1. Quality assurance administrative and technical procedures development continued.
2. A matrix of quality assurance requirements and existing procedures was completed. This matrix identifies the administrative procedures that need to be written, and existing EG&G/EM administrative procedures that require modification.

MAJOR PROBLEMS AND CORRECTIVE ACTION UNDERTAKEN: none.

ANTICIPATED SIGNIFICANT EVENTS PLANNED DURING NEXT REPORT PERIOD:

1. The Software Quality Assurance Plan should be sufficiently developed for Quality Assurance review.
2. A statement of work for continued Quality Assurance support will be developed. The scope will primarily involve procedure development with a completion date of December 31, 1991.

EXPENDITURES
10/01/91 Through 10/27/91

<u>Task</u>	<u>Budget</u>	<u>October Cost</u>	<u>Total Costs To Date</u>	<u>Remaining</u>
WBS 1.2.1 Systems	\$104.0K	\$ 58.6K	\$ 58.6K	\$ 45.4K
WBS 1.2.3 Site Investigations	\$ 6.0K	\$ <0.1K>	\$ <0.1K>	\$ 6.1K
WBS 1.2.9 Admin Support	<u>\$20.0K</u>	<u>\$ 0.0K</u>	<u>\$0.0K</u>	<u>\$20.0K</u>
TOTAL	\$ 130.0K	\$58.5K	\$ 58.5K	\$71.5K

STATUS OF DELIVERABLES FOR EG&G/EM RSL SUPPORT TO YMP
October 01, 1991 Through October 31, 1991

GIS MAP SUPPORT

<u>Description</u>	<u>Requested by/ Organization</u>	<u>Date Sent</u>	<u>Size</u>	<u>No.of Copies</u>
YMP-91-026.1 YMP Proposed Drillholes and Subsurface Drifts	Nance/SAIC	10/11/91	Full	1
YMP-91-25.1 YMP Existing Drillholes and Subsurface Access Drifts	Sullivan/DOE	10/10/91	Full Page	1 1
YMP-91-26.1 YMP Proposed Drillholes and Subsurface Access Drifts	Sullivan/DOE	10/10/91	Full Page	1 1
YMP-91-026.1 YMP Basemap	Roberson/DOE	10/11/91	Page	1
YMP-91-025.1 YMP Existing Drillholes and Subsurface Access Drifts	Baird/SAIC	10/15/91	Full	1
YMP-91-025.1 YMP Existing Drillholes and Subsurface Access Drifts	Brodski/DOE	10/17/91	Full	2
YMP-91-026.1 YMP Proposed Drillholes and Subsurface Access Drifts	Brodski/DOE	10/17/91	Full	2
YMP-91-025.1 YMP Existing Drillholes and Subsurface Access Drifts	Beckett/EGG	10/17/91	Full Page	12 12
YMP-91-026.1 YMP Proposed Drillholes and Subsurface Access Drifts	Beckett/EGG	10/17/91	Full Page	12 12

<u>Description</u>	<u>Requested by/ Organization</u>	<u>Date Sent</u>	<u>Size</u>	<u>No.of Copies</u>
YMP-91-039.2 YMP Environmental Sampling Locations and Existing Activities	Distel/M&O	10/22/91	Full	2
YMP-91-040.2 YMP Environmental Sampling Locations and Proposed Activities	Distel/M&O	10/22/91	Full	2
YMP-91-041.2 YMP Environmental Sampling Locations	Distel/M&O	10/22/91	Full	2
YMP-91-041.2 YMP Sampling Locations	Nance/SAIC	10/22/91	Full	1
Twenty foot elevation contour map	Distel/M&O	11/01/91	Full	1

