Department of Energy
Office of Civilian Radioactive Waste Management
Yucca Mountain Site Characterization Office
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MAY 0 1 1997

OVERNIGHT MAIL

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U.S. Nuclear Regulatory Commission
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SUBMITTAL OF PARTICIPANTS' MONTHLY PROGRESS REPORT

As you have requested, the U.S. Nuclear Regulatory Commission is on distribution to receive a copy of the Yucca Mountain Site Characterization Project participants' monthly status reports on a regular basis. Enclosed is the U.S. Geological Survey Progress Report for March 1997.

If you have any questions, please contact April V. Gil at (702) 794-5578.

Stephan J. Brocoum
Assistant Manager for Licensing

AML:AVG-1451

Enclosure:
Ltr, 4/14/97, Craig to Kozai, w/encl

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IN REPLY REFER TO:

INFORMATION ONLY

April 14, 1997

Wayne Kozai
Yucca Mountain Site Characterization
Project Office
U. S. Department of Energy
P.O. Box 30307
Las Vegas, Nevada 89036-0307

SUBJECT: Yucca Mountain Project Branch - U.S. Geological Survey (YMPB-USGS) Progress Report, March, 1997

Attached is the USGS progress report in the required format for the month of March, 1997.

If you have any questions or need further information, please call Raye Ritchey Arnold at (303)236-0516, ext. 282.

Sincerely,

Raye Ritchey Arnold

for Robert W. Craig
Technical Project Officer
Yucca Mountain Project Branch
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U. S. GEOLOGICAL SURVEY
EXECUTIVE SUMMARY
March, 1997

WBS 1.2.3.1 Coordination and Planning

U. S. Geological Survey - Yucca Mountain Project Branch is currently processing 186 scientific papers prepared by USGS authors. Of these, 100 are related to hydrologic studies and 86 to geologic studies. In addition, 48 abstracts are being processed, as well as 17 reports by LBL personnel.

WBS 1.2.3.2 Geology

Geologic Framework

Level 4 Milestone SPG212M4 report that discusses the procedures being followed in verifying the status of geophysical log interpretations for pre-1991 boreholes was completed. The report (1) summarizes the results of a comprehensive data transcription verification with respect to geophysical logging data collected prior to 1991; (2) documents the Q-status (qualified vs. non-qualified) of digital borehole geophysical logs used in petrophysical analysis activities; and (3) addresses the Q-status of calculated geophysical logs of porosity, water content, and saturation. Two existing pre-1991 geophysical-log databases were used in the verification process, one represented by USGS Geophysical Investigations Map GP-1001 published in 1991 (P. H. Nelson and others, Geophysical Logs and Core Measurements from Forty Boreholes at Yucca Mountain, Nevada) and the other included in USGS Open-File Report 96-078 published in 1996 (P. H. Nelson, Computation of Porosity and Water Content from Geophysical Logs, Yucca Mountain, Nevada). To verify data transcriptions, original field copies of logs were compared with these data bases, and determinations made as to the accuracy of the data transfers. A table in the report records the status of all the logs examined for each of the boreholes studies; inconsistencies in data transcription were found to be rare.

Bedrock geologic mapping at the scale of 1:24,000 continued in the northwestern part of the site area, principally in the Yucca Wash, Prow, Windy Wash, and Fatigue Wash areas. Mapping along the northern Windy Wash fault zone shows it to be a complex block-bounding zone in which the hanging-wall (on the west) is made up of long (2 km), thin (200 m) panels of welded units of the Yucca Mountain Tuff and Tiva Canyon Tuff separated by steep faults. These fault-bound structural panels form north-northwest-striking relays between the Fatigue Wash fault on the east and another north-striking block-bounding fault located approximately in the floor of Windy Wash to the west. The structural panels merge southward into the trace of the northern Windy Wash fault, and

in places the Rainier Mesa Tuff (11.6 Ma) was observed to be in fault contact with rocks of the Yucca Mountain Tuff. This relationship leads to a new interpretation regarding the history of deformation in this area. Earlier workers had stressed a structural model in which the Rainier Mesa Tuff was erupted and emplaced after much of the regional tectonism had taken place prior to 11.6 Ma, and was therefore not involved in that episode of faulting. The new mapping indicates, to the contrary, that the Rainier Mesa Tuff was erupted prior to the faulting, and that displacement along the Windy Wash fault took place after 11.6 Ma. A preliminary version of the 1:24,000-scale geologic map of the site area is being prepared for use in preparation of the Site Description report.

In conjunction with LANL, project scientists participated in the preparation and completion of a level 4 milestone report (by LANL) regarding chlorine-36 fast pathways in the ESF. The report (1) describes progress to date in the development of conceptual models for several fast pathways; (2) summarizes the analytical methods used to collect and analyze samples for isotopic and mineralogic characteristics; and (3) discusses the guidelines used for descriptions of structural features in the field. Fast pathways are discussed in the context of major tectonic structures and the smaller scale fracture networks at Yucca Mountain, focusing on the manner in which these structural features establish a framework for flow paths. The report (a mid-year progress report) emphasizes those aspects of the fast pathway studies that will continue to be the focus of the joint LANL/USGS effort, culminating in the development of a conceptual model for fast pathway distribution at Yucca Mountain and in recommendations as to how the resulting model can be incorporated into site-scale flow and transport models.

Geologic mapping in the ESF was accomplished as follows: (1) full-periphery geologic mapping was completed to station 76+60; (2) detailed line survey at the heading was completed to station 76+65.33, (3) stereophotography was completed at the heading to station 76+60, (4) detailed line surveys were completed in the cross-over drift and the heated drift of Testing Alcove #5, and (5) full-periphery geologic mapping was completed in the heated drift of Testing Alcove #5. Project geologists participated in a meeting designed to provide guidelines for geologic mapping in the potential repository.

Project personnel continued preparation of papers on site stratigraphy, site structural geology, and fracture characteristics for inclusion in the Site Description report.

Seismotectonic Studies

Formal elicitation of experts' interpretations regarding seismic source characterization has been completed for preliminary calculations of seismic source geometry and potential earthquake magnitudes and recurrence rates. The calculations team will

present the preliminary results of seismic source characterization to the experts for sensitivity analyses and feedback discussions at a workshop scheduled in April. The ground motion experts will also present their interpretations at the April workshop, although actual ground motion calculations are not expected to be completed until sometime in May. Preparation of the probabilistic seismic hazard analysis report is continuing, and workshop discussions and summaries are incorporated as they are completed.

Work toward evaluation of tectonic scenarios for performance assessment included review of numerous relevant documents and data sources. Three days were spent in the field investigating structural and stratigraphic features that are deemed important to these evaluations.

Project personnel continued to prepare sections for the Site Description report on subjects covering regional geologic setting (structure and stratigraphy), seismicity and seismic hazards, surficial geology and erosion, and tectonic models. Several of the investigators were also closely involved in activities and plans related to the workshops for probabilistic seismic hazard analyses.

WBS 1.2.3.3 HYDROLOGY

Regional Hydrology

Analysis and interpretation of regional precipitation data continued. Data packages for the rain-wedge and tipping-bucket datasets have been submitted, completing **milestone SPH21IM4 [Memo to TPO: Meteorological Data FY96 to RPC/TDB]** on March 14. Transfer of 14 tipping bucket precipitation stations to SAIC had been previously completed. Submittal of three data packages ("FY96 Site Meteorology Data: Relative Humidity, Temperature, Wind Speed, Wind Direction, and Net Solar Radiation from 2 Weather Stations in the Yucca Mountain Area for October 1 to December 3, 1995," DTN: GS970108312111.001; "Precipitation data from the non-recording gage network at Yucca Mountain, Nevada, for water year 1995 (October 1, 1994 to September 30, 1995)," DTN: GS970108312111.002; and "Precipitation Rate Measurements from 11 Locations at Yucca Mountain, Nevada, 1994 to 1996") were completed as part of this milestone.

Collection of site streamflow data continued during the period. Discharge and precipitation records for the three recording streamgage sites on Fortymile Wash have been computed, checked, and reviewed, and 1996 Water-Year (WY96) records were submitted to the Nevada District Data Section for final tabulation and publication in the annual data report. Due to the recent winter floods which occurred in the Reno and Carson City areas, Data Section staff were reassigned to assist in the collection and processing of hydrologic data associated with the flooding. The District's annual report has been delayed until the end of June, but data have been released for Project use.

The data records package for streamflow and precipitation data collected during WY96 for the three recording streamgage sites on Fortymile Wash was submitted to the RPC/TDB on March 14. Completion of this activity fulfills **milestone SPH22DM4 [Memo to TPO: Subm FY96 Data to RPC/TDB]**. Streamflow and precipitation data collected through February have been compiled and stored in project files. During the month, routine maintenance was made on the three recording streamflow gages along Fortymile Wash. Project staff kept vigilance during the reporting period for potential precipitation and runoff within the southern Nevada area. Runoff was neither observed nor reported during the period for the three gages.

In work on the regional saturated-zone synthesis report, the regional hydrogeologic framework model received two technical reviews and was submitted to DOE on March 14, completing this activity and **milestone SPH23DM4 [Memo to TPO: Final Hydrogeo Framewrk Data to RPC]**.

Work continued on the draft text and illustrations for the regional synthesis report, and discussions were held concerning the logistics for completion of illustrations. About 75% of the text has been written.

In unscheduled work, staff participated in a three-day workshop on future goals and directions for ground-water modeling in the USGS, March 18 through 20. Although there is no specific activity for continuing model simulations, simulation of past and future climate scenarios has been continuing, and significant progress is being made. Post-processing work has been required to aid in interpretation. Currently, work is being done on a method to automatically compare model-predicted discharge areas with those regions previously believed to be discharge areas.

Unsaturated-Zone Hydrology

Efforts continued on the unsaturated-zone numerical infiltration model. Work was completed on developing a transfer function for using results from the Global Climate Model to estimate recharge and infiltration in the Yucca Mountain region. A memo was written to the TPO describing these results, satisfying the requirements for **milestone SPH22FM4 [Memo to TPO: Transfer Functions Precipitation/Infiltration of Numerical Model]**, which was completed on March 14. Work also was completed on the development and refinement of the numerical model of shallow infiltration.

