

**BASIS OF ESTIMATE
FOR THE INITIAL ACTIVITIES OF THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: 0G32212EB5
2. Summary Account Title: Geologic Mapping of the Enhanced Characterization
Repository Block
3. Summary Account MGR./ORG: Robert Craig/USGS
4. Status of Change: ___ Revised X New
5. Scope Description:

Conduct full-periphery geologic mapping and detailed line surveys in the Enhanced Repository Block Characterization from station 0+00 to 23+00. Data from the mapping will be fed in a non-QA form relatively quickly to the Project for assessment of encountered conditions. Provide geotechnical data from as-built excavations for verification of preconstruction predictions. Data will be transmitted to the GENISES data base. Mapping also will be done in associated alcoves and niches associated with the ECRB. A report will address the major topics of geologic setting, geologic features of engineering and construction significance, and encountered ground conditions. The report will assess the predictive capabilities for geologic and geotechnical parameters.

6. Scope Differences from the Baseline: New scope.
7. Key Assumptions:

Excavation of the launch chamber will start in October, 1997, completed in December, 1997. Excavation of the drift to start in early February, 1998. Excavation of the drift completed by May 15, 1998. Mapping support provided by the constructor, especially daily cleaning of excavated tunnel. Cross block drift will penetrate Solitario Canyon Fault by September 30, 1998.
8. Cost Rationale: Total (\$833K):
Labor: (7.05 FTE)

Geologist GS- (0.75 FTE): Expertise in management and technical experience; will supervise the geological/geotechnical portion of the report preparation and provide technical assistance. Responsible for staffing and planning interactions with the M&O, USGS, DOE, etc.

Geologist(s) GS- (3.0 FTE): Experienced in underground mapping techniques and engineering geology will examine existing data and develop expectations for conditions to be encountered during new excavations.

Civil Engineer (1.0 FTE): Proficient in rock mass classification according to established systems and familiar with ground support specifications and ground conditions at Yucca Mountain.

Physical Science Technician GS- (2.0 FTE): Expertise in data processing to perform data entry, development of graphics for report, and maintenance of computer systems.

Geologist GS- (0.3 FTE): Expertise to provide technical review of presented data and review expectations for conditions during new excavation.

Other Direct Costs:

Travel: (\$12K)

5 trips at \$1000/trip for reviewers to Las Vegas.

12 trips at \$600/trip for staff

9. Level III Milestones: Two

A level 3 milestone (No. SPG42GM3, due 31 Aug 98) will consist of a report summarizing geologic and geotechnical data from the cross block drift.

10. Level III Milestone Description:

Milestone will contain: 1) Cross block drift mapping data from the North Ramp to the Solitario Canyon Fault. The report will integrate all mapping and other data, including, as appropriate: geologic units and subunits, faults, fractures and other important features, location of all samples collected for geochemical analysis, and as-constructed ground support; 2) A cross section comparing the predicted geology of the cross block drift and as-determined structural and stratigraphic interpretations will be included; 3) Results of the detailed line survey, Results of the Q-RMR analyses will be provided and integrated into the geographic data; 4) all geologic data collected from the cross block drift will be submitted into the GENISES data base as part of this deliverable.

11. Attachments and References:

12. Schedule:

Activity

Early Start

Early Finish

**Conduct Mapping Fm Sta 0+00
to 23+00**

01 Oct 97 31 Aug 98

July 2, 1997 (7:20pm)

WBS 1.2.3.2.2.1.2 Structural Features Within the Site Area

ATTACHMENT B

SPG42GM3 Report on the Geology of the Cross Block Drift

30-sep-98

This deliverable shall include all information identified herein unless specifically exempted in writing by the COR at least 60 days before the scheduled due date (30 days in special cases agreed to by the COR).

This milestone report will consist of a compilation and summary of mapping data collected in the cross block drift. It will include data delivery for the same interval into the GENISES data base.

The report will integrate all mapping and other data, including, as appropriate, maps at a scale of 1:125, geologic units and subunits, fractures, faults, and other important structural features (as appropriate), the location of all samples collected for mineralogical or geochemical analysis and as-constructed installed ground support and type.

The deliverable will supply fracture analysis for the cross block drift in the form of tabulated data sets, stereo plots, and statistical treatment of fracture information (by stratigraphic unit, or some selected interval along the course of tunnel excavation).

A cross section comparing the predicted geology of the cross block drift and as-determined structural and stratigraphic interpretations will be presented. Predicted and actual stratigraphic, structural and other key features will be discussed in the report. Important sampling and testing activities will be identified and discussed, as appropriate. A general discussion of the stratigraphy and structure will be provided that will include characterization of predicted locations of known or suspected fault features. The report will also include a description of rock characteristics associated with features that do not lend themselves well to graphical presentations contained in the report such as fault gouge and breccia.

Results of the detailed line survey and appropriate graphical and tabular presentation of data will be included in the report. The report will briefly describe any unusual features observed in the mapping, detailed line survey, or sampling exercises. Results of the RQD and Q & RMR analyses will also be provided and integrated into map or other graphical presentations of related data. Simple statistical treatment or qualitative assessment of the results of the subject survey will be provided.

Alcove maps (for constructed portions of the various test alcoves and niches), a summary of detailed line survey data, tabulations and assessment of structural data from alcove mapping investigations, and statistical treatment of alcove fracture data will be included in the report. Alcove borehole information will be incorporated for enhanced assessment of the geometry of stratigraphic units and structural features, as appropriate.

This deliverable shall be prepared in accordance with OCRWM approved quality assurance procedures implementing requirements of the Quality Assurance Requirements Description. The product shall be developed on the basis of the best technical data, including both Q and non-Q data. The Q status of data used and cited in the report shall be appropriately noted. Optional: Stratigraphy used shall be consistent with the Reference Information Base section 1.12 (a): Stratigraphy-Geologic Lithologic Stratigraphy. Within the report's Reference Section, references to data used in the report shall include record Accession Numbers or Data Tracking Numbers when available. Technical data contained within the deliverable and not already incorporated in the Geographic Nodal Information Study and Evaluation System (GENISES) shall be submitted for incorporation into the GENISES in accordance with YAP-III.3Q. Verification of technical data submittal compliance shall be demonstrated by including as part of the deliverable: 1) a copy of the Technical Data Information Form generated identifying the data in the Automated Technical Data Tracking system, and 2) a copy of the transmittal letter attached to the technical data transmittal to the GENISES Administrator. This deliverable shall be processed in accordance with YAP-5.1Q.

Completion criteria

**BASIS OF ESTIMATE
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1. Summary Account Number: TR32713GB1
2. Summary Account Title: Rock Properties Lab Tests.
3. Summary Account MGR/ORG: Kessel/SPO-SNL
4. Status of Change: Revised New
5. Workscope:

TASK 1: Laboratory rock properties samples will be collected in the E-W cross drift during excavation at 3 locations. The samples will be taken from core from the in situ borehole jack tests, TR32733GB1. The samples will be collected in the Topopah Spring middle nonlithophysal, lower lithophysal, and lower nonlithophysal units. The results of these tests will be used to 1) confirm predictions made for rock geomechanical conditions to be encountered in the Enhanced Repository Characterization Drift, 2) characterize the single heater test niche, TR3E2GB14 and, 3) Rock Properties Modeling, TR32222GB1.

The total suite of tests will include:

- 30 unconfined compression
- 30 triaxial compression
- 30 thermal expansion and x-ray diffraction
- 30 thermal conductivity and grain density

TASK 2: Core samples will be collected from boreholes SD-11 and SD-13 for lab thermal and mechanical tests. This fulfils a repository design requirement to assess the spatial variability and bounding estimates of elastic moduli, strength, and thermal expansion coefficients and supports Rock Properties Modeling, TR32222GB1.

The number of tests is:

- SD-11
 - 10 unconfined compression
 - 10 triaxial compression
 - 10 thermal expansion and x-ray diffraction
 - 10 thermal conductivity and grain density
- SD-13
 - 10 unconfined compression
 - 10 triaxial compression
 - 10 thermal expansion and x-ray diffraction

10 thermal conductivity and grain density

6. **Scope Differences from the Baseline: New Scope**

TASK 1 Deliverable: Two level 4 deliverables will be submitted. These will be TDIF data reports that will conform to ASTM standard reporting requirements.

Data report for thermal lab tests due 2nd quarter FY99

Data report for mechanical lab tests due 2nd quarter FY99

TASK 2 Deliverable: The results of the tests will be reported in accordance with applicable ASTM standards. Two data reports for SD-11, one thermal properties and the other mechanical properties, will be submitted as level 4 deliverables Due 3rd quarter FY99. Two similar data reports for SD-13 will be submitted as level 4 deliverables Due 4th quarter FY99.

7. **Key Assumptions:**

TASK 1: Samples will be collected and shipped to test lab in fourth quarter FY98. Test will commence first quarter FY99.

TASK 2: Core Samples will be available from SD-11 by end of 1st quarter FY99 and SD-13 by the end of 2nd quarter FY99.

8. **Cost Rationale:**

TASK 1

Labor

3.16 FTEM 101B Geotechnical Engineer to plan and manage testing. Prepare QA documents including work agreements and record packages, select core samples, data analysis and reporting.

8.4 FTEM 106 Engineering Technician to prepare samples and perform lab tests.

0.1 FTEM 100C Management.

0.2 FTEM 103 Administration. Prepare records.

\$1080 Travel - one 2 day trip from Albuquerque to Las Vegas for sample selection.

\$1K ODC for laboratory supplies.

\$6.5K WBO Report Production

\$33.6K WBO X-ray diffraction tests.

TASK 2:

Labor

5.26 FTEM 101B Geotechnical Engineer to plan and manage testing. Prepare QA documents including work agreements and record packages, select core samples, data analysis and reporting.

8.4 FTEM 106 Engineering Technician to prepare samples and perform lab tests.

0.2 FTEM 100C Management.

0.2 FTEM 103 Administration. Prepare records.

Travel - two 2 day trips from Albuquerque to Las Vegas for sample selection.

\$2K ODC for laboratory supplies.

\$13K WBO Report Production

\$22.4K WBO X-ray diffraction tests.

9. **Level III Milestones: None.**
10. **Level III Milestone Acceptance Criteria: N/A**
11. **Attachments and References:**
12. **Schedule**

TASK 1:

Collect samples 4th quarter FY98

Test samples and start reports preparation 1st quarter FY99

Complete reports and submit reports 2nd quarter FY99

TASK 2:

SD-11

Drilling complete 12/15/98

Collect samples 1st quarter FY99

Test samples and start reports preparation 2nd quarter FY99

Complete reports and submit reports end of 3rd quarter FY99

SD-13

Drilling complete 4/99

Collect samples 2nd quarter FY99

Test samples and start reports preparation 3rd quarter FY99

Complete reports and submit reports end of 4th quarter FY99

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
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1. Summary Account Number: 0G32733FB1
2. Summary Account Title: Predictive Geotechnical Analysis for Enhanced Characterization
3. Summary Account MGR/ORG: Robert Craig, USGS
4. Status of Change: ___ Revised X New
5. Scope Description:

A predictive geotechnical memorandum will be developed to support three goals: 1) Exercise predictive capabilities for stratigraphy, rock properties and expected ground conditions; 2) provide geotechnical results from the enhanced characterization program to support the viability assessment; 3) provide geotechnical data to support design in advance of construction enhanced characterization.

The memorandum will address the major topics of geologic setting, geologic features of engineering and construction significance, and anticipated ground conditions. The report will provide the strategy for assessing the predictive capability for geotechnical parameters and recommend metrics for evaluation of capability with data from the cross drift.

6. Scope Differences from the Baseline:

This is new work.

7. Key Assumptions:

Work to be done between September 1997 and November 1997.

8. Cost Rationale: Total (\$267K): (\$107K - FY97; \$160K - FY98)

Labor: (2.5 FTE)

Geologist (0.2 FTE): Expertise with management and technical experience will supervise the geological/geotechnical portion of the report preparation and provide technical assistance. Responsible for staffing and planning interactions with M&O, USGS, DOE, etc.

Geologist (1.0 FTE): Experienced in underground mapping techniques and engineering geology will examine existing data and develop expectations for conditions to be encountered during new excavations.

Civil Engineer (0.20 FTE): Proficient in rock mass classification according to established systems and familiar with ground support specifications and ground conditions at Yucca Mountain.

Physical Science Technician (1.0 FTE): Expertise in data processing to preform data transfer, development of graphics for report, and maintenance of computer systems.

Geologist (0.1 FTE): Expertise to provide technical review of presented data and review expectations for conditions during new excavation.

Other Direct Costs:

Travel: (\$2K)

Two trips at \$1000/trip for technical reviewers to Las Vegas.

9. Level IV Milestones:

A level 4 milestone (No. SP327AM4, due 14 Nov 97) will consist of a memorandum to the USGS TPO (Memo to TPO: Predictive Geotech. Analysis ECRB).

10. Level IV Milestone Description:

The memorandum will include the following: a) a brief overview of geologic setting (maps and figures developed from ISM); b) a brief overview of site exploration and testing program used for data input into this report; c) typical exposures and outcrops; d) presentation of specific data from various boreholes and tunnel data; e) properties of each rock unit to be encountered in the ECRB cross block drift; f) baseline estimates of the various lengths of percentages of each distinguishable rock or ground type to be encountered during excavation; g) baseline estimates of the degree of fracturing and expected orientations to be encountered across the repository block; h) predicted rock quality for the cross block drift; i) specific ground conditions that should be anticipated and j) potential geologic sources of excavation delay (shears, faults, wedges, block ground).

11. Attachments and References: None

12. **Schedule:**

<u>Activity</u>	<u>Early Start</u>	<u>Early Finish</u>
Develop Predictive Geotechnical Memorandum	02 Sep 97	14 Nov 97

July 2, 1997 (7:20pm)

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1. Summary Account Number: TR32733GB1
2. Summary Account Title: Rock Mass Geomechanical Properties
3. Summary Account MGR/ORG: Kessel/SPO-SNL
4. Status of Change: Revised New
5. Workscope:

TASK 1: Borehole jack (Goodman Jack) tests will be conducted at 3 locations in the cross-block drift. Two boreholes will be tested at each location (6 boreholes). The tests will be conducted in the Topopah Spring middle nonlithophysal, lower lithophysal, and lower nonlithophysal units. The results of these tests will be used to confirm predictions made for rock geomechanical conditions to be encountered in the Enhanced Repository Characterization Drift. One of the 3 test locations will be in or near the niche for the single heater test and will provide characterization data for the heater test (TR3E2GB14).

Measurements of the rock mass stiffness using surface seismic and Schmidt Hammer tests will be performed at the same locations as the jack tests. The results obtained will be compared with the borehole tests values to establish a baseline. The two techniques allow an evaluation of the potential effects of scale on the measured modulus values. Core specimens from the boreholes will be tested in the laboratory to determine the elastic properties of the matrix rock at the test locations (TR32713GB1).

TASK 2: In situ stress tests will be conducted in two locations in the lower lithophysal and lower nonlithophysal units. The results of these tests will be used to confirm predictions made for rock geomechanical conditions to be encountered in the Enhanced Repository Characterization Drift. Two hydraulic fracturing stress measurements will be performed in each of two boreholes (four tests in all). Each test location is approximately 50 m in depth. Tests will be performed in the Topopah Spring lower lithophysal and lower nonlithophysal units. Principal horizontal stresses at the repository horizon will be calculated from the test results.

6. Scope Differences from the Baseline: New Scope

Two Level 4 Deliverable will be submitted as a result of this work:

TASK 1 Deliverable: The results would be reported in a data analysis report. Estimates of rock mass modulus and intact rock strength will be made. The deliverable will be due 2nd quarter FY99.

TASK 2 Deliverable: The results would be reported in a data analysis report. This will be a level 4 deliverable due 2nd quarter FY99. The report will include the principal stresses.

7. **Key Assumptions:** Test holes will be drilled 4th quarter FY98. Testing will start in the first quarter of FY99.

8. **Cost Rationale:**

TASK 1

Labor

400 hours (101B) Geotechnical Engineer to conduct tests, analysis and report

120 hours (101C) Instrumentation Engineer to install equipment, calibration and perform tests

20 hours (100C) Technical Management and Integration

Other Direct Costs

\$2,500 Calibration of transducers, and data recording equipment

Travel

\$3,000 Three two day trips Albuquerque to Las Vegas

TASK 2

Labor

200 hours (101B) Geotechnical Engineer to plan, conduct tests and report results

80 hours (101C) Instrumentation Engineer to calibrate instrumentation and conduct tests

20 hours (100C) technical management and integration

Other Direct Costs

\$2,500 calibration of transducers, and data recording equipment

Work By Others

\$40,000 Geotechnical Support and Report preparation

\$1000 Travel for one 2 day trip Albuquerque to Las Vegas

9. **Level III Milestones: None.**
10. **Level III Milestone Acceptance Criteria: N/A**
11. **Attachments and References:**
12. **Schedule**

drill boreholes and collect core 4th quarter FY98
perform tests 1st quarter FY99
analyze results and report 2nd quarter FY99

**BASIS OF ESTIMATE
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1. Summary Account Number: TR32733GB3
2. Summary Account Title: Seismic Tomography Testing for Enhanced Characterization
3. Summary Account MGR/ORG: Kessel/SPO-SNL
4. Status of Change: Revised New
5. Workscope:

This account will provide for the use of acoustic tomography to verify and calibrate construction monitoring activities and examine stratigraphic and structural features surrounding the Enhance Characterization Drift. A acoustic tomography array would be installed in the underlying ESF Main Drift. This array will be connected to an automated data logger which would record variations acoustic impedance in the surrounding matrix as the Tunnel Boring Machine advances over the Main Drift. The TBM would be used as a continuous signal source permitting continual data collection and analysis without interrupting the mining cycle.

This technique utilizes a relationship between stress, seismic wave velocity, and attenuation to obtain information on the distribution and relative magnitudes of stress concentrations in the area under excavation. These stresses within the rock mass will result in either microfracture dilation resulting in lower seismic velocities or microfracture closure resulting in higher seismic wave velocities. The system can also be configured to synchronously record and analyze microseismic events which then provides additional resolution of developing areas of high stress which could result in rock falls or bursts. The tomographic display provides a clear easily evaluated image of the geologic feature or potential hazard area and permits the easy application of additional monitoring or mitigation activities. By installing the array in the ESF Main Drift below the cross over of the Enhanced Characterization Drift several geologic, structural, and hydrologic features can be examined and evaluated. Monitoring from the ESF Main Drift prior to the cross over of the TBM will permit evaluating the existing ground conditions prior to excavation. Once the TBM has passed over the ESF Main Drift the techniques evaluation can be confirmed and calibrated by Rock Mass Quality (Q and RMR) analysis. Monitoring while the TBM advances over the ESF Main Drift the variations in the stressfield caused by the excavation could be established. This technique would permit the evaluation and tracing of structural discontinuities such as joints, faults and horizontal discontinuities. This could assist in evaluation of the continuity and physical properties of such discontinuities. If this technique can be demonstrated to be cost effective and possess sufficient sensitivity it

could applied to numerous technical and analytical investigations. For example it could be quickly applied to such investigations as key block analysis, tracing of ³⁶Cl defined fast path faults and joints, cement debonding, blast monitoring damage investigations, determination of placement of construction monitoring convergence stations, structural and rock quality examination of repository drifts prior to excavation.

Workscope in FY '97 includes the installation and monitoring of a seismic tomographic array in the Main Drift underlying the anticipated path of the Enhance Characterization Drift. An analysis report will be produced evaluating the features and properties observed using the technique. In addition an determination of the sensitivity and resolution of the technique will be established by comparing the predicted structures and ground conditions to those actually encountered in the excavation.

6. **Scope Differences from the Baseline: New Scope**

One Level 4 Deliverable will be submitted as a result of this work:

Title: Acoustic Tomographic Examination of the Enhanced Characterization Drift.

Deliverable Description: The report will consist of text and a graphical overview of the structural, rock quality, stratigraphic, and stress field predicted by acoustic tomographic analysis. These predicted conditions will be illustrated in a number of volume slices through the area under investigations. These predictions will then be compared to the conditions and properties observed in the completed excavation. Once the comparison is completed a recommendation as to the purchase and continual application of the analytical system will be submitted.

7. **Key Assumptions: none**

8. **Cost Rationale:**

Labor

400 hours (101B) Geotechnical Engineer to plan, conduct tests, analysis and report results

Work By Others

\$50,000 Geotechnical Support, set up instrumentation and conduct tests

\$1000 Travel for one 2 day trip Albuquerque to Las Vegas

9. **Level III Milestones: None.**

10. **Level III Milestone Acceptance Criteria: N/A**

11. **Attachments and References:**

12. **Schedule**

Set up instrumentation during first quarter FY98
Conduct tests during construction in second and third quarter FY98
Report results and deliverable end of fourth quarter FY98

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1. Summary Account Number: TR32734GB1
2. Summary Account Title: In Situ Design Verification for Enhanced Characterization
3. Summary Account MGR/ORG: Kessel/SPO-SNL
4. Status of Change: Revised X New
5. Workscope: Perform in situ design verification tests in the Enhanced Characterization Drift. Install and monitor nine convergence monitoring stations in the drift. (1 station in starter tunnel, 2 stations in each of TSW1, Tptpmn, Tptpll, and Tptpln. Each station consists of one 25 ft. MPBX one 10ft. SPBX and 2 automated convergence meters. Conduct blast monitoring at one location where drill and blast is conducted.
6. Scope Differences from the Baseline: New Scope

Deliverable: Submit one level 4 deliverable in situ design verification data and analysis report September 1998 with data cutoff date August 1998.
7. Key Assumptions:
Work will start in April, 1998 and finish in September 1998.
8. Cost Rationale:

Labor
5 FTEM (101B) Geotechnical Engineer to plan, conduct tests and report results
2 FTEM (101C) Instrumentation Engineer to install and maintain instrumentation
2 FTEM (106) Engineering technician to install and read instruments
.93 FTEM (100C) technical management and integration

Other Direct Costs
\$90,000 (equipment costs \$10,000 per station)
\$5,000 Blast monitoring instrumentation

Work by others
\$10,000

\$4000 Travel for four 2 day trips Albuquerque to Las Vegas

9. **Level III Milestones: None.**
10. **Level III Milestone Acceptance Criteria: N/A**
11. **Attachments and References:**

**TECHNICAL BASIS
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1. Summary Account Number: TR33122FBF
2. Summary Account Title: Distribution of chlorine-36 and halides in the E-W Drift, SD-11 and SD-13
3. Summary Account MGR/ORG:
4. Status of Change: NEW
5. Scope description

Objectives:

- (a) evaluate the extent to which controlled use of water for suitable dust control impacts the quality of geochemical or isotopic data collected for site characterization
- (b) evaluate existing conceptual models for the distribution of fast paths, fracture/matrix interactions, and travel times
- (c) evaluate whether the current geochemical and isotopic data base for samples acquired from the ESF and surface-based boreholes is representative of repository block conditions

Note: All of the following tasks are to be undertaken in close coordination with parallel USGS and LANL activities:

USGS/Warren Day:

USGS/Don Sweetkind:

USGS/Alan Flint: OG33124FBD, Moisture monitoring in the ESF

LANL/Schon Levy: Petrology of flow paths in the E-W Drift

Specific tasks:

- (a) Conduct Cl/Br analyses in support of USGS proposal to monitor migration of construction water:
 - migration of construction water beneath the floor of the ESF Main Drift
 - migration of construction water beneath the floor of the E-W Drift
 - penetration of construction water into the walls of the E-W Drift, as determined from 2-m multi-purpose drillholes every 25 meters along the drift
- (b) Determine the distribution of chlorine-36 in the E-W Drift, SD-11 and SD-13 (as an indicator of fast paths and travel times)
 - systematic sampling every 100 meters along the E-W Drift
 - feature-based sampling of fractures, faults, broken or brecciated zones, subunit contacts, wet areas in the E-W Drift
 - systematic and feature-based sampling of SD-11 and SD-13
 - structural characterization of sampling sites (in conjunction with the USGS)

basic mineralogic and petrologic characterization of sampling sites (detailed studies, e.g., mineral alteration and tectural analyses, will be conducted as a separate activity)

(c) Determine the distribution of chloride porewater concentrations in the E-W Drift (as an indicator of surface infiltration rates), using samples provided by the USGS from its systematic multi-purpose drillholes. Determine the distribution of chloride porewater concentrations in SD-11 and SD-13 samples. Conduct basic structural, mineralogic and petrologic characterization of selected cores.

(d) FY98 progress report interpreting above data in light of the objectives

(e) FY99 summary report interpreting above data in light of the objectives

6. Scope Differences from Baseline: NEW

7. Key Assumptions: a) TCO escort will be available for four 2-day trips to the E-W Drift; b) mining support will be available to mine out samples suitable for ^{36}Cl analysis; c) core samples from the ESF boreholes (for the USGS activity, Moisture Monitoring in the ESF) will be available by January 1998; d) tunnel construction of the E-W Drift begins in April 1998 and is completed by October 1998; e) core samples from the E-W Drift boreholes (for Flint's two studies) will start to become available by June 1998 and will be completed by June 1999; f) preliminary results from the USGS structural activity in the E-W Drift are available for use in the Level IV milestone report submitted in support of the Project's Level III predictive report; g) samples suitable for analysis will be available from SD-11 and SD-13 in early FY99

8. Cost Rationale:

FY98 cost rationale

Labor category 101B, Hydrologist, 0.2 FTE: Principal investigator of activity. Expertise in collection, analysis and interpretation of isotopic and geochemical data for hydrologic studies. Knowledge of appropriate quality assurance requirements.

Labor category 101B, hydrologist, 0.15 FTE: coordinate and perform simulation studies of subsurface transport of chloride, carbon-14 and chlorine-36. Integrate supporting Project process and material work such as USGS infiltration studies, USGS material properties, USGS structural model, SNL stratigraphic model, and LANL flow and transport model. Use simulation of flow, transport and mixing to predict and interpret sample data.

Labor category 101B Mineralogist-Petrologist. 0.2 FTE: Responsible for site selection and for field and laboratory characterization of sampling sites. Expertise in field-scale and laboratory studies of mineralogic and textural alteration, particularly in welded tuffs. Knowledge of appropriate quality assurance requirements.

Labor category 109C postdoc, 0.1 FTE: Assist staff members and technicians in conducting tasks, interpreting data and preparing reports. Expertise in collection and interpretation of geochemical and isotopic data for hydrologic studies. Knowledge of appropriate quality assurance requirements.

Labor category 101C, Chemistry lab technician, 0.15 FTE: Expertise in laboratory analyses of major and trace elements. Responsible for acquisition of high-quality analyses of major and minor ions in aqueous samples. Knowledge of appropriate quality assurance requirements.

Labor category 101C, Chemistry lab technician, 0.15 FTE: Expertise in porewater extraction and sample preparation for analysis of environmental tracers and isotopes, including chlorine-36. Responsible for sample management. Knowledge of appropriate quality assurance requirements.

Labor category 109C, students, 0.1 FTE: Assist staff members and technicians in conducting tasks.

Labor category 109C, Administrative Assistant, 0.1 FTE: Responsible for editing and formatting reports, preparing data packages and records packages, and providing reviews of laboratory data to ensure traceability. Knowledge of appropriate quality assurance requirements.

Travel:

Yucca Mountain: 2 trips for 3 people each @ \$1K = \$6K

Las Vegas: 2 trips @\$1K for meetings with M&O, DOE, USGS = \$2K

Outside analytical services for ^{36}Cl analyses: 50 samples @ \$500 = \$25K (E-W Drift samples)

Not costed: Miner support for ^{36}Cl sampling (see item 7b)

FY99 cost rationale

Labor category 101B, Hydrologist, 0.2 FTE: Principal investigator of activity. Expertise in collection, analysis and interpretation of isotopic and geochemical data for hydrologic studies. Knowledge of appropriate quality assurance requirements.