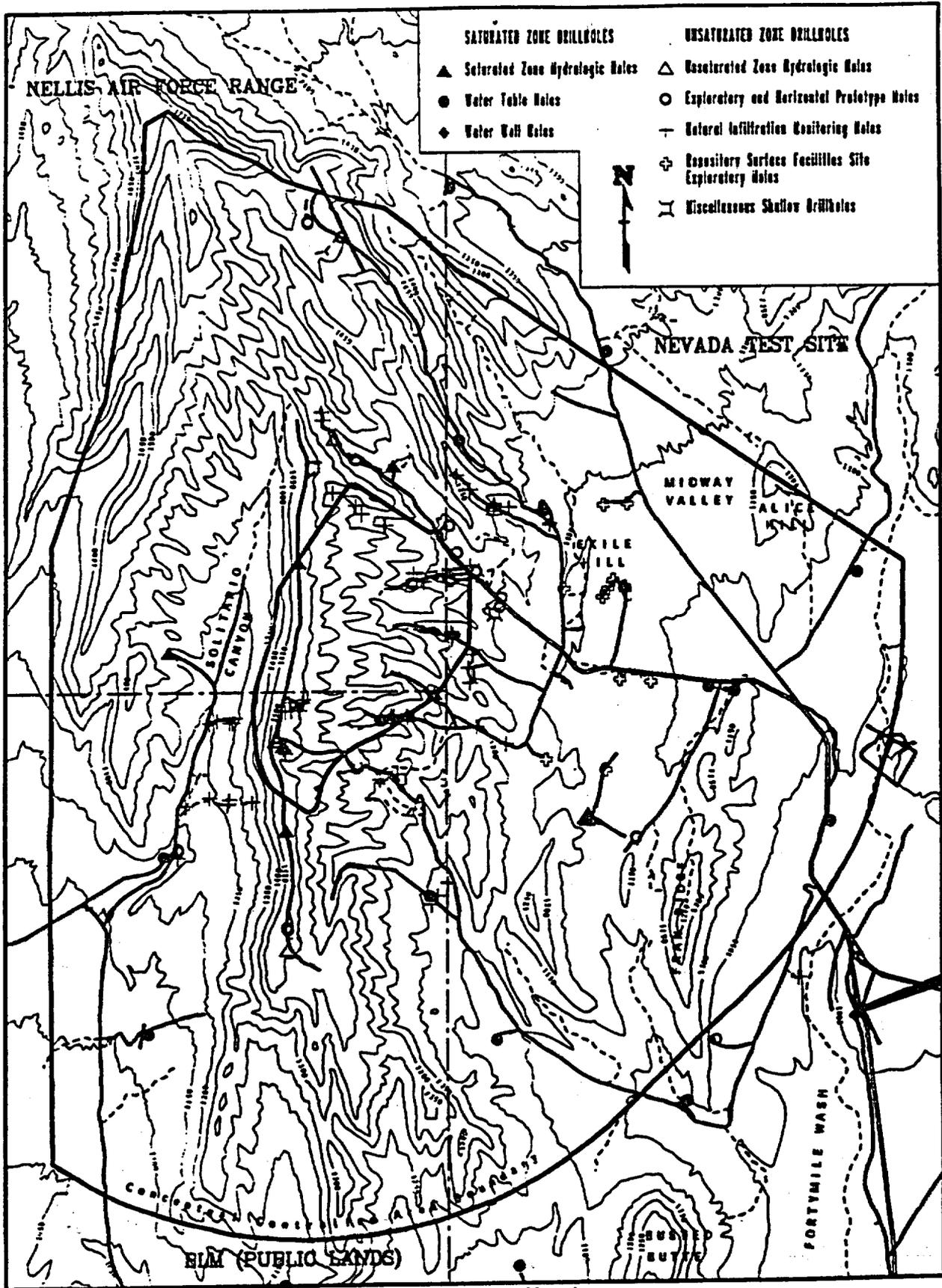
STATUS OF DELIVERABLES FOR EG&G/EM RSL SUPPORT TO YMP
October 01, 1991 Through October 31, 1991

PHOTO SUPPORT

<u>Description</u>	<u>Requested by/ Organization</u>	<u>Size (Inches)</u>	<u>Number of Copies</u>
Color Infrared Positive Transparencies	Ezra/EGG	9x9"	1000
Color Slides	Rohde for Fasano/SAIC	35 mm	12
Laser Color Prints	Rohde/EGG	8.5x11"	11
Laser Color Prints	Rohde/EGG	8.5x11"	4
Color Prints	Ezra for Whitney/USGS	30x30"	4
Color Prints	Ezra for Whitney/USGS	9.5x9.5"	526
Color Prints	Lorenz for SAIC	9x9"	4
Color Prints	Ervin/USGS	20x20"	6