Preparation of the Main Drift Hydrology report was completed to fulfill Level 3 **milestone SPH223M3 [Main Drift Hydrology Report]** on March 14. The report received technical, QA, and data review and was forwarded to DOE. The report contains pneumatic-pressure, temperature, and water-potential data from four instrumented boreholes along the Main Drift of the ESF. These data are being used in the 3-D site-scale model to characterize flow in the UZ and imply limited areal extent of the perched water zone in encountered in borehole SD-12. Temperatures in all but the

deepest Topopah Spring Tuff instrument station have reversed to a cooling trend since the onset of tunnel-induced disturbance. Tunnel interference effects have been observed only on the footwall side of the Ghost Dance fault zone. Within the Topopah Spring welded hydrogeologic unit, the imbition capacity of the matrix is low, but within the Tiva Canyon hydrogeologic unit, matrix suctions are high and result in an unsaturated environment less conducive to deep fracture flow.

Monitoring data from instrumented UZ boreholes in the main drift of the ESF and other locations were synthesized in a memorandum emphasizing pneumatic and hydrogeological properties of geologic structures associated with the boreholes (Level 4 **milestone SPH22IM4 [Memo to TPO: Synthesize UZ monitoring data from main drift of ESF]**). This activity was completed on March 14.

A memorandum was completed to fulfill Level 4 **milestone SPH22KM4 [Memo to TPO: Results of Matrix Hydro-Prop determinations]**. The memo presented interpretations based on analyses of matrix-properties data collected during the period from October 1, 1996, to January 17, 1997. Analyses and interpretation were based on 1) a study conducted in the main drift of the ESF to assess the spatial variability of properties within the middle nonlithophysal unit of the Topopah Spring Tuff (Tptpmn); 2) samples collected from various alcove boreholes; 3) samples collected from the borehole intersecting the Ghost Dance fault in Alcove #6; 4) analyses done to correlate hydrologic properties with measured mineral percentages (from LANL) on borehole core samples; and 5) measurements of unsaturated hydraulic conductivity using the ultra-centrifuge.

A memorandum was completed on March 11 detailing compilation and submittal of data from hydrologic property measurements made in the ESF during the period from October 1996 through January 1997, in fulfillment of Level 4 **milestone SPH22LM4 [Memo to TPO: Matrix-Hydro-Prop Compl pkg to RPC]**. Completed data packages include the following: (1) DTN: GS970108312231.001, "Physical properties and water content calculated from relative humidity: dried core samples from ESF alcove boreholes ESF-AL#2-HPF#1, ESF-BRFA-HPF#2, ESF-AL#3-RBT#1, ESF-AL#3-RBT#4, and ESF-AL#4-RBT#1; (2) DTN: GS970108312231.002,: "Physical properties of surface samples from the ESF Main Drift (29+00 m to 57+00 m)"; and (3) DTN: GS970208312231.003, "Physical properties, water content and water potential on samples from boreholes ESF-NAD-GTB#1 and ESF-NAD-GTB#1A from Alcove 6 in the ESF."

Monitoring of selected boreholes and compilation of data continued during the period. Borehole data from NRG-7a, UZ#4, UZ#5, UZ-7a, and SD-12 were transferred to Denver, converted to engineering units, and archived to optical disk on a routine basis throughout the month. Daily EKES files were checked for any shelter activity. Sensor readings were checked daily as well for unusual occurrences, and any statistical

outliers were flagged. Data packages were submitted in completion of Level 4 **milestone SPH22NM4 [borehole instrumentation records and data through 31 January to RPC]** on March 14. Eight Druck pressure transducers and four thermistors were calibrated for the ESF air-permeability (air-K) testing program. A malfunctioning computer and Hart Water Bath were replaced on thermistor calibration rack #8. Monitors, video cards, and other computer components were swapped in order to get one fully-functional pressure transducer and one thermistor calibration rack operational. Two functional computers are available as spares for these two racks;

most other computer equipment in the Cal Lab is not functional, and may not be repairable because of obsolescence.

Several trips were made to field sites for routine generator maintenance and to correct generator problems, and to exchange UPS battery packs at SD-12 (possibly degraded due to generator problems). Expectation is that batteries at NRG-7a will last another 6 to 10 months, and those at the other field sites 18 to 40 months, depending mainly on the number of generator failures. Eight site visits were made to correct data acquisition-related problems.

Permeability measurements were conducted on samples from the systematic sampling of the main drift in the ESF as part of the broad effort to evaluate matrix properties of unsaturated tuffs as constraints on UZ flow models. Samples have been requested from Alcove 7, the south Ghost Dance alcove. Most of the available samples show flow properties too low for measurement of permeabilities using the present instrumentation and will be processed using the high-pressure permeameter which is currently under development. Prototype methodology for the steady-state centrifuge, with which unsaturated hydraulic conductivity measurements will be made, as well as moisture-retention curves, are still being developed. Revisions to the technical procedure for this method continued with incorporation of technical review comments.

USGS staff provided discussion of spatial distribution of infiltration to engineering staff in order to establish a baseline understanding of the potential for spatially variable flux at the repository level as a guide to design details. USGS milestone report 3GUI623M, "Conceptual and numerical model of infiltration for the Yucca Mountain area, Nevada," was provided as well.

The current phase (through January 1997) of ESF air-permeability and hydrochemical testing was completed. All data collected through the end of January have been analyzed, interpreted and presented in a report to the TPO as required to meet Level 4 **milestone SPH35EM4 [Memo to TPO: Tech Anal/Interp air-k and hydrochem in ESF]**, completed on March 14. The interpretations of this memo were accompanied by submittal of data packages to the RPC in completion of **milestone SPH35FM4 [Memo to TPO: Submit air-k / hydrochem testing data to RPC]**, also completed on March

14.

Newly initiated field estimation of *in situ* percolation flux across the repository horizon was begun during the period. Evaluation of instrumentation for developing field measurement of water potential and water content using two new time-domain reflectometry (TDR) systems and heat dissipation probes (HDP) was started. Single sensors for each type of TDR will be ordered for field evaluation in April. The manufacturer will provide technical consultation and additional monitoring instrumentation for the evaluation phase of this work.

Temperature and relativity humidity data from four sites in the ESF collected between October 1, 1996, and January 31, 1997, have been assembled, reviewed, and submitted to the RPC and TDB. The data package "Moisture Monitoring in the ESF, October 1, 1996 to January 31, 1997" (DTN: GS970208312242.001) represents completion of this Level 4 **milestone SPH22RM4 [Memo to TPO: Data Collected thru Jan 97 to RPC]**. A further memo to the TPO discussing analyses and interpretation of data collected in the ESF between October 1, 1996 and January 31, 1997 was completed and submitted to the TPO. This Level 4 **milestone SPH22QM4 [Memo to TPO: Results analyses/Interpret thru Jan 97]** has been completed. Collection of temperature and relativity humidity data continued at four sites in the ESF. Wind speed data are currently being collected at two locations (near Alcoves 3 and 4). Barometric pressure, temperature and relative humidity are being collected in Alcove 4 and near station 70+50 (meters). Collection of data from four heat-dissipation probes in Alcove 3 continued.

A project designed to preserve the *in situ* water content of selected sites in the tunnel continued. Plastic sheets (1.5 X 1.5 m) are being attached to the tunnel wall (below the spring line) using nails and silicon sealer. These selected locations may be the site of future sampling and/or instrumentation locations. To date approximately 43 pieces of plastic have been installed. As the TBM advances, additional plastic will be installed.

Sets of tensiometer and heat-dissipation probes continued to monitor the dry-out of the tunnel wall. To date, a total of eight tensiometers and eight heat dissipation probes have been installed at two locations. Monitoring of the probes shows the change in water potential in the rock. The collected data are being assembled for a data package submittal.

Investigations into south-ramp hydrology have been initiated. Plastic sheets were located in key areas in the south ramp to protect the rock from water spray during mapping and from dry-out after mapping. These locations will be evaluated as possible locations for boreholes for collecting core and installing instrumentation. Tensiometers and heat-dissipation probes were installed at two locations in the south ramp to

evaluate dry-out conditions prior to drilling boreholes. Two prototype boreholes were drilled, and core was collected for laboratory analysis. Physical and chemical analyses will be conducted on core samples removed from the 2-m boreholes.

Borehole locations were sited in the PTn in the north ramp in preparation for investigation of lateral diversion in the PTn. Instrument packer designs were evaluated in the laboratory to force contact between tensiometers and heat-dissipation probes with the rock in the boreholes. These instruments will be used to measure *in situ* water potentials.

In work for the ESF drift-scale flux and niche study, the site for Niche #1 was selected at ESF station 35+66 based on the location of a shear at 35+57. Bomb pulse ^{36}Cl was found at the shear and at the Sundance Fault (station 35+98). Niche #1 will cross the shear, and boreholes will be drilled to cross the fault. This niche is designed to provide valuable insight into the hydrologic conditions of the Topopah Spring middle nonlithophysal zone (Tptpmn) in a known fast pathway.

Niche #2 was located at ESF station 35+50 based on the location of Niche #1 and measured non-bomb pulse ^{36}Cl at station 35+77. Repository design required that Niche #2 be south of Niche #1. The rock appears typical of the Topopah Spring middle nonlithophysal (Tptpmn) unit. This niche was designed to provide insight into hydrologic conditions of the Topopah Spring middle nonlithophysal zone in a known non-bomb-pulse pathway.