Labor category 101B, hydrologist, 0.15 FTE: coordinate and perform simulation studies of subsurface transport of chloride, carbon-14 and chlorine-36. Integrate supporting Project process and material work such as USGS infiltration studies, USGS material properties, USGS structural model, SNL stratigraphic model, and LANL flow and transport model. Use simulation of flow, transport and mixing to interpret sample data.

Labor category 101B Mineralogist-Petrologist. 0.3 FTE: Responsible for site selection and for field and laboratory characterization of sampling sites. Expertise in field-scale and laboratory studies of mineralogic and textural alteration, particularly in welded tuffs. Knowledge of appropriate quality assurance requirements.

Labor category 109C postdoc, 0.1 FTE: Assist staff members and technicians in conducting tasks, interpreting data and preparing reports. Expertise in collection and interpretation of geochemical and isotopic data for hydrologic studies. Knowledge of appropriate quality assurance requirements.

Labor category 101C, Chemistry lab technician, 0.15 FTE: Expertise in laboratory analyses of major and trace elements. Responsible for acquisition of high-quality analyses of major and minor ions in aqueous samples. Knowledge of appropriate quality assurance requirements.

Labor category 101C, Chemistry lab technician, 0.25 FTE: Expertise in porewater extraction and sample preparation for analysis of environmental tracers and isotopes, including chlorine-36. Responsible for sample management. Knowledge of appropriate quality assurance requirements.

Labor category 109C, students, 0.1 FTE: Assist staff members and technicians in conducting tasks.

Labor category 109C, Administrative Assistant, 0.1 FTE: Responsible for editing and formatting reports, preparing data packages and records packages, and providing reviews of laboratory data to ensure traceability. Knowledge of appropriate quality assurance requirements.

Travel:

Yucca Mountain: 2 trips for 3 people each @ \$1K = \$6K

Las Vegas: 2 trips @\$1K for meetings with M&O, DOE, USGS = \$2K

Outside analytical services for ^{36}Cl analyses: 100 samples @ \$500 = \$50K (E-W Drift, SD-11 and SD-13 samples)

Not costed: Miner support for ^{36}Cl sampling (see item 7b)

9. Level 4 Milestones:

(Predictive Report Milestone, due 15 November 1997, can be found in TR39BFB6, "E-W Drift Predictive Reports.")

Progress Report on the Distributions of Chlorine-36 and Chloride Porewater Concentrations in E-W Drift

Due: 30 September 1998

FY99 Level IV milestones

Summary Report on the Distributions of Chlorine-36 and Chloride Porewater Concentrations in E-W Drift

Due: 30 September 1999

10. Level 4 Milestone Acceptance Criteria:

Predicted Distributions of Chlorine-36 and Chloride Porewater Concentrations in the E-W Drift: Input to Level III Predictive Report (due 15 November 1997). A letter report will be written for incorporation into a project Level III milestone predictive report. The letter report will assess existing data pertinent to selected isotopic and geochemical characteristics of porewater in the

stratigraphic and structural features that may be intersected by the E-W Drift, SD-11 and SD-13, and will describe the development of criteria for evaluating the distribution and frequency of fast paths, distribution and range of chloride porewater concentrations, distribution and range of $^{36}\text{Cl}/\text{Cl}$ ratios, ^{14}C activity, and tritium activity.

Progress Report on Chlorine-36 and Chloride Distributions in the E-W Drift (due 30 September 1998). A letter report will report the measured distributions of chlorine-36, chloride, and bromide in samples obtained from the ESF and E-W Drift, for data available as of 8/31/98. Structural, mineralogic and petrologic characterization of the ^{36}Cl sampling sites in the E-W Drift sample sites will be included. Preliminary interpretation of the data will be discussed, relative to its implications for: (a) the influence of construction water on the quality of geochemical or isotopic data, (b) the validity of existing conceptual models for the distribution of fast paths, fracture/matrix interactions, and travel times, and © the extent to which the current geochemical and isotopic data base for samples acquired from the ESF and surface-based boreholes is representative of repository block conditions.

Summary Report on Chlorine-36 and Chloride Distributions in the E-W Drift, SD-11 and SD-13 (due 30 September 1999). A letter report will report the measured distributions of chlorine-36, chloride, and bromide in samples obtained from the E-W Drift, SD-11 and SD-13, for data available as of 8/31/99. Structural, mineralogic and petrologic characterization of the ^{36}Cl sampling sites will be included. Interpretation of the data will be discussed, relative to its implications for: (a) the influence of construction water on the quality of geochemical or isotopic data, (b) the validity of existing conceptual models for the distribution of fast paths, fracture/matrix interactions, and travel times, and © the extent to which the current geochemical and isotopic data base for samples acquired from the ESF and surface-based boreholes is representative of repository block conditions.

11. Attachments and References: None

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: OG33123EBE
2. Summary Account Title: Air Permeability Testing in SD-6 and WT-24
3. Summary Account MGR/ORG: Robert Craig/IISGS
4. Status of Change: Revised New
5. Scope Description:

Air permeability testing will be conducted in boreholes USW SD-13 and USW SD-11 using the existing surface-based air-K testing equipment, consisting of borehole packers, packer handling equipment, and associated borehole instrumentation and data acquisition systems. The air permeability testing is conducted by isolating zones of interest using the borehole packers and then injecting known volumes of air with a tracer gas under controlled pressure and flow rates into the pore space, rock matrix and fractures, in the formations being tested. Testing is normally accomplished by starting at the deepest zone of interest and working towards the top of the borehole. The duration of this testing is dependent upon the thickness of the unsaturated zone being tested and the number of zones to be tested, but will take approximately three (3) months per borehole. This testing does not require the support of a drill rig or crew. Diesel fuel for the generator will be required. Backup electric power at the borehole locations could be required.

6. Scope Differences from the Baseline:

Work will be conducted in boreholes USW SD-13 and USW SD-11.

7. Key Assumptions:

The unsaturated zone in the borehole(s) is accessible for conducting the air permeability testing. Needed equipment has been procured and/or serviced and is in good working condition to conduct testing. Instrumentation and data acquisition systems are available and have been calibrated prior to beginning testing. Borehole lithostratigraphy and borehole geophysical logs are available to assist with the selection of zones to be tested and the interpretation of test results.

8. Cost Rationale: (\$404.4K) (FY99 - \$375K, FY00 - \$29.4K)

USW SD-13: (\$202.2K) (FY99 - \$175K, FY00 - \$27.2K)

Labor (1.02 FTE):

Hydrologist GS-13 (0.4 FTE): Principal investigator for the pneumatic pressure monitoring and testing. Will plan and conduct the test, analyze test results, and report on results.

Hydrologist GS-12 (0.4 FTE): Expertise in preparing for and conducting the test. Conduct computer simulations to assist with the interpretation of field data. Help with data collection and analysis, and report preparation.

Hydrologist GS-12 (0.2 FTE): Expertise in constructing fracture network models and conducting flow simulations using appropriate computer codes.

Hydrologist GS-14 (0.02 FTE): Expertise in supervisory management and integration duties associated with this activity.

Travel (\$8K):

Fifteen trips from Denver to Yucca Mountain to prepare for air permeability testing, conduct air-permeability testing, and begin preliminary analysis of data. Trips may be required to present testing results to other project participants.

Other Direct Costs (\$29K):

\$10K for instrument calibration (transducers, data loggers, flow meters, etc.); \$5K for equipment repair and fabrication for borehole packer system; \$14K (2 replacement packer elements at \$7K each for downhole borehole packer system).

Work by Others (\$53K):

One (1) hydrologist to assist with preparing for and conducting the air-permeability testing; and to help with data collection and analysis, and report preparation. One (1) hydrologic technician to repair and maintain borehole testing equipment and to assist with the borehole air-permeability testing. One (1) quality assurance implementation/data specialist to provide QA support and assemble data packages for submittal to the appropriate records repository.

USW SD-11: (\$202.2K) (FY99 - \$200K, FY00 - \$2.2K)

Labor (1.02 FTE):

Hydrologist GS-13 (0.4 FTE): Principal investigator for the pneumatic pressure monitoring and testing. Will plan and conduct the test, analyze test results, and report on

results.

Hydrologist GS-12 (0.4 FTE): Expertise in preparing for and conducting the test. Conduct computer simulations to assist with the interpretation of field data. Help with data collection and analysis, and report preparation.

Hydrologist GS-12 (0.2 FTE): Expertise in constructing fracture network models and conducting flow simulations using appropriate computer codes.

Hydrologist GS-14 (0.02 FTE): Expertise as supervisory hydrologist to perform management and integration duties associated with this activity.

Travel (\$8K):

Fifteen trips from Denver to Yucca Mountain to prepare for air permeability testing, conduct air-permeability testing, and begin preliminary analysis of data. Trips may be required to present testing results to other project participants.

Other Direct Costs (\$29K):

\$10K for instrument calibration (transducers, data loggers, flow meters, etc.); \$5K for equipment repair and fabrication for borehole packer system; \$14K (2 replacement packer elements at \$7K each for downhole borehole packer system).

Work by Others (\$53K):

One (1) hydrologist to assist with preparing for and conducting the air-permeability testing; and to help with data collection and analysis, and report preparation. One (1) hydrologic technician to repair and maintain borehole testing equipment and to assist with the borehole air-permeability testing. One (1) quality assurance implementation/data specialist to provide QA support and assemble data packages for submittal to the appropriate records repository.

9. **Level IV Milestones:**

USW SD-13

A Level 4 milestone (SPH234M4, due 25 Aug 99) will consist of a memorandum to the USGS TPO documenting the air-permeability testing in borehole USW SD-13. The types of tests conducted, duration of tests, problems encountered, and other relevant information will be included in the memorandum. Delivery date will be one (1) months after completion of testing.

A Level 4 milestone (SPH294M4, due 25 Oct 99) will consist of a memorandum to the USGS TPO documenting the submittal of Air Permeability Test Data to the RPC. This

level 4 milestone consists of data obtained during air-permeability testing of borehole USW SD-13, including logbook pages, data reductions, and supporting documents. This milestone supports the level 4 milestone, "Air Permeability Testing USW SD-13". Delivery date is TBD (experience has shown that these types of data submittals take approximately 3 months to assemble, review, etc.).

A Level 4 milestone (SPH254M4, due 25 Jan 00) will consist of a memorandum to the USGS TPO describing air permeability testing in borehole USW SD-13. This level 4 milestone consists of a final memorandum describing the air-permeability testing and test results in borehole USW SD-13, including text, figures, tables, and illustrations. The memorandum will include methods used, test results, and other relative information. Delivery date is TBD (it is expected that this memorandum will be completed approximately 3 months after the submittal of the data package).

USW SD-11

A Level 4 milestone (SPH264M4, due 14 May 99) will consist of a memorandum to the USGS TPO documenting the air-permeability testing in borehole USW SD-11. The types of test conducted, duration of tests, problems encountered, and other relevant information will be included in the memorandum. Delivery date will be one (1) months after completion of testing.

A Level 4 milestone (SPH274M4, due 15 Jul 99) will consist of a memorandum to the USGS TPO documenting submittal of air permeability test data to the RPC. This level 4 milestone consists of data obtained during air-permeability testing of borehole USW SD-11, including logbook pages, data reductions, and supporting documents. This milestone supports the level 4 milestone, "Air Permeability Testing USW SD-11" (SPH264M4). Delivery date is TBD (experience has shown that these types of data submittals take approximately 3 months to assemble, review, etc.).

A Level 4 milestone (SPH284M4, due 15 Oct 99) will consist of a memorandum to the USGS TPO describing air permeability testing in borehole USW SD-11". This level 4 milestone consists of a final memorandum describing the air-permeability testing and test results in borehole USW SD-11, including text, figures, tables, and illustrations. The memorandum will include methods used, test results, and other relative information. Delivery date is TBD (it is expected that this memorandum will be completed approximately 3 months after the submittal of the data package).

10. **Level IV Milestone Acceptance Criteria:**

See above

11. **Attachments and References:**

12. Schedule:

<u>Activity</u>	<u>Early Start</u>	<u>Early Finish</u>
Conduct Air-K Testing in USW SD-13	26 Apr 99	23 Jul 99
Prepare Data Pkg Air-K Tstg USW SD-13	26 Jul 99	25 Oct 99
Prepare Memo Air Permeability Tstg USW SD-13	26 Oct 99	25 Jan 00
Conduct Air-K Testing in USW SD-11	15 Jan 99	15 Apr 99
Prepare Data Pkg Air-K Tstg USW SD-11	16 Apr 99	15 Jul 99
Prepare Memo Air Permeability Tstg USW SD-11	16 Jul 99	15 Oct 99

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: 0G33123FBF
2. Summary Account Title: Hydrologic Characterization of Surface-Based Boreholes
3. Summary Account MGR/ORG: Robert Craig/USGS
4. Status of Change: Revised New
5. Scope Description:

Work scope for this summary account will include (1) analyses to provide a prediction of hydrologic conditions and hydrogeologic properties for surface-based boreholes SD-11 and SD-13 and (2) sample testing and analyses to provide the characterization of hydrologic conditions and hydrogeologic properties for boreholes SD-11 and SD-13 for the evaluation of hydrologic predictions. Expected ranges in values to be derived from these measurements will be provided to predictive reports for the boreholes, developed in SA TR39BFB1G. Actual measurements acquired will be compared against the predicted values in the Level 3 deliverables developed in SA TR39BFB1G.

FY97 activities will involve the development of the predicted properties, and one- or two-dimensional flow models to provide predictions of hydrogeologic conditions and properties for SD-11 and SD-13 using lithostratigraphic prognoses, an existing database of matrix properties and surface infiltration estimates for the borehole locations.

FY98: Matrix properties and hydrologic conditions will be measured on core samples collected from borehole SD-11. Initial measurements on all samples will be saturation and water potential, porosity, bulk density and particle density. Additional measurements on selected samples will include moisture retention and saturated and unsaturated hydraulic conductivity.

FY99: Matrix properties and hydrologic conditions will be measured on core samples collected from borehole SD-13. Initial measurements on all samples will be saturation and water potential, porosity, bulk density and particle density. Additional measurements on selected samples will include moisture retention and saturated and unsaturated hydraulic conductivity. Interpretations and evaluations of predictive accuracy will be done and a Level 4 milestone letter to the TPO describing the submittal of a draft interpretive report will be provided.

6. **Scope Differences from the Baseline:**

This is new work not included in original FY97 plans. The ability to provide predictions of moisture conditions and properties to test our data bases, conceptual models and understanding of spatial distributions of physical and hydrologic features within the mountain is critical to the credibility of the flow and performance assessment models produced for viability assessment.

7. **Key Assumptions:**

Predictions rely on a complete lithostratigraphic prognosis and schedules are dependent on drilling schedules.

8. **Cost Rationale: (Total FY97-FY99: \$260K)**

FY97: (\$20K)

Labor (0.15 FTE):

Research Hydrologist GS-12 (0.1 FTE): Expertise in application of numerical-modeling codes to simulate unsaturated matrix flow in layered volcanic systems and in determination and evaluation of physical and hydrologic properties of rock cores at Yucca Mountain.

Hydrologist GS-12 (0.05 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes.

FY98: (\$90K)

Labor (0.7 FTE):

Research Hydrologist GS-12 (0.2 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes.

Hydrologist GS-12 (0.1 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes.

Hydrologic Technician GS-9 (0.3 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in data collection and analysis and organization.

QA Implementation Specialist/Data Management GS-9 (0.1 FTE): Expertise in organization and compilation of data for preparation of records packages, technical procedures and record keeping.

ODC's (\$10K): Lab equipment, calibration and travel.

FY99 Costs (\$150K):

Labor (1.1 FTE):

Research Hydrologist GS-14 (0.2 FTE): High-level expertise in unsaturated flow, soil physics, unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes: expertise in use of numerical-model codes for simulation of UZ flow.

Research Hydrologist GS-12 (0.4 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes.

Hydrologist GS-12 (0.1 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes.

Hydrologic Technician GS-9 (0.3 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in data collection and analysis and organization.

QA Implementation Specialist/Data Management GS-9 (0.1 FTE): Expertise in organization and compilation of data for and preparation of records packages, technical procedures and record keeping.

ODC's (\$10K): Lab equipment, calibration and travel.

Level III and IV Milestones:

Level III: none

Level IV:

Level 4 milestone (No. SPH375M4, due 3 Nov 97) will provide predictive analyses for hydrologic-property measurements for the USW WTSD-11 and SD-13 boreholes in a letter to the TPO.

Level 4 milestone (No. SPH376M4, due 30 Sep 1998) will consist of a memorandum to the USGS TPO documenting the preparation and submittal to the Records Processing center and Technical Data Base, as appropriate, of laboratory analyses done from 4/1/98 through 7/31/98.

Level 4 milestone (No. SPH377M4, due 30 Sep 1998) will consist of a memorandum to the USGS TPO presenting the data and results of analyses and interpretations conducted from 4/1/98 through 8/31/98.

A Level 4 Milestone (No. SPH380M4, due April 1, 1999) will consist of a memorandum to the USGS TPO reporting analysis of actual vs. predicted range for hydrologic-property measurements for the USW SD-11 borehole.

A Level 4 Milestone (No. SPH382M4, due July 1, 1999) will consist of a memorandum to the USGS TPO reporting analysis of actual vs. predicted range for hydrologic-property measurements for the USW SD-13 borehole.

Level 4 milestone (No. SPH378M4, due 30 Sep 1999) will consist of a memorandum to the USGS TPO documenting the preparation and submittal to the Records Processing center and Technical Data Base, as appropriate, of laboratory analyses done from 8/1/98 through 7/31/99.

Level 4 milestone (No. SPH379M4, due 30 Sep 1999) will consist of a memorandum to the USGS TPO describing the results of a USGS draft interpretive report that will have been submitted for technical review presenting the data and results of analyses and interpretations from data collected from 4 boreholes, and will include an analysis of the accuracy of pre-drilling predictions of properties and hydrologic conditions.

10. Level III Milestone Acceptance Criteria:

11. Attachments and References:

12. Schedule:

<u>Activity</u>	<u>Early Start</u>	<u>Early Finish</u>
Conduct Predictive Analyses	1 Jul 97	01 Oct 97
Prep/Sub Memo to TPO Predictive Analysis	02 Oct 97	03 Nov 97
Collect and Analyze Data SD-11	01 Oct 97	30 Sep 98
Prep/Sub Data Pkg Apr 98 - Jul 98	01 Apr 98	30 Sep 98
Prep Memo Presenting Data/Results Apr - Aug 98	01 Apr 98	30 Sep 98

Prep/Sub Data Pkg Aug 98 - Jul 99

3 Aug 98

30 Sep 99

Prepare Draft Report on Borehole Analyses

01 Oct 98

30 Sep 99

Prep/Sub Memo to TPO on Draft Report

01 Jul 99

30 Sep 99

TECHNICAL BASIS FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED CHARACTERIZATION OF THE REPOSITORY BLOCK

1. Summary Account Number: 0G33124FB8
2. Summary Account Title: Hydrologic Characterization of the Repository Horizon
3. Summary Account MGR/ORG: Robert Craig/USGS
4. Status of Change: x Revised New
5. Scope Description:

The objectives of this study are to (1) provide a predictive analysis of the distribution of physical properties and hydrologic conditions in the Cross Drift and (2) sample and instrument the Cross Drift in order to collect data to evaluate and characterize the range and variability in water status (water potential and water content) and hydrologic properties in the Cross Drift, and then to evaluate the accuracy of the pre-excavation predictions of hydrologic conditions and properties. The data obtained and analyses performed will provide (1) information on the spatial distribution of the hydrologic conditions leading to the identification of flow pathways and estimation of the spatial distribution of flux into the repository horizon, (2) a detailed database of the spatial distribution and variability of physical and hydrologic properties of the repository horizon, (3) possible identification and location of fast and/or preferential flow pathways through isotopic and hydrologic analysis. This study is in support of evaluating the attribute of the DOE Waste Containment and Isolation Strategy concerned with the rate of water seepage into the potential repository.

The approach to estimating hydrologic conditions in the repository horizon located along the Cross Drift is to analyze the surface trace of the Cross Drift for potential high or low flux conditions based on the conceptual model of infiltration (Flint and others, 1996). Even with lateral flow in the PTn some evidence of high fluxes are expected to remain in the repository horizon. Water potential and saturation will be estimated for zones along the drift. Physical properties will be estimated based on an existing data base of matrix properties from boreholes and systematic sampling in the ESF main drift, and a lithostratigraphic prognosis.

To evaluate percolation flux into the repository horizon, a systematic and feature-based monitoring program is being proposed for the Cross Drift. (1) Heat dissipation probes used for the measurement of *in situ* water potential will be installed 2 m into the tunnel wall and spaced at 25-m intervals throughout the drift, and 6-m boreholes will be drilled every 500 m and monitored for changes in water status. These locations will all be covered by plastic sheets immediately following excavation. The data from these instruments will

provide continuous measurements at these locations. High flow pathways would be indicated by lower water potentials and higher water contents. Because the data is continuous, there is the possibility that transient pulses of water might be detected. Zones of higher fluxes could be indicated if there were zones of higher permeability associated with zones of higher water contents. (2) Fifty 2-m cored boreholes will be drilled in the locations covered by plastic to provide monitoring holes for water content measurements, core samples for geochemical analysis (tritium, stable isotopes (hydrogen, oxygen, carbon), cation/anion concentration, ^{14}C , strontium isotopes, chloride (pore water), and ^{36}Cl), and physical and hydrologic properties. (3) Samples collected from the drift walls at 10-m spacing (250 samples), will be processed to determine porosity, bulk density, particle density and saturated hydraulic conductivity. This data, along with geologic and fracture mapping, will provide a detailed analysis of the rocks within the repository host horizon of the spatial distribution and variability of the rock properties for confirmation of modeled distributions and flow model parameters.

FY97:

Activities for FY97 will include analyses to provide predictions of hydrologic and physical conditions along the Cross Drift.

FY98:

Activities for FY98 will include the procurement, development and calibration of borehole monitoring instrumentation, installation of wall and borehole instrumentation and subsequent monitoring, systematic and borehole sample collection in the Cross Drift, sample processing and analysis.

FY99:

Activities in FY99 will include the completion of laboratory analyses, ongoing monitoring and the final analysis of the accuracy of the predictive analyses to evaluate the adequacy of the conceptual models and analytical methodology. This analysis will be in the form of a milestone letter to the TPO describing the submittal of a draft interpretive report that has been provided as input to LA, and consisting of the compilation and interpretations of hydrogeologic data collected in the Cross Drift and an analysis of the accuracy of the predictions of properties and hydrologic conditions done prior to excavation.

6. **Scope Differences from the Baseline:**

This is new work due to the excavation of the Cross Drift.

7. **Key Assumptions**

Data collection and analyses are contingent on excavation schedules.

8. Cost Rationale: Total for FY97-FY99 is \$745K.

FY97 Costs (\$88K):

Staffing: (0.5 FTE)

Research Hydrologist GS-14 (0.1 FTE): High-level expertise in unsaturated flow, soil physics, unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes; expertise in use of numerical-model codes for simulation of UZ flow.

Research Hydrologist GS-12 (0.1 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes.

Hydrologist GS-12 (0.1 FTE): Expertise in installation of moisture monitoring instrumentation and operation of dataloggers, and data collection and analysis.

Hydrologic Technician GS-9 (0.2 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in calibration and installation of moisture monitoring instrumentation and operation of dataloggers, and data collection and analysis.

Travel (\$2K): Travel is for 4 person trips for onsite work attendant with planning and testing development.

Other Direct Costs (\$25K): Purchase of equipment and supplies.

FY98 Costs: (\$357K):

Staffing (2.3 FTE):

Research Hydrologist GS-14 (0.3 FTE): High-level expertise in unsaturated flow, soil physics, unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes; expertise in use of numerical-model codes for simulation of UZ flow.

Hydrologist GS-13 (0.2 FTE): Expertise in collection, analysis, and interpretation of unsaturated-zone hydrologic data with particular emphasis gaseous-phase flow, chemistry, and isotopic analysis for source determination and age dating.

Research Hydrologist GS-12 (0.2 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes.

Hydrologist GS-12 (0.2 FTE): Expertise in determination and interpretation of physical and hydrologic properties of rock cores and soil samples through application of state-of-the-art

laboratory methods; expertise in application of numerical-modeling codes to simulate unsaturated matrix flow to support laboratory determinations, specialized expertise in operation of an ultra-centrifuge to perform direct measurements of unsaturated hydraulic conductivity.

Hydrologic Technician GS-9 (0.4 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in calibration and installation of moisture monitoring instrumentation and operation of dataloggers, and data collection and analysis.

Hydrologic Technician GS-9 (0.3 FTE): Expertise in laboratory calibration and field installation of moisture monitoring instrumentation, field measurements of hydrologic properties, operation of dataloggers, data collection, processing and analysis, and preparation of data packages.

Hydrologic Technician GS-9 (0.3 FTE): Expertise in laboratory calibration and field installation of moisture monitoring instrumentation, field measurements of hydrologic properties, operation of dataloggers, data collection, processing and analysis, and preparation of data packages.

Hydrologic Technician GS-9 (0.1 FTE): Proficiency in laboratory methods to extract pore fluids from rock cores by uniaxial compression and vacuum distillation; competency in field methods to collect gas samples from boreholes.

Administrative assistant GS-9 (0.2 FTE): Proficiency in organization, budgets, word processing, spreadsheets, databases, quality assurance and data package preparation and submittal.

Other Direct Costs (\$92K): Purchase of equipment and supplies, and isotopic lab analyses and travel.

FY99 Costs (\$300K):

Staffing (2.0 FTE):

Research Hydrologist GS-14 (0.3 FTE): High-level expertise in unsaturated flow, soil physics, unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes: expertise in use of numerical-model codes for simulation of UZ flow.

Hydrologist GS-13 (0.1 FTE): Expertise in collection, analysis, and interpretation of unsaturated-zone hydrologic data with particular emphasis gaseous-phase flow, chemistry, and isotopic analysis for source determination and age dating.

Research Hydrologist GS-12 (0.3 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in unsaturated hydrologic-properties analysis, unsaturated-flow theory, and percolation processes.

Hydrologist GS-12 (0.3 FTE): Expertise in determination and interpretation of physical and

hydrologic properties of rock cores and soil samples through application of state-of-the-art laboratory methods; expertise in application of numerical-modeling codes to simulate unsaturated matrix flow to support laboratory determinations, specialized expertise in operation of an ultra-centrifuge to perform direct measurements of unsaturated hydraulic conductivity.

Hydrologist GS-11 (0.1 FTE): Proficiency in hydrologic and geochemical data-collection and analysis methods; proficiency in laboratory methods to determine composition of gas samples collected from boreholes and to determine the tritium content of water samples; proficiency in methods of preparation, preservation, and transport of gas and water samples for chemical analysis by outside laboratories.

Hydrologic Technician GS-9 (0.2 FTE): Expertise in determination of physical and hydrologic properties of rock cores through application of state-of-the-art laboratory methods; expertise in calibration and installation of moisture monitoring instrumentation and operation of dataloggers, and data collection and analysis.

Hydrologic Technician GS-9 (0.45 FTE): Expertise in laboratory calibration and field installation of moisture monitoring instrumentation, field measurements of hydrologic properties, operation of dataloggers, data collection, processing and analysis, and preparation of data packages.

Hydrologic Technician GS-9 (0.1 FTE): Proficiency in laboratory methods to extract pore fluids from rock cores by uniaxial compression and vacuum distillation; competency in field methods to collect gas samples from boreholes.