YUCCA MOUNTAIN PROJECT

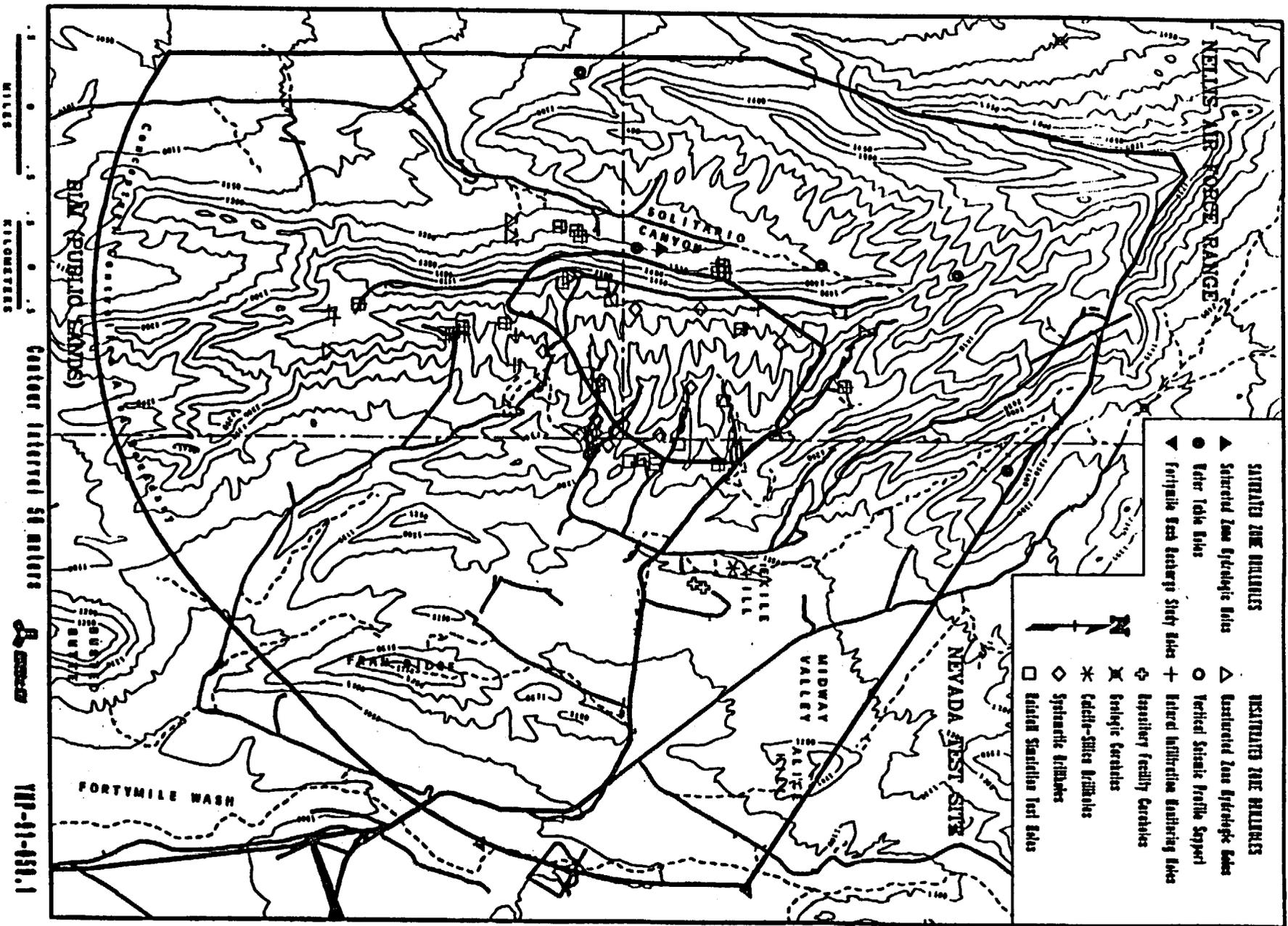
EXISTING DRILLHOLES 1978 - 1986

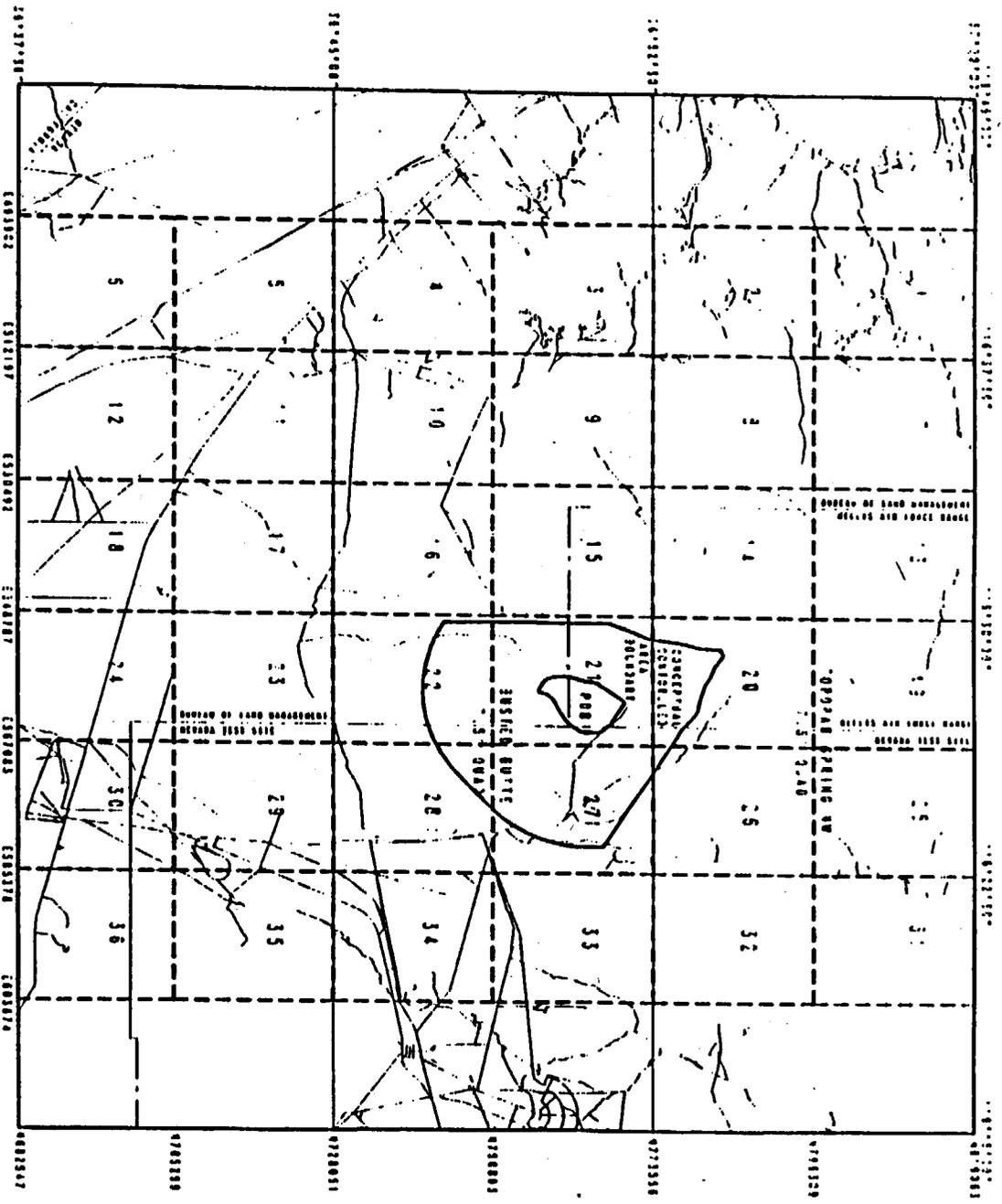


0 0.5 1 MILES
0 0.5 1 KILOMETERS
Contour Interval 50 meters
 YMP-01-040.1

YUCCA MOUNTAIN PROJECT

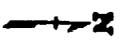
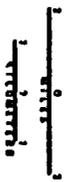
PROPOSED DRILLHOLES IN SITE CHARACTERIZATION PLAN