Studies of hydrochemistry in the UZ continued during the period. Level 4 **Milestone SPH22XM4 [Memo to TPO: Pkg of Chem Anal thru Jan 97 to RPC]** was completed on March 14 with finalization of the data package for tabulated chemical analyses. Isotope investigations continued with eight ESF pore water samples from ESF alcoves counted for tritium concentration, and the tritium data were reduced and recorded in the tritium data base. Collection of data from samples from the SD-12 borehole was completed as of March 14. Water collection by compression and distillation methods during March was recorded in the water-collection database. Pore water from nine SD-9 core samples (six from shallow depths, three from the saturated zone) was collected using one-dimensional compression. CO_2 was distilled from eight SD-9 and SD-12 core samples, and the acidification part of the distillation method was performed on two of the core samples. The extracted CO_2 will be analyzed for carbon isotopes, and the extracted pore water will be analyzed for tritium. Four CO_2 gas samples for shipment to Beta Analytical Laboratory for carbon-isotope analysis. The CO_2 samples were extracted from SD-9 cores using the distillation and acidification methods.

Interpretations of the results of chemical and isotopic data collection through January were drafted and sent for colleague review and further review by Team Chief in early March. The Level 4 milestone memo was written and filed with TPO on March 14

(milestone SPH22WM4 [Memo to TPO: Rslts Chem Analysis Thru Jan 1997]).

In geochronological studies, five samples from TSw and CHn hydrogeologic units were degassed and acidified to extract CO_2 for ^{14}C age determinations on pore water.

In unscheduled work, four spring-water samples, collected from Coffers Ranch, Nevada, were distilled and analyzed for tritium concentration. Preparations for inserting the Seamist packer liner into borehole UZ-14 were completed. Liner insertion is expected to be conducted the week of April 7.

Saturated-Zone Hydrology

Processing of saturated-zone data obtained at the C-hole complex between July and December 1996 continued during the period. Pressure and water-level data collected at the C-holes and nearby wells UE-25 ONC-1, USW H-4, UE-25 WT#14, UE-25 WT#3, and UE-25 p#1, had been processed for submittal as one data package and reviewed during February 1997; the package was submitted to the Records Processing Center (RPC) and the Technical Data Base (TDB) during the last week of March 1997.

A memo describing the tracer testing in UE-25 c#1 and c#2 was completed on March 14 as Level 4 **milestone SPH23NM4 [Memo to TPO: results of tracer tests July through December 1996]**. This memorandum had been planned to describe the USGS purely-convergent tracer test with Pyridone injection into UE-25 c#1 and 2,6, Difluoro-benzoic acid (2,6 DFBA) injection into UE-25 c#2 through 1996, but delays required modification of the memo. The test was finally initiated in January 1997. The memo described analysis of (recent) previous tracer experiments at the C-hole complex by USGS and LANL, including pumping tests of the Bullfrog Tuff at c#3, predictions for breakthrough of tracer materials in the convergent test, and preliminary interpretations of the current tests. During February and March 1997, the concentration of 2,6 DFBA steadily decreased, forming a very clearly-defined breakthrough curve. On March 14, the 2,6 DFBA test had been in progress for 63 days. No Pyridone has been detected to date. In order to locate the Pyridone plume, a two-part plan was developed. The first step required removal of the tracer-injection tubing from UE-25 c#2 in order to obtain bailed samples of fluid from the packed-off Lower Bullfrog interval. This would ascertain whether the Pyridone had traveled along preferential pathways from UE-25 c#1 to UE-25 c#2 formed by fracture zones representing the intersection of the Paintbrush Canyon (or Midway Valley) fault with the vertical plane passing through these two boreholes. Secondly, recirculation of a portion of the water pumped from UE-25 c#3 into UE-25 c#1 was planned, to speed the migration of the Pyridone plume, which is presumably between UE-25 c#1 and UE-25 c#3.

The USGS proposal to conduct hydraulic and tracer tests in the low-transmissivity Prow Pass Tuff at the C-hole complex was approved in January 1997, and plans were

established to stop the current 2,6,DFBA / Pyridone test on July 1 and to start reconfiguration of the C-holes to enable testing of the Prow Pass. Planning and design of the down-hole mixing and sampling system that will be used for the *in situ* mixing of the tracer in the injection zone, and for obtaining samples of the injection-zone fluid at the surface, continued during the period. A meeting was held on March 24 with representatives from Baker Oil Tools, Inc., who presented a down-hole mixing and sampling system that Baker previously had rented to Sandia National Laboratory (SNL) to conduct tracer tests at the WIPP site near Carlsbad, New Mexico.

Processing of data obtained since January 1997 at the C-hole complex continued. Concentrations of 2,6 difluorobenzoic acid as a function of time, from the tracer test conducted between January and March 1997, will be submitted as one data package. The pressure and water-level data collected at the C-holes and nearby wells UE-25 ONC-1, USW H-4, UE-25 WT#14, UE-25 WT#3, and UE-25 p#1, will be processed for submittal as another data package.

Efforts in support of site-scale potentiometric-level monitoring were ongoing. For the month of March, 31 manual measurements were completed. Five zones in four wells were monitored hourly with transducer measurements. Monitored wells include UE-25 WT#3, UE-25 WT#14, UE-25 p#1, and USW H-4 (upper and lower intervals). Hourly monitoring of the lower interval of USW H-4 was discontinued on March 25. Water-level measurements were made at numerous sites during the month, including USW WT-1 and USW WT-2 on March 3; UE-25 WT#4 and UE-25 b#1, upper interval, on March 4; USW H-1 (tubes 1, 2, 3, and 4) on March 5; J-11, J-12, and J-13 on March 6; UE-25 WT#6 and UE-25 WT#16 on March 10; UE-25 WT#13, USW G-2, and UE-25 WT#15 on March 11; USW H-3, upper and lower intervals, and USW H-5, upper and lower intervals, on March 12; USW VH-1, USW WT-7, USW WT-10, USW WT-11, and USW H-6 (upper and lower intervals) on March 18; USW H-4, upper and lower intervals, on March 25; and UE-25 WT#3, UE-25 WT#14, and UE-25 p#1 on March 26. Transducers were calibrated at several sites on March 25 and 26. In some cases, transducers were removed for water-level measurements, calibrated and returned to the well. A new transducer was installed at UE-25 WT#14. Data were downloaded from 21X recorders at several wells, including USW H-4 (upper and lower zones), UE-25 WT #3, UE-25 WT #14, and UE-25 p#1. Staff participated in an audit of field and technical procedures on March 5.

In a newly started activity to measure eH and pH in WT holes, USGS personnel met to discuss a variety of sampling and hole-selection issues for eH, pH, and hydrochemical analyses attendant with this new activity. USGS personnel are exploring possible software for use in developing a spatial data base of hydrochemical and isotopic data as well as key extensive and intensive parameters to be included in the data synthesis.

In a recent trip to Sweden to attend an SKB workshop on the geochemistry and stability of saline waters in the circum-Baltic region, USGS staff discussed the construction and deployment of a Finnish-designed tube sampler with Runarr Blomqvist (Finnish Geological Survey), Marcos Laaksoharju (Intera) and Shaun Frape (University of Waterloo, Canada). The tube sampler is a simple device that can be used for discrete sampling in wells that have previously been purged and have come into equilibrium with the aquifer. The USGS is exploring the possibility of using this sampler in some of the H holes at Yucca Mountain.

Work continued on preparation of potentiometric-surface maps that will be used for SZ flow-model calibration and for the Site SZ flow-model synthesis report. Analysis of water-level fluctuations to estimate hydraulic properties of saturated-zone rock units also continued.

Refinement of the grid spacing of the hydrogeologic framework model to 250 meters was completed. The model was regridded and visually inspected, but formal review has not yet been done. The updated model, containing three different upper surfaces corresponding to three interpretations of the potentiometric surface of the site model area, was sent to LANL for generation of the site flow model mesh. Grid generation is proceeding, and although these are different data sets, there are no new operational details, and grid generation is expected to be a smooth process. Some delays were encountered at both LANL and Colorado School of Mines when new operating systems and revisions of the Stratamodel software were installed. Software QA documents for Stratamodel were submitted to the USGS QA office, and the software was determined to be exempt for anticipated applications at Yucca Mountain. Planning was done for a new Stratamodel scenario in which the top of the model will be the potentiometric surface but, unlike other models, vertical subdivisions within the units which contain hydraulic-head observation points will be specified. Without this subdivision, model elements may have thicknesses spanning the thickness of the model.

Calibration efforts for the site flow model continued. Numerous (>50) simulations were run using an older mesh for optimal acquisition of steady-state hydrostatic conditions. A routine to extract nodal coordinates from an arbitrary node list was developed. Also developed were routines to process and sort pressure results from the flow, heat, and transport simulator, FEHMN, and to automatically edit lists of control files used in the execution of FEHMN. Specific-capacity data from wells at and in the vicinity of Yucca Mountain were processed using a method developed by Czarnecki and Craig (1985) to yield transmissivity values.

In a significant achievement toward calibration of the flow model, boundary-condition preprocessors to FEHMN were developed. The preprocessors enable operators 1) to reference fluid-pressure boundary conditions at the water table to nodal elevations within the model; and 2) to project hydrostatic-pressure boundary conditions based on

the referenced water-table boundary conditions down and along the outside faces of the model domain. These specifications resulted in a stable, rapidly converging flow and heat simulation using FEHMN for both homogeneous and heterogeneous permeability distributions using an early version of a three-dimensional, irregular finite-element mesh consisting of 3,223 nodes and 15,964 tetrahedral elements. This mesh was constructed such that its top represented a smoothed rendition of the potentiometric surface located approximately 100 m above the actual potentiometric surface; the bottom of the mesh paralleled this top surface. The actual potentiometric surface was represented by nodes that were added within the mesh. However, for the testing of the boundary-condition preprocessors, the smoothed top surface was used as the potentiometric surface so that fully saturated conditions could be maintained. Subsequent model meshes are designed with the water table representing the top of the model. Vector fields of flow for these simulations developed using an Advanced Visualization System network show well-behaved magnitude and direction.

Work continued on writing various sections of the draft saturated-zone synthesis report. Assignments as to required sections from co-authors were made, and a list and description of figures was compiled. Staff continued work on revisions to a table of aquifer hydraulic characteristics.