Administrative assistant GS-9 (0.15 FTE): Proficiency in organization, budgets, word processing, spreadsheets, databases, quality assurance and data package preparation and submittal.

Other Direct Costs (\$32K): General supplies and laboratory support for calibration services, and travel.

9. Level III and IV Milestones:

Level IV:

Level 4 milestone (No. SPH351M4, due 3 Nov 97) will consist of a memorandum to the USGS TPO describing the predictive analysis for hydrologic conditions and physical properties in the Cross Drift.

Level 4 milestone (No. SPH352M4, due 30 Sep 1998) will consist of a memorandum to the USGS TPO documenting the preparation and submittal to the Records Processing center and Technical Data Base, as appropriate, of data collected from 01 Oct. 1997 through 31 Jul. 1998.

Level 4 milestone (No. SPH353M4, due 30 Sep 1998) will consist of a memorandum to the USGS TPO presenting the data and results of analyses and interpretations conducted from 01 Oct. 1997 through 31 Aug. 1998.

Level 4 milestone (No. SPH356M4, due 14 May 1999) will consist of a memorandum to the USGS TPO documenting the submittal of a draft USGS interpretive report for technical review. This report is also intended to support LA. It will present data collected from the Cross Drift and will describe the hydrologic conditions and physical properties in the Cross Drift to provide an identification of flow pathways, and will provide an analysis of the accuracy of predictions of properties and hydrologic conditions that were done prior to excavation.

Level 4 milestone (No. SPH354M4, due 30 Sep 1999) will consist of a memorandum to the USGS TPO documenting the preparation and submittal to the Records Processing center and Technical Data Base, as appropriate, of data collected from 01 Oct. 1998 through 31 Jul. 1999.

Level 4 milestone (No. SPH355M4, due 30 Sep 1999) will consist of a memorandum to the USGS TPO presenting the data and results of analyses and interpretations conducted from 01 Oct. 1998 through 31 Aug. 1999.

10. Level III Milestone Acceptance Criteria:

11. Attachments and References: None

12. Schedule:

<u>Activity</u>	<u>Early Start</u>	<u>Early Finish</u>
Conduct Predictive Analysis of Cross Drift	1 Jul 97	3 Nov 97
Prep/Sub letter to TPO on predictive analysis	1 Oct 97	3 Nov 97
Collect and Analyze Data in Cross Drift	1 Oct 97	30 Sep 99
Prep/Sub Data Pkg Oct 97 - Jul 98	1 Oct 97	30 Sep 98
Prepare draft report on Cross Drift	1 Jun 98	14 May 99
Prep/Sub Data Pkg Oct 98- Jul 99	1 Oct 98	30 Sep 99
Prep/Sub letter to TPO on draft report	1 Apr 99	14 May 99

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: OG33124FBB
2. Summary Account Title: Air-Permeability & Hydrochemistry Testing ESF
3. Summary Account MGR/ORG: Robert Craig/ISGS
4. Status of Change: X Revised ___ New
5. Scope Description:

FY99: The objectives of this study are to determine in situ the pneumatic properties of and gas-chemistry within and across structural features, including the Solitario Canyon fault, within the unsaturated zone. These data, analyses, and interpretations will be used as input to and as constraints on revisions to the site-scale unsaturated-zone flow model that is being developed. Air-permeability and hydrochemistry testing will be conducted in boreholes cored across the Solitario Canyon fault from an access drift or an alcove. Testing will include, as appropriate 1) temperature and heat flow surveys, 2) geophysical logging, 3) pneumatic pressure monitoring, 4) gas sampling for chemical analyses, and 5) single-hole and cross-hole air-permeability testing.

6. Scope Differences from the Baseline:

This work will be conducted on the Solitario Canyon Fault as opposed to the Ghost Dance Fault.

7. Key Assumptions:

Personnel will be available to conduct the various field activities associated with this new work and replacement components for the underground testing equipment will be procured prior to the initiation of testing.

8. Cost Rationale: **FY99:** (\$221K)

Staffing: (1.0 FTE)

Hydrologist GS-13 (0.2 FTE): Expertise in design, conduct, and interpretation of air-permeability and pneumatic-tracer tests to determine hydrologic and pneumatic properties pertinent to flow of water and gas in fractured, unsaturated rock.

Hydrologist GS-13 (0.1 FTE): Expertise in collection, analysis, and interpretation of unsaturated-zone hydrologic data with particular emphasis on gaseous-phase flow, chemistry, and isotopic analysis for source determination and age dating.

Hydrologist GS-12 (0.25 FTE): Proficiency in the design and operation of pneumatic and hydrologic testing equipment and the interfacing of analog measurement devices to automated data-acquisition systems and data bases.

Hydrologist GS-11 (0.2 FTE): Competency in the collection, compilation, and analysis of hydrologic and chemical data with emphasis on gaseous-tracer detection, gas sampling, and field determinations of gas composition using a gas chromatograph.

Engineering Technical GS-11 (0.1 FTE): High-level proficiency in the fabrication and assembly of pneumatic-testing systems.

Computer Specialist GS-9 (.1 FTE): Competency in the implementation of procedure to calibrate and test precision measurement devices; proficiency in the application of moderately complex computer programs to operate automated field-testing equipment and compile test data.

QA Specialist GS-11 (0.05 FTE): Proficiency in the implementation of QA requirements pertinent to calibration of precision instruments, collection of hydrologic data, sample tracking, and compilation and review of complex data packages.

Travel: (\$12K): 20 person-trips (Denver to NTS) to perform air-permeability and hydrochemistry testing in the SCF alcove and to consult with ESF Test Coordinator Office staff.

Work By Others: (0.4 FTE)

Field Hydrologist (0.3 FTE): to oversee day-to-day air-permeability testing operations, to serve as the on-site representative for the principal investigator, and perform initial reduction of air-permeability test data.

Hydrologic Equipment Technician (0.1 FTE): to assemble and maintain hydrologic testing equipment, to perform routine testing operations, and to assist with the placement and removal of testing equipment.

Other Direct Costs: (\$55K)

Vendor-performed calibration of test equipment (\$5K); isotopic analyses of gas samples from alcove boreholes and water extracted from core (\$15K); alcove-borehole heat-flow surveys (\$30K); miscellaneous field supplies (\$5K).

9. **Level III Milestones: None.**

A level 4 milestone (No. SPH35GM4, due 15 Jan 99) will consist of a memorandum to the USGS TPO stating that pneumatic pressure monitoring and gas sampling and/or air-permeability testing has started.

A level 4 milestone (No. SPH35KM4, due 31 Aug 99) will consist of a memorandum to the USGS TPO describing the results of air-permeability, pneumatic, and hydrochemical testing conducted in the Solitario Canyon fault alcove.

10. **Level III Milestone Acceptance Criteria: None**

11. **Attachments and References:**

12. **Schedule:**

<u>Activity</u>	<u>Early Start</u>	<u>Early Finish</u>
Conduct Air-K/Hydrochem Tstg Solitario Canyon	12 Jan 99	12 May 99
Prepare Report on Air-K/Hydrochem Tstg	13 May 99	31 Aug 99

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: 0G33124FBD
2. Summary Account Title: Moisture Monitoring in the ESF
3. Summary Account MGR/ORG: Robert Craig, USGS
4. Status of Change: X Revised New
5. Scope Description:

This activity is a USGS/LBNL collaborative effort. The objectives of this study are (1) to determine the moisture balance within the Cross Drift, (2) to determine the effects of TBM water use and ventilation on the water balance and water status surrounding the Cross Drift, and (3) to estimate the relationship of TBM water use with dust control and percolation of applied water away from the tunnel. The moisture balance will be estimated by monitoring the quantity of water applied during construction and excavation, measuring the quantity of water removed by ventilation, measuring the change in water storage in the tunnel wall due to dry out, and estimating the percolation depth of applied water. The fate and locations of applied water tunnel will be investigated by determining the moisture balance within the Cross Drift and adjacent rock mass in response to water-vapor transport out of the Cross Drift by operation of the ventilation system, water application in the Cross Drift due to construction activities, changes in water storage in rock mass surrounding the Cross Drift, and percolation away from the Cross Drift. Water application rates for construction and excavation will be evaluated for adequate dust control while at the same time minimizing or at least understanding the percolation depths and pathways of this water into the rock surrounding the Cross Drift. These data will provide initial and boundary conditions for the site-scale unsaturated-zone flow model as well as large-scale in-situ moisture flow in the rock mass near the Cross Drift in support of evaluating the attribute of the DOE Waste Containment and Isolation Strategy concerned with the rate of water seepage into the potential repository.

FY98: USGS activities: Eight monitoring stations will be installed to measure air pressure, temperature, relative humidity, and in selected locations, wind speed. At permanently installed monitoring stations, changes in the near-surface water storage in the exposed Cross Drift wall will be monitored with heat dissipation probes and neutron probes or TDR. Stations will be located on the TBM and systematically throughout the Cross Drift. Data will be collected and analyzed from these stations on a regular basis and the stations will be maintained in calibration and in a functional state. The contractor will supply timely records of water application rates as well as tracer application rates. These data

will provide estimates of the quantity of water added to the Cross Drift, the quantity of applied water removed by ventilation, and the quantity of water removed from the exposed Cross Drift wall in order to develop a water mass balance for moisture in the Cross Drift. A thirty-meter deep borehole will be drilled in the invert of the ESF Main Drift in the Topopah Spring in each of three locations with varying lengths of time since TBM excavation. Cuttings from these boreholes will be analyzed for tracers from construction water to determine depth profiles for the percolation depth of construction water. These boreholes will give an indication of the rates and amounts of percolation of construction water below the TBM. Before TBM excavation begins, three 30-meter boreholes will be drilled at an angle from the TBM launch chamber to pass underneath the path of the TBM. In addition, three 30-meter boreholes will be drilled upward at an angle through the ESF Main Drift to pass underneath the path of the TBM at the intersection of the ESF Main Drift and the Cross Drift. These boreholes will be video logged and instrumented to measure the water status underneath the TBM before, during, and after excavation. These boreholes will also be partially lined with absorbent material to collect water samples that percolate to the borehole due to TBM excavation. The arrival times of construction water tracers at various locations underneath the TBM will be a measure of percolation rates and pathways for applied construction water. During TBM excavation, various water application rates will be used for dust control. Dust samples will be collected and related to the water application rates. The dust samples will be analyzed for quantity, mineralogy, and carbonate content. At three locations in the Cross Drift, under three distinctly different water application rates, 2 10-meter boreholes and 1 2-m borehole will be drilled and the cuttings analyzed for construction water tracers with depth. At each location, at three times following excavation, three holes will be drilled for a total of 27 boreholes. These boreholes will provide estimates of construction water percolation depths and percolation depths in relation to construction water application rates. Water content profiles in these boreholes will be periodically measured with neutron probes to measure water construction percolation rates.

FY99: Collection and analysis of air pressure, temperature, relative humidity, wind speed, and water status in the Cross Drift will continue. The stations will be maintained in calibration and in a functional state. The contractor will continue to supply timely records of water application rates as well as tracer application rates. These data will provide estimates of the quantity of water added to the Cross Drift, the quantity of applied water removed by ventilation, and the quantity of water removed from the exposed Cross Drift in order to develop a water mass balance for moisture in the Cross Drift. Water content profiles in the boreholes in the Cross Drift that were drilled to monitor construction water percolation rates and percolation depths will be measured. Analysis of cutting samples for construction water tracers and dust samples will continue.

6. **Scope Differences from the Baseline:**

This work is expanded to encompass the Cross Drift and includes a more detailed analysis of the amount and movement of construction water.

7. Key Assumptions

Cross Drift construction will begin in the middle of FY98. Constructor will provide timely records of water and tracer application rates. Moisture monitoring will be established in FY98 and will continue at the same level in FY99. Samples will be analyzed for construction water tracers.

8. Cost Rationale:

FY98: \$185K

Staff (1.35 FTE) :

Research Hydrologist GS-14 (0.25 FTE): High-level expertise in hydrology and unsaturated flow including meteorology, evapotranspiration, soil physics, unsaturated hydrologic-properties analysis, unsaturated-flow theory, and infiltration processes.

Hydrologist GS-12 (0.25 FTE): Expertise in hydrology and unsaturated flow, experience in moisture balance studies, fluid flow, data package preparation and data management.

Hydrologic Technician GS-9 (0.75 FTE): Proficiency in data collection and calibration of instruments, expertise in compilation of data for records packages.

Administrative Assistant GS-9 (0.1 FTE): Proficiency in organization, budgets, word processing, spreadsheets, databases, quality assurance and data package preparation and submittal.

Other Direct Costs (\$45 K): Purchase of Equipment (\$35 K); Repair and calibration of monitoring equipment (\$8 K); misc. field and office supplies (\$2 K).

Travel (\$5 K) 5 trips to site or Denver.

FY99: \$150K

Staff (1.4 FTE) :

Research Hydrologist GS-14 (0.25 FTE): High-level expertise in hydrology and unsaturated flow including meteorology, evapotranspiration, soil physics, unsaturated hydrologic-properties analysis, unsaturated-flow theory, and infiltration processes.

Hydrologist GS-12 (0.25 FTE): Expertise in hydrology and unsaturated flow, experience in moisture balance studies, fluid flow, data package preparation and data management.

Hydrologic Technician GS-9 (0.75 FTE): Proficiency in data collection and calibration of instruments, expertise in compilation of data for records packages.

Administrative Assistant GS-9 (0.15 FTE): Proficiency in organization, budgets, word processing, spreadsheets, databases, quality assurance and data package preparation and submittal.

Other Direct Costs (\$10 K): Repair and calibration of monitoring equipment (\$8 K); misc. field and office supplies (\$2 K).

Travel (\$5 K) 5 trips to site or Denver.

9. Level IV Milestones:

Level 4 milestone (No. SPH361M4, due 30 Sep 1998) will consist of a memorandum to the USGS TPO documenting the preparation and submittal to the Records Processing Center and Technical Data Base, as appropriate, of data collected from 15 Sep. 1997 through 31 Jul. 1998.

Level 4 milestone (No. SPH363M4, due 30 Sep 1998) will consist of a memorandum to the USGS TPO presenting the data and results of analysis and interpretations conducted from 15 Sep. 1997 through 31 Aug. 1998.

Level 4 milestone (No. SPH362M4, due 30 Sep 1999) will consist of a memorandum to the USGS TPO documenting the preparation and submittal to the Records Processing Center and Technical Data Base, as appropriate, of data collected through from 15 Sep. 1998 through 31 Jul. 1999.

Level 4 milestone (No. SPH364M4, due 30 Sep 1999) will consist of a memorandum to the USGS TPO presenting the data and results of analysis and interpretations conducted from 15 Sep. 1998 through 31 Aug. 1999.

10. Level III Milestone Acceptance Criteria: None

11. Attachments and References: None

12. Schedule:

<u>Activity</u>	<u>Early Start</u>	<u>Early Finish</u>
Conduct Analysis On Water Balance In Cross Drift	15 Sep 97	30 Sep 99
Conduct Analysis TBM Water Migration	22 Dec 97	30 Sep 98
Prep Pkg Data Collected Sep. 97 - Jul. 98	15 Sep 97	30 Sep 98
Prep Pkg Data Collected Sep. 98 - Jul. 99	15 Sep 98	30 Sep 99

July 2, 1997 (7:21pm)

TECHNICAL BASIS FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED CHARACTERIZATION OF THE REPOSITORY BLOCK

1. Summary Account Number: OG33124GBA (FY98)
2. Summary Account Title: Infiltration of Construction Water in the ESF
3. Summary Account MGR/ORG: Robert Craig, USGS
4. Status of Change: Revised New
5. Scope Description:

This activity will be conducted in conjunction with OG33124FBD (Moisture Monitoring in the ESF).

It has been proposed to use the downward infiltration of bromine-spiked J-13 construction water in the ESF as the basis for a long-term tracer test for studying fracture-matrix interaction in the unsaturated zone. In addition to containing the bromine tracer, the construction water has unique measurable isotopic compositions that can also be used as tracers. Because of evaporation due to the ventilation system, construction water infiltrating the rock mass below the inverts will be strongly enriched in deuterium and oxygen-18. Consequently the isotopic composition of this water will be unique compared with any native water in the rock mass; thus it will be easily detectable as a plume of isotopically "heavy" water moving downward in fractures and the matrix. Because the degree of isotopic enrichment is a direct function of the degree of evaporation (Rayleigh fractionation law), these data will also be used to constrain the construction water budget, i.e. the isotopic composition of the infiltrating water will indicate how much water has been lost to evaporation.

The J-13 construction water has a $\delta^{87}\text{Sr}$ value of +3.2‰ whereas the native pore water in the Topopah Spring Tuff has values between +4.5 and +4.7‰. The difference between the $\delta^{87}\text{Sr}$ of construction water ponding between the inverts and native water will have been enhanced by contact with the concrete which has a large strontium content and a $\delta^{87}\text{Sr}$ value near zero. (Cement is made from limestones with a marine $\delta^{87}\text{Sr}$ signature). Thus, strontium isotopic compositions can be used to trace the downward movement of construction water as well as provide some information on the kinetics of reaction between water and concrete.

If liquid water is found in the boreholes, indicating the development of local saturation, this water could be sampled directly for analytical work of which we would need approximately 1.5 liters of water. If liquid water is not encountered, the core would have to be preserved following Al Yang's technical procedure. Water for oxygen and deuterium would then be extracted by vacuum distillation. Strontium isotopes would

be determined by leaching of pore salts from core.

6. **Scope Difference from the Baseline: New work.**

7. **Key Assumptions:**

The following assumptions are embodied in the development of the BOE: (1) studies will be conducted at three sites in the ESF, (2) a minimum of 10 samples from each site will be selected for oxygen, hydrogen, and strontium isotopic analyses, (3) the USGS stable and radiogenic isotope facilities will be fully functional in FY98, (4) sampling and analyses will be completed in FY98, and (5) all construction costs are covered elsewhere.

8. **Cost Rationale: (\$101 K)**

Labor (0.95 FTE):

Geologist GS-15 (0.01 FTE): Expertise in management, supervision, sample collection design, data synthesis and interpretation.

Hydrochemist GS-14 (0.1 FTE): Principal Investigator in UZ Hydrochemistry activities and to oversee the tritium and fluid extraction laboratory.

Geologist GS-13 (0.07 FTE): Expertise in stable isotope geochemistry.

Hydrologist GS-13 (0.07 FTE): Expertise in strontium isotope geochemistry, geochemical modeling, and data base development and management.

Chemist GS-13 (0.1 FTE): Expertise in strontium and rare earth chemistry and thermal ionization mass spectrometry.

Chemist GS-12 (0.07 FTE): Expertise in stable isotope analyses (oxygen, carbon, hydrogen) and gas mass spectrometry.

Chemist GS-11 (0.15 FTE): Expertise in extractive analytical methodologies for stable isotope analyses.

Physical Science Technician GS-9 (0.07 FTE): Expertise in the operation of stable extraction lines, sample collection and documentation, and data management.

QA Implementation Specialist GS-9 (0.01 FTE): Expertise in maintenance of QA records, tracking of milestones, and monitoring adherence to technical procedures and other QA requirements during the course of the investigation.

Two Physical Science Technicians GS-7 (0.3 FTE) for extractive work and general

laboratory support.

Travel: (\$5 K)

Two sample collecting trips by 4-man team of specialists.

Other Direct Costs: (\$16 K)

Includes \$5K for support of the radiogenic isotope laboratory, \$7K for the tritium/water extraction laboratory, and \$4K for the stable isotope laboratory.

9. Level III Milestones: None

A level IV milestone (No. SPH373M4, due September 15, 1998) will consist of a memorandum to the USGS TPO describing the data collection with preliminary interpretations.

10. Level III Milestone Acceptance Criteria: NA.

11. Attachments and References: None

12. Schedule:

<u>Activity</u>	<u>Early Start</u>	<u>Early Finish</u>
Sample Bh For Oxygen/Hydrogen/ Isotopic Analyses	01 Oct 97	15 Sep 98

are used to design the tests and predict the drift impacts before the drift excavation and compare and interpret the tests during the excavation. The models calibrated with the Cross Drift data can further improve the credibility of the models and enhance the confidence in the model predictions for drift impact on the repository performance.

FY98 Activities:

Moisture Stations: The study will install moisture monitoring stations along the Cross Drift to collect relative humidity, temperature, pressure, and air velocity data. In addition to stationary stations, the sensors can also be installed on the TBM. The data can be used to determine the moisture removed by ventilation induced air stream along the drift.

Wall Monitoring: The stationary sensor measurements are supplemented by moisture and infrared imaging along the drift periodically with a mobile moisture cart. The IR images monitors the evaporation processes on the drift wall.

Drying and Rewetting Monitoring: The drift and wall monitoring can supplement by short boreholes on the drift walls for the measurement of rock drying processes with water potential and saturation sensors, including psychrometers, tensiometers, HDP, TDR. At selected locations, the walls can be covered with plastic sheets to either preserve the water content in the rocks or induce rewetting of the rocks.

Ceiling Monitoring: The ceiling of sections of the drift can be instrumented with drip collection system. The drip collection system can be used to quantify the seepage into the drift. For some sections, we can enclose the monitoring grid so that the space between the grid and the crown can be isolated from the ventilation operation of the drift.

Water Usage and Ventilation Evaluation: The construction water usage and the ventilation rates will be monitored jointly by Scientific Operation and ESF Constructor to make the water usage data and ventilation flow data qualified for the assessment of drift impact on the surrounding rock formation. Spatial and temporal distributions of water usage and ventilation flow rates are required for water and moisture balance evaluations. The ponding of construction water on the invert will be documented.

Vertical Temperature and Potential Measurement for Percolation

Quantification: After sample collections, the boreholes can be instrumented with temperature probes, psychrometric and other sensors to collect data for better quantification of the percolation flux through the unsaturated zone. As the Cross Drift moves into deeper stratigraphic units, the boreholes can reach the lithophysal and Calico Hills units. The objective of this study to determine if water released at the repository level can migrate over long distances and reach

the Calico Hills unit, especially at locations near the western boundary with the repository closer to the underlying barrier units. The accumulation of construction water at interfaces and the downward flow from the repository can lead us to gain better understanding of the flow of future waste (thermally) induced flow toward the water table and the biosphere. The temperature and hydrologic data from borehole monitoring can lead to better quantification of the percolation fluxes in the Unsaturated Zone.

FY 99 Activities:

Moisture Monitoring will continue at reduced levels to evaluate longer term conditions in the Cross Drift.

6. Scope Differences from the Baseline:

This work was not included in the original FY97 plans. The necessity to conduct this work is a result of the expressed desire of regulatory groups to assess the predictive capabilities of the project for moisture monitoring and plume evaluation along the East-West Drift. The data collected in the drift monitoring will also be used for evaluation of ventilation system, dust control, and other issues for design of waste emplacement drifts and performance confirmation drifts.

7. Key Assumptions:

Adequate resources will be made available to complete this work.

8. Cost Rationale:

Model Prediction, Test Design, and Interpretation; Moisture Stations; Wall Monitoring; Drying and Rewetting Monitoring; Ceiling Monitoring; Water Usage and Ventilation Evaluation; and Vertical Temperature and Potential Measurement for Percolation Quantification will require a total (unburdened) budget of \$400 for LBNL.

LBNL will require the following:

FY98: (\$176K)

approximately 0.25FTE of labor category 101B, 0.6 FTE of labor category 101C, and 0.25 FTE of labor category 106, 7.5K in travel, and 45K in sensory equipment, maintenance, etc, and 5K for micropurchases, telephones, computer recharges, etc.

FY99: (\$189K)

approximately 0.25FTE of labor category 101B, 0.7 FTE of labor category 101C, and 0.25 FTE of labor category 106, 5K in travel, and 5 K for micropurchases, telephones, computer recharges, etc.

9. **Level III Milestones:**

There will be a level 3 milestone No. SP33S9M3 (Construction Water and Dust Control in the Cross Drift) in conjunction with USGS due Nov 30, 1998 to be issued as an M&O report. The report will present data and results of analyses and interpretations conducted from December 1997 through August 1999, and evaluates the current hydrologic conditions in the area of the ESF Cross Drift. If testings has been delayed for any reason (i.e.construction), no incomplete data sets will be included in this milestone.

There will be a level 3 milestone No. SP33T9M3 (Moisture monitoring and plume evaluation due Aug 30, 1999) consisting of a M&O report to be prepared as input to LA. The report will present data and results of analyses and interpretations conducted from December 1997 through August 1999, and evaluates the impact of the construction activities of the ESF Cross Drift. If testings has been delayed for any reason (i.e.construction), no incomplete data sets will be included in this milestone.

Level IV Milestones:

L4 letter report on Model Prediction of Cross Drift Impact on Moisture Conditions and Plume Migration. Report will include the results of the model simulations using the UZ Site-Scale and Drift-Scale models to predict the impact of the construction of the Cross Drift on the moisture conditions in the ESF and Cross Drift and the potential construction water plume migration. Model efforts will include the results from moisture study and drift seepage in niche study in the ESF Main Drift, and previous construction water usage data from the ESF Constructor. Recommendation on test design for the moisture monitoring program will be included. Due 1/31/97 (SP33T1M4)

L4 letter report summarizing the progress of Moisture Monitoring, Wall Monitoring, and Drying Study along the Cross Drift, due 4/30/98. If testings has been delayed for any reason (i.e.construction), no incomplete data sets will be included in this milestone. (SP33T2M4)

L4 letter report summarizing the progress of Seepage Detection activity, due 6/30/98. If testings has been delayed for any reason (i.e.construction), no incomplete data sets will be included in this milestone. (SP33T3M4)

L4 letter report summarizing the progress of Vertical Temperature and Percolation Evaluation, 8/31/98. If testings has been delayed for any reason (i.e.construction), no incomplete data sets will be included in this milestone. (SP33T4M4)

10. Level III Milestone Acceptance Criteria:

Construction Water Usage and Dust Containment - Cross Drift, due November 30, 1998. (M/S# SP33S9M3)

Need completion criteria

Milestone Acceptance Criteria:

The report ill discuss the results of the monitoring of moisture conditions and dust containment in the Cross Drift during the excavation and for the evaluation of the impact of excavation, ventilation, and construction water usage on the surrounding rocks before, during, and after the drift excavation. Specifically a summary of relative humidity, temperature, pressure, and air velocity measurement results will be reported. In addition, measurements from the sensors installed on the TBM will be discussed. A determination of the moisture removed by ventilation induced air stream along the drift will be included. The report will analyze the migration of construction water used for excavation and dust control downward from the drift to underlying barriers. The report will discuss the coupling of field testing and monitoring with UZ Site-Scale Model and Drift Scale Model. The data collected in the drift monitoring will also be used for evaluation of ventilation system, dust control, and other issues for design of waste emplacement drifts and performance confirmation drifts. If testings has been delayed for any reason (i.e.construction), no incomplete data sets will be included in this milestone.

Moisture Monitoring and Plume Evaluation Studies along the Cross Drift, due in August 30, 1999. (M/S# SP33T9M3)

Need completion criteria

Milestone Acceptance Criteria:

The Level 3 milestone report will include the results and evaluation of the moisture monitoring and plume evaluation studies conducted in the ESF Cross Drift and will be done in collaboration with the USGS. The discussion will include the results of all model predictions, test design and interpretation. It will include the results of the drift monitoring program from the various moisture stations. It will summarize the finding of the wall evaporation monitoring with infrared imaging and the drying measurements taken with in-wall sensors; Results of the drip monitoring in drift ceiling will be presented, as well as the results of sampling of plume migration below the invert. Vertical temperature

and potential measurements for percolation flux determination and their interpretation will be presented. The report will also include the evaluation results of the LiBr plume seepage experiment and the analyses of data from boreholes for detection of LiBr traces. If testings has been delayed for any reason (i.e.construction), no incomplete data sets will be included in this milestone.