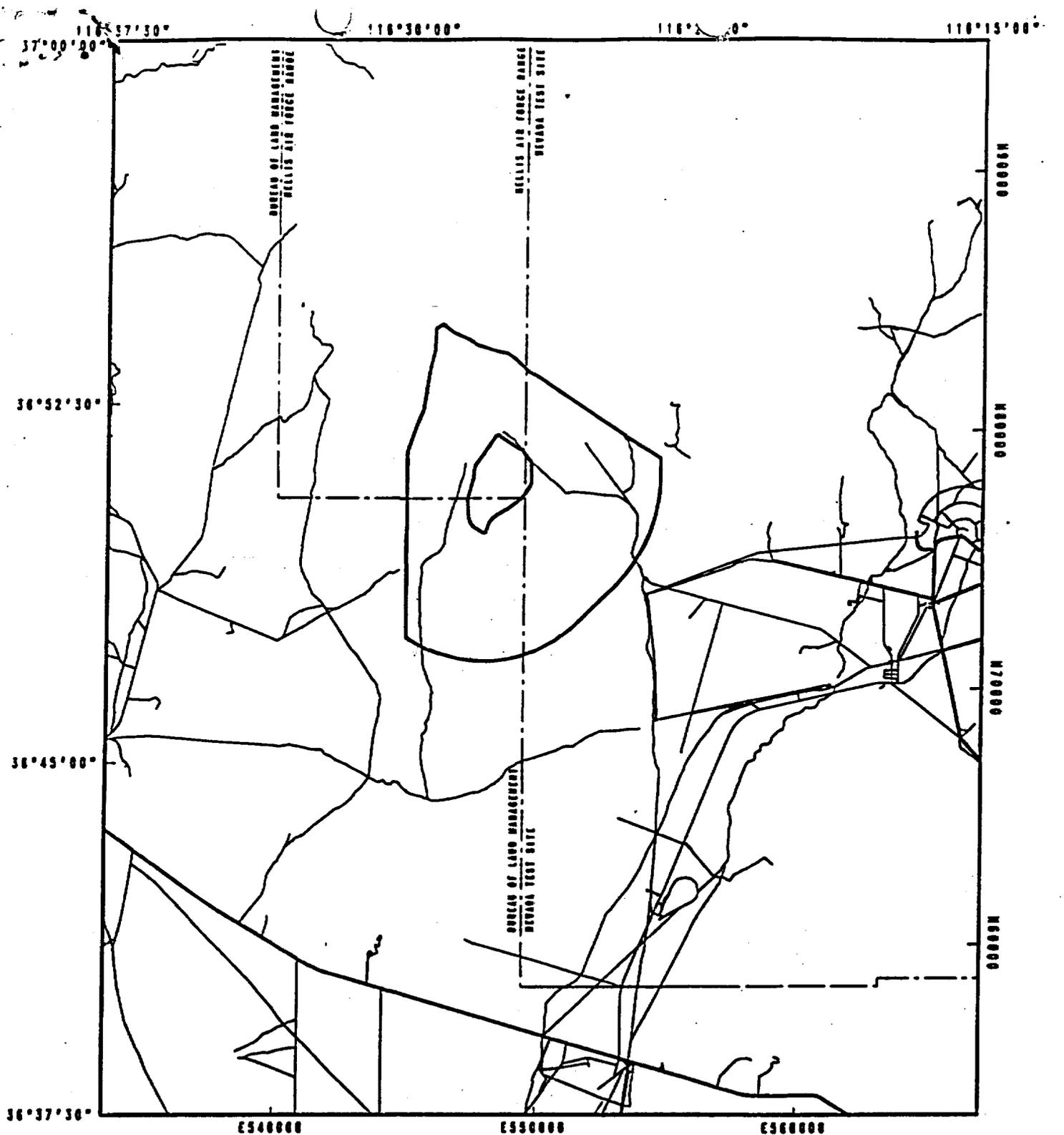
LEGEND

1:12,000 Scale Orthophoto Quad
 7.5' USGS Topographic Quad

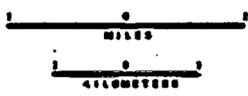


1:12,000 SCALE
ORTHOPHOTO INDEX

USGS MAP-91-052.1







METERS
KILOMETERS

NEW ACTIVITIES THIS REPORT

- Drillhole
- ⊕ Trench
- Test Pit

CONTOUR INTERVAL 300 FEET