In support of oversight activities, follow-up discussions had occurred in February 1997 with the M&O and DOE regarding M.J. Umari's (USGS) presentation to the NWTRB on January 29. There was disagreement about the placement of a interpreted northwest-striking fault that hydraulically connects the C-hole complex with UE-25 ONC-1 and USW H-4 in Antler Wash, which had been inferred from the shape of the cone of depression resulting from pumping UE-25 c#3. The NRC had also inquired about the matter. During March, these disagreements were ironed out. On March 19, a conference call was conducted with P. Justus of the NRC, who declared the matter closed.

Work on the viability-assessment of the SZ flow-model sensitivity analysis continued with investigations of alternate conceptual flow models. Water-level measurements were made at site NT-1, near the Funeral Mountains. A difference in head of about 12 m (40 ft) was found between the upper and lower piezometers indicating that the alluvial and carbonate parts of the flow system are not well connected. A draft of a report documenting results of aquifer testing at well USW G-2, a critical site in looking at alternative conceptual models of flow at the large hydraulic gradient, was completed. Supervisor's review of the report was completed, and the report is being revised in preparation for colleague review.

Planning continued with SNL for a workshop that will address critical issues on SZ flow modeling and the transfer of information obtained in process modeling for use by PA

modelers. Staff also prepared presentations and input to the Abstraction/Testing Workshop for PA, scheduled for April 1 through 3.

In unscheduled work, staff participated in a workshop on future directions for ground-water modeling in the USGS, March 18 through 20, and attended a Symposium on the Application of Geophysics in Environmental and Engineering Problems, March 24 through 26. Staff also participated in the annual meeting of the USGS Borehole Geophysics Advisory Group, March 27.

WBS 1.2.3.6 CLIMATOLOGY and PALEOHYDROLOGY

In studies of lakes, playas, and marshes for climatic history, additional samples of Owens Lake core OL 92/2 have been counted to provide higher-resolution paleoclimate analyses back to 500 ka than are currently available. Count data have been entered to spreadsheets for graphic and numeric analysis. The final database for diatom analysis of the Owens Lake core will contain about 1000 samples with a temporal resolution of 500 to 750 years for the past 500 kyr. Diatom data, along with the ostracode data, provide the means with which to estimate the rate of change and timing (duration) of regional climate change. Rate of change and timing are key factors sought by the NRC in their deliberations about the future behavior of the potential repository.

Collection of ostracode data from Owens Lake is complete. The final data set includes about 1400 samples with a temporal resolution of about 500 to 750 years for the past 500 kyr. Work has begun on study of ostracode morphological change through long Quaternary lake records in order to document within-species range changes that may enhance the paleoclimatic resolving power of the ostracode record.

Several efforts were ongoing. Preparation of diatom samples from Owens Lake cores and from analog sites continued during the period. Picking of ostracodes from prepared sediment residues continued, for inclusion in the baseline data set. Collection of ostracode data from the Las Vegas and Indian Springs Valley deposits for stable isotope analyses also continued for study of ground-water flow at critical sites. Aquatic molluscs were picked from sediment residues of samples from the ostracode baseline data set. The molluscs will be identified (by Saxon Sharpe at the Desert Research Institute) and used to identify the source(s) of past discharge at sites located in Crater Flat, along Highway 95, and near the Amargosa River.

Climate staff met with 3-D regional hydrologic framework modelers to discuss preliminary output from the model. Staff provided a written synopsis of the climatic context of paleodischarge and paleohydrologic history for the local Yucca Mountain area to accompany the paleodischarge model report.

In support of the paleoclimate synthesis report, staff attended the PISA Climate Site Description/Integration meeting with DOE and M&O officials in Denver. General plans

for the climate chapter were discussed including anticipated content of the paleoclimate chapters.

Work continued on several manuscripts. One describes the common ostracode taxa from the wetland sediments in the Yucca Mountain area. This manuscript once complete will provide the key documentation of paleontological data used in the interpretations of past climate and past discharge. A paper titled "Reliable late-Pleistocene stratigraphic ages and shorter ground-water travel times from ^{14}C in fossils snails from the southern Great Basin," by Bob Brennen and Jay Quade, will be published soon in *Quaternary Research*. A manuscript titled "Paleoenvironments of black mats in the southern Great Basin," by Jay Quade, Richard M. Forester, William L. Pratt, and Claire Carter, has been reviewed by the USGS, revised, and submitted for Director's Approval. Staff continued work on a manuscript that treats the climate and hydrological states that existed in the Las Vegas and Indian Springs Valley during the Pleistocene. Three manuscripts were recently published in Geological Society of America *Special Paper* 317: "A diatom-paleohydrologic record of climate change for the past 800 ky from Owens Lake, California," by J. Platt Bradbury; "Ostracodes in Owens Lake Core OL-92: Alternation of saline and freshwater forms through time," by Claire Carter; and "Synthesis of the paleoclimate record from Owens Lake Core OL-92" by George I. Smith, James L. Bischoff, and J. Platt Bradbury. Each of the above manuscripts fulfills a portion of milestone SPC332M4, submittal for publication of parts of updated FY96 climate synthesis report, due in August.

Evaluation of paleo ground-water discharge continued with staff attendance at the Devil's Hole Workshop on March 26. Staff also met with representatives from the USGS Las Vegas Subdistrict and the Nevada District (Carson City), Lawrence Livermore National Laboratory, and the Desert Research Institute to discuss potential new work on the Oasis Valley ground-water system with particular reference to flow from Pahute Mesa westward towards Oasis Valley. Although this work, if funded, will be conducted under the DOE Environmental Restoration Program, the results will have direct bearing to furthering the understanding the regional flow systems including that of Yucca Mountain.

Level 4 **milestone report SPC23FM4** "Geochronology of fracture fill material, ESF, and estimated past water fluxes" was delivered on schedule to the USGS TPO on March 14. The report contains new analyses completed since August 31, 1996, including U-series, ^{14}C, and U-Pb ages for calcite and opal, stable-isotope and strontium data for calcite, and strontium isotope data for pore water salts extracted from SD-7 core samples. The new U-Pb data allow complete characterization of the depositional range of the calcite-opal deposits and temporal calibration of the stable and strontium isotopic records contained within these minerals. Deposition in fractures and cavities appears to have commenced 2 to 4 million years after emplacement of the host tuffs and continued either episodically or continuously until relatively recently. Long-term growth

rates were remarkably constant over the past 8 million years for four samples that have been analyzed in detail. These data indicate that the unsaturated-zone hydrologic system has remained remarkably stable during this interval and that the system will likely be stable during the functional life span of the potential repository. Additional detailed analyses will be conducted on other samples to test this hypothesis. Long-term rates of mineral growth have remained constant to within a factor of 1.5 for a given sample site or a factor of 4 among sites over the history of the mountain in spite of wide ranges in climatic conditions. The implications with regard to a possible system buffered from climate change require further investigation. Collectively, the new age and isotopic data support a UZ flow model involving some lateral diversion of percolation by the PTn, and as a result, lowered fluxes in much of the ESF main drift. These implications can be comprehensively tested in the proposed east-west drift which will access a part of the repository block that may not have been geologically characterized by the ESF.

Geochronological and isotope-tracer studies continued during the period. Microsampling of calcite and opal specimens continued for U-series, ^{14}C and U-Pb dating as well as for stable and strontium isotopic analyses. An abstract entitled "Strontium isotopes in pore water from the unsaturated zone at Yucca Mountain, Nevada," by B. Marshall, K. Futa, and Z. Peterman, was submitted to the 1997 Goldschmidt Conference to be held in Tucson AZ.

Staff (B. Marshall, L. Neymark, Z. Peterman, and J. Whelan) responded to a request from the M&O for assistance in addressing allegations in an article by Mary Manning in the Las Vegas Sun concerning the hydrologic significance of dating calcite and "zircon" in fractures at Yucca Mountain. The following response was prepared jointly with the M&O (M. McGraw):

> "The U.S. Geological Survey has an active program to determine the age and origin of the calcite at the surface and in fractures and cavities within Yucca Mountain. The results from age studies in the ESF indicate that calcite deposition within the rock mass is a slow and relatively constant process that has spanned the past 10 million years. Ongoing chemical and isotopic studies indicate that calcite is formed at low temperature from rain water trickling down from the surface along fractures within the volcanic rocks. There is no chemical, mineralogical, or isotopic evidence to suggest that the [potential] repository horizon was ever flooded by water in the past.
>
> USGS and other Project scientists are well aware of the presence of zircon in the surficial calcite deposits including near-surface fracture fillings. All zircon at Yucca Mountain is of igneous origin. This mineral is ubiquitous in trace amounts in the Miocene volcanic rocks and younger volcanic ashes that were deposited in the region. Zircon is a very hard mineral which is highly resistant to abrasion

and weathering. It is transported by both wind and water along with silt and sand particles which fall into cracks and crevices where the particles are eventually incorporated into calcite deposits. Therefore, the presence of zircon in the deposits does not indicate high formation temperatures for the enclosing material. Previous research conducted by the USGS, Los Alamos National Laboratory, and by scientists of the University of Utah at Trench 14 indicated that the calcite deposits were formed by low-temperature pedogenic processes rather than from upwelling fluids. The National Academy of Sciences in their 1991 report concurred with these conclusions.

The static water level at Yucca Mountain is roughly at 2400 ft above mean sea level. A rise of 300 to 450 ft, as indicated by Frankie Sue Del Papa, is consistent with evidence of past rises first determined by Yucca Mountain Project scientists. [A] cross section of the [potential] repository and the static water level. . .[indicates] that a 300- to 450-ft rise would not flood the repository and would therefore pose no direct threat to the ability of the natural and engineered systems to contain and isolate the waste."

WBS 1.2.3.9 SPECIAL STUDIES

Preparation of PISA Chapter 2.3 (Geological Systems) continued. The Principal Investigator (PI) and six others from the USGS attended a meeting with DOE and the M&O on March 18 and presented a detailed description of contents of the site structure subsection. USGS provided a rough draft (about 80% complete) of that subsection to other chapter authors. A draft (about 90% complete) on the regional geology and stratigraphy and a similar draft for the tectonic model were also provided to co-authors of the geology chapter.