11. Attachments and References:
None

12: Schedule:	Early Start	Early Finish
Predictions	7/1/97	1/20/98
TBM Water Migration	12/22/97	9/30/98
Water Balance	9/15/98	9/30/99

matrix, and fracture-matrix parameters to be used in Performance Assessment models and UZ site scale models near the repository horizon.

6. **Scope Differences from the Baseline:**

This work was not included in the original FY97 plans. The necessity to conduct this work is a result of the expressed desire of regulatory groups to assess the predictive capabilities of the project for Fracture Flow, Fracture-Matrix Interaction, and Matrix Imbibition Test in the Cross Drift.

7. **Key Assumptions:**

Adequate resources will be made available to complete this work.

8. **Cost Rationale:**

FY98:

To start on this work, LBNL will require 0.1 FTE of labor category 101A, 0.2 FTE of labor category 101B, and .25 FTE of labor category 101C; 7K in travel; and 20K in equipment, miscellaneous purchases, telephone, etc.

FY99:

In order for LBNL to complete its objective of quantifying the fracture flow, fracture-matrix interaction, effective fracture surface area, and matrix imbibition processes in both the lower lithophysal and nonlithophysal units in the East/West Drift, we will require approximately 0.4 FTE of labor category 101A, 0.8 FTE of labor category 101B, and 1.85 FTE of labor category 101C; 28K in travel; and 55K in equipment, miscellaneous purchases, telephone, etc. (Total 750K, based on FY98 Projected Labor Rates)

9. **Level III Milestones:**

None

Level IV Milestones:

Title: Progress report on the Test Site Characterization and Tracer Flow Configuration

Deliverable No.:

Due Date: October 15, 1998

The report summarizes the results of the test site preparation, including slot cutting and instrumentation, borehole drilling and cross-hole characterization, and the test design for the sequence of liquid tracer injection tests. Available data of fracture and matrix characteristics will be used in the modeling to predict the extent of matrix imbibition and diffusion, the rates of fracture flows, and the strengths of fracture-matrix interactions. If testing has been delayed for any reason (i.e. construction), no incomplete data sets will be included in this milestone.

Title: Progress report on the laboratory measurements of cores and samples collected in the flow tests

Deliverable No.:

Due Date: May 15, 1999

The report summarizes the data from laboratory measurements of cores from both lithologic units and samples which are stained with water imbibed into the matrix. The areal distributions of wetted surfaces on the fracture planes (effective fracture surface area) and the depth of penetration of the wetting front into the matrix will be compared with model predictions. If testing has been delayed for any reason (i.e. construction), no incomplete data sets will be included in this milestone.

Title: Final Report on the Fracture Flow, Fracture-Matrix Interaction, and Matrix Imbibition.

Deliverable No.:

Due Date: August 1, 1999

This report summarizes the results of field testing and monitoring of fracture flows from the boreholes to the slot, and quantifies the fracture-matrix interactions, effective fracture surfaces, and matrix imbibition and diffusion in fractured tuff units. The effective parameters for flow partition between fracture and matrix domains will be quantified for inputs to the unsaturated zone models and performance assessment models. The results will feed into the Level III milestone: Dynamic and Static Testing for Fracture Flow, Seepage, and Ponding. If testing has been delayed for any reason (i.e. construction), no incomplete data sets will be included in this milestone.

10. **Level III Milestone Acceptance Criteria:**

None

11. **Attachments and References:**

None

12: **Schedule:**

Early Start

Early Finish

Testing

6/12/98

9/30/99

TECHNICAL BASIS FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED CHARACTERIZATION OF THE REPOSITORY BLOCK

1. Summary Account Number: TR33124FBB
2. Summary Account Title: Moisture Monitoring in the ESF (Phase 2)/Drift Seepage Test
3. Summary Account MGR/ORG: J. Wang
4. Status of Change: Revised New
5. Scope Description: Drift to Drift/Borehole Study

This activity will be performed in collaboration with the USGS. LBNL will be responsible for all predictive modeling, and the tracer testing, including injection, sampling and monitoring. The USGS will be responsible for the water infiltration test. The objective is to instrument both the Cross Drift and the ESF Main Drift to determine if water from one drift can be detected in the other drift. The seepage into the lower drift can be used to quantify the travel times between drifts and the water seepage rates into drift which determine the performance of most of the waste isolation attributes in the drift. The field testing and monitoring will be strongly coupled with UZ Site-Scale Model and Drift Scale Model. The models will be used to design the tests, and the data will be used to calibrate the models for input into TSPA-LA. This study also can be used to contribute to the design of performance confirmation drifts which are planned to monitor the waste emplacement drifts.

This proposal is based on the opportunity that the Cross Drift will already intersect the ESF Main Drift as the Cross Drift starts from the left rib along the ESF North Ramp, and moves toward southwestern direction at an elevation higher than the ESF Main Drift and passes above the N-S trending ESF Main Drift. The Cross Drift is currently planned to pass directly above one of the niches along the ESF Main Drift. After Cross Drift excavation, an alcove is planned to locate at the cross-over point directly above the ESF Main drift.

The drift-drift/borehole interaction study includes the following activity in FY98:
(1) ESF Main Drift sensor. In addition, there will be the following activities in FY

99: (1) network model prediction, test design and interpretation; (2) Cross Drift invert ponding evaluation and tracer release; (3) Controlled releases of traced water in boreholes; (4) Controlled release of traced water from alcove; (5) long term borehole, niche, and alcove monitoring.

1998 Activities

Model Prediction, Test Design, and Interpretation: UZ Site Scale Model and Drift Scale Model will be used to predict the plume migration, taking into account the results from drift seepage in niche study in the ESF Main Drift, and previous construction water usage data from the ESF Constructor. The models are used to design the tests and predict the drift impacts before the drift excavation and compare and interpret the tests during the excavation.

Cross Drift Invert Monitoring and Tracer Release: Any ponding of construction water near the cross-over point will be monitored. If ponding persists, additional tracers can be added to improve the spatial resolution to quantify plume migration from the Cross Drift to the ESF Main Drift. This activity will be done in collaboration with the USGS who will have an established monitoring network in Niche #1 under the cross-over point, and will continue monitoring.

FY 1999 Activities

These activities are proposed to further improve the credibility of the models and enhance the confidence in the model predictions for drift impact on the repository performance.

Controlled Release of Traced Water in Boreholes: Depending on the distances between the two drifts at the cross-over location, the drift monitoring sensor network can be supplemented by vertical boreholes drilled from the upper drift. If the controlled releases of traced water from the boreholes can be detected in the ceiling of the lower drift, travel times and flux rates can be determined. The downward drillings can be supplemented by upward drilling to intersect the plume. Before tracer study, all boreholes will be characterized by single and cross-hole pneumatic tests.

Controlled Release of Traced Water in Alcoves: Depending on the results of tracer study from invert and boreholes, additional tests can be designed in the alcove to allow large traced water release. The intense flooding in alcove represents the extreme conditions with a large body of water accumulated above a drift. The confidence in the quantification of seepage into drift can be greatly improved.

Long Term Monitoring: Boreholes from invert, crown, and alcoves can also be instrumented for temperature, potential and other hydrological monitoring after the tracer tests. The findings can be used in design of performance confirmation drifts near the waste emplacement drifts.

Borehole sampling of Construction Water Plume: Sampling of the construction water plume can be accomplished through the drilling of slanted boreholes from

niches located along the Main Drift, from the connecting drift of the Thermal Test Facility, and from the starter tunnel of the Cross Drift. Borehole locations will be determined through the modeling during the site evaluation and selection phase.

6. **Scope Differences from the Baseline:**

This work was not included in the original FY97 plans. The necessity to conduct this work is a result of the expressed desire of regulatory groups to assess the predictive capabilities of the project for Drift-Drift/Borehole Hydrologic Interaction between Cross Drift and ESF Main Drift.

7. **Key Assumptions:**

Adequate resources will be made available to complete this work.

8. **Cost Rationale:**

FY 1998 Activities

To complete the Cross Drift Invert Monitoring and Tracer Release workscope will require 0.3 FTE of labor category 101C and 0.35 FTE of labor category 106, 10K for travel, and 32K for ODC.

FY 1999 Activities

Model Prediction, Test Design, and Interpretation; ESF Main Drift Monitoring Network; Controlled Release of Traced Water in Boreholes; Controlled Release of Traced Water in Alcoves; and Long Term Monitoring will require 0.5 FTE of labor category 101B, 1.3 FTE of labor category 101C, and 0.1 FTE of labor category 106; 5K for travel; and 25K for sensory instruments and computer interpretations.

9. **Level III Milestones:**

None

Level IV Milestones:

L4 letter report discussing Model Prediction of Local Plume Migration from the Cross Drift Cross-Over Point, due 1/31/98. If testings has been delayed for any reason (i.e.construction), no incomplete data sets will be included in this milestone.

L4 letter report presenting the Alcove Test Plan and Tracer Test Design, due 12/31/98. If testings has been delayed for any reason (i.e.construction), no incomplete data sets will be included in this milestone.

L4 letter report summarizing the results and evaluation of the Drift-Drift/borehole

Hydrologic Interaction between Cross Drift and Alcove and ESF Main Drift and Niche, This report will be due August 15, 1999. This report will provide input to the Level III milestone entitled Dynamic and Static Testing for Fracture Flow, Seepage and Ponding, which will be presented for incorporation as a chapter in the LA. This milestone will be due in September 1999. If testings has been delayed for any reason (i.e.construction), no incomplete data sets will be included in this milestone.

10. Level III Milestone Acceptance Criteria:
NONE

11. Attachments and References:
NONE

12: Schedule:	Early Start	Early Finish
Predictions	10/1/97	1/31/98
Testing	6/12/98	9/30/99

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: TR33124GBD
2. Summary Account Title: Moisture Monitoring in the ESF
3. Summary Account MGR/ORG: Biggar/SPO-WCFS
4. Status of Change: ___ Revised X New
5. Scope Description:

This work will involve worker exposure monitoring for correlation with the water use/water penetration study associated with operation of the TBM. The exposure monitoring will focus on fiber and dust levels generated during tunneling activities. Monitoring will provide background information necessary for health professionals to recommend appropriate exposure control technologies, if necessary. The work program will consist of the following tasks:

- Meet with M&O and contractor Health and Safety Department to discuss safety issues, and ensure this scope of work satisfies project needs.
- Working with the SPO/TCO, the industrial hygienist will obtain sampling equipment and develop a work plan for installing dust collection sampling units along the entire length of the East-West Drift.
- Perform personal air monitoring during water use testing activities to measure respirable dust and fiber concentrations to which workers are being exposed. This monitoring will be performed by an industrial hygienist.
- Conduct ambient air monitoring with direct reading instruments for total dust concentrations generated during water use testing activities.
- Coordinate air monitoring with different engineering controls to reduce worker dust and fiber exposures.
- Provide a report summarizing field activities, observations, and air monitoring data.

Personal and ambient air monitoring will be performed on workers in the tunnel with the greatest potential for exposure to excessive dust and fiber levels. The number of samples collected will vary depending on the amount of dust generated during tunneling activities and direct reading instrumentation. Personal monitoring will include respirable and total dust levels. Total dust samples will be collected using pre-loaded cassettes and a low flow sampling pump. The pump and sampling media will be worn by the worker and the cassette will be within 12 inches of their breathing zone. The respirable dust samples will be collected using polyvinyl chloride cassettes, cyclones, and the low flow sampling pump. The cyclone filter assembly is designed to trap only those particles that are typically inhaled by workers. Larger particles are expelled from the assembly, allowing for quantification of respirable versus total dust. Ambient monitoring will be performed with a Mini-Ram, which is a direct reading instrument for total dust. The industrial hygienist will consider the work crew, work shift, and environmental conditions at the site when establishing a sampling plan.

In addition to supporting the water related studies, this effort will also support the continuous sampling of dust for geochemical analysis of dust throughout the entire length of the East-West drift tunnel. This effort will involve selection of a continuous sampling system that is installed on the TBM. This system would be downloaded periodically, by the TCO as a part of their coordinated sampling effort. The collected samples would be routinely provided to the USGS for their analysis and interpretation.

One Level 4 Deliverable will be submitted as a result of this work:

Title:	Results of Dust and Fiber Measurements Associated with Water Use Tests During Tunneling Operations
Milestone:	SP
Due Date:	Five weeks following completion of the first 1000 feet of East-West Drift tunneling.
Milestone Description:	The report will present dust and fiber measurement correlated to the various stages of water use testing during the first 1000 ft of East-West drift testing. This report will serve as input to the USGS test of water use and water penetration below the tunnel insert.

This report will be incorporated into the level 3 milestone (SP33S9M3) developed in SA TR33124FBB.

6. **Scope Differences from the Baseline:**

All scope is new.

7. **Key Assumptions:**

- This study will be conducted during the first 1000 ft of tunneling of the East-West Drift. It is anticipated that the first 1000 ft will require 4 weeks of tunneling. The industrial hygienist will be on-site during the entire first phase of this project to evaluate dust levels during various phases of tunneling.
- Sampling from the dust collection units will be done by the TCO.
- Cross Drift construction will begin in the middle of FY98. Constructor will provide timely records of water and tracer application rates. Moisture monitoring will be established in FY98 and will continue at the same level in FY99. Samples will be analyzed for construction water tracers.
- All analyses will be non-Q.

8. **Cost Rationale:**

Labor

- (101B, WCFS) 0.25 FTE Industrial hygienist having expertise in performing personal air monitoring in tunnel environment.

ODCS

- Travel (2 round-trips LA to LV)
Hotel/Lodging in LV (one month)
Rental Car in LV (one month)
- Five Personal Pumps w/Cyclone Filters @ \$1000/month (1 month use anticipated)
- Safety Equipment @ \$960/month (1 month use anticipated)
- Mini-RAM Dust Meter @ \$480/month (1 month use anticipated)
- Continuous Sampling Equipment (6 month period) \$20,000
- Sampling Media \$2000
- Laboratory Analysis \$10,000

9. **Level III Milestones:**

No Level III activity.

10. **Level III Milestone Acceptance Criteria:**

No Level III activity.

11. **Attachments and References:**

None.

12. **Schedule:**

Early Start: 1Dec97

Early Finish: 1Jun98

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: 0G33126GB1 (FY99)
2. Summary Account Title: Gas Phase Movement in the Unsaturated Zone
3. Summary Account MGR/ORG: Robert Craig, USGS
4. Status of Change: Revised New
5. Scope Description:

To further constrain and understand gas-phase circulation in Yucca Mountain especially as influenced by topography, a Seamist liner will be installed in SD11 and SD13. Perforations in the liner will allow monitoring of the UZ pressure response to daily barometric change. These ports will also be used to obtain gas samples for CFC and carbon dioxide analyses, and for oxygen, hydrogen, and carbon (including C-14) isotopic measurements. Temperature probes can be installed at the ports if this information is deemed essential.

6. Scope Difference from Baseline:

Drill holes SD-11 and SD-13 were not planned when this work was baselined. The technical approach is a continuation of baseline work.

7. Key Assumptions:

Assumptions include: (1) completion of boreholes SD-11 and SD-13 on schedule (July 22, 1998 for SD-13 and Oct. 20, 1998 for SD-11), (2) availability of these boreholes for insertion of Seamist liner, and (3) availability of staff for conducting this work.

8. Cost Rationale: (\$279K)

Labor (1.62 FTE):

Geologist GS-15 (0.01 FTE): Expertise in management, supervision, sample collection design, data synthesis and interpretation.

Hydrologist GS-13 (0.1 FTE): Principal investigator with broad expertise in isotope geochemistry, mineralogy, petrology, and U-series dating.

QA Implementation Specialist GS-9 (0.01 FTE): Expertise in maintenance of QA

records, tracking of milestones, and monitoring adherence to technical procedures and other QA requirements.

Two Hydrologic Technicians GS-11 (1.5 FTE): Expertise in installation of borehole liner and conducting monitoring and sampling.

Travel: (\$17K)

For travel to site for liner installation and monitoring, and for technical interchanges.

Other Direct Costs: (\$84K)

Includes \$60K for procurement of borehole liner and \$24K for analyses.

9. Level III Milestones: None

A Level IV milestone (No. SPH22SM4, due Sept. 15, 1999) will consist of a memorandum to the USGS TPO describing data obtained during monitoring of SD-11 and SD-13.

10. Level III Milestone Acceptance Criteria: NA

11. Attachments and References: None

12. Schedule:

<u>Activity</u>	<u>Early Start</u>	<u>Early Finish</u>
Collect Data on Boreholes SD-11 and SD-13	01 Oct 98	30 Sep 99

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: OG33127GB2 (FY 99)
2. Summary Account Title: Isotopic & Hydrochemical Studies of UZ Water & Gas
3. Summary Account MGR/ORG: Robert Craig, USGS
4. Status of Change: X Revised New
5. Scope Description:

This work entails chemical and isotopic characterization of pore water (including isotopic dating) in the unsaturated zone by a variety of extractive methodologies using core obtained in drilling attendant with the Enhanced Characterization of the Repository Block (ECRB) program. Pore water from nonwelded core will be obtained by uniaxial compression and analyzed for major dissolved ions, stable and radiogenic isotopes, tritium and C-14 ages. Pore water from densely welded units will be extracted by vapor distillation for tritium, C-14 of extracted carbon dioxide gas, and stable isotope (D/H and O-18/O-16) analyses. Radiogenic isotope analyses (Sr and U) will be obtained on densely welded units by leaching of pore water salts using high-purity deionized water. The principal objectives of this analytical work are to further overall understanding of percolation through the unsaturated zone including its spatiotemporal variability, percolation flux at the repository horizon, quantify travel time, and elucidate the relationship between fracture and matrix flow. These data contribute importantly to the UZ flow model to be used in the TSPA-LA. Core obtained in the drilling of ECRB bore holes SD-11 and SD-13 will provide improved sampling for these key measurements, and the results will greatly enhance the existing data base of information on UZ pore water ages, compositions, and nature of flow.

6. Scope Difference from Baseline:

The proposed work entails a more comprehensive approach to UZ hydrochemistry and dating in that new techniques have been added to USGS capabilities to more effectively meet Program objectives. Carbon dioxide dissolved in pore water in densely welded units can now be extracted for C-14 measurements. This approach will allow direct determination of downward water flow velocity in the unsaturated zone. The USGS has also adapted a technique whereby pore salts formed by evaporation of pore water can be extracted with high-purity deionized water for strontium and uranium isotopic analyses. These data will be critical in assessing the degree and efficacy of communication between pore and fracture water during infiltration and percolation.

7. Key Assumptions:

To complete analytical work in FY99 as described above, the following assumptions are made: (a) drilling and selective coring of SD-11 and SD-13 bore holes will be completed in FY98 or early in FY99, (b) core suitable for the analyses will be properly taken and preserved, (c) the USGS UZ hydrochemistry research unit will be functional and operational in FY98 so that this work can be conducted in FY99, and (d) the laboratories and requisite instruments for conducting the analyses will have an availability of 75 percent or more during FY99.

8. Cost Rationale: (\$255K)

Labor (1.40 FTE):

Geologist GS-15 (0.01 FTE): Expertise in management, supervision, sample collection design, data synthesis and interpretation.

Hydrologist GS-14 (0.25 FTE): Principal Investigator with broad expertise in dissolved ion hydrochemistry, C-14, tritium, and hydrochemical concepts and interpretations.

Hydrologist GS-13 (0.01 FTE): Expertise in isotope geochemistry, mineralogy, petrology, and U-series dating.

Geochemist GS-13 (0.03 FTE): Expertise in isotope geochemistry, thermal ionization mass spectrometry, U-series and U-Pb dating.

Geologist GS-13 (0.01 FTE): Expertise in mineralogical paragenesis and stable isotope geochemistry.

Hydrologist GS-13 (0.01 FTE): Expertise in strontium isotope geochemistry, geochemical modeling, and data base development and management.

Chemist GS-12 (0.03 FTE): Expertise in uranium and lead chemistry and thermal ionization mass spectrometry.

Chemist GS-13 (0.03 FTE): Expertise in strontium and rare earth chemistry and thermal ionization mass spectrometry.

Chemist GS-11 (0.49 FTE): Expertise in extractive analytical methodologies for tritium, C-14, and dissolved ion analyses.

Physical Science Technician GS-9 (0.03 FTE) for operation of stable extraction lines, sample collection and documentation, and data management.

QA Implementation Specialist GS-9 (0.01 FTE): Expertise in maintenance of QA records, tracking milestones, and monitoring adherence to technical procedures and

other QA requirements during the course of the investigation.

Physical Science Technician GS-7 (0.49 FTE): For extractive work and general laboratory support.

Travel: (\$5K)

Trips to the SMF and to Las Vegas for technical exchanges.

Other Direct Costs: (\$90K)

Includes \$10K for apportioned cost of radiogenic isotope laboratory, \$13K for operation and maintenance of tritium and C-14 laboratory, \$12K for stable isotope analyses, \$21K for dissolved ion analyses, and \$34K for C-14 analyses.

9. Level III Milestones:

A Level III milestone (No. SPH37AM3, due 15 Sep 1999) will consist of a detailed technical report to the DOE that will include new data and synthesis of previous data on UZ pore waters as well as a comprehensive interpretative section.

10. Level III Milestone Acceptance Criteria:

The Level III milestone report will synthesize previously reported and new data on pore waters in the unsaturated zone. The report will be comprehensive and will supersede all previous Level IV reports on the subject. It will include a detailed interpretive section describing the key implications of the data sets with regard to flux to the repository horizon and from the repository horizon to the water table, flow velocity and its spatial variation, and interaction of matrix and fracture water.

11. Attachments and References: None.

12. Schedule:

<u>Activity</u>	<u>Early Start</u>	<u>Early Finish</u>
Conduct Chemical and Isotopic Char of Pore Water	01 Oct 98	15 Sep 99
Prep Rpt On UZ Pore Waters	01 Oct 98	15 Sep 99

WBS 1.2.3.3.1.2.7 Unsaturated Zone Hydrochemistry
ATTACHMENT B

SPH37AM3 Report: Unsaturated Zone Pore Waters

15-sep-99

This deliverable shall include all information identified herein unless specifically exempted in writing by the COR at least 60 days before the scheduled due date (30 days in special cases agreed to by the COR).

This level 3 milestone report will consist of a detailed technical report that will synthesize previously reported and new data on pore waters in the unsaturated zone. the report will be comprehensive and will supersede all previous level 4 reports on the subject. It will include a detailed interpretive section describing the key implications of the data sets with regard to flux to the repository horizon and from the repository horizon to the water table, flow velocity and its spatial variation, and interaction of matrix and fracture water.

This deliverable shall be prepared in accordance with OCRWM approved quality assurance procedures implementing requirements of the Quality Assurance Requirements Description. The product shall be developed on the basis of the best technical data, including both Q and non-Q data. The Q status of data used and cited in the report shall be appropriately noted. Stratigraphic nomenclature cited in the deliverable shall be consistent with the Reference Information Base section 1.12 (a): Stratigraphy-Geologic Lithologic Stratigraphy. The report shall note data used and shall include record Accession Numbers or Data Tracking Numbers when available. This deliverable shall be processed in accordance with YAP-5.1Q.

Completion criterion

TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED CHARACTERIZATION OF
THE REPOSITORY BLOCK

1. Summary Account Number: TR33129FBH
2. Summary Account Title: Confirm UZ Hydrologic Flow Models
3. Summary Account MGR/ORG: Y.S. Wu
4. Status of Change: Revised New
5. Scope Description:

The objectives of this activity are to perform the model predictions of the ambient conditions along the planed Cross Drift from the ESF, and to further calibrate the 3-D site-scale UZ flow model for its capability in simulating the UZ flow system of Yucca mountain. The model to be used is the calibrated 3-D site-scale UZ flow and transport model of LBNL. The results of model predictions are presented in terms of the ambient moisture, gas, thermal and geochemical conditions and can be used to support the various investigations associated with the Cross Drift as part of the TSPA-VA and TSPA-LA activities.

Activity Include:
FY 97-98

Apply the calibrated 3-D, site-scale UZ flow model to prediction of the ambient moisture, gas, heat and geochemical conditions along the planed Cross Drift. The model input data include the updated fracture/matrix rock properties, fault parameters, perched water analysis results, thermal analysis results, geochemical data, and new conceptual models. The modeling approach is the dual-permeability method for both flow and transport simulation studies. Both rigorous tracer transport solution and particle tracking scheme are used in predictions of geochemical concentrations

Generate a small-scale 3-D grid with local refined meshes along the drift and couple this drift-scaled grid with the 3-D site-scale model grid.

Complete model predictions of the ambient hydrogeologic conditions, their distributions and variations along the Cross Drift including:

pneumatic conditions: gas pressure and gas flow;

moisture conditions: matrix rock water saturation and water potentials;

thermal conditions: temperature;

possible perched water zones if existing;

Geochemical conditions: Cl-36, H-3, Cl and Sr concentrations including $^{87}\text{Sr}/^{86}\text{Sr}$, and C-14 in gas and liquid.

Check the model predictions against the actual observations when the observed data become available during and after the drift construction. The differences between the model predictions and observations will be identified, and further calibrations or adjustments will be made to the UZ flow model in terms of geological layers/models, fracture/matrix properties, and surface and other described boundary conditions, based on the data from the drift.

6. Scope Differences from the Baseline:

This work was not included in the original FY97 plans. The necessity to conduct this work is a result of the expressed desire of regulatory groups to assess the predictive capabilities of the project for prediction of the ambient conditions of Cross Drift using UZ Flow Model.

7. Key Assumptions:

Adequate resources will be made available to complete this work.

8. Cost Rationale:

FY97: 38K

Beginning in FY97, model predictions of the ambient conditions along the planned Cross Drift from the ESF will begin and to further calibrate the 3-D site-scale UZ flow model for its capability in simulating the UZ flow system of Yucca mountain will require 0.25 FTE of labor category 101C and 1.5K of ODC (such as micro-purchases, telephone, etc.). Total funding required is approximately \$38K.

FY98: 63K

To complete the model predictions of the ambient conditions along the planned Cross Drift from the ESF, and to further calibrate the 3-D site-scale UZ flow model for its capability in simulating the UZ flow system of Yucca mountain, LBNL will require 0.41 FTE of labor category 101C and 5K of ODC (such as micro-purchases, telephone, etc.). Total funding required is approximately \$63K.

9. Level III Milestones:

None

Level IV Milestone:

Prediction of the Ambient Conditions of Cross Drift Using UZ Flow Model due 30 November, 1997. If testing has been delayed for any reason (i.e. construction), no incomplete data sets will be included in this milestone.

10. **Level III Milestone Acceptance Criteria:**
None

Level IV Milestone Acceptance Criteria:

This milestone will consist of a series of model predictions of the ambient conditions along the Cross Drift in terms of pneumatic, moisture, thermal and geochemical variations and distributions. This report will describe the 3-D model grid and geological model used, and the model boundary conditions, infiltration rates, modeling approach, and rock properties. This report will also discuss the assumptions and conceptual model used for the prediction studies. If testing has been delayed for any reason (i.e. construction), no incomplete data sets will be included in this milestone.