The geological-systems PI met with DOE and the M&O on March 5 to discuss implementation of the Web-based Information System (WBIS); a management plan for this effort was also reviewed.

The geological-systems PI worked with M&O personnel on problems with reference format and accession numbers. Accession numbers for references identified thus far by contributing authors from the USGS (around 400 references) have been identified. As many as one-third of these references lack accession numbers.

Preparation of the PISA Hydrology chapter sections continued during the period. A revision of the PISA Content Guide has redesignated the Hydrology Chapter, formerly Chapter 2.4, as Chapter 2.5. Proposed revisions of the Content Guide were evaluated. The revisions would have required descriptions of the applications of hydrologic findings to the resolution of the Nuclear Regulatory Commission's "Key Technical Issues," to confirming the hypotheses in the DOE's Waste Containment and Isolation Strategy, and to additional transport and engineering considerations. It was

recommended that these changes to the existing scope should not be imposed. Authors continued preparation of draft sections of the hydrology chapter. **Milestone SPH394M4 [Memo to TPO: Rev Drft PISA Chap 2.4]** was completed on March 13.

The PISA climate/meteorology chapter outline was revised to incorporate new subchapters dealing with paleoclimate. The new subchapters will systematically target the drivers of past and future climate, their actual (past) and probable future impact on the timing and rate of change of regional climate, the magnitude of climate change within the Yucca Mountain area, and record of climate change within the Yucca Mountain UZ. Staff attended a climate chapter kickoff meeting with M&O staff. General logistics were discussed, and some items to be discussed in some subchapters were presented.

In support of Site Characterization Progress Report (SCPR) summary activities, work continued on revision of SCPR Appendix A, which is documenting differences between the site-characterization program outlined in the SCP and the current program. Revisions involve expanding the text prepared for SCPR #15 by inserting additional rationale for program changes and literature citations to support interpretations and conclusions. These revisions were made in response to review comments from M&O and DOE staff. The final section of Appendix A on the USGS Climate program was completed and submitted. It is expected that revisions will continue during the upcoming months as Appendix A progresses through the review process.

USGS input to SCPR #16 for Rock Characteristics (Geologic Framework), Geohydrology, Climate, Postclosure Tectonics, and Preclosure Tectonics was compiled, edited, and transmitted to the M&O. The input included progress and forecast narratives for 29 SCP activities encompassing 27 summary accounts. About 10 questions and comments on the SCPR #16 input were received from M&O staff within the first week after submittal of the USGS input. All questions and comments were expeditiously resolved. Revisions to the USGS input to SCPR #16 will continue during the next several months as SCPR #16 progresses through the review process. The M&O/USGS interactive review is scheduled for April 30 through May 2, and the YMSCO and DOE-HQ reviews are scheduled for June and July, respectively. In addition, work continued on the collection and transmittal of hard copies of reports and memoranda cited as references in SCPR #16.

In unscheduled work, revisions to the text of the North Ramp UZ hydrogeology report in response to the editorial review were completed. The report was transmitted to the YMPB Reports Specialist for further processing towards approval and publication as a USGS Water-Resources Investigations Report.

In interactions with the Nuclear Regulatory Commission, USGS staff participated in a video-conference briefing by USGS Headquarters for Debra Knopman, a newly

appointed member of the Nuclear Waste Technical Review Board. The technical lead for the SCPR gave a presentation on the status of USGS studies at Yucca Mountain based on the content of the recently compiled SCPR Appendix A. Emphasis was given to unresolved uncertainties in various aspects of the Rock Characteristics, Geohydrology, and Climate programs. Of particular interest during the discussions were the densely fractured zone mapped in the repository horizon in the ESF Main Drift, the large hydraulic gradient in the saturated zone, fracture flow through the PTn and into the repository horizon in the TSw, the history of flux through the TSw recorded in fracture coatings, and future studies designed to determine the magnitude of vertical flux and lateral diversion within the PTn.

WBS 1.2.8.4.7 WATER-RESOURCES MONITORING

Modification of technical procedures (necessitated by additional sample collection, processing, and laboratory analyses scheduled during the third quarter of FY 1997) continued during the reporting period. Collection and delivery of water samples to personnel associated with the M&O's Radiological/Environmental Field Programs was completed on March 14. Equipment preparation began for collection of water samples in May.

Ground-water levels were measured at 29 sites and at one flowing well. Ground-water data collected during February were checked and filed.

In support of the FY 1997 environmental program, staff participated in USGS Headquarters and Nevada-District review of project activities on March 6. The NWIS database was checked for consistency with previously stored and reported monitoring data after the merging of USGS-NV District and USGS-ESIP databases, and inconsistencies were discussed with USGS-NV District data-management personnel. Staff attended the Devil's Hole Workshop in the Amargosa Valley on March 26 and 27. On March 31, staff prepared materials and participated in DOE's mid-year financial and technical review. Potential modifications to future data-collection activities in the immediate vicinity of Yucca Mountain (to continue satisfying requirements of the water-appropriations permit) were discussed with DOE and USGS-YMPB personnel.

Preparations for the water-resources summary monitoring report (through calendar-year 1996) continued during the period. Evaluation of electric-tape calibration data was completed. Processing and checking of pressure-sensor data collected at wells JF-3 and AD-6 were begun. Checking continued of periodic USGS water-level measurements. Water-use data for Amargosa Desert and water-level and discharge data for monitoring sites in Ash Meadows were obtained, respectively, from the Nevada State Engineer and from USFWS personnel. The initial version of the base map to be included in the summary monitoring report was modified; a revised version was received from USGS-NV District reports personnel.

USGS Level 3 Milestone Report

October 1, 1996 - March 31, 1997

Sorted by Baseline Date

Deliverable	Due Date	Expected Date	Completed Date	Comments
LETTER REPORT **Milestone Number:** SSH13BM3	11/1/96	10/30/96	10/30/96	
LETTER REPORT **Milestone Number:** SSH13CM3	1/31/97	1/30/97	1/30/97	
Ltr Rpt: Geo S.R. Sta 55+00 to STA 63+47 **Milestone Number:** SPG42BM3	2/28/97	2/27/97	2/27/97	
Rpt Geo North/South Main Drft Sta 28+00 to55+00 **Milestone Number:** SPG42AM3	2/28/97	2/28/97	2/28/97	
Main Drift Hydrogeology Report **Milestone Number:** SPH223M3	3/14/97	3/14/97	3/14/97	

USGS Level 4 Milestone Report

October 1, 1996 - March 31, 1997

Sorted by Baseline Date

Deliverable	Due Date	Expected Date	Completed Date	Comments
Memo to TPO: SS Hazards Methodologies Wrkshop **Milestone Number:** SPG28FM4	10/25/96	10/24/96	10/24/96	
Memo to TPO: Jan-Jun96 Perio Wtr Lvl Data to RPC **Milestone Number:** SPH21CM4	10/31/96	10/30/96	10/30/96	
Memo to TPO: SS Hazards Method. Wrkshop Summary **Milestone Number:** SPG28GM4	11/15/96	11/14/96	11/14/96	
Memo toTPO: Seis. Src. Mdls & Proponents Wrkshop **Milestone Number:** SPG28HM4	11/27/96	11/26/96	11/26/96	
Memo to TPO: Comp Frac Data Coll:Cal. Hills,Prow **Milestone Number:** SPG34M4	11/27/96	11/27/96	11/27/96	
Memo to TPO: Comp Re-Eval Priority Strat Contact **Milestone Number:** SPG21M4	12/13/96	12/13/96	12/13/96	
Memo to TPO: Detailed Content Outline **Milestone Number:** SPH391M4	12/13/96	12/13/96	12/13/96	
Memo to TPO: SS Modls & Propnents Wrkshop Summry **Milestone Number:** SPG28IM4	12/19/96	12/19/96	12/19/96	
Report: Mod Flow In UZ Frac Ntwk TS W-U in ESF **Milestone Number:** SPH21AM4	12/31/96	12/19/96	12/19/96	
Memo to TPO: Monitoring Data Apr-Sep 1996 to RPC **Milestone Number:** SPH22GM4	12/31/96	12/23/96	12/23/96	
Memo to TPO: GM Models and Interpret. Workshop **Milestone Number:** SPG28AM4	1/17/97	1/13/97	1/13/97	
Memo to TPO: Seismic Source Interp. Wrkshop **Milestone Number:** SPG28JM4	1/17/97	1/13/97	1/13/97	

Deliverable	Due Date	Expected Date	Completed Date	Comments
Memo to TPO: Clim Scenarios Recvd & Sim Started **Milestone Number:** SPH23AM4	1/30/97	1/13/97	1/13/97	
Memo to TPO: SS Interpretations Wrkshop Summary **Milestone Number:** SPG28KM4	2/4/97	2/3/97	2/3/97	
Memo to TPO: GM Modls & Interpret Wrkshp Summry **Milestone Number:** SPG28BM4	2/6/97	2/5/97	2/5/97	
Memo to TPO: Sub Bh Video Frac Db to GENISES **Milestone Number:** SPG211M4	2/28/97	2/27/97	2/27/97	
Memo to TPO: Jul-Dec96 Perio Wtr Lvl Data to RPC **Milestone Number:** SPH21BM4	2/28/97	2/7/97	2/7/97	
Memo to TPO: Annotated Outline Site SZ Synth Rpt **Milestone Number:** SPH23VM4	2/28/97	2/11/97	2/11/97	
Memo to TPO: Summary of Meetings with PA Mdlrs **Milestone Number:** SPH25CM4	2/28/97	2/13/97	2/13/97	
Memo to TPO: Rslts New Age & Iso Determinations **Milestone Number:** SPC23FM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: 1995 Water-Level Data **Milestone Number:** SPH21FM4	3/14/97	2/13/97	2/13/97	
Memo to TPO: Meteorlogical Data FY96 to RPC/TDB **Milestone Number:** SPH21IM4	3/14/97	3/14/97	3/14/97	
Publish Sel Streamflow & Precip Data for FY96 **Milestone Number:** SPH22CM4	3/14/97	6/30/97		
Memo to TPO: Subm FY96 Data to RPC/TDB **Milestone Number:** SPH22DM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Trans Funct Precip/Infil of Num Mdl **Milestone Number:** SPH22FM4	3/14/97	3/11/97	3/11/97	
Memo to TPO: Synth UZ Mont Data fm MD of ESF **Milestone Number:** SPH22IM4	3/14/97	3/14/97	3/14/97	