11. **Attachments and References:**

12:	Schedule:	Early Start	Early Finish
	Predictions	7/1/97	11/30/97

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: OG33131FBF
2. Summary Account Title: WT Eh and Ph Measurements
3. Summary Account MGR/ORG: Robert Craig, USGS
4. Status of Change: Revised X New
5. Scope Description:

Water samples from saturated zones (perched and regional) in SD11 and SD13 will be collected systematically for major and minor dissolved ion and isotopic analyses, and initial analyses will be conducted for selected dissolved materials. Objectives are (1) to determine whether the first saturated zone encountered is perched or part of the regional saturated system, (2) to elucidate the age and origin of the water if perched, (3) to determine the residence time of water in the saturated zone, (4) to determine the degree of mixing (isotopic and chemical uniformity) of the upper part of the saturated zone, (5) to detect any potential recharge in the uppermost part of the saturated zone, and (6) to detect potential trace element plumes that may emanate from up gradient mineralized zones in the caldera rocks north of Yucca Mountain (such a plume could be used to determine effective dispersion in SZ beneath the repository block). Isotopic analyses will include oxygen, hydrogen, carbon (C-13 and C-14), chlorine (LANL), sulfur, uranium, and strontium. Uranium and strontium isotopic compositions and concentrations will be determined by high-precision thermal-ionization mass spectrometry. Other isotope systems such as helium, nitrogen, lead, and neodymium will be considered if they are deemed to be potentially useful. Samples will be obtained by pumping with onsite monitoring of temperature, pH, and conductivity to establish compositional stability. Time series sample suites will be collected to capture compositional changes during pumping as would be expected from a fracture-dominated system. Dissolved ion analyses will be conducted by the USGS national water quality laboratory and may include analyses of metals indicative of potential up gradient mineralization such as gold, silver, lead, copper and associated metals.

Drilling water (J-13) will be analyzed for the same suite of dissolved ions and isotopes as the water samples. These analyses, coupled with the lithium spike added to the drilling water, will allow exact corrections for the presence of drilling fluid in the water samples. Sampling will be closely coordinated with sampling and measurements to be conducted by LANL as part of the Water Table Eh-pH work.

EY98: All sampling equipment will be procured, assembled, and mobilized. Work will entail sampling of any perched water encountered and regional saturated-zone water during drilling and during subsequent pump tests of SD11 and on-site measurements such as alkalinity, temperature, pH, and conductivity. Some samples will be submitted for

major dissolved ion analyses. Drilling water will be analyzed for stable, radiogenic, and dissolved ions for accurate corrections for the sample native water should they be necessary.

FY99: Work will entail sampling of any perched water encountered and regional saturated-zone water during drilling and during subsequent pump tests of SD11 and SD13 and on-site measurements such as alkalinity, temperature, pH, and conductivity. Some samples will be submitted for major dissolved ion analyses. Drilling water will be analyzed for stable, radiogenic, and dissolved ions for accurate corrections for the sample native water should they be necessary.

6. **Scope Differences from the Baseline:**

This is new work. The necessity to conduct this work is a result of the need to fully characterize the perched and regional saturated zones encountered in these 2 new boreholes in order to interpret and evaluate the extent and occurrence of perched water and the elevation of the regional water table.

7. **Key Assumptions:**

The completion of sample analysis and interpretation is contingent on progress of borehole drilling and sample acquisition.

8. **Cost Rationale:**

FY98 activities for sampling design and implementation, hydrochemical equipment and analyses, synthesis and interpretation is estimated at \$100K. FY99 activities for additional isotopic and dissolved ion analyses, synthesis, interpretation, and report preparation is \$175K.

9. **Level III Milestones:**

No level III milestones are directly a result of this activity.

A level 4 milestone (No. SPC344M4, due Sep 30, 1999) will consist of a memorandum to the USGS TPO summarizing dissolved ion and isotopic data collected on water samples from SD11 and SD13 and final interpretations.

10. **Level III Milestone Acceptance Criteria:** None.

11. **Attachments and References:**

12. Schedule:

<u>Activity</u>	<u>Early Start</u>	<u>Early Finish</u>
Procure and assemble sampling equip.	1/5/98	4/27/98
Sample Perched Wtr Encountered SD-11 and SD-13	4/28/98	3/25/99
Sum Ion and Isotopic Data Collected SD-11 and SD-13	3/26/99	9/30/99

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: OG33131EBG
2. Summary Account Title: Perched-Water Testing and SZ Hydraulic Testing
3. Summary Account MGR/ORG: Robert Craig, USGS
4. Status of Change: Revised New
5. Scope Description:

FY99: This summary account will provide funding to support pre-construction, during and post-construction saturated-zone hydrologic monitoring and testing of boreholes USW SD-11 and USW SD-13. Activities connected with this study include conducting necessary borehole hydraulic tests to determine the hydrologic properties of the saturated zone, determining borehole formation properties, collecting and analyzing fluid samples, and providing interpretation of test results. The work will consist of providing support during borehole construction for the identification of the regional table. Provide personnel to instrument the borehole(s) being tested and any ancillary monitoring wells. Maintain monitoring instrumentation during hydraulic testing, download and process data, and oversee/recommend any changes. Provide personnel to conduct borehole hydraulic tests and interpret/analyze the results of those tests. Prepare associated data reports and interpretive reports on the results of borehole hydraulic testing.

Conduct perched-water testing in borehole USW SD-13. Work will consist of monitoring the borehole during construction for the occurrence of perched water and conducting the necessary borehole hydraulic tests to determine the nature of any perched water encountered in the borehole.

6. Scope Differences from the Baseline:

This work will be conducted in boreholes SD-11 and SD-13.

7. Key Assumptions:

Perched water will be encountered in borehole SD-13. Perched water will not be encountered in borehole SD-11. Maximum time allowed for perched water testing is 2 weeks. During construction, on site monitoring for occurrence of perched water will be minimal for USGS PI/UDR. Saturated-zone hydraulic testing assumes boreholes SD-11 and SD-13 will be constructed as planned. Needed ancillary monitoring wells are

properly configured for monitoring instrumentation. Appropriate capacity downhole pumps and power supplies are available to conduct the borehole hydraulic tests. Borehole lithostratigraphy and borehole geophysical logs are available to assist with the interpretation of borehole hydraulic tests. All necessary monitoring and DAS equipment are available and properly calibrated prior to commencing any test. Labor costs/FTE loads are based upon borehole construction monitoring taking approximately 14 days, and hydraulic testing of the saturated zone lasting approximately 14 days.

8. Cost Rationale: FY99 \$334K

Saturated-zone hydraulic testing FY99: \$112K

USW SD-11 FY99 (\$112K)

Labor (0.55 FTE):

Hydrologist GS-13 (0.1 FTE): Principal investigator/coordinator for monitoring and testing of borehole.

Hydrologist GS-12 (0.1 FTE): Expertise in borehole instrumentation, borehole testing, and data collection and compilation.

Hydrologist GS-11 (0.1 FTE): Participate in SZ testing and sampling.

Hydrologic Technician GS-9 (0.2 FTE): Expertise in instrumentation of boreholes for SZ monitoring and testing.

Hydrologist GS-14 (0.05 FTE): Supervisory expertise to provide management oversight of HMT personnel conduction work and to participate in testing.

Travel (\$8K):

Support trips to Yucca Mountain for during-construction monitoring, and saturated-zone testing and sampling, including 9 trips from Denver to Yucca Mountain to prepare for and conduct testing and sampling, 4 trips from Denver to Yucca Mountain by principal investigator/coordinator and/or HMT team chief to plan/coordinate testing activities.

Other Direct Costs (\$29.5K):

Borehole instrumentation for pumping and monitoring boreholes, \$10K (data loggers, interfaces, storage module, and various calibrations); downhole transducers, \$12K (2 transducers at \$6K/transducer) if additional transducers are required, this cost will increase. Sample Collection/Analysis, \$6K for sample collection equipment and sample analysis of saturated-zone water samples. Vehicles, \$1.5K for two (2) GSA trucks for transportation from Mercury/Area 25 to the well sites for approximately 1 month.

Work By Others (\$14K):

One on site (NTS/Area 25) Hydrologic Technician to assist with the emplacement, monitoring, and maintenance of data acquisition equipment and the collection of hydraulic test data

One QA Implementation Specialist to provide QA support and assist with the assembly and review of data packages.

Perched-water testing FY99: \$110K

USW SD-13 FY99 (\$110K)

Labor (0.45 FTE):

Hydrologist GS-13 (0.1 FTE): Principal investigator/coordinator for monitoring and testing of the borehole.

Hydrologist GS-13 (0.1 FTE): Principal investigator for conducting perched water hydraulic testing.

Hydrologist GS-11 (0.1 FTE): Expertise in testing and sampling of perched-water zones.

Hydrologic Technician GS-9 (0.1 FTE): Expertise in instrumentation of boreholes for perched-water monitoring and testing.

Hydrologist GS-14 (0.05 FTE): Supervisory expertise to provide management oversight of HMT personnel conducting work.

Travel (\$8K):

Travel budget will support trips to Yucca Mountain to conduct perched water testing.

Other Direct Costs (\$35.5K):

Borehole Instrumentation, \$5K (data loggers, storage modules, miscellaneous equipment); downhole pressure transducers, \$12K (2 transducers at \$6K each); \$2K water sampling, storage, preservation equipment; Vehicles, \$1.5K for two GSA trucks for transportation from Mercury/Area 25 to well site; borehole geothermal logging (USGS) \$15K.

Work By Others (\$17K):

One on site Hydrologic Technician to assist with perched-water testing, monitoring, and sampling. Will maintain sampling and monitoring equipment.

One QA Implementation Specialist to provide QA support.

One Hydrologist to support perched-water testing.

Saturated-zone hydraulic testing FY99: \$112K

USW SD-13 FY99 (\$112K)

Labor (0.55 FTE):

Hydrologist GS-13 (0.1 FTE): Principal investigator/coordinator for monitoring and testing of borehole.

Hydrologist GS-12 (0.1 FTE): Expertise in borehole instrumentation, borehole testing, and data collection and compilation.

Hydrologist GS-11 (0.1 FTE): Participate in SZ testing and sampling.

Hydrologic Technician GS-9 (0.2 FTE): Expertise in instrumentation of boreholes for SZ monitoring and testing.

Hydrologist GS-14 (0.05 FTE): Supervisory expertise to provide management oversight of HMT personnel conduction work and to participate in testing.

Travel (\$8K):

Support trips to Yucca Mountain for during-construction monitoring, and saturated-zone testing and sampling, including 9 trips from Denver to Yucca Mountain to prepare for and conduct testing and sampling, 4 trips from Denver to Yucca Mountain by principal investigator/coordinator and/or HMT team chief to plan/coordinate testing activities.

Other Direct Costs (\$29.5K):

Borehole instrumentation for pumping and monitoring boreholes, \$10K (data loggers, interfaces, storage module, and various calibrations); downhole transducers, \$12K (2 transducers at \$6K/transducer) if additional transducers are required, this cost will increase. Sample Collection/Analysis, \$6K for sample collection equipment and sample analysis of saturated-zone water samples. Vehicles, \$1.5K for two (2) GSA trucks for transportation from Mercury/Area 25 to the well sites for approximately 1 month.

Work By Others (\$14K):

One on site (NTS/Area 25) Hydrologic Technician to assist with the emplacement, monitoring, and maintenance of data acquisition equipment and the collection of hydraulic test data

One QA Implementation Specialist to provide QA support and assist with the assembly and review of data packages.

9. Level IV Milestones:

Saturated-zone hydraulic testing

USW SD-11

A Level 4 Milestone (No. SPH22VM4, due January 8, 1998) will consist of a memorandum to the USGS TPO reporting predicted depth to perched water and the saturated zone, and ranges in values to be derived from the hydraulic measurements for the USW SD-11 borehole.

A level 4 milestone (No. SPH22TM4, due 29 Jan 99) will consist of a memorandum to the USGS TPO documenting the hydraulic testing effort at borehole USW SD-11. Types of tests conducted, duration of tests, monitoring wells instrumented, problems encountered, and other relevant information will be included in the memorandum. The report will also include an analysis of the predicted vs. actual depth to perched water and the saturated zone, and hydraulic measurements. Delivery date will be one (1) month after completion of testing.

A level 4 milestone (No. SPH22UM4, due 30 Mar 99) will consist of a memorandum to the USGS TPO documenting the preparation and submittal to the RPC of data obtained during pumping and monitoring of borehole USW SD-11 and any associated monitoring boreholes, including logbook pages, data reductions, and supporting documents. Delivery date will be three (3) months after completion of testing; experience has shown that this amount of time is needed for the assembly, review, and approval of these types of data packages.

USW SD-13:

Perched-water testing

A Level 4 Milestone (No. SPH22YM4, due September 1, 1998) will consist of a memorandum to the USGS TPO reporting predicted depth to perched water and the saturated zone, and ranges in values to be derived from the hydraulic measurements for the USW SD-13 borehole.

A level 4 milestone (No. SPH22HM4, due 30 Mar 99) will consist of a memorandum to the USGS TPO documenting the perched-water hydraulic testing efforts. Types of tests conducted, duration of tests, monitoring well instrumented, problems encountered, and other relevant information will be included in the memorandum. Delivery date will be one (1) month after completion of testing.

A level 4 milestone (No. SPH22JM4, due 28 May 99) will consist of a memorandum to the USGS TPO documenting the preparation and submittal of a data package to the Records Processing Center and the Technical Data Base, as appropriate. Delivery date will be three (3) months after completion of the testing.

A level 4 milestone (No. SPH22MM4, due 30 Jun 99) will consist of a memorandum to the USGS TPO documenting the results of the perched-water testing conducted in the boreholes. The memorandum will receive internal USGS technical review. Delivery date will be four (4) months after completion of testing.

Saturated-zone hydraulic testing

USW SD-13

A level 4 milestone (No. SPH22OM4, due 28 May 99) will consist of a memorandum to the USGS TPO documenting the hydraulic testing effort at borehole USW SD-13. Types of tests conducted, duration of tests, monitoring wells instrumented, problems encountered, and other relevant information will be included in the memorandum. The report will also include an analysis of the predicted vs. actual depth to perched water and the saturated zone, and hydraulic measurements. Delivery date will be one (1) month after completion of testing.

A level 4 milestone (No. SPH22PM4, due 30 Jul 99) will consist of a memorandum to the USGS TPO documenting the preparation and submittal to the RPC of data obtained during pumping and monitoring of borehole USW SD-13 and any associated monitoring boreholes, including logbook pages, data reductions, and supporting documents. Delivery date will be three (3) months after completion of testing; experience has shown that this amount of time is needed for the assembly, review, and approval of these types of data packages.

10. Level IV Milestone Acceptance Criteria:

11. Attachments and References:

12. Schedule:

<u>Activity</u>	<u>Early Start</u>	<u>Early Finish</u>
Conduct SZ Hydraulic Testing in USW SD-11	15 Dec 98	31 Dec 98
Prep Data Pkg SZ Hydraulic Tstg USW SD-11	04 Jan 99	30 Mar 99
Conduct Perched Water Testing	12 Feb 99	01 Mar 99

USW SD-13

**Prep Data Pkg Perched Water Tstg
USW SD-13**

02 Mar 99 28 May 99

**Prep Memo Perched Water Testing
USW SD-13**

02 Mar 99 30 Jun 99

**Conduct SZ Hydraulic Testing in
USW SD-13**

25 Mar 99 15 Apr 99

**Prep Data Pkg SZ Hydraulic Tstg
USW SD-13**

16 Apr 99 15 Jul 99

July 2, 1997 (7:21pm)

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: TR34122FB3
2. Summary Account Title: Microbial Analysis - ESF
3. Summary Account MGR/ORG:
4. Status of Change: Revised x New
5. Scope Description: The proposed studies outlined below represent what we believe to be the minimum work necessary to provide essential information for critical assessment and license application issues. Studies will be directed specifically at determining the functional microbial population within Yucca Mountain. While we do have substantial general information on this population, we are still lacking certain specific details, including:
 - A. Information of the population of microorganisms within the 36Cl "fast-paths", and
 - B. Information on the population in the wetter regions of the ESF.

The two studies would complete the evaluation of the ESF microbial population such that performance assessment could be performed on the extant microbial population.

METHODS.

Comparison of microbial communities in 36Cl fast path locations to non-fast path environments.

Comparison of wet locations to dryer locations (i.e., south ramp vs. north ramp of the ESF). (Note: methods section for 1 and 2 will come from the description of the ESF sample analysis DP-405, and as discussed in the Kieft et al, 1997; and Ringelberg et al, 1997 – the final reports of the ESF microbial analysis. However, it will not be necessary to do as rigorous analysis as was done in the earlier ESF study).

6. Scope Differences from the Baseline: new work
7. Key Assumptions: Sample collection will occur immediately following the passage to the TBM. Sample location (2 m x 2m) will be protected from introduced water. Pneumatic air will be supplied.
8. Cost Rationale:

FY98 costs .

0.65 FTE LANL (0.15 TSM, 0.5 GRA), \$50 K for subcontracts to UNLV and NM Tech for microbial analysis of samples (approx \$25 ea.).

FY99 costs

0.65 FTE LANL (0.15 TSM, 0.5 GRA), \$50 K for subcontracts to UNLV and NM Tech for microbial analysis of samples (approx \$ 25K ea.).

9. Milestones:

(Predictive Report Milestone, due 15 November 1997, can be found in TR39BFB6, "E-W Drift Predictive Reports.")

1 level IV milestone, predictive report, due 15 November 97

1 level IV milestone, final report, due 30 September 99

10. Level III Milestone Acceptance Criteria:

11. Attachments and References:

Hersman, L.E. 1997. "The Effects of Microorganisms on the Sorption and Transport of Radioactive Wastes." Los Alamos National Laboratory Report, in press.

Kieft, T.L., W.P. Kovacik, D.B. Ringelberg, D.C. White, D.L. Haldeman, L.E. Hersman. 1996. Limiting factors to microbial activity in volcanic tuff at Yucca Mountain. Submitted to Appl. Environ. Microbiol.

Ringelberg, D.B., J.O. Stair, D.L. Haldeman, L. Ragatz, T.L. Kieft, W.P. Kovacik, M. Kahil, D.C. White, and L.E. Hersman. 1996. Microbial community composition in a volcanic tuff: Yucca Mountain, NV: In preparation for Appl. Environ. Microbiol.

**BASIS OF ESTIMATE
FOR THE ENHANCED CHARACTERIZATION OF THE
REPOSITORY BLOCK**

1. Summary Account Number: TR353GA1
2. Summary Account Title: FIELD SUPPORT FOR SURFACE BASED TESTING ACTIVITIES
3. Summary Account MGR/ORG: Oliver/M&O LANL/PK
4. Status of Change: Revised x New

Scope Description:

Provide construction support for the Enhanced Characterization of the Repository Block specific to surface base testing

Provide equipment, support and materials to maintain the access road to the SD-11, construct a temporary drill/test pad, mobilize and demobilize a Class One Drill Rig to the SD-11 site, and general support for test preparation activities. Provide drilling, rig maintenance/materials and provide test support services during the drilling and initial testing of SD-11. Procure drilling/test related equipment/consumable (Including TFM record submissions). SD-11 is approximately 2900 feet deep and will be drilled 2 shifts per day, five days per week (South-West corner of potential repository block) .

Provide equipment, support and materials to maintain the access road to the SD-13, construct a temporary drill/test pad, mobilize and demobilize a Class One Drill Rig to the SD-13 site, and provide general support for test preparation activities. Provide drilling, rig maintenance/materials and test support services during the drilling and initial testing of SD-13. Procure drilling/test related equipment/consumables/technical services (including TFM record submissions). SD-13 is approximately 2650 feet deep and will be drilled 2 shifts per day, five days per week (North of current potential repository block) .

1. **Scope Differences from the Baseline:**

new

1. **Key Assumptions:**

It is assumed that drilling will be based on five days per week, two shifts per day, but general test support will normally be done on day shift. There will be two operational drill rigs available. Testing for/of perched water will be limited to locations where it will most likely occur. Continuation to TD will follow a two week analysis/testing period if perched water is being evaluated. Necessary SMF and Drilling Engineering support is funded during the FY-98 period. Drilling is completed on schedule for SD-6 and WT-24. Necessary drill crews are trained and available.

Cost Rationale:

FY 98 \$1,531k
Contract Construction

SD-11 Pad \$220k
SD-11 Drill \$1,311k

FY 99 \$702k
Contract Construction
SD-13 Pad \$125k
SD-13 Drill \$577k

9. Level III Milestones:

- 1. SPSD11M Complete Drill Pad for SD-11, 28 Nov. 1997**
- 2. SPSD13M3 Start Drilling SD-13, 19 Nov. 1998**

10. Level III Milestone Acceptance Criteria:

Notification letter to DOE.

11. Attachments and References: Schedule and Tasks

Road Maint. & Pad Construction for SD-11	1 Oct. 97	28 Nov. 97
Complete Construction of Drill Pad SD-11	28 Nov. 97	
Drill and Test SD-11	25 Mar. 98	7 Sept. 98
Road Mod. And Pad Construction SD-13	1 Oct. 98	18 Nov. 98
Start Drilling SD-13	19 Nov. 98	
Drill and Test SD-13	19 Nov. 98	2 Apr. 99

Milestone Title: Complete Drill Pad for SD-11

Milestone ID: SPSD11M3

Due Date: 28 Nov 97

Milestone Acceptance Criteria: This milestone will be met by submission of a letter to YMSCO stating that the drill pad for borehole SD-11 has been completed. The deliverable will be submitted as per YAP5.1Q.

Milestone Title: Start Drilling SD-13

Milestone ID: SPSD13M3

Due Date: 19 Nov 98

Milestone Acceptance Criteria: This milestone will be met upon submission of a letter to YMSCO stating that drilling has been initiated at borehole SD-13. The deliverable will be submitted as per YAP5.1Q.

**BASIS OF ESTIMATE
FOR THE ENHANCED CHARACTERIZATION OF THE
REPOSITORY BLOCK**

1. Summary Account Number: TR355FA1
2. Summary Account Title: ESF TESTING SUPPORT
3. Summary Account MGR/ORG: Oliver/M&O TCO
4. Status of Change: Revised New

Scope Description:

All efforts required to drill and core (if needed) holes for installing instruments, heaters, and other equipment. All efforts required to provide grouting services for installing instruments and other purposes. All efforts required to design and install bulkheads, as necessary, for testing. All efforts required to cut slots and other specialized excavations in rock. Assist in collecting samples and provide for miscellaneous services or materials. Provide grouting, and other necessary services for testing in the ESF.

Provide construction support for the Enhanced Characterization of the Repository Block

1. **Scope Differences from the Baseline:**

Provide construction support for the Enhanced Characterization of the Repository Block

1. **Key Assumptions:**

It is assumed that construction will be based on three shifts per day, but drilling and general test support will normally be done on day shift. There will be three 30 meter holes angled from the launch chamber to the underpath of the TBM and four 30 meter holes angled from the ESF to the underpath of the TBM to measure water penetration from the mining process. Three 30 meter holes will be drilled in the ESF main to measure percolation below the tunnel through the invert. Eighteen additional 10 meter holes will be drilled in the cross drift for moisture monitoring. Alcoves will be constructed at four different locations along the route of the cross drift. Two niches will be developed for moisture measurement studies. Holes will be drilled in each one of the alcoves (~6 X 20m in each alcove) and in the niches (~8 X 10m in each niche). There will be two meter holes drilled at regular intervals (~25m) along the right hand rib for measurement of *in situ* water potential. There will be four 6 meter holes (instrumented) spaced 500 meters apart to gain more detailed water measurements. There will be fifty 2 meter (cored) holes for water content measurements, geochemical analysis and physical and hydrologic properties. There will be three borehole jack test locations with two 7 meter (cored) holes each. The total number of meters of drilling is in the neighborhood of 1, 521 and the locations vary as listed above.

Samples will be collected from the rib at ten meter intervals (~250 samples).

Cost Rationale: (See Assumptions)
FY 98 543k

Contract Construction

1 Drilling Crew (Driller + Helper + .3 Supervisor) -233k

1 Survey Crew -180k

1 miner for misc. support including support for Mapping and Sampling -50k

ODC

Drilling tool support and normal construction supplies support \$80K

FY 99 135k

Contract Construction

.25 Drilling Crew -58k

.25 Survey Crew -45k

.25 miner -12k

ODC

Drilling tool support and normal construction supplies support \$20K

9. Level III Milestones:

10. Level III Milestone Acceptance Criteria:

11. Attachments and References:

12. Tasks and Schedules (No Milestones)

07/01/97 - 09/15/97	Drilling and Testing in ESF Tpt
09/15/97 - 12/15/97	Drilling and testing associated with Launch Chamber excavation
12/15/97 - 12/19/97	Launch chamber boreholes (2 each - 30 meters, 1 each - 30 meter cored)
01/15/98 - 05/12/98	Drilling and testing associated with excavation of Cross Drift
06/12/98 - 09/02/99	Drilling and testing associated with Alcoves and Niches
09/15/97 - 09/02/99	Drilling Engineering Support/SMF Support (This task requires LOE Support form TR3522G42)
09/15/97 - 09/02/99	Tracer Support (This task requires LOE Support from 0G3521G41)

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: 0G36221EB3
2. Summary Account Title: Syn Dist & Anal Geochron Age Dets Potent Repos Blk
3. Summary Account MGR/ORG: Robert Craig/LISGS
4. Status of Change: X Revised ___ New
5. Scope Description:

This work will extend ongoing ESF studies of calcite and opal fracture fillings to similar deposits exposed along the ECRB cross drift. These low-temperature deposits are long-term records of percolation, and the new data will contribute to a better understanding and improved estimate of the spatiotemporal distribution of flux through the repository block

FY98 Task 1:

The spatiotemporal distribution and abundance of calcite and opal in the ECRB cross drift will be predicted on the basis of data acquired from such deposits and their occurrence in the ESF. Zonal features (lithophysal vs. nonlithophysal), structural (faults and fractures) features, and surficial controls will be considered in developing this predictive capability. Estimates of calcite and opal in the ECRB will be based on 100 meter increments along the cross drift. A grading assessment of these predictions will be prepared at the end of the fiscal year.

FY98 Task 2:

This work will entail sample collection and documentation of calcite and opal occurrences, isotopic dating to establish depositional history (U-series, C-14, and U-Pb), isotopic characterization (O, C, Sr, U isotopes) to establish the nature of the precipitating fluids, and line surveys and systematic collection of dust in a specially designed dust collector mounted on the TBM near the cutter head to establish the spatial distribution and abundance of calcite and opal sequestered in fractures and cavities. Sampling and analyses will be closely coordinated with the LANL investigation of Cl-36, and USGS samples will be made available to LANL for specialized mineralogical and geochemical studies. The numerical age and isotopic data obtained for samples from the ECRB cross drift will be incorporated and interpreted with data obtained for samples from the ESF and from drill core.

FY99:

This workscope includes sampling of fracture fillings from the Solitario Canyon fault alcove and other alcoves constructed in FY99 and completion of numerical age and isotopic analyses of these samples and samples collected in FY98 from the ECRB cross drift. The work will entail sample collection and documentation of calcite and opal occurrences, isotopic dating to establish depositional history (U-series, C-14, and U-Pb), and isotopic characterization (O, C, Sr, U isotopes) to establish the nature of the precipitating fluids and conditions of deposition. Sampling and analyses will be closely coordinated with the LANL investigation of CI-36, and USGS samples will be made available to LANL for specialized mineralogical and geochemical studies. The numerical age and isotopic data obtained for samples from the ECRB cross drift, including the Solitario Canyon fault alcove, will be incorporated and interpreted with data obtained for samples from the ESF and from drill core.

6. Scope Differences from the Baseline:

The ECRB cross drift greatly extends subsurface access to secondary calcite and opal fracture and cavity deposits. The increased availability of material requires additional effort in sampling, documentation, and numerical dating and isotopic characterization of these deposits. The new work will substantially enhance the data base for modeling the spatial and temporal distribution of flux in the repository block based on the mineralogical record.

7. Key Assumptions:

FY98--(a) sampling and line surveying will be conducted during the construction of the cross drift before tunnel walls become obscured by fine air-borne muck, (b) the linear abundance of fracture and cavity fillings in the cross drift as a function of lithologic unit will be similar to that in the ESF, (c) based on assumed cross drift length of approximately 3 km, and previous experience in the ESF between Stations 22 and 65, 40 to 70 localities will be sampled and these sites will yield specimens suitable for 80 to 150 numerical ages and isotopic analyses, (d) analyses will not be started until after samples obtained in the first sampling campaign are fully described and documented (early June), (e) sampling of the Solitario Canyon and other alcoves will not be conducted until FY99, (f) approximately half of the total analyses will not be completed until FY99.

FY99--(a) the Solitario Canyon fault alcove will be accessible for sampling of fracture calcite and opal deposits by no later than March, 1999, (b) requisite samples will already have been collected from the main reaches of the ECRB cross drift in FY98 with minimal additional collection (new alcoves only) in FY99, (c) USGS ESF dating work will have continued through FY98 and into FY99 to insure availability of staff, laboratories and equipment (e.g. thermal ionization mass spectrometer).

8. Cost Rationale:

FY98: (\$441K)

Labor (3.5 FTE):

Geologist GS-15 (0.1 FTE): Expertise in management, supervision, sample collection design, data synthesis and interpretation.

Hydrologist GS-13 (0.4 FTE): Principal investigator with broad expertise in isotope geochemistry, mineralogy, petrology, and U-series dating.

Geochemist GS-13 (0.4 FTE): Expertise in isotope geochemistry, thermal ionization mass spectrometry, U-series and U-Pb dating.

Geologist GS-13 (0.4 FTE): Expertise in mineralogical paragenesis and stable isotope geochemistry.

Hydrologist GS-13 (0.4 FTE): Expertise in strontium isotope geochemistry, geochemical modeling, and data base development and management.

Chemist GS-12 (0.4 FTE): Expertise in uranium and lead chemistry and thermal ionization mass spectrometry.

Chemist GS-13 (0.4 FTE): Expertise in strontium and rare earth chemistry and thermal ionization mass spectrometry.

Chemist GS-12 (0.2 FTE): Expertise in stable isotope analyses (oxygen, carbon, hydrogen) and gas mass spectrometry.

Physical Science Technician GS-9 (0.4 FTE): Expertise in the operation of stable extraction lines, sample collection and documentation, and data management.

QA Implementation Specialist GS-9 (.04 FTE): Expertise in the maintenance of QA records, tracking milestones, and to monitor adherence to technical procedures and other QA requirements during the course of the investigation.

Travel: (\$14K)

Five sample collecting trips by a 4-man team of specialists.

Other Direct Costs: (\$42K)

Includes \$26 K for USGS laboratory and mass spectrometer costs attendant with U-series, U-Pb, stable isotope, and petrographic analyses; and \$15.5 K for AMS C-14 analyses (20 samples at \$778.45/sample) by a contract laboratory.

FY99: (\$520 K)

Labor (4.35 FTE):

Geologist GS-15 (0.1 FTE): Expertise in management, supervision, sample collection design, data synthesis and interpretation.

Hydrologist GS-13 (0.5 FTE): Project manager with broad expertise in isotope geochemistry, mineralogy, petrology, and U-series dating.

Geochemist GS-13 (0.5 FTE): Expertise in isotope geochemistry, thermal ionization mass spectrometry, U-series and U-Pb dating.

Geologist GS-13 (0.5 FTE): Expertise in mineralogical paragenesis and stable isotope geochemistry.

Hydrologist GS-13 (0.5 FTE): Expertise in strontium isotope geochemistry, geochemical modeling, and data base development and management.

Chemist GS-12 (0.5 FTE): Expertise in uranium and lead chemistry and thermal ionization mass spectrometry.

Chemist GS-13 (0.5 FTE): Expertise in strontium and rare earth chemistry and thermal ionization mass spectrometry.

Chemist GS-12 (0.25 FTE): Expertise in stable isotope analyses (oxygen, carbon, hydrogen) and gas mass spectrometry.

Physical Science Technician GS-9 (0.5 FTE): Expertise in the operation of stable extraction lines, sample collection and documentation, and data management.

QA Implementation Specialist GS-9 (0.5): Expertise in the maintenance of QA records, tracking milestones, and to monitor adherence to technical procedures and other QA requirements.

Travel: (\$6K)

Two sample collecting trips by 4-man team of specialists.

Other Direct Costs: (\$35 K)

Includes \$27K for USGS laboratory and mass spectrometer costs attendant with U-series, U-Pb, stable isotope, and petrographic analyses; and \$8K for AMS C-14 analyses (20 samples at \$809.60/sample) by a contract laboratory.

9. **Level III Milestones:**

None in FY98

FY98 Level IV Milestones:

A Level IV milestone (No. SPC233M4, due 28 Nov 97) will consist of a memorandum to the USGS TPO describing spatiotemporal predictions of calcite and opal fracture and cavity fillings in the ECRB cross drift. The memorandum will list the criteria used in making these predictions.

A Level IV milestone (No. SPC234M4, due 30 Sep 98) will consist of a memorandum to the USGS TPO evaluating and grading the predictions made against actual observations and measurements of the spatiotemporal distribution of calcite and opal cavity and fracture fillings in the ECRB cross drift.

A Level IV milestone (No. SPC235M4, due 30 Sep 98) will consist of a memorandum to the USGS TPO describing geochronologic and isotopic analyses of calcite and opal samples from the ECRB cross drift completed through August 15, 1998.

FY99 Level III Milestone:

A Level III milestone (No. SPC233M3, due 15 Sep 99) will consist of a detailed technical report to the DOE describing the spatiotemporal distribution of percolation through the repository block as indicated by calcite and opal fracture fillings.

10. **Level III Milestone Acceptance Criteria:**

The Level III milestone report will synthesize previously reported and new data and will interpret the results of numerical dating and isotopic studies conducted on calcite opal and fracture fillings in the ESF and the ECRB cross drift. The report will be comprehensive and supersede all previous Level IV reports on this subject. The report will include a refined model of the spatiotemporal distribution of percolation through the repository block based on these data, and the model will be evaluated in the context of independent models of percolation derived from other data sets. In documenting the temporal distribution of calcite and opal deposits, the report will evaluate the relationship between depositional history and surficial climate variations to develop a predictive capability of the future variation of percolation as a function of climate change.

11. **Attachments and References:**

12. **Schedule:**

Activity

Early Start

Early Finish

Collect Calcite and Opal Data in Cross Drift	01 Oct 97	28 Nov 97
Collect Samples of Calcite and Opal Occurrences	01 Oct 97	30 Sep 98
Sample Fracture Filling From Solitario Canyon	01 Oct 98	30 Sep 99
Complete Numerical Age and Isotopic Analysis	01 Oct 98	30 Sep 99
Prep Rpt Describing Spatiotemporal Distr	01 Oct 98	15 Sep 99

WBS 1.2.3.6.2.2.1 Quaternary Regional Hydrology
ATTACHMENT B

SPC233M3 Report: Spatiotemporal Distribution of Percolation

15-sep-99

This deliverable shall include all information identified herein unless specifically exempted in writing by the COR at least 60 days before the scheduled due date (30 days in special cases agreed to by the COR).

The Level III milestone report will consist of a detailed technical report describing the spatiotemporal distribution of percolation through the repository block as indicated by calcite and opal fracture fillings. The report will synthesize previously reported and new data and will interpret the results of numerical dating and isotopic studies conducted on calcite opal and fracture fillings in the ESF and the ECRB cross drift. The report will be comprehensive and supersede all previous level 4 reports on this subject. The report will include a refined model of the spatiotemporal distribution of percolation through the repository block based on these data, and the model will be evaluated in the context of independent models of percolation derived from other data sets. In documenting the temporal distribution of calcite and opal deposits, the report will evaluate the relationship between depositional history and surficial climate variations to develop a predictive capability of the future variation of percolation as a function of climate change.

This deliverable shall be prepared in accordance with OCRWM approved quality assurance procedures implementing requirements of the Quality Assurance Requirements Description. The product shall be developed on the basis of the best technical data, including both Q and non-Q data. The Q status of data used and cited in the report shall be appropriately noted. Stratigraphic nomenclature cited in the deliverable shall be consistent with the Reference Information Base section 1.12 (a): Stratigraphy-Geologic Lithologic Stratigraphy. The report shall note data used and shall include record Accession Numbers or Data Tracking Numbers when available. This deliverable shall be processed in accordance with YAP-5.1Q.

Completion Criterion

BASIS OF ESTIMATE FOR THE ENHANCED CHARACTERIZATION OF THE REPOSITORY BLOCK

1. Summary Account Number: TR397FA1
2. Summary Account Title: ESF Test Coordination
3. Summary Account MGR/ORG: Oliver/M&O TCO
4. Status of Change: X Revised New

Scope Description:

Integrate test planning development and provide test-related controls, constraints and instructions. Prepare test planning documents to initiate field testing. Maintain testing schedule. Provide support to testing participants, and Project managers/test leads. Provide response to Project Office requests for information on test planning and field implementation. Support systems studies and other studies through definition of testing required to meet needs of design, performance assessment, site suitability, environmental impact analysis, and license application. Provide project engineering (PE) and Field Work Package (FWP) coordination leading to field implementation and operation of testing activities. Integrate test planning development with facility design/ construction planning, and provide formal facility design requirements and test-related controls, constraints, and instructions as appropriate. Serve as liaison between test planning, facility design, and test implementation. Produce FWPs for all newly initiated tests. Produce associated documentation for field initiation such as Field Operation Permits and Job Safety Analyses. Submit FWPs and associated documents to DOE announcing recommendations to proceed. Hold Test Lead meetings. Provide field coordination for all tests, consolidated sampling, and support activities.

Scope Differences from the Baseline:

Construction of the facilities for enhanced characterization will involve several kilometers of tunnel, testing niches, drilling and sampling in the ESF and at least two vertical boreholes (Non-ESF) that are not covered by FY 97 baseline staffing. Work closely with the constructor and testing community to evaluate dust mitigation strategy that is closely tied to moisture balance investigations.

Provide single point of contact for calibration requirements for the test program.

Coordinate data collection and distribution for test program to include collection/distribution network and supplies that are not provided by individual

Key Assumptions:

It is assumed that construction will be based on three shifts per day with TCO/FTR support during underground construction or testing activities. The test related activities will continue through 98 into FY 99. Testing activities will follow a TBM advance with emphasis on geologic mapping, construction monitoring, consolidated sampling and some kind of dust mitigation/moisture study. Alcoves will be constructed at the cross over of the existing main, in the lower lithophysal unit, in the middle lithophysal in, under the Yucca Mountain Crest and at the contact for the Solitario Canyon fault. Two niches will

be mined to provide space for moisture studies. These testing programs and the construction coordination dovetail into the overall TCO mission, but augmentation of engineers for Field Test (FTRs) and Test Planning is necessary to support this heading and subsequent increased testing activity.

Cost Rationale:

FY 98

Labor

1 FTE 101b LANL: Field Test Representatives/PEs are Laboratory engineers with a instrumentation / project management background. Integrate test planning development and provide test-related controls, constraints and instructions. Prepare test planning documents to initiate field testing.

ODC

Programming and Software support for trouble-shooting \$40K

Instrumentation maintenance and parts \$30K

Storage and Transport Containers \$17k

Travel

3 Trips to Los Alamos, 2 Trips to Seattle or Similar Contract Facility

FY 99

Labor

5 FTE 101b LANL: Field Test Representatives/PEs are Laboratory engineers with a mining/ project management background. Integrate test planning development and provide test-related controls, constraints and instructions. Prepare test planning documents to initiate field testing.

9. **Level III Milestones:**
10. **Level III Milestone Acceptance Criteria:**
11. **Attachments and References:**

BASIS OF ESTIMATE FOR THE ENHANCED CHARACTERIZATION OF THE REPOSITORY BLOCK

1. Summary Account Number: TR397FA2
2. Summary Account Title: SBT Test Coordination
3. Summary Account MGR/ORG: Oliver/M&O LANL/WCFS
4. Status of Change: Revised New

Scope Description:

Provide management and support staff to coordinate all surface based testing (SBT) activities. This includes administrative support of surface based site characterization activities, including planning, coordination, scheduling, budgeting, controlling, revision, maintenance, weekly and monthly (not daily) reporting, and close-out. It is the function of SBTCO to serve as the SPO testing interface with the A/E, CMO, DMO, and PIs (through the USGS and M&O). The SBTCO process includes oversight review of the test criteria documents, i.e., the PI test plans, DIES, Work Programs, environmental stipulations, and subsequent development of the Field Work Packages (FWPs) as the implementing documents for each SBT activity.

Develop and maintain a field presence in coordination with the drilling contract services for the Enhanced Characterization of the Repository Block initiative. Working with the drilling engineer evaluate work schedules, drilling performance, and logistical support to enhance drilling performance, product availability for the scientific investigator and the safe economical performance of surface based testing. Represent the PI during drilling/testing activities and supplement SMF and Drilling Engineering activities as required. Provide an on location management presence during all test related activities including pad construction, drilling/coring operations, testing and data collection. In conjunction with the construction manager, constructor and scientific representatives conduct and document field safety meeting.

Provide single point of contact for calibration requirements for the test program.

Coordinate data collection and distribution for test program to include collection/distribution network and supplies that are not provided by scientific participants.

~~Provide engineer/scientific personnel to review, and contribute to Safety Assurance evaluations.~~

Scope Differences from the Baseline:

Construction of the facilities for enhanced characterization will at least two vertical boreholes (Non-ESF) that are not covered by FY 97 baseline staffing. Working with the drilling engineer evaluate work schedules, drilling performance, and logistical support to enhance drilling performance, product availability for the scientific investigator and the safe economical performance of surface based testing.

Provide single point of contact for calibration requirements for the test program.

Coordinate data collection and distribution for test program to include collection/distribution network and supplies that are not provided by individual

Key Assumptions:

It is assumed that construction drilling will be based on three shifts per day with TCO/FTR support during drilling construction and someor testing activities. The testing construction related activities will continue through 98 into FY 99. Testing locations will include drilling construction of two crest holes between 2,500 feet and 3,000 feet in length and continued testing in several other existing holes (day - shift primarily).

Cost Rationale:

FY 98

—Labor

5 FTE 101b LANL: Field Test Representatives/PEs are Laboratory engineers with a project management background. Provide for administrative support of surface based site characterization activities, including planning, coordination, scheduling, budgeting, controlling, revision, maintenance, weekly and monthly (not daily) reporting, and close-out. Evaluate work schedules, drilling performance, and logistical support to enhance drilling performance, product availability for the scientific investigator and the safe economical performance of surface based testing.

1 FTE 101b WCFS: Field Test Representatives/PEs are professional engineers with a drilling / project management background. Provide for administrative support of surface based site characterization activities, including planning, coordination, scheduling, budgeting, controlling, revision, maintenance, weekly and monthly (not daily) reporting, and close-out. Evaluate work schedules, drilling performance, and logistical support to enhance drilling performance, product availability for the scientific investigator and the safe economical performance of surface based testing.

5 FTE 101a WCFS: Project engineer to support Safety Assurance reviews and provide test related input to evaluations

ODC

Vehicle Support \$40K

Instrumentation maintenance and parts \$10K

Storage Containers Trailer upgrade \$17k

Travel

1 Trips to Los Alamos, 2 Trips to Denver, 2 Classes for Environmental Training

FY 99

Labor

.5 FTE 101b LANL: Field Test Representatives/PEs are Laboratory engineers with a project management background. Provide for administrative support of surface based site characterization activities, including planning, coordination, scheduling, budgeting, controlling, revision, maintenance, weekly and monthly (not daily) reporting, and close-out. Evaluate work schedules, drilling performance, and logistical support to enhance drilling performance, product availability for the scientific investigator and the safe economical performance of surface based testing.

1 FTE 101b WCFS: Field Test Representatives/PEs are professional engineers with a drilling / project management background. Provide for administrative support of surface based site characterization activities, including planning, coordination, scheduling, budgeting, controlling, revision, maintenance, weekly and monthly (not daily) reporting, and close-out. Evaluate work schedules, drilling performance, and logistical support to enhance drilling performance, product availability for the scientific investigator and the safe economical performance of surface based testing.

.5 FTE 101a WCFS: Project engineer to support Safety Assurance reviews and provide test related input to evaluations

ODC

Vehicle Support \$40K

Instrumentation maintenance and parts \$10K

Storage Containers Trailer upgrade \$17k

Travel

1 Trip to Los Alamos, 2 Trips to Denver, 2 Classes for Environmental Training

9. **Level III Milestones:**
10. **Level III Milestone Acceptance Criteria:**
11. **Attachments and References:**

BASIS OF ESTIMATE FOR THE INITIAL ACTIVITIES OF THE ENHANCED CHARACTERIZATION OF THE REPOSITORY BLOCK

1. Summary Account Number: TR39BFBIG
2. Summary Account Title: Provide Prognosis of Planned Boreholes
3. Summary Account MGR/ORG: Biggar / M&O - WCFS
4. Status of Change: Revised New
5. Scope Description:

The following work shall be controlled in accordance with approved implementing procedures identified on the current OCRWM-accepted Requirements Traceability Network Matrix.

The objective of this activity is to compile for the SD-11 and SD-13 boreholes predictive descriptions of the geology and hydrology parameters, and then compare the predicted parametric values with confirmatory data. The predictive information will be derived from the Reference Information Base (RIB), recently Yucca Mountain reports, and the geologic framework model (ISM.2) and other process models. The source or basis of the predicted values will be referenced. Data anticipated to be included in each of the reports, as appropriate, are stratigraphy, structure, elevations of saturated zones, hydrologic matrix properties of the unsaturated zone, geomechanical and geothermal properties, occurrences of hazardous minerals and zeolites, and major chemical characteristics of the saturated zone(s). These data will be presented in two level 3 reports (SP3VB1M3 for borehole USW SD-11; and SP3VB2M3 for borehole USW SD-13).

After testing has been conducted for the predicted parameters, a follow-up report will be prepared in which the predicted and actual measurements are presented and compared. Hypotheses will be presented to explain unexpected variations in the acquired data. These data will be assembled in two level 3 reports (SP3VB3M3 for borehole USW SD-11; and SP3VB4M3 for borehole USW SD-11).

6. Scope Differences from the Baseline: New Scope is being added to SA proposed for SD-6/WT-24 C/SCR. A title change for the summary account is also proposed with this C/SCR.
7. Key Assumptions:

Prognoses and comparison analyses of actual measurements of will be developed in the originating accounts for the different scientific studies.

The scheduling of the Analysis and Measurements reports assume that measurements will be available within four to five months after completion of drilling of the borehole. If actual measurements are not available in time for these reports, the analyses of that data will provided as addendums to the Level 3 reports when they are available.

8. Cost Rationale:

FY'98 Costs: (\$10k)

Compilation of the Predictive reports will be performed by a Senior Project Scientist 101B (0.1 FTE) with interdisciplinary site characterization expertise. Specific tasks include compilation, integration, and review and editing of contributed materials.

FY'99 Costs: (\$31k)

Compilation of the Analyses and Measurements reports will be performed by a Senior Project Scientist (101A, 0.25 FTE) having interdisciplinary site characterization expertise. Specific tasks include compilation, integration, and review and editing of contributed materials.

9. Level III Milestones: 4

Deliverable Title: Predictive Report for USW SD-11 Borehole
Deliverable ID: SP3VB1M3
Deliverable Due Date: March 2, 1998

Deliverable Title: Predictive Report for USW SD-13 Borehole
Deliverable ID: SP3VB2M3
Deliverable Due Date: November 2, 1998

Deliverable Title: Analysis of Prediction and Measurements for USW SD-11 Borehole
Deliverable ID: SP3VB3M3
Deliverable Due Date: July 1, 1998

Deliverable Title: Analysis of Prediction and Measurements for USW SD-13 Borehole
Deliverable ID: SP3VB4M3
Deliverable Due Date: September 30, 1999

10. Level III Milestone Acceptance Criteria:

Deliverable Title: Predictive Report for USW SD-11 Borehole
Deliverable ID: SP3VB1M3
Deliverable Due Date: March 2, 1998

Deliverable Acceptance Criteria: This deliverable shall include all information identified herein unless specifically exempted in writing by the COR at least 60 days before the scheduled due date (30 days in special cases agreed to by the COR). This milestone will be satisfied by a report

*Completion
criteria for
all 4*

providing predictions of the geology, hydrology, and rock properties that will be encountered in the borehole. The predictions will be presented as bounds on the values that are anticipated to be actually measured in subsequent tests. Geologic predictions derived from the ISM.2 geologic framework model will include depths to contacts defining lithologic, thermo-mechanical, and hydrogeologic units. Geoengineering data will include geomechanical and thermomechanical predictions, including parameters such as Youngs modulus, Poissons ratio, unconfined compressive strength, rock cohesion, angle of internal friction, thermal expansion and thermal conductivity. Predicted unsaturated zone rock properties derived from the rock properties model will include parameters such as matrix porosity, lithophysal porosity, saturated hydraulic conductivity, bulk density, zeolite alteration, and thermal conductivity. Hydrologic rock properties data from the USGS model will include parameters such as porosity, bulk density, particle density, saturated hydraulic conductivity, saturation, and water potential. From the UZ site-scale flow model, parameters such as matrix saturation, moisture tension, perched water conditions and ages, borehole temperature gradient will be predicted. Other input will include predictions on the occurrence of hazardous minerals, petrophysical zones, and major chemical characteristics of the saturated zone, such as alkalinity, pH, conductivity, and temperature. The basis for the predictions will be provided; an explanation will be provided if a prediction cannot be made.

This deliverable shall be prepared in accordance with OCRWM approved quality assurance procedures implementing requirements of the Quality Assurance Requirements Description. The product shall be developed on the basis of the best technical data, including both Q and non-Q data. The Q status of data used and cited in the report shall be appropriately noted. Stratigraphy used shall be consistent with the Reference Information Base section 1.12 (a): Stratigraphy-Geologic Lithologic Stratigraphy. Within the report's Reference Section, references used in the report shall include record Accession Numbers or Data Tracking Numbers when available. Technical data contained within the deliverable and not already incorporated in the Geographic Nodal Information Study and Evaluation System (GENISES) shall be submitted for incorporation into the GENISES in accordance with YAP-SIII.3Q. Verification of technical data submittal compliance shall be demonstrated by including as part of the deliverable: 1) a copy of the Technical Data Information Form generated identifying the data in the Automated Technical Data Tracking system, and 2) a copy of the transmittal letter attached to the technical data transmittal to the GENISES Administrator.

Deliverable Title: Predictive Report for USW SD-13 Borehole

Deliverable ID: SP3VB2M3

Deliverable Due Date: November 2, 1998

Deliverable Acceptance Criteria: This deliverable shall include all information identified herein unless specifically exempted in writing by the COR at least 60 days before the scheduled due date (30 days in special cases agreed to by the COR). This milestone will be satisfied by a report providing predictions of the geology, hydrology, and rock properties that will be encountered in the borehole. The predictions will be presented as bounds on the values that are anticipated to be actually measured in subsequent tests. Geologic predictions derived from the ISM.2 geologic framework model will include depths to contacts defining lithologic, thermo-mechanical, and hydrogeologic units. Geoengineering data will include geomechanical and thermomechanical predictions, including parameters such as Youngs modulus, Poissons ratio, unconfined compressive strength, rock cohesion, angle of internal friction, thermal expansion and thermal

conductivity. Predicted unsaturated zone rock properties derived from the rock properties model will include parameters such as matrix porosity, lithophysal porosity, saturated hydraulic conductivity, bulk density, zeolite alteration, and thermal conductivity. Hydrologic rock properties data from the USGS model will include parameters such as porosity, bulk density, particle density, saturated hydraulic conductivity, saturation, and water potential. From the UZ site-scale flow model, parameters such as matrix saturation, moisture tension, perched water conditions and ages, borehole temperature gradient will be predicted. Other input will include predictions on the occurrence of hazardous minerals, petrophysical zones, and major chemical characteristics of the saturated zone, such as alkalinity, pH, conductivity, and temperature. The basis for the predictions will be provided; an explanation will be provided if a prediction cannot be made.

This deliverable shall be prepared in accordance with OCRWM approved quality assurance procedures implementing requirements of the Quality Assurance Requirements Description. The product shall be developed on the basis of the best technical data, including both Q and non-Q data. The Q status of data used and cited in the report shall be appropriately noted. Stratigraphy used shall be consistent with the Reference Information Base section 1.12 (a): Stratigraphy-Geologic Lithologic Stratigraphy. Within the report's Reference Section, references used in the report shall include record Accession Numbers or Data Tracking Numbers when available. Technical data contained within the deliverable and not already incorporated in the Geographic Nodal Information Study and Evaluation System (GENISES) shall be submitted for incorporation into the GENISES in accordance with YAP-SIII.3Q. Verification of technical data submittal compliance shall be demonstrated by including as part of the deliverable: 1) a copy of the Technical Data Information Form generated identifying the data in the Automated Technical Data Tracking system, and 2) a copy of the transmittal letter attached to the technical data transmittal to the GENISES Administrator.

Deliverable Title: Analysis of Prediction and Measurements for USW SD-11 Borehole

Deliverable ID: SP3VB3M3

Deliverable Due Date: July 1, 1998

Deliverable Acceptance Criteria: This deliverable shall include all information identified herein unless specifically exempted in writing by the COR at least 60 days before the scheduled due date (30 days in special cases agreed to by the COR). This milestone will be satisfied by a report providing comparisons of the predictions made in Deliverable SP3VB1M3 of the geology, hydrology, and rock properties anticipated to be encountered in the borehole, with actual measurements and occurrences. The methods used to derive the measurements will be provided, as well as a commentary regarding measurements that are outside of the bounds provided in the predictions.

This deliverable shall be prepared in accordance with OCRWM approved quality assurance procedures implementing requirements of the Quality Assurance Requirements Description. The product shall be developed on the basis of the best technical data, including both Q and non-Q data. The Q status of data used and cited in the report shall be appropriately noted. Stratigraphy used shall be consistent with the Reference Information Base section 1.12 (a): Stratigraphy-Geologic Lithologic Stratigraphy. Within the report's Reference Section, references used in the report shall include record Accession Numbers or Data Tracking Numbers when available. Technical data contained within the deliverable and not already incorporated in the Geographic

Nodal Information Study and Evaluation System (GENISES) shall be submitted for incorporation into the GENISES in accordance with YAP-SIII.3Q. Verification of technical data submittal compliance shall be demonstrated by including as part of the deliverable: 1) a copy of the Technical Data Information Form generated identifying the data in the Automated Technical Data Tracking system, and 2) a copy of the transmittal letter attached to the technical data transmittal to the GENISES Administrator.

Deliverable Title: Analysis of Prediction and Measurements for USW SD-13 Borehole

Deliverable ID: SP3VB4M3

Deliverable Due Date: September 30, 1999

Deliverable Acceptance Criteria: This deliverable shall include all information identified herein unless specifically exempted in writing by the COR at least 60 days before the scheduled due date (30 days in special cases agreed to by the COR). This milestone will be satisfied by a report providing comparisons of the predictions made in Deliverable SP3VB2M3 of the geology, hydrology, and rock properties anticipated to be encountered in the borehole, with actual measurements and occurrences. The methods used to derive the measurements will be provided, as well as a commentary regarding measurements that are outside of the bounds provided in the predictions.