Deliverable	Due Date	Expected Date	Completed Date	Comments
Memo to TPO: Reslt of Matrix-Hydro-Prop Determin **Milestone Number:** SPH22KM4	3/14/97	3/11/97	3/11/97	
Memo to TPO: Matrix-Hydro-Prop Compl Pkg to RPC **Milestone Number:** SPH22LM4	3/14/97	3/11/97	3/11/97	
Memo to TPO: Monitoring Data Thru Jan 97 to RPC **Milestone Number:** SPH22NM4	3/14/97	3/7/97	3/7/97	
Memo to TPO: Rslts Analyses/Interpret thru Jan97 **Milestone Number:** SPH22QM4	3/14/97	3/11/97	3/11/97	
Memo to TPO: Data Collected thru Jan 97 to RPC **Milestone Number:** SPH22RM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Rslts Chem Analysis Thru Jan 1997 **Milestone Number:** SPH22WM4	3/14/97	3/10/97	3/10/97	
Memo to TPO: Pkg of Chem Anal thru Jan 97 to RPC **Milestone Number:** SPH22XM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Final Hydrogeo Framewrk Data to RPC **Milestone Number:** SPH23DM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Test Data for July-Dec 1996 to RPC **Milestone Number:** SPH23MM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Results of Tests Comp Jul-Dec 96 **Milestone Number:** SPH23NM4	3/14/97	3/14/97	3/14/97	
Memo to TPO: Tech Anal/Interp Air-Perm & Hydroch **Milestone Number:** SPH35EM4	3/14/97	3/13/97	3/13/97	
Memo to TPO: Subm Air-Perm/Hydrochem Tstg to RPC **Milestone Number:** SPH35FM4	3/14/97	3/14/97	3/14/97	
Memo to TPO:Elicit of Experts Interpret Complete **Milestone Number:** SPG28LM4	3/20/97	3/20/97	3/20/97	
Memo to TPO: Comp QA Eval pre-1992 Bh Geo Logs **Milestone Number:** SPG212M4	3/28/97	3/26/97	3/26/97	

Inc. Dollars in Thousands

Yucca Mtn. Site Char. Project-Planning & Control System
PACS Participant Work Station (PPWS)
WBS Status Sheet (WBS02)

WBS No. - 1.2

WBS Title - Yucca Mountain Project

Parent WBS No. - 1.0

Parent WBS Title - Mined Geologic Disposal System

Element ID - 12

Statement of Work:

See the current WBS Dictionary

Cost/Schedule Performance

		Current Period					FY1997 Cumulative to Date					FY1997 at Completion		
Id	Description	BCWS	BCWP	ACWP	SV	CV	BCWS	BCWP	ACWP	SV	CV	BAC	EAC	VAC
1.2.3	Site Investigations	990	1019	1037	29	-18	5662	5831	5555	169	276	11402	12756	-1354
1.2.5	Regulatory	43	43	40	0	3	224	224	188	0	36	504	500	4
1.2.8	Environment, Safety, and H	51	51	98	0	-47	304	304	296	0	8	612	656	-44
1.2.9	Project Management	52	52	42	0	10	312	312	268	0	44	664	618	46
1.2.12	Information Management	6	6	4	0	2	39	39	24	0	15	80	75	5
1.2.15	Support Services	146	146	135	0	11	859	859	813	0	46	1722	1717	5
Total		1288	1317	1356	29	-39	7400	7569	7144	169	425	14984	16322	-1338

Resource Distributions by Element of Cost

Fiscal Year 1997
Budgeted Cost of Work Scheduled

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
LBRHRS	19540	19599	16166	20824	21329	20182	22106	22047	22573	22479	21615	20362	248822
LABOR	885	899	632	866	876	906	909	904	921	919	891	856	10464
SUBS	139	143	87	148	145	145	140	150	153	149	148	136	1683
TRAVEL	25	43	34	45	43	47	35	37	38	36	35	31	449
PM&E	7	6	7	5	9	6	7	6	9	7	5	4	78
OTHER	197	201	179	206	285	184	178	182	176	179	170	173	2310
Total BCWS	1253	1292	939	1270	1358	1288	1269	1279	1297	1290	1249	1200	14984

Actual Cost of Work Performed

LBRHRS	19283	18578	18523	18723	17133	18725	0	0	0	0	0	0	110965
LABOR	771	712	732	829	727	782	0	0	0	0	0	0	4553
SUBS	127	139	117	185	134	179	0	0	0	0	0	0	881
TRAVEL	11	24	61	53	42	46	0	0	0	0	0	0	237
PM&E	43	16	88	85	89	110	0	0	0	0	0	0	431
OTHER	119	129	145	158	252	239	0	0	0	0	0	0	1042
Total ACWP	1071	1020	1143	1310	1244	1356	0	0	0	0	0	0	7144

Prepared - 04/15/97:07:46:14 | WBS Status Sheet (WBS02) | Inc. Dollars in Thousands

WBS No. - 1.2 -Yucca Mountain Project

Resource Distributions by Element of Cost

Fiscal Year 1997
Estimate to Complete

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
LBRHRS	0	0	0	0	0	0	23045	23657	24443	24246	23064	21821	140276
LABOR	0	0	0	0	0	0	956	992	1018	1003	973	921	5863
SUBS	0	0	0	0	0	0	181	191	205	209	194	177	1157
TRAVEL	0	0	0	0	0	0	52	54	57	57	62	52	334
PM&E	0	0	0	0	0	0	9	51	9	7	7	1	84
OTHER	0	0	0	0	0	0	290	296	259	228	299	368	1740
Total ETC	0	0	0	0	0	0	1488	1584	1548	1504	1535	1519	9178

Resource Distributions

Fiscal Year 1997	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
BCWS	1253	1292	939	1270	1358	1288	1269	1279	1297	1290	1249	1200	14984
BCWP	1195	1245	1131	1353	1328	1317	0	0	0	0	0	0	7569
ACWP	1071	1020	1143	1310	1244	1356	0	0	0	0	0	0	7144
ETC	0	0	0	0	0	0	1488	1584	1548	1504	1535	1519	9178

Fiscal Year Distribution

	Prior	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	Future	At Complete
BCWS	15914	14984	9432	980	0	0	0	0	0	0	0	0	41310
BCWP	15609	7569	0	0	0	0	0	0	0	0	0	0	
ACWP	15908	7144	0	0	0	0	0	0	0	0	0	0	
ETC	0	9178	9432	980	0	0	0	0	0	0	0	0	42642

YMP PLANNING AND CONTROL SYSTEM (PACS)

Participant U.S. Geological Survey
Date Prepared 04/15/97 08:54

MONTHLY COST/FTE REPORT

Fiscal Month/Year MARCH 1997
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WBS ELEMENT	CURRENT MONTH END ACTUAL COSTS	CURRENT MONTH END PARTICIPANT HOURS	CURRENT MONTH END SUBCON HOURS	CURRENT MONTH END PURCHASE COMMITMENTS	CURRENT MONTH END SUBCON COMMITMENTS	CURRENT MONTH END ACCRUED COSTS	FISCAL YEAR APPROVED BUDGET[1]	FISCAL YEAR APPROVED FUNDS	FISCAL YEAR CUMMULATIVE COSTS
1.2.3	1032	14943	3276	0	848	95	11387	9110	5538
1.2.5	40	368	672	0	152	0	504	404	185
1.2.8	97	1292	0	0	0	0	612	490	296
1.2.9	42	840	168	0	58	5	664	530	269
1.2.12	4	168	0	0	0	6	80	64	24
1.2.15	133	1114	336	0	54	35	1722	1378	801
TOTALS	1348	18725	4452	0	1112	141	14969	11976	7113

U.S. GEOLOGICAL SURVEY
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		OCT EST	NOV EST	DEC EST	JAN EST	FEB EST	MAR EST	APR EST	MAY EST	JUN EST	JUL EST	AUG EST	SEP EST	TOTAL
0G311FA1	Scientific Programs Management & Integra	15.7	16.6	12.0	21.8	62.3	32.4	0.0	0.0	0.0	0.0	0.0	0.0	160.8
1.2.3.1.1		15.7	16.6	12.0	21.8	62.3	32.4	0.0	0.0	0.0	0.0	0.0	0.0	160.8
0G312FA1	Nevada Operations/Earth Science Investig	55.0	57.4	62.9	66.3	98.9	87.7	0.0	0.0	0.0	0.0	0.0	0.0	428.2
1.2.3.1.2		55.0	57.4	62.9	66.3	98.9	87.7	0.0	0.0	0.0	0.0	0.0	0.0	428.2
*1.2.3.1		70.7	74.0	74.9	88.1	161.2	120.1	0.0	0.0	0.0	0.0	0.0	0.0	589.0
0G32211FB1	Review & Revision of Lithostratigraphy B	14.1	13.4	50.3	23.9	8.6	14.0	0.0	0.0	0.0	0.0	0.0	0.0	124.3
1.2.3.2.2.1.1		14.1	13.4	50.3	23.9	8.6	14.0	0.0	0.0	0.0	0.0	0.0	0.0	124.3
0G32212FB2	Complete Site Area Geologic Map	36.9	24.9	34.2	12.0	21.2	50.7	0.0	0.0	0.0	0.0	0.0	0.0	179.9
0G32212FB3	Fracture Studies	6.3	16.8	14.9	12.2	9.9	9.7	0.0	0.0	0.0	0.0	0.0	0.0	69.8
0G32212FB4	Geologic Mapping of the Exploratory Stud	119.7	139.2	106.3	155.8	135.2	146.7	0.0	0.0	0.0	0.0	0.0	0.0	802.9
1.2.3.2.2.1.2		162.9	180.9	155.4	180.0	166.3	207.1	0.0	0.0	0.0	0.0	0.0	0.0	1052.6
0G3252FB1	Evalute Tectonic Scenarios for PA	10.6	4.1	-4.1	2.3	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	15.4
1.2.3.2.5.2		10.6	4.1	-4.1	2.3	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	15.4
0G32836FB1	Conduct Probabilistic Seismic Hazards An	88.3	62.1	54.3	46.4	36.5	3.0	0.0	0.0	0.0	0.0	0.0	0.0	290.6
1.2.3.2.8.3.6		88.3	62.1	54.3	46.4	36.5	3.0	0.0	0.0	0.0	0.0	0.0	0.0	290.6
*1.2.3.2		275.9	260.5	255.9	252.6	211.4	226.6	0.0	0.0	0.0	0.0	0.0	0.0	1482.9
0G333111FB4	Collection of Site Meteor. Data for Hydr	7.8	8.8	12.2	17.5	14.3	29.6	0.0	0.0	0.0	0.0	0.0	0.0	90.2
1.2.3.3.1.1.1		7.8	8.8	12.2	17.5	14.3	29.6	0.0	0.0	0.0	0.0	0.0	0.0	90.2
0G333112FB1	Collection of Site Streamflow Data	5.6	5.1	5.3	7.4	5.7	7.1	0.0	0.0	0.0	0.0	0.0	0.0	36.2
0G333112FB2	Collection of Site Streamflow Data	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.2.3.3.1.1.2		5.6	5.1	5.3	7.4	5.7	7.1	0.0	0.0	0.0	0.0	0.0	0.0	36.2
0G333114FB3	Regional Saturated Zone Synthesis Report	7.6	7.6	0.0	12.5	29.1	11.6	0.0	0.0	0.0	0.0	0.0	0.0	68.4
1.2.3.3.1.1.4		7.6	7.6	0.0	12.5	29.1	11.6	0.0	0.0	0.0	0.0	0.0	0.0	68.4
0G333121FB1	Infiltration Processes	21.5	16.0	19.0	18.3	30.7	41.4	0.0	0.0	0.0	0.0	0.0	0.0	146.9
1.2.3.3.1.2.1		21.5	16.0	19.0	18.3	30.7	41.4	0.0	0.0	0.0	0.0	0.0	0.0	146.9
0G33123FB4	Integrated Analysis & Interpretation	14.5	5.4	14.5	20.9	38.8	10.6	0.0	0.0	0.0	0.0	0.0	0.0	104.7
0G33123FB5	Matrix Properties of Hydrologic Units	14.1	12.0	16.2	17.8	1.8	3.7	0.0	0.0	0.0	0.0	0.0	0.0	65.6
0G33123FBA	Unsaturated Zone Borehole Instrumentatio	31.9	36.3	32.6	32.3	34.2	-10.8	0.0	0.0	0.0	0.0	0.0	0.0	156.5
0G33123FBB	Unsaturated Zone Borehole Instrumentatio	0.0	0.0	0.0	0.0	0.0	11.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0
0G33123FBC	Integrated Analysis & Interpretation	0.0	0.0	0.0	0.0	0.0	9.3	0.0	0.0	0.0	0.0	0.0	0.0	9.3
0G33123FBD	Matrix Properties of Hydrologic Units	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.2.3.3.1.2.3		60.5	53.7	63.3	71.0	74.8	23.8	0.0	0.0	0.0	0.0	0.0	0.0	347.1
0G33124E96	Air-K and Hydrochemisty Test - North Ram	5.5	3.1	6.4	6.1	1.4	5.8	0.0	0.0	0.0	0.0	0.0	0.0	28.3
0G33124FA1	Support E&I Design Basis Modeling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0G33124FB7	Air Permeability & Hydrochem Testing ESF	46.1	40.6	40.9	68.9	62.7	21.6	0.0	0.0	0.0	0.0	0.0	0.0	280.8
0G33124FB8	Percolation Flux across Repository Horiz	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	3.9
0G33124FBA	Moisture Monitorning in the ESF	2.4	2.4	1.5	18.3	8.3	2.6	0.0	0.0	0.0	0.0	0.0	0.0	35.5

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OG33124FBB	Air-Permeability & Hydrochem Testing ESF	0.0	0.0	0.0	0.0	0.0	14.5	0.0	0.0	0.0	0.0	0.0	0.0	14.5
OG33124FBD	Moisture Monitoring in the ESF	0.0	0.0	0.0	0.0	0.0	4.9	0.0	0.0	0.0	0.0	0.0	0.0	4.9
OG33124FBF	South Ramp Hydrology	0.0	0.0	0.0	0.0	0.0	44.3	0.0	0.0	0.0	0.0	0.0	0.0	44.3
OG33124FBG	PTn Lateral Diversion (Phase I)	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
OG33124FBH	ESF Drift Scale Flux and Niche Study	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
1.2.3.3.1.2.4		54.0	46.1	48.8	93.3	72.4	101.6	0.0	0.0	0.0	0.0	0.0	0.0	416.2
OG33127B96	UZ Hydrochemistry	0.0	0.0	0.0	20.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	20.4
OG33127FBA	UZ Hydrochemistry	23.0	27.1	22.0	1.2	18.0	14.5	0.0	0.0	0.0	0.0	0.0	0.0	105.8
OG33127FBB	UZ Hydrochemistry	0.0	0.0	0.0	0.0	0.0	12.8	0.0	0.0	0.0	0.0	0.0	0.0	12.8
1.2.3.3.1.2.7		23.0	27.1	22.0	21.2	18.0	27.7	0.0	0.0	0.0	0.0	0.0	0.0	139.0
OG33128FBD	Fluid Flow in Unsaturated Zone Fractured	7.6	5.3	2.9	6.0	4.8	2.0	0.0	0.0	0.0	0.0	0.0	0.0	28.6
1.2.3.3.1.2.8		7.6	5.3	2.9	6.0	4.8	2.0	0.0	0.0	0.0	0.0	0.0	0.0	28.6
OG33129FBG	Site Unsaturated Zone Flow Model	7.8	6.4	8.3	25.5	-13.3	10.9	0.0	0.0	0.0	0.0	0.0	0.0	45.6
OG33129FBK	Support UZ Model Expert Elicitation	0.0	21.2	6.8	8.6	7.4	3.5	0.0	0.0	0.0	0.0	0.0	0.0	47.5
1.2.3.3.1.2.9		7.8	27.6	15.1	34.1	-5.9	14.4	0.0	0.0	0.0	0.0	0.0	0.0	93.1
OG33131FBA	C-Well Complex Hydraulic & Conservative	46.5	42.2	46.6	74.2	58.5	31.3	0.0	0.0	0.0	0.0	0.0	0.0	299.3
OG33131FBB	C-Well Complex Hydraulic & Tracer Test	0.0	0.0	0.0	0.0	0.0	22.2	0.0	0.0	0.0	0.0	0.0	0.0	22.2
OG33131FBC	Water-Level Monitoring	20.7	17.8	20.5	18.2	14.3	6.2	0.0	0.0	0.0	0.0	0.0	0.0	97.7
OG33131FBD	Water-Level Monitoring	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0
OG33131FBF	WT Eh and Ph Measurements	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.2.3.3.1.3.1		67.2	60.0	67.1	92.4	72.8	65.7	0.0	0.0	0.0	0.0	0.0	0.0	425.2
OG33133FB3	Site Saturated Zone Flow Model	16.5	25.9	21.8	27.0	22.2	10.3	0.0	0.0	0.0	0.0	0.0	0.0	123.7
OG33133FB4	Site Saturated Zone Synthesis Report	1.3	0.0	2.5	0.3	11.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	21.3
OG33133FB5	Conduct VA SZ Flow Model Sensitivity An	4.0	2.0	2.6	8.5	8.9	12.9	0.0	0.0	0.0	0.0	0.0	0.0	38.9
OG33133FB6	Confirm SZ Hydrologic Flow Models	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	1.4
1.2.3.3.1.3.3		21.8	27.9	26.9	35.8	42.1	30.8	0.0	0.0	0.0	0.0	0.0	0.0	185.3
*1.2.3.3		284.4	285.2	282.6	409.5	358.8	355.7	0.0	0.0	0.0	0.0	0.0	0.0	1976.2
OG3521FA1	Tracer Gas Support	5.7	5.1	6.0	6.8	5.4	9.5	0.0	0.0	0.0	0.0	0.0	0.0	38.5
1.2.3.5.2.1		5.7	5.1	6.0	6.8	5.4	9.5	0.0	0.0	0.0	0.0	0.0	0.0	38.5
*1.2.3.5		5.7	5.1	6.0	6.8	5.4	9.5	0.0	0.0	0.0	0.0	0.0	0.0	38.5
OG36212FB1	Confirmatory Aquatic Investigations	0.0	2.1	6.9	7.9	3.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	24.0
1.2.3.6.2.1.2		0.0	2.1	6.9	7.9	3.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	24.0
OG36215FB2	Paleoclimate/Paleoenvironmental Synthesi	40.1	38.6	31.7	62.4	37.8	19.5	0.0	0.0	0.0	0.0	0.0	0.0	230.1
1.2.3.6.2.1.5		40.1	38.6	31.7	62.4	37.8	19.5	0.0	0.0	0.0	0.0	0.0	0.0	230.1
OG36221FB1	Evaluation of Paleo Ground-Water Dischar	17.4	15.4	27.9	28.8	13.0	9.9	0.0	0.0	0.0	0.0	0.0	0.0	112.4
OG36221FB2	Geo. Fract. Fill Mater, ESF & Est Past W	57.0	39.2	87.6	70.6	85.8	107.1	0.0	0.0	0.0	0.0	0.0	0.0	447.3
OG36221FB3	Syn.Dist.&Anal Geochron. Age Dets Potent	0.0	0.0	0.0	0.0	0.0	24.4	0.0	0.0	0.0	0.0	0.0	0.0	24.4