This deliverable shall be prepared in accordance with OCRWM approved quality assurance procedures implementing requirements of the Quality Assurance Requirements Description. The product shall be developed on the basis of the best technical data, including both Q and non-Q data. The Q status of data used and cited in the report shall be appropriately noted. Stratigraphy used shall be consistent with the Reference Information Base section 1.12 (a): Stratigraphy-Geologic Lithologic Stratigraphy. Within the report's Reference Section, references used in the report shall include record Accession Numbers or Data Tracking Numbers when available. Technical data contained within the deliverable and not already incorporated in the Geographic Nodal Information Study and Evaluation System (GENISES) shall be submitted for incorporation into the GENISES in accordance with YAP-SIII.3Q. Verification of technical data submittal compliance shall be demonstrated by including as part of the deliverable: 1) a copy of the Technical Data Information Form generated identifying the data in the Automated Technical Data Tracking system, and 2) a copy of the transmittal letter attached to the technical data transmittal to the GENISES Administrator.

11. **Attachments and References:** N/A

12. **Schedule:**

Develop predictive report for Borehole SD-11: 2 Jan 98 - 2 Mar 98
Develop predictive report for Borehole SD-13: 1 Oct 98 - 2 Nov 98
Develop analysis report for Borehole SD-11: 1 Apr 99 - 1 Jul 99
Develop analysis report for Borehole SD-13: 1 Jul 99 - 30 Sept 99

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: TR39BFB6
2. Summary Account Title: Predictive Reports
3. Summary Account MGR/ORG: Smith/SPO-WCFS
4. Status of Change: X Revised New
5. Scope Description:

A Level 3 predictive report for the East-West Drift will be developed, consisting of two separate volumes. The first will focus on geologic/geotechnical/mineralogical issues and the second will deal with hydrologic/environmental isotope issues. Both reports will provide predictions of the conditions anticipated to be encountered in the East-West Drift tunnel.

The geology/geotechnical/mineralogical volume will be patterned after the suggested guidelines for "Geotechnical Baseline Reports for Underground Construction Suggested Guidelines" prepared by the Underground Technology Research Council. This volume will be based on Level 4 reports from LANL, SNL, USBR, and USGS. These reports will be supplemented by design and construction data from the ESF as analyzed by the M&O. M&O will combine its analysis with the Level 4s and produce a Level 3 report comparable to the above referenced Geotechnical Baseline Report.

The hydrology/environmental isotope volume will focus on predictions of East-West Drift conditions to be encountered resulting from current process and conceptual models. These predictions will include mineralogy related to hydrologic flow paths, hydrologic conditions and environmental isotopes. Multiple predictions may exist for the same parameter if different conceptual or numerical models are used. In such cases the conceptual or numerical models used in the predictions will be described. The predictions will be set forth in Level 4 reports developed by the LANL, LBNL, and USGS. The predictions will involve parameters that are either directly measurable in the tunnel or directly measurable from samples taken from the tunnel.

The Level 4 reports from LBNL, LANL and the USGS will be synthesized by the M&O and released as volume one of the Level 3 Deliverable. Volume two will be the Geotechnical Baseline Report.

6. **Scope Differences from the Baseline:**

This is an addition to the account set up in the change request for the Boreholes WT-24/SD-6.

7. **Key Assumptions:**

TBM start date is February, 1998.

8. **Cost Rationale:**

FY97 Components of Cost:

- 0.20 FTE Senior Geotechnical Engineer (101A, MK)
Oversee the collection and analyses of existing geotechnical data relevant to development of the Geotechnical Baseline Report for Construction of the East-West Drift Tunnel.
- 0.09 FTE Senior Scientist (100A, TRW)
Provide oversight to and prepare a synthesis report of the work of LBNL and USGS who will prepare predictions as to the hydrologic conditions to be encountered in the East-West Drift Tunnel.
- 0.05 FTE Staff Support (101C, WCFS)
Provide technical support to the lead professionals.

FY98 Components of Cost:

- 0.20 FTE Senior Geotechnical Engineer (101A, MK)
Prepare the Geotechnical Baseline Report for Construction of the East-West Drift Tunnel.
- 0.05 FTE Senior Geotechnical Engineer (101A, WCFS)
Advise and support preparation of the Geotechnical Baseline Report.
- 0.15 FTE Senior Scientist (100A, TRW)
Provide oversight to and prepare a synthesis report of the work of LBNL and USGS who will prepare prediction as to the hydrologic conditions to be anticipated in the East-West Drift tunnel.
- 0.15 FTE Geologists/3-D Modelers (101B, WCFS)
Provide 3-D model and geologic support to the lead professionals.
- 0.15 FTE Staff Support (101C, WCFS)
Provide technical support to the lead professionals.

9. **Level III Milestones:**

One Level III Deliverable.

Title: Predictive Report on Subsurface Conditions in the East-West Drift Tunnel

Milestone ID: xxxxx

Due Date: 15Dec97

Acceptance Criteria: This report will be prepared in accordance with applicable M&O QA procedures and following the M&O style guide. The report will consist of two volumes; one devoted to geologic/geotechnical/mineralogical issues and one devoted to hydrologic and environmental isotope issues. The geologic/geotechnical/mineralogic volume will be developed in general conformance with: "Geotechnical Baseline Reports for underground Construction - Suggested Guidelines" prepared by the Underground Technology Research Council (in process, due for release) Jun 1997, ASCE Press.

Hydrologic/environmental isotope volume will be based on predictive models applied to the East-West Drift alignment. These models predictions will include efforts from Flint, USGS (?); Bodvarsson, LBNL (ambient hydrologic conditions); Fabryka-Martin, LANL (CL-36); and Peterman, USGS (?). All predictions will address parameters directly measurable either in the tunnel from samples taken from the tunnel.

This deliverable shall be prepared in accordance with OCRWM approved quality assurance procedures implementing requirements of the Quality Assurance Requirements Description. The product shall be developed on the basis of the best technical data, including both Q and non-Q data. The Q status of data used and cited in the report shall be appropriately noted. Stratigraphy used shall be consistent with the Reference Information Base section 1.12 (a): Stratigraphy-Geologic Lithologic Stratigraphy. Within the report's Reference Section, references used in the report shall include record Accession Numbers or Data Tracking Numbers when available. Technical data contained within the deliverable and not already incorporated in the Geographic Nodal Information Study and Evaluation System (GENISES) shall be submitted for incorporation into the GENISES in accordance with YAP-SIII.3Q. Verification of technical data submittal compliance shall be

demonstrated by including as part of the deliverable: 1) a copy of the Technical Data Information Form generated identifying the data in the Automated Technical Data Tracking system, and 2) a copy of the transmittal letter attached to the technical data transmittal to the GENISES Administrator.

Completion criterion

10. Level III Milestone Acceptance Criteria:

See item 9 above.

11. Attachments and References:

12. Schedule:

Early Start: 01Aug97

Early Finish: 15Dec97

**TECHNICAL BASIS
FOR THE REQUIRED ACTIVITIES FOR THE ENHANCED CHARACTERIZATION
OF THE REPOSITORY BLOCK**

1. Summary Account Number: TR39BFB7
2. Summary Account Title: E-W Drift Predictive Reports
3. Summary Account MGR/ORG: Dixon/SPO-LANL
4. Status of Change: New
5. Scope Description:

Predictive Reports, due November 15, 1997, will be prepared for the following activities:

Analysis of Calcites and Associated Minerals

This activity will provide mineralogic analysis and trace-element analysis of calcites and of associated minerals (opal, clay, and Mn-oxides in particular) in concert with the isotopic and field studies of ESF calcites and opals by the USGS. Data to be obtained from the E-W drift will help to address the importance of variable calcite chemistry as seen in a few samples from drill core USW GU-3 (Vaniman, 1994) and test the applicability of flux and transport inferences from these data across the entire exploration block. These results will support evaluation of lateral variability in UZ transport models for TSPA-LA.

Level 4 Deliverables:

Title: Predictive Report on Calcite and Associated Mineral Data for the E-W drift

Due Date: 11/15/97

This report will provide predictions of mineral calcite and associated mineral compositions to be encountered in excavation of the E-W drift. These predictions will use the current model of calcite compositions related to UZ geochemical stratigraphy in the host rock (Vaniman et al., 1996). Predictions will also be made of what mineral associations might be expected in the Solitario Canyon Fault, based on present experience with ESF fault-zone mineralogy.

Analysis of Hazardous Minerals from the ESF to Facilitate Repository Testing, Design, Construction, and Operation

This activity will address two problems in past site characterization that should be addressed prior

to the development of documents needed for License Application:

1. There is a need to provide quantitative data on mineral abundances and distributions to address hazardous-mineral distributions in those subunits of the Topopah Spring Tuff that may contain the potential repository level. These data should be obtained and examined to generate predictive models of (1) the distributions of silica polymorphs in the potential host rock and (2) zeolite distributions within the potential repository level.
2. There is a need to obtain quantitative data for both size and mineralogy of particulates generated from alcove and drift mining operations. These data will be important in evaluating those approaches to excavation practice that will address OSHA respiratory protection standards without compromising testing or construction.

Level 4 Deliverables:

Title: Predictive Report on Hazardous Mineral Distributions

Due Date: 11/15/97

This report will provide a prediction of where and in what quantities hazardous minerals may be encountered in mining operations at Yucca Mountain, based on past experience with drill core and ESF samples. Operations for both exploration and for full-scale repository development will be considered. Drilling operations will also be considered as applicable.

Petrology of Flow Paths in the E-W Drift

The E-W Drift will provide subsurface access to a portion of Yucca Mountain with higher net infiltration than the Main Drift and Ramps. The E-W Drift may intersect traces of the Sundance fault and the area below a low-angle thrust fault; both of these features are loci of fast infiltration in the Main Drift. The drift will terminate at the Solitario Canyon fault, a major block-bounding fault, where an alcove will be constructed. In conjunction with the chlorine-36 studies of the Water Movement Test, rock alteration and deformation associated with fast pathways, and, for comparison, with slow pathways, will be analyzed by field and laboratory techniques. The resulting contributions to a database of mineralogic and petrologic attributes will be used to test hypotheses about the origins, longevity, and connectivity of fast paths. In particular, we will examine whether fast paths, if they are found, below higher infiltration areas have distinctive characteristics that would cause us to revise our conceptual models of fast-path existence.

Level 4 Deliverables:

Title: Fast-Path Feature Mineralogy Input to Level III Predictive Report

Due Date: 11/15/97

A letter report will be written for incorporation into a project Level III milestone predictive report. The letter report will assess existing data pertinent to the mineralogic and petrologic characteristics of transmissive structures that may be intersected by the E-W Drift and will describe the development of criteria for evaluating the longevity and connectivity of fast-path features. If samples from the associated boreholes are available in time, mineralogic data from these samples will be included.

Distribution of chlorine-36 and halides in the E-W Drift, SD-11 and SD-13

This activity will:

- (a) evaluate the extent to which controlled use of water for suitable dust control impacts the quality of geochemical or isotopic data collected for site characterization
- (b) evaluate existing conceptual models for the distribution of fast paths, fracture/matrix interactions, and travel times
- (c) evaluate whether the current geochemical and isotopic data base for samples acquired from the ESF and surface-based boreholes is representative of repository block conditions

Level 4 Deliverables:

Title: Predicted Distributions of Chlorine-36 and Chloride Porewater Concentrations in the E-W Drift.

Due Date: 11/15/97

A letter report will be written for incorporation into a project Level III milestone predictive report. The letter report will assess existing data pertinent to selected isotopic and geochemical characteristics of porewater in the stratigraphic and structural features that may be intersected by the E-W Drift, SD-11 and SD-13, and will describe the development of criteria for evaluating the distribution and frequency of fast paths, distribution and range of chloride porewater concentrations, distribution and range of $^{36}\text{Cl}/\text{Cl}$ ratios, ^{14}C activity, and tritium activity.

Microbial Analysis - ESF

The proposed studies represent what we believe to be the minimum work necessary to provide essential information for critical assessment and license application issues. Studies will be directed specifically at determining the functional microbial population within Yucca Mountain. While we do have substantial general information on this population, we are still lacking certain specific details, including:

- A. Information of the population of microorganisms within the ^{36}Cl "fast-paths",
- B. Information on the population in the wetter regions of the ESF, and
- C. Completion of the chelated actinide transport studies.

The first two studies would complete the evaluation of the ESF microbial population such that performance assessment could be performed on the extant microbial population. The third study would allow us to evaluate a potential mechanism of microbial influenced transport of radioactive waste elements.

Level 4 Deliverables:

Title: Microbial Analysis Predictive Report

Due Date: November 15, 1997

6. Scope Differences from the Baseline: New Work

7. Key Assumptions: None

8. Cost Rationale:

Labor Category 101A, 0.20 FTE

Labor Category 101B, 0.18 FTE

Labor Category 101C, 0.06 FTE

Labor Category 109C, 0.14 FTE

9. Level III Milestones: None

10: Level III Milestone Acceptance Criteria: N/A

11. Attachments and References: None

BASIS OF ESTIMATE FOR THE ENHANCED CHARACTERIZATION OF THE REPOSITORY BLOCK

1. Summary Account Number: TR3B1GA1
2. Summary Account Title: Surface Geophysical Data Collection
3. Summary Account MGR/ORG: Oliver/M&O TCO
4. Status of Change: Revised X New

Scope Description: _____

Surface Borehole Geophysical Logging:

Objective:

Provide data acceptance records and reports of borehole geophysical logs that can be used to support stratigraphic studies, rock material properties modeling, analysis of surface geophysical data, and development of the 3-D Integrated Site Model for boreholes SD-11 and SD-13.

Customers:

Results will be used by log analysts, stratigraphers, by rock properties modelers, and in the preparation of the 3-D Integrated Site Model.

Activities:

Deployments of two logging contractors and associated equipment are planned for each borehole at various stages of the drilling / testing activity. Drilling support video inspections may be required. Data collection may include borehole video inspection, deviation survey, selected side wall coring and geophysical logging suites. Activities include field supervision and verification of data collection. Contract administration services to include permitting of equipment and acceptance of field activities related to the contracted geophysical services. Provide maintenance for geophysical log processing software.

Scope Differences from the Baseline: New

Key Assumptions:

Borehole Geophysics - It is assumed that the acquired data will be received from the contractors without the need for extensive vendor or in-house reprocessing. Labor estimates based on no more than one borehole being drilled / serviced concurrently. Labor estimates based on 24 hour/day operations during field data collection.

Cost Rationale:

FY-98
Labor

SD-11	
Labor Category 101A, Engineer/ Scientist	.25 FTE
FY-99	
SD-13	
Labor Category 101A, Engineer/ Scientist	.25 FTE

ODC

Materials and supplies

Contracts, Materials

fy98

SD-11	
Drilling support video inspections (two)	\$16,100
Geophysical Log Suite	\$50,00
Side Wall Core samples (50)	\$37,000

fy99

SD-13	
Drilling support video inspections (two)	\$16,100
Geophysical Log Suite (3 runs)	\$151,550
Side Wall Core samples (50)	\$37,000

Travel

Vendor visit - Bakersfield two days/nights	\$3k
fy98 SD-11	
Field work Area 25. 24 day/nights	\$4k
fy99 SD-13	
Field work Area 25. 24 day/nights	\$4k

9. Level III Milestones:

10. Level III Milestone Acceptance Criteria:

Attachments and References:

Schedule: Geophysical logging of SD-11 May 1, 1998 to Nov 1, 1998
 Geophysical logging of SD-13 Nov 1, 1998 to April 30, 1999

**BASIS OF ESTIMATE
FOR THE INITIAL ACTIVITIES OF THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: TR3B2FB3
2. Summary Account Title: Geophysical Data Analysis
3. Summary Account MGR/ORG: Biggar/SPO-WCFS
4. Status of Change: Revised New
5. Scope Description:

A. Borehole Geophysical Logging:

For Boreholes USW SD-11 and USW SD-13: Provide prognosis of petrophysical zones to be encountered in boreholes for input to Level 3 report developed in SA TR39BfB1G. Provide data processing, management, and analyses of borehole geophysical logs that can be used to support stratigraphic studies, rock material properties modeling, analysis of surface geophysical data, and development of the 3-D Integrated Site Model. Results will be used by stratigraphers, by rock properties modelers, and in the preparation of the 3-D Integrated Site Model.

Activities:

Provide data processing, validation, forensic evaluation, log analysis, report writing, report reviewing, preparation and submittal of records packages for acquired and developed data, and data base management of geophysical log data. All data acquired to date will be catalogued and stored for future use. Provide consultation to PIs with regard to collection of logs and geophysical log analyses and interpretations.

OUTPUTS:

Title: Borehole Geophysics Forensic and Log Analysis Report for Borehole USW SD-11
Deliverable No. SP
Due Date: 15 March, 1999
Milestone Level: 4
Deliverable Description: The report will include a forensic evaluation of the geophysical logs collected for the SD-11 borehole, and an analysis of petrophysical properties interpreted from the logs.

Title: Borehole Geophysics Forensic and Log Analysis Report for Borehole USW SD-13

Deliverable No. SP

Due Date: 25 June, 1999

Milestone Level: 4

Deliverable Description: The report will include a forensic evaluation of the geophysical logs collected for the SD-13 borehole, and an analysis of petrophysical properties interpreted from the logs.

B. Neutron Log Analyses

The objective of this effort is (1) to calibrate the Sidewall Neutron Porosity (SNP) tool response in air-filled boreholes in the YM volcanic rock environment to develop a lithology-corrected neutron porosity; and (2) confirm the Epithermal Neutron Log (ENP) porosity from the "historical" borehole data set. Currently, the rock properties model is based on geophysical logs from which porosity has been calculated using two different approaches. This effort is to ascertain that the data can be applied interchangeably, or, if not, to develop a conversion factor to standardize the data. These are the first steps of a process that is anticipated to continue into FY'98 with the FY'98 planning effort. The intention is to start the effort in FY'97 in order to apply the results to the new sets of borehole logs that will be derived from the boreholes drilled in FY'97-'98.

Epithermal neutron data from the Modern Borehole Data Set consists primarily of SNP logs that have not been characterized in the Yucca Mountain (YM) borehole environment. In the current measurement system, using standard limestone porosity units, the data cannot be used quantitatively for evaluation of the volume of free water in the rocks, or for estimation of the volume of zeolites. A trial calibration will be conducted to determine if a standard sandstone conversion is appropriate to the Yucca Mountain volcanic units; if initial calibration results in values that satisfactorily mimic sandstone units, there is no reason to continue further into the calibration process. If not, additional approaches may include: (1) computation of idealistic responses based on mineralogical/chemical composition of the rocks using the SNUPAR program by Schlumberger, which will output matrix and water content neutron responses which may be used to calibrate the existing SNP log data; (2) comparison to water saturation measurements from core samples; or (3) comparison of the response of a calibrated neutron log in the YM borehole environment (APS Neutron Log). For the first approach, "target" petrophysical rock types will be identified, and a procedure will be developed to ensure the QA status of the investigation. The third approach requires the acquisition of APS neutron data, from which neutron porosity can be determined, from a borehole in which SNP data are available to calibrate the SNP response. This calibration would be confirmed by running both tools in one to two additional boreholes. An assessment will be made regarding the viability of replacing the SNP tool with the Schlumberger APS/NPLT tool in future boreholes.

Results of the above effort will be applied to confirm the Epithermal Neutron Log (ENP) porosity value from the Historical Borehole Data Set, which were not calibrated using a

"Q" process. This activity will calibrate the raw ENP data from the historical logs to the algorithms for "target petropysical rock types" used in the SNUPAR program in (1) above. There are 3 boreholes where both ENP and "modern" SNP data have been collected; these two data sets will be used to assess if the historical data are a reasonable representation of the neutron data; if it is necessary to recompute ENP porosity in the Historical boreholes; or if inconclusive, if the problem is related to the drilling history of the older boreholes. If useable through these processes, the historical ENP data will be fully qualified as they will have been calibrated to or verified with qualified measurements and computations.

Outcome: A letter report on status of neutron log calibration investigation - due October 30, 1997. The report will present the scope and findings of the analysis done for the above described effort.

C. Subsurface Geophysical Imaging Integrating ESF and East-West Drift

Tomographic/crosshole methods are proposed in order to obtain the necessary resolution on transport and mechanical properties that surface methods cannot provide. Also, recent developments in seismic source technology has now allowed high frequency sources to be deployed in unsaturated environments. This work complements the tomography effort proposed in TR32733GB3, which utilizes low-frequency source of the TBM. This work is a result of the expressed desire of regulatory groups to assess the predictive capabilities of the project for subsurface geophysical imaging to integrating data from the ESF and East West Drift.

Phase I (FY97-98)

Conduct seismic and electromagnetic (EM) imaging experiments in the vicinity of the proposed E-W Drift tunnel location. Sources and receivers are to be placed in the ESF and in surrounding available boreholes (such as SD-6, SD-9, UZ-6, G-4, H-4, H-3, H-5) in order to gather data for "crosshole" analysis. The objective of the work is to investigate the region between the boreholes and drifts for the potential existence and extension of vertical structure as well as to examine fault/fracturing in the region of the E-W drift. The repository horizon would be concentrated upon. Furthermore this experiment could be supported by surface sources/receivers to estimate the nature of fracturing and connectivity to the surface. These investigations could be carried out before the start of the E-W Drift tunneling activities to estimate the geological structure in the vicinity of the E-W Drift which could be of value during the tunnel boring activities.

Output: Level IV deliverable, due January 30, 1998, presenting data and analysis of a three component tomographic survey (P and SV recorded into multicomponent multilevel receivers). The analysis would include the location of faulting and fracturing between boreholes used and the ESF drift. If testing has been delayed for any reason (i.e. construction), no incomplete data sets will be included in this milestone.

Phase II (FY98)

In conjunction with the tunneling activities, predictions made during Phase I can be checked by geological site investigations in the completed section of the E-W Drift tunnel. Based on these results the geophysical interpretation can be updated and refined by incorporating the observational data. Thus a feedback process can be established to provide improved estimates for the yet unexplored tunnel area. Also during the E-W Drift tunnel boring activities, a network of receivers within the ESF and selected boreholes could use the seismic energy from tunneling to image the volume in the vicinity of the E-W drift (reverse seismic profiling). If the TBM does not create sufficient energy in the frequency band of interest (50 hz to 500 hz, or higher) small impulsive sources could be used instead. If this method is successful it could be routinely applied in the future to map regions of the future repository. Acoustic data generated from the tunnel boring machine may provide further concerning faulting and fracturing in the area surrounding the crossing points of the two drifts.

Output: A level 4 deliverable, due September 1, 1998, reporting data and analysis of imaging the location of faults and fracturing in the zone imaged. If testings has been delayed for any reason (i.e. construction), no incomplete data sets will be included in this milestone.

Phase III (FY99):

Upon completion of the E-W Drift tunnel seismic and EM crosshole/crossdrift experiments can be conducted to provide better estimates of the geological parameters between the drifts. The vertical separation of approximately 15 m between the drifts provides an ideal environment for a high resolution geophysical experiments based on frequencies in the KHz range. A crosshole experiment will be conducted using piezo-electrical sources and high frequency EM coils in the first drift and 3-component geophones and EM coils in the second. This experiment would support the results of phase I, where the properties of the fractures were determined using their reflective properties for seismic and EM waves, whereas the cross hole survey is based on the transmission of seismic and EM waves through the fractures. The cross hole experiment is expected to reveal more information on the nature of the horizontally oriented fractures. The proposed experiments in conjunction with the tunneling activities provide a unique opportunity to apply and test the resolving power of jointly using seismic and EM methods to estimate fracture properties, in that it provides a platform to apply complimentary methods to estimate these parameters with the possibility of verification and evaluation by direct observations from the drifts, thus being able to fine tune high resolution imaging methods for this type of experiment.

Output: A Level 4 deliverable, due 15 June 1999, presenting data and a report describing the estimate of faults which could be significant transport routes. By combining the

seismic and electrical methods, estimates of saturation and conductivity could be made. Calibration would be made by comparing results from known fault zones to other zones not intersected by the ESF. If testings has been delayed for any reason (i.e.construction), no incomplete data sets will be included in this milestone.

6. **Scope Differences from the Baseline:** New Scope is being added to SA proposed for SD-6/WT-24 C/SCR.

7. **Key Assumptions:**

Borehole Geophysical Log Analysis: It is assumed that the acquired borehole geophysical data will be received without need for extensive vendor or in-house reprocessing. It is assumed that the software packages used for in house processing are maintained.

8. **Cost Rationale:**

A. Borehole Geophysical Data Analysis (FY'98, FY'99)

Labor: (0.5 FTE)

0.25 FTE (0.1 FTE in FY'98; 0.15 FTE in FY'99) geophysist (101A, SAIC), principal investigator, with expertise in geophysical data processing, verification, forensic evaluation, log analysis, report writing, reviewing, data archiving, development of records packages, visit to vendor offices

0.25 FTE (0.1 FTE in FY'98; 0.15 FTE in FY'99) geophysicist (101B, SAIC), to assist in geophysical data processing, verification, forensic evaluation, log analysis, report writing, reviewing, data archiving, development of records packages

TRAVEL: In FY'98, one 5-day trip to Bakersfield and one 5-day trip to Denver to meet with logging companies for processing data. In FY'99, one 5-day trip to Bakersfield and one 5-day trip to Denver to meet with logging companies for processing data.

OCDs (\$2k) : In FY'98 and FY'99, \$500/month for miscellaneous expenses.
ADP: (\$2800) for software maintenance

B. Neutron Log Analysis

0.13 FTE (0.1 FTE in FY'97; 0.03 FTE in FY'98) geophysicist technical lead (101A, SAIC), principal investigator, with expertise in geophysical data processing, verification, forensic evaluation, log analysis, report writing, reviewing, data archiving, development of records packages

0.13 FTE (0.1 FTE in FY'97; 0.03 FTE in FY'98) geophysicist (101B SAIC) to assist in

geophysical data analysis.

TRAVEL: In FY'97, three 15-day trips from Houston to Las Vegas for geophysicist to assist in the neutron data analysis. One 3-day trip to Bakersfield to meet with logging company. In FY'98, one 15-day trip from Houston to Las Vegas for geophysicist to assist in analyzing data.

OCDs (\$2k): FY'97: In FY'97, \$500/month for three months for miscellaneous expenses. In FY'98, the same (\$500/month) for one month.

C. Subsurface Geophysical Imaging Integrating ESF and East-West Drift

Phase I: 0.2 FTE of labor category 101A, 0.3 FTE of labor category 101B, and 1.0 FTE of labor category 101C, 10K for travel; and 75K for equipment.

Phase II: 0.2 FTE of labor category 101A, 0.3 FTE of labor category 101B, and 1.4 FTE of labor category 101C, 5K for travel; and 25K for equipment.

Phase III: 0.2 FTE of labor category 101A, 0.4 FTE of labor category 101B, and 1.45 FTE of labor category 101C, 5K for travel; and 25K for equipment.

- 9. Level III Milestones: None.
- 10. Level III Milestone Acceptance Criteria: N/A
- 11. Attachments and References: N/A
- 12. Schedule:

A. Borehole Geophysical Data Analysis (FY'98, FY'99)

Start July 15, 1998, end March 15, 1999

B. Neutron Log Analysis

Start July 1, 1997, end October 30, 1997

C. Subsurface Geophysical Imaging

Phase I: Pre-tunnel monitoring	9/1/97	1/30/98
Phase II: Tunnel monitoring	2/1/98	9/1/98
Phase III: Drift/drift	10/1/98	6/15/98

**BASIS OF ESTIMATE
FOR THE ENHANCED CHARACTERIZATION OF THE
REPOSITORY BLOCK**

1. Summary Account Number: TR3B3GA1
2. Summary Account Title: ESF Geophysical Logging and Data Collection
3. Summary Account MGR/ORG: Oliver / M&O TCO
4. Status of Change: Revised X New

Scope Description:

ESF Borehole Geophysical Logging:

Objective:

Provide data acceptance records of borehole geophysical logs data that can be used to support UZ studies, rock material properties modeling, to provide input for the development of the 3-D Integrated Site Model and repository design

Customers:

Results will be used by UZ principle investigators, stratigraphers, by rock properties modelers, and in the preparation of the 3-D Integrated Site Model prediction conformation and repository design.

Activities:

Multiple deployments logging services and associated equipment are planned for 20% of the boreholes drilled in the E-W Drift and alcoves at various stages of the drilling / testing activities. Drilling and testing support video inspections will be required. Data collection may include borehole video inspection and geophysical logging suites. Activities include field supervision, equipment deployment / operation and record submission of data collected. Provide maintenance for geophysical log equipment.

6. **Scope Differences from the Baseline:** New

7. **Key Assumptions:**

ESF Borehole Geophysics - Staff support will be available as needed from the TCO and principle investigator resources. Construction support will be available for equipment transportation and set up. Services are limited to existing geophysical logging and video equipment.

8. Cost Rationale: \$120k Labor \$12 ODC \$5k Travel (Total \$137k)

Labor

FY-98

Labor Category 101A, Engineer/ Scientist .5 FTE

FY-99

Labor Category 101A, Engineer/ Scientist .5 FTE

ODC

Equipment maintenance \$12k

Travel

Vendor visits and workshops visit \$5k

9. Level III Milestones:

10. Level III Milestone Acceptance Criteria:

11. Attachments and References:

12. Schedule:

ESF geophysical logging

Dec. 1, 1997 to Oct. 1, 1998

**BASIS OF ESTIMATE
FOR THE INITIAL ACTIVITIES OF THE ENHANCED
CHARACTERIZATION OF THE REPOSITORY BLOCK**

1. Summary Account Number: TR3E2GBE
2. Summary Account Title: Single Heater Test in E-W Drift
3. Summary Account MGR/ORG: Datta/SPO
4. Status of Change: Revised X New
5. Scope Description:

FY'98

Develop plans for one single heater test in the E-W drift (Second Single Heater Test). Perform scoping calculations and preliminary test design, documenting test objectives, test configuration, facility requirements, schedule, and analyses/reporting. Begin the process of specifying and procuring the necessary instrumentation.

Document the outcome of preliminary test planning and design into a Level 4 report, Preliminary Test Planning and Design for the Second Single Heater Test, due August 14, 1998 to the SPO Manager.

FY'99

Finalize the design of the Second Single Heater Test and specify and procure the necessary instrumentation. Conduct detailed, predictive model calculations of thermal-hydrologic (T-H) and thermal-mechanical (T-M) processes prior to heater turn-on.

Conduct pre-test characterization of the test bed. This will include (but not be necessarily limited to) : a) detailed scanline mapping (assumption - already completed as part of mapping during excavation); b) thermal and mechanical properties of core (assumption - closely coordinated with laboratory testing planned for the E-W Drift in 1.2.3.2.7); c) mineralogic-petrologic analyses of core; d) Goodman Jack measurements.

Prepare and install the heater and thermal and mechanical instrumentation. This will include (but not be necessarily limited to) a single element heater, MPBX's, thermocouples, rock bolt load cells, Goodman Jack (this is not installed downhole, but only used periodically throughout the test), and strain gauges.

Conduct data collection and analysis of the thermal and thermal-mechanical response of the rock throughout the duration of the test (heater turn-on scheduled for 15-Jan-99).

EY'00

Conduct data collection and analysis of the thermal and thermal-mechanical response of the rock throughout the duration of the test.

Conduct post-test characterization of the test area. This will include (but not be necessarily limited to) rock bolt pull tests, Goodman Jack measurements, and overcoring and associated laboratory tests for thermal, mechanical, and mineralogic-petrologic properties.

Conduct a comprehensive analysis (including modeling) of the test results. Document the results of the analyses and modeling in the Draft Second Single Heater Test Final Report, due to the SPO Technical Lead on 14-Apr-00. Prepare the Level 3 Second Single Heater Test Final Report, due on 01-Jun-00.

6. **Scope Differences from the Baseline: New Scope**

Three Level 4 Deliverables and one Level 3 Deliverable will be completed as a result of this work:

a) **Title: Preliminary Test Planning and Design for the Second Single Heater Test**

Milestone ID: SP3E2AM4

Due Date: 14-Aug-98

Level: 4

Milestone Description: The report will document the planning and preliminary design for the Second Single Heater Test. It will include documentation of the location selected for the test, as well as the borehole and instrumentation layout.

b) **Title: Second Single Heater Test Heater Turn-On**

Milestone ID: SP3E2BM4

Due Date: 15-Jan-99

Level: 4

Milestone Description: This milestone will be met when the heater is turned on for the Second Single Heater Test. The accompanying report will document the pre-test T-H and T-M predictive analyses and pre-test characterization results.

c) **Title: Draft Second Single Heater Test Final Report**

Milestone ID: SP3E2CM4

Due Date: 14-Apr-00

Level: 4

Milestone Description: The report will document the as built test, the progression of the test with adjustments, if any, and a comprehensive, interpretive analysis of the test results including an evaluation of the various measuring systems employed. This deliverable shall be prepared in accordance with OCRWM-approved quality assurance procedures implementing requirements of the Quality Assurance Requirements Description. The product shall be developed on the basis of the best technical data, including both Q and non-Q data. The Q status of data used and cited in the report shall be appropriately noted.

d) Title: Second Single Heater Test Final Report

Milestone ID: SP3E2DM3

Due Date: 01-Jun-00

Level: 3

Milestone Description: This deliverable shall include all information identified herein unless specifically exempted in writing by the COR at least 60 days before the scheduled due date (30 days in special cases agreed to by the COR). This milestone will be met upon submission of the Second Single Heater Test Final Report. The report will document the as built test, the progression of the test with adjustments, if any, and a comprehensive interpretive analysis of the test results including an evaluation of the various measuring systems employed. This deliverable shall be prepared in accordance with OCRWM-approved quality assurance procedures implementing requirements of the Quality Assurance Requirements Description. The product shall be developed on the basis of the best technical data, including both Q and non-Q data. The Q status of data used and cited in the report shall be appropriately noted. Stratigraphic nomenclature used shall be consistent with the Reference Information Base section 1.12 (a): Stratigraphy-Geologic Lithologic Stratigraphy. Within the report's Reference Section, references to data used in the report shall include Record Accession Numbers or Data Tracking Numbers when available. Technical data contained within the deliverable and not already incorporated in the Geographic Nodal Information Study and Evaluation System (GENISES) shall be submitted, if appropriate for incorporation into the GENISES in accordance with YAP-SIII.3Q. Verification of technical data submittal compliance shall be demonstrated by including as part of the deliverable: 1) a copy of the Technical Data Information Form generated identifying the data in the Automated Technical Data Tracking system, and 2) a copy of the transmittal letter attached to the technical data transmittal to the GENISES Administrator. This deliverable shall be processed in accordance with YAP-5.1Q.

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7. Key Assumptions:

The Second Single Heater Test will be conducted in the E-W Drift in FY'99, after completion of excavation in FY'98. It will not require an alcove, but only a small niche and a limited number of boreholes for a single element heater and necessary instrumentation. The niche will be co-located with planned Goodman Jack holes (planned in 1.2.3.2.7), and laboratory testing for thermal and mechanical properties on these core will provide some of the necessary pre-test characterization data. Niche construction and drilling will take place in the first quarter of FY'99. Support for drilling and construction will be captured in 1.2.3.5.5. Barring any damage or other problems, the heater from the Single Heater Test in Alcove 5 will be used in this test. USBR mapping data and scanline mapping data will be available for the test area during the pre-test characterization phase (first quarter of FY'99). The test will have a one-year duration (January, 1999 to January, 2000), which includes heating and cooling phases. Data collection will be conducted using a data logger.

8. Cost Rationale:

FY'97 costs: None

FY'98 costs:

550 hours: 350 hours (101A); 150 hours (101C); 50 hours (106) [SNL, LANL, WCFS]

\$10,000(travel)

\$3500 (ODC)

Total Cost (approximate): \$68,500

FY'99 Cost:

2540 hours: 1290 hours (101A); 650 hours (101C); 600 hours (106) [SNL, LANL, WCFS]

\$50,000 (travel)

\$200,000 (ODC)

\$20,000 (ADP)

Total Cost (approximate): \$524,000

FY'00 Cost:

2000 hours: 1220 hours (101A); 400 hours (101C); 380 hours (106) [SNL, LANL, WCFS]

\$10,000 (travel)

\$5000 (ODC)

Total Cost (approximate): \$215,000

9. Level III Milestones:

Title: Second Single Heater Test Final Report

Milestone ID: SP3E2DM3

Due Date: 01-Jun-00

10. Level III Milestone Acceptance Criteria:

This deliverable shall include all information identified herein unless specifically exempted in writing by the COR at least 60 days before the scheduled due date (30 days in special cases agreed to by the COR). This milestone will be met upon submission of the Second Single Heater Test Final Report. The report will document the as built test, the progression of the test with adjustments, if any, and a comprehensive interpretive analysis of the test results including an evaluation of the various measuring systems employed. This deliverable shall be prepared in accordance with OCRWM-approved quality assurance procedures implementing requirements of the Quality Assurance Requirements Description. The product shall be developed on the basis of the best technical data, including both Q and non-Q data. The Q status of data used and cited in the report shall be appropriately noted. Stratigraphic nomenclature used shall be consistent with the Reference Information Base section 1.12 (a): Stratigraphy-Geologic Lithologic Stratigraphy. Within the report's Reference Section, references to data used in the report shall include Record Accession Numbers or Data Tracking Numbers when available. Technical data contained within the deliverable and not already incorporated in the Geographic Nodal Information Study and

Evaluation System (GENISES) shall be submitted, if appropriate for incorporation into the GENISES in accordance with YAP-SIII.3Q. Verification of technical data submittal compliance shall be demonstrated by including as part of the deliverable: 1) a copy of the Technical Data Information Form generated identifying the data in the Automated Technical Data Tracking system, and 2) a copy of the transmittal letter attached to the technical data transmittal to the GENISES Administrator. This deliverable shall be processed in accordance with YAP-5.1Q.

*inspection
criteria*

11. Attachments and References:

12. Schedule:

Prepare test plans and preliminary design - 10/1/97 to 8/14/98
Prepare Level 4, Preliminary Test Planning and Design - 7/1/98 to 8/14/98
Level 4 Milestone: Preliminary Test Planning and Design - 8/14/98
Specify and procure instrumentation - 2/2/98 to 1/15/99
Conduct pre-test T-H and T-M predictive analyses - 8/17/98 to 1/15/99
Conduct pre-test characterization of test bed - 8/17/98 to 1/15/99
Install heaters, instruments, and data logger system - 10/15/98 to 1/15/99
Level 4 Milestone: Heater Turn-On - 1/15/99
Conduct heating phase - 1/18/99 to 7/16/99
Conduct cooling phase - 7/19/99 to 1/17/00
Conduct post-test characterization of test bed - 1/18/00 to 4/3/00
Analyze data and prepare Level 4, Draft Second Single Heater Test Final Report - 1/18/00 to 4/14/00
Level 4 Milestone: Draft Second Single Heater Test Final Report - 4/14/00
Prepare Level 3, Second Single Heater Test Final Report - 4/17/00 to 6/1/00
Level 3 Milestone: Second Single Heater Test Final Report - 6/1/00

**BASIS OF ESTIMATE
FOR THE ESF CHANGE REQUEST TO IMPLEMENT THE ECRB**

1. Summary Account Number: TR547GA2
2. Summary Account Title: PA Support for Enhanced Characterization of the Repository Block (ECRB) - Phase II (Including SBT Activities)
3. Summary Account MGR/ORG: James Houseworth/PA Waste Isolation Evaluation
4. Status of Change: Revised New
5. Scope Description:

A. Provide the following support for development of ECRB Subsurface Excavation:

1. Provide waste isolation impact analysis including development of revised water use model required for the development of Determination of Importance Evaluations (DIEs) including revisions; and support Tracers, Fluids, and Materials (TFM) evaluation;
2. Address waste isolation impacts as required for revisions to ESF Classification Analyses (CAs) with respect to ECRB-related requirements on permanent repository items; and
3. Evaluate waste isolation impacts associated with the TBM special requirements in support of DIE prior to start of excavation of the main drift of the ECRB; and
4. Participate in the review of implementation of Determination of Importance Evaluation requirements through site visits and reviews of constructor submittals to A/E, drawings, specifications, job and field work packages, and work programs.

B. Provide the following support for ECRB Surface-Based Testing Activities:

1. Provide waste isolation impact analysis required for the development of Determination of Importance Evaluations (DIEs) including revisions for ECRB SBT for South Crest and Northern Teacup Wash Boreholes; and support Tracers, Fluids, and Materials (TFM) evaluation; and
2. Evaluate implementation of SBT DIE requirements through site visits and reviews of constructor submittals to A/E, drawings, specifications, job and field work packages, underground field testing activities, and work programs.

6. **Scope Differences from the Baseline:**

New work - ECRB phase I work complete.

7. **Key Assumptions:**

- A. The account is limited to the resources necessary to perform the assigned tasks that are in addition to the current management, technical, and administrative staff resources funded by the FY98 and FY99 baseline.
- B. This estimate assumes funding approval and completion of ECRB Phase I (early start).
- C. This estimate assumes work scope to commence October 1, 1997 and completes September 30, 1999, and does not include planning for Calico Hills excavation.

8. **Cost Rationale:**

The period of conduct of activities for the purposes of this estimate, and in accordance with assumption 7.C above, is assumed to be 01-OCT-97 through 30-SEP-99.

Four man-months of one half-time Performance Assessment (PA) resource (DE&S 101B) and four man-months of one half-time PA resource (DE&S 101C) (01-OCT-97 through 31-MAY-98) to prepare waste isolation impact analyses including development of revised water use model. Analyses for the subsurface excavation will include the effects of construction water retained in geosphere on potential repository performance. Given that the proposed excavation alignment crosses above a major section of the potential repository block, an analysis will also be performed to address the effects of such an excavation on thermal dryout and rewetting of waste emplacement areas that have been predicted to occur after waste emplacement. Analyses will also consider the effects of other materials that may be retained in the geosphere, such as organic materials. The resource will also be utilized to prepare similar waste isolation impact analysis for SBT activities in support of the ECRB. Analyses of the potential effects of the planned north and south Yucca Crest boreholes will include drill pad and access road construction, borehole drilling, potential interaction of the boreholes with perched water, and sampling. All of these analyses will be incorporated in the appropriate DIES for these activities. Revisions to these analyses will include evaluations of changes to construction operations and materials usage, and testing-related excavations and materials usage.

Twelve man-months of one half-time PA resource (DE&S 101C) (01-OCT-97 through 30-SEP-99) to perform field work package reviews, design reviews, assist with and review classification analyses, review TFM submissions, conduct site visits, and review TFM as-builts.

Two man-months of PA resource (DE&S 101C) (01-JAN-98 through 31-MAY-98) to perform discipline reviews of waste isolation sections of DIES.

Total estimated cost based on above estimate: \$249,000 [\$181,000 in FY98 and \$68,000 in FY99].

9. Level III Milestones:

For the waste isolation section of the DIE ECRB activities, no Level 3 milestones have been identified.

10. Level III Milestone Acceptance Criteria:

Not applicable.

11. Attachments and References:

None.

UPPER LEVEL TECHNICAL BASIS FOR THE ECRB ESF (WBS 1.2.6.) ACTIVITIES

FOREWORD

The purpose of this section is to define the upper level ESF technical basis for ECRB activities which, by definition, consists of all the key information necessary to develop a cost estimate and a schedule for each defined activity. The information in this section is generally applicable to all ESF ECRB activities. This is followed by a definition of each ESF Summary Account selected to represent the ECRB activities. This Summary Account descriptions are identified on a standard form. Additional, more specific, assumptions may be provided on the summary Account form. Other supplementary information along, with a cost estimate, will utilize the Summary Account form as a cover sheet and will be attached.

BACKGROUND

Over the past several years, budget reductions have required the YMP/DOE to evaluate not just the timing of the east-west drift, but also whether or not completion of the 5-mile loop itself was the best use of resources. In the second quarter of FY 1997, reconsideration of Project status, costs, and budget priorities has resulted in an opportunity to reexamine the benefit and timing of the east-west drift along with other enhanced characterization options.

YMP/DOE has recently examined how best to enhance characterization of the repository block, including an east-west drift. The objective was to enhance the scientific understanding of the behavior of the site, as well as enhance understanding of engineering, construction, health and safety, cost, and regulatory and performance aspects of the potential repository.

The YMP/DOE has consistently noted that the site characterization program has many scientific components that will provide additional controls and information on structure and stratigraphy, including information from the surface-based drilling program and geophysics, including reflection, gravity and magnetics. This has included activities related to the development of an east-west drift as an important data source in the site characterization program since the completion of the Exploratory Studies Facility Alternatives Study. This was principally driven by the need for information about potential structures west of the north-south main drift of the ESF main tunnel. Completion of the main ESF drift (five mile loop) was considered the initial data source, followed by an east-west drift constructed shortly thereafter. However, budget projections in FY95-FY96 required that work be reprioritized and restructured such that an acceptable continuation of the characterization effort and ultimate license application could be accomplished with a smaller data set, corresponding to the reduced funding. This reduced funding and subsequent reprioritization resulted in moving the east-west drift activities to the out years (FY98-FY99 time frame).

Data enhancement is expected in three general areas:

1. Enhancement of the scientific data that is used for the TSPA/LA. For planning purposes, this activity will be sub-divided into three categories: data collected during the excavation of the ESF cross drift; data collected underground after excavation is complete and data collected from surface boreholes.
2. Enhancement of scientific or construction data that is used for LA Design. The vast majority of this data will be collected concurrent to the cross drift excavation and from surface boreholes.
3. Enhancement of data for repository construction planning. To date, there has been only limited focus on the planning for repository construction which will be a significant line item in the total life cycle cost. If Construction Authorization is received, the YMP will be the site of one of the largest civil underground excavation projects in the world. Additionally it must be managed with a unique set of technical, administrative, and quality requirements. Therefore it will be very beneficial to enhance the knowledge in areas such as: Dust control techniques and equipment, emplacement drift sized TBM configurations, Dust mitigation for alcove excavation, emplacement drift sized TBM productivity, and Construction management techniques for increased effectiveness. This enhanced planning data will improve the accuracy of the repository planning and could result in significant changes in the projection of future costs. The enhanced data will be a by-product of the repository cross-drift and alcove excavation.

ASSUMED TECHNICAL BASIS FOR THE DEVELOPMENT OF ESF COST AND SCHEDULE FOR THE ECRB

The initial phase of the 90 day ECRB planning effort consisted of the justification for data enhancement and the conceptual development for the basic configurations required. This technical basis includes these basic ESF configuration concepts and expands them, where necessary, to form a full basis for cost and schedule development. The upper level concepts shown below are supplemented by the Summary Account assumptions and descriptive material contained in the cost estimates.

1. The repository cross drift will start from the left rib of the ESF North Ramp and proceed 2815 meters with a slight south of west bearing. The drift will be excavated with a TBM and trailing gear currently owned by PK. This TBM has a diameter of 16 foot 5 inches. Additionally PK will provide a 24 in. conveyor belt which will interface with the North Ramp belt near the launch chamber.
2. The North Ramp launch chamber station has been established near station 20+00. It is located up-station of the curve in a location supported by rockbolts with a minimum of interference to the North Ramp electrical and mechanical systems. Its location will provide a .5% upgrade in the cross drift to provide drainage.

3. The cross drift will be designed and constructed in such a manner as to not preclude a downward extension into the Calico Hills. A conceptual design of this extension will be proposed as a FY98 activity.

4. The ESF A/E will prepare design documents that address the following design elements for the E-W cross drift and starter tunnel: excavation line and grade, ground support, and general construction requirements. Construction support utilities such as power, lighting, communications, fresh water, waste water, compressed air, ventilation, and fire protection will also be designed by the A/E. It is expected that these systems will be configured similar to the main loop systems with the possible exception of ventilation and power. The Constructor will develop the configurations for TBM, conveyor, and transportation systems. Constructor developed configurations will be submitted to the M&O for information or review.

5. The average overall production rate for TBM Excavation rate after shake down and conveyor installation is 30 meters per day, with 20 meters per day through the Solitario Canyon Fault.

6. It is expected that the cross-drift ground support will be non-Q as the drift will not be a functional part of the waste emplacement system.

7. The Safety Code for this work shall be the M&O Health and Safety Plan (B 00000000-01717-4600-0016-Rev. 2).

8. The constructor will construct the required configuration in a cost effective manner. The as-built configurations must be consistent with the design prior to construction acceptance. The constructor may propose the installation of alternate configuration with a later upgrade to the designed configuration, subject to approval. The acceptance of any proposed alternate configurations must be based on cost effectiveness, Health and Safety, and compliance to DIE requirements. A constructor developed configuration that is approved by the AE via the submittal process is part of the required technical ESF baseline.

9. The following defines the ESFDR applicability to ECRB systems. Current ESFDR requirements (YMP/CM-0019, Rev 02) will be applicable to the design of the Subsurface Excavations, CI: BABE00000 (i.e. Underground Openings and Ground Support Systems). Any subsurface utilities installed in the ECRB will be classified as construction support systems. Construction Support Systems will be designed in accordance with requirements of OSHA 1926, applicable DIEs, specific testing needs, and ESFDR Section 3.2.1.2.3 only. Construction support systems will consist of all power, lighting, communications, ventilation, water supply, waste water removal, compressed air, fire protection, sanitation, monitoring and warning, associated utility mountings, TBM, conveyors, and material and personnel handling (rail) systems installed in the ECRB main drift, alcoves or starter tunnel.

10. The CMO will integrate and develop the requirements for the TBM and the conveyor. The focus of these requirements will be on compliance to the established DIE requirements, enhancement of dust control, and operability and productivity in the expected rock conditions. Kiewit will submit a proposal for CMO approval describing the plans for rebuilding the TBM

including methods for complying with special performance requirements.

11. The AE designed ground support is expected to be similar in concept to the main loop. Steel set supported ground is assumed to be similar to the actual conditions encountered in the Main Drift which had a set requirement along 27% of its length.

12. The mapping and sampling program performed concurrent with TBM operations will be more limited than the program in the main loop. It is expected that the cross drift mapping program will be conducted separate from TBM operations and will lag the production area by about 200 meters.

13. Transportation will be provided by a single track, 36" gauge as presently used in the main drift. Pre-cast concrete invert sections will not be used.

14. For the ECRB cross drift, an Exposure Control Program for Silica will be implemented. This program shall be consistent with the OSHA Special Emphasis Program and NIOSH guidance and incorporate ALARA principles. Implementation of this program will require an integrated approach to work planning, Hazard identification, Hazard control, and Work execution and monitoring.

The M&O goal is to conduct the excavations associated with the cross drift without the use of personnel respirators. This is important for the health and safety of the workers and will tend to significantly reduce the projected repository construction costs. The enhancement on dust control will tend to focus on the controlled use of water to prevent the suspension of dust in the air, proper dust containment and cleaning, and real time monitoring of system performance. In addition, control technology will be carefully evaluated to enable improved repository construction design and costs estimates.

A reasonable level of activities and the associated costs will be incorporated into this CR to support the goals for Silica Control. However it is understood that other mitigating measures may be required, if so, the cost and schedule impacts of these measures will be evaluated and subjected to an integrated project level management review prior to implementation.

15. Three alcoves will be excavated from the cross drift after the completion of TBM operations to investigate the Solitario Canyon Fault and for Hydrological/Geomechanical studies of the host rock after the demobilization of the TBM. Alcoves will be excavated by drill and blast.

16. The cross drift will be ventilated from the air stream entering the North Portal by the use of the Fans in the South Drift bulkhead. Exhaust air from crossdrift TBM operations will be via a vent tube that joins the North Ramp 66in. system to be exhausted at the North Portal without intermixing with the incoming air stream. The 66 in. duct in the North Ramp will be repaired as necessary to assure that the incoming air stream is not contaminated. The ECRB vent tube system

will be independent of the main loop alcove system. The air ventilation system will have the capacity to provide a minimum air velocity of up to 100FPM. The operating capacity of the system will be optimized to address field conditions.

17. During Launch chamber construction and TBM operations, primary access to the main drift testing areas will be via the South Portal. South portal improvements to facilitate this function will include: security, power service from the existing south ramp system, access control facilities designed by the ESF-AE; and surface rail, spur materials storage and handling facilities established by the constructor. The improvements will be left in place at the completion of the cross drift. The modifications to the existing configuration shall be part of the ECRB, the operation of the secondary access shall be part of the ESF loop operations and will be considered as part of FY98 planning.

18. The launch chamber will be configured to enhance crossdrift construction. PK will develop their requirements as a prerequisite to the AE's launch chamber design. The focus of the design activity is to meet construction requirements while providing Q ground support within the North Ramp zone of influence.

19. The cross drift muck storage area will be south, but adjacent, of the existing North Pad. Suitable drainage will be provided. Additional permits are not required

20. Safety Analyses will be performed on the AE designed configuration and performance specifications, as well as the construction and operational activities associated with development and use of those configurations. Safety analyses will consist of System Safety Analyses (SSAs) prepared as described in Summary Account TR18GA3, in conjunction with the constructor's Job Safety Analyses, to determine the hazards in the construction environment and mitigate issues with engineered solutions or administrative control and training. Safety analysis processes will be subject to integration reviews to ensure consistency between analyses, and to ensure all configurations are evaluated as appropriate.

21. The Constructor will prepare a pre-construction checklist early in the construction planning process. This check list will be reviewed and approved by M&O management. Construction will commence once the actions identified on the check-list are accomplished.

22. ECRB excavation activity will be conducted on a 3 shifts, five day schedule. In general, one shift on Saturday each week will be scheduled for major maintenance. It is anticipated that the crews will change at the face.

23. One of the goals for Repository planning improvement is to use the ECRB construction program to develop a cost model for future repository estimates. Therefore to the extent practical, ECRB construction costs will be segregated from the main loop activities. However this is difficult and impractical in some of the indirect accounts that tend to serve the total ESF. The accounts that tend to be dependent on the general level of ESF activities will be developed during FY98 planning. At ECRB completion, some of these costs can be allocated to form a more accurate cost model for repository planning. Items that are specifically excluded from the

ECRB cost estimate but will be included in FY98 planning are: General Management; Project Engineering; AE Management and Coordination; Construction management; Planning and scheduling coordination; Constructors management; Constructors Administration; Test Coordination office; Test Facilities; Engineering Document Control; Materials Testing service; Equipment Calibration; Design Supervision; Records Coordination; ESF Procedures and Training; Construction QC; Power; Janitorial; Trash and Refuse; Warehousing and Materials Handling; Outside Equipment Rental.

24. The surface waste water storage pond will not be required. The limited dewatering system used in the main loop excavation will be sufficient for water removal required during cross drift TBM operations.

25. Power for the South Ramp surface facilities will be supplied from the South Ramp. There have been discussions to extend this power feed to the C-well complex to eliminate the reliance on diesel generators. This additional extension is not part of this change request. However the design for the ESF usage shall not preclude a future extension to C-Well by WBS1.2.3.

26. The performance of the cross-drift ground control will be monitored for potential input into the LA repository design.

27. The electrical work and equipment shall conform to NFPA article 70 requirements. Note: Initial evaluation indicate that this requirement can be incorporated in the cross-drift without a significant cost impact. However if a significant impact is determined, it will be subjected to an integrated project level management review prior to implementation.

28. The ESF change house will be available for use for ECRB cross drift excavation. Use of the building behind the FOC will be discontinued.

29. Proper authorization must be provided to start the rehabilitation of the TBM by 7JUL97 to achieve the excavation milestones established by the ECRB CR.