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		OCT EST	NOV EST	DEC EST	JAN EST	FEB EST	MAR EST	APR EST	MAY EST	JUN EST	JUL EST	AUG EST	SEP EST	TOTAL
1.2.3.6.2.2.1		74.4	54.6	115.5	99.4	98.8	141.4	0.0	0.0	0.0	0.0	0.0	0.0	584.1
*1.2.3.6		114.5	95.3	154.1	169.7	139.6	165.0	0.0	0.0	0.0	0.0	0.0	0.0	838.2
OG398FA1D	Support Systems Engineering Reports & St	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OG398FA1F	Data & Del Mgt., QA Compl, Oversite Sup,	14.6	13.0	13.3	10.9	15.1	26.8	0.0	0.0	0.0	0.0	0.0	0.0	93.7
OG398FB1	Support Development of PISA Ch 2.3 (Geol	30.1	29.7	43.9	50.1	55.5	50.1	0.0	0.0	0.0	0.0	0.0	0.0	259.4
OG398FB1C	Provide Support to LA Plan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OG398FB1E	Provide Input to SC Progress Report 16	9.9	11.0	10.9	5.6	13.1	9.1	0.0	0.0	0.0	0.0	0.0	0.0	59.6
OG398FB2	Develop PISA Chapter 2.4 (Hydrology)	11.6	12.5	33.0	31.0	43.5	54.0	0.0	0.0	0.0	0.0	0.0	0.0	185.6
OG398FB2E	Provide Input to SC Progress Report 17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OG398FB4	Dev Climate/Meteorologic Sys Desc (PISA	0.0	0.0	0.0	0.0	0.0	16.1	0.0	0.0	0.0	0.0	0.0	0.0	16.1
1.2.3.9.11		66.2	66.2	101.1	97.6	127.2	156.1	0.0	0.0	0.0	0.0	0.0	0.0	614.4
*1.2.3.9		66.2	66.2	101.1	97.6	127.2	156.1	0.0	0.0	0.0	0.0	0.0	0.0	614.4
**1.2.3		817.4	786.3	874.6	1024.3	1003.6	1033.0	0.0	0.0	0.0	0.0	0.0	0.0	5539.2
OG535FA1	Provide FY97 Technical Data Base Input	21.3	18.0	18.0	40.7	25.5	29.9	0.0	0.0	0.0	0.0	0.0	0.0	153.4
1.2.5.3.5		21.3	18.0	18.0	40.7	25.5	29.9	0.0	0.0	0.0	0.0	0.0	0.0	153.4
*1.2.5.3		21.3	18.0	18.0	40.7	25.5	29.9	0.0	0.0	0.0	0.0	0.0	0.0	153.4
OG541FA2	Viability Assessment Scenarios Developme	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5
1.2.5.4.1		0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5
OG544FA1	UZ Flow Model Abstractions for VA	0.0	0.0	5.5	1.3	5.2	8.3	0.0	0.0	0.0	0.0	0.0	0.0	20.3
OG544FA2	SZ Flow Model Abstractions for VA	0.0	0.0	7.1	-0.4	-0.4	1.6	0.0	0.0	0.0	0.0	0.0	0.0	7.9
1.2.5.4.4		0.0	0.0	12.6	0.9	4.8	9.9	0.0	0.0	0.0	0.0	0.0	0.0	28.2
*1.2.5.4		0.0	0.0	12.6	4.4	4.8	9.9	0.0	0.0	0.0	0.0	0.0	0.0	31.7
**1.2.5		21.3	18.0	30.6	45.1	30.3	39.8	0.0	0.0	0.0	0.0	0.0	0.0	185.1
OG825FA1	Federal Occupation Safety & Health	8.8	7.1	9.0	8.9	7.3	7.4	0.0	0.0	0.0	0.0	0.0	0.0	48.5
1.2.8.2.5		8.8	7.1	9.0	8.9	7.3	7.4	0.0	0.0	0.0	0.0	0.0	0.0	48.5
*1.2.8.2		8.8	7.1	9.0	8.9	7.3	7.4	0.0	0.0	0.0	0.0	0.0	0.0	48.5
OG845FA1	Radiation Protection	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1.2.8.4.5		0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
OG847FA1	Water Resources Envir Impact Stmt Suppor	0.0	0.0	0.0	0.0	2.4	2.8	0.0	0.0	0.0	0.0	0.0	0.0	5.2
OG847FA2	Rad Water Quality Sample Collection	0.0	0.0	0.0	0.0	0.0	49.3	0.0	0.0	0.0	0.0	0.0	0.0	49.3
OG847FB1	Water Resources	30.4	29.6	30.3	48.3	17.0	37.6	0.0	0.0	0.0	0.0	0.0	0.0	193.2
1.2.8.4.7		30.4	29.6	30.3	48.3	19.4	89.7	0.0	0.0	0.0	0.0	0.0	0.0	247.7
*1.2.8.4		30.4	29.6	30.4	48.3	19.4	89.7	0.0	0.0	0.0	0.0	0.0	0.0	247.8
**1.2.8		39.2	36.7	39.4	57.2	26.7	97.1	0.0	0.0	0.0	0.0	0.0	0.0	296.3
OG912FA1	Participant Technical Project Office	25.0	23.2	27.3	25.9	29.0	22.2	0.0	0.0	0.0	0.0	0.0	0.0	152.6
1.2.9.1.2		25.0	23.2	27.3	25.9	29.0	22.2	0.0	0.0	0.0	0.0	0.0	0.0	152.6
*1.2.9.1		25.0	23.2	27.3	25.9	29.0	22.2	0.0	0.0	0.0	0.0	0.0	0.0	152.6

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR 10/1/96 - 03/31/97

		OCT EST	NOV EST	DEC EST	JAN EST	FEB EST	MAR EST	APR EST	MAY EST	JUN EST	JUL EST	AUG EST	SEP EST	TOTAL
OG922FA1	Participant Project Control - USGS	21.4	18.6	18.1	20.5	17.5	19.9	0.0	0.0	0.0	0.0	0.0	0.0	116.0
1.2.9.2.2		21.4	18.6	18.1	20.5	17.5	19.9	0.0	0.0	0.0	0.0	0.0	0.0	116.0
*1.2.9.2		21.4	18.6	18.1	20.5	17.5	19.9	0.0	0.0	0.0	0.0	0.0	0.0	116.0
**1.2.9		46.4	41.8	45.4	46.4	46.5	42.1	0.0	0.0	0.0	0.0	0.0	0.0	268.6
OGC522FA1	Satellite Records Operations	3.8	3.5	4.7	4.2	4.2	3.9	0.0	0.0	0.0	0.0	0.0	0.0	24.3
1.2.12.5.2.2		3.8	3.5	4.7	4.2	4.2	3.9	0.0	0.0	0.0	0.0	0.0	0.0	24.3
*1.2.12.5		3.8	3.5	4.7	4.2	4.2	3.9	0.0	0.0	0.0	0.0	0.0	0.0	24.3
**1.2.12		3.8	3.5	4.7	4.2	4.2	3.9	0.0	0.0	0.0	0.0	0.0	0.0	24.3
OGF23FA1	Support/Personnel Services	32.4	28.7	35.4	25.6	22.5	27.7	0.0	0.0	0.0	0.0	0.0	0.0	172.3
OGF23FA2	Facilities Management - Space	61.7	61.7	61.7	61.7	61.7	61.7	0.0	0.0	0.0	0.0	0.0	0.0	370.2
OGF23FA3	Facilities Management - Computers/Phones	16.7	16.7	16.7	16.7	16.7	16.7	0.0	0.0	0.0	0.0	0.0	0.0	100.2
OGF23FA4	Facilities Management - Other	12.5	12.5	12.5	12.5	12.5	12.5	0.0	0.0	0.0	0.0	0.0	0.0	75.0
OGF23FA5	Procurement/Property Management - USGS	10.2	11.0	8.0	7.3	11.5	9.9	0.0	0.0	0.0	0.0	0.0	0.0	57.9
1.2.15.2.3		133.5	130.6	134.3	123.8	124.9	128.5	0.0	0.0	0.0	0.0	0.0	0.0	775.6
*1.2.15.2		133.5	130.6	134.3	123.8	124.9	128.5	0.0	0.0	0.0	0.0	0.0	0.0	775.6
OGF3FA1	USGS Training Support	4.5	4.2	3.7	4.8	4.2	4.2	0.0	0.0	0.0	0.0	0.0	0.0	25.6
1.2.15.3		4.5	4.2	3.7	4.8	4.2	4.2	0.0	0.0	0.0	0.0	0.0	0.0	25.6
*1.2.15.3		4.5	4.2	3.7	4.8	4.2	4.2	0.0	0.0	0.0	0.0	0.0	0.0	25.6
**1.2.15		138.0	134.8	138.0	128.6	129.1	132.7	0.0	0.0	0.0	0.0	0.0	0.0	801.2
1.2 OPERATING		1066.1	1021.1	1132.7	1305.8	1240.4	1348.6	0.0	0.0	0.0	0.0	0.0	0.0	7114.7
CAPITAL EQUIPMENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOTAL		1066.1	1021.1	1132.7	1305.8	1240.4	1348.6	0.0	0.0	0.0	0.0	0.0	0.0	7114.7
FTEs														
FEDERAL		112.7	108.9	108.0	109.3	99.7	109.6	0.0	0.0	0.0	0.0	0.0	0.0	
CONTRACT		17.0	17.8	19.2	26.5	22.1	25.9	0.0	0.0	0.0	0.0	0.0	0.0	
TOTAL		129.7	126.7	127.2	135.8	121.8	135.5	0.0	0.0	0.0	0.0	0.0	0.0	

* Fourth level WBS roll-up
** Third level WBS roll-up