Department of Energy
Office of Civilian Radioactive Waste Management
Yucca Mountain Site Characterization Office
P.O. Box 98608
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JAN 17 1997

OVERNIGHT MAIL

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U.S. Nuclear Regulatory Commission
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Rockville, MD 20852

SUBMITTAL OF PARTICIPANTS' MONTHLY STATUS REPORTS

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 October and November, 1996.

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

For Stephan J. Brocoum
Assistant Manager for Licensing

AML:AVG-0736

Enclosure: (NOT RECORD MATERIAL)
U.S. Geological Survey Monthly
Status Report for October and
November 1996

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IN REPLY REFER TO:

INFORMATION ONLY

November 15, 1996

Wayne Kozai
Yucca Mountain Site Characterization
Project Office
U. S. Department of Energy
P.O. Box 98608
Las Vegas, Nevada 89193-8608

SUBJECT: Yucca Mountain Project Branch - U.S. Geological Survey (YMPB-USGS) Progress Report, October, 1996

Attached is the USGS progress report in the required format for the month of October, 1996.

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
U.S. Geological Survey

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102.8

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U. S. GEOLOGICAL SURVEY
EXECUTIVE SUMMARY

October, 1996

WBS 1.2.3.1 Coordination and Planning

U. S. Geological Survey - Yucca Mountain Project Branch is currently processing 195 scientific papers authored by USGS authors. Of these, 113 are related to hydrologic studies and 85 to geologic studies. In addition, 50 abstracts by USGS are being processed, as well as 17 reports from LBL.

WBS 1.2.3.2 Geology

Geologic Framework

Outlines for the sections on site stratigraphy and site structure for the site description report (part of the Project Integrated Safety Assessment report - PISA) were completed and submitted for preliminary review. Work continued on preparing more expanded versions of these outlines.

Geologic mapping of the site area is being broadened to include Fran Ridge, Bow Ridge, and part of the west side of Dune Wash near borehole UT-17. The central block geologic map (scale 1:6,000) that has been referred to in previous reports was submitted for processing for publication. Staff involved in studies to revise lithostratigraphic contacts for use in 3-D modeling completed identification of contacts for the seven boreholes in Group 3 (WT-4, -5, -13, -14, -15; UZ-4, -5). Work is continuing on the ten boreholes in Group 4, which is the last group scheduled for study.

Seven oral presentations and a poster session on the results of studies related to the general subject of the geologic framework of Yucca Mountain were given at the annual national meeting of the Geological Society of America (Denver, CO, October 28-31). Topics included the structural setting of the repository site area, integration of surface and underground geologic mapping, central block geologic map, interpretations of subsurface structure based on geophysical data, lithologic and hydrogeologic correlations, and development of computer-based geologic framework models.

Collection and analysis of surface fracture data from the Calico Hills Formation and the Prow Pass Tuff are continuing. Data from borehole video logs from QA'd boreholes are being compiled and analyzed. Project staff participated (with LANL personnel) in a sampling program in the ESF. The process of digitally integrating surface geologic mapping, full periphery mapping in the ESF, and data from the detailed line survey in the ESF was begun.

Geologic mapping of the south ramp of the ESF was accomplished as follows: (1) full periphery geologic mapping was completed to station 67+14, (2) detailed line survey was completed to station 67+11, and (3) stereophotography was completed to station 67+13. In Alcove #6, detailed line survey was completed to station 0+85. Compilation, field checking, and digitizing of geologic maps on portions of the ESF continued.

Seismotectonic Studies

Outlines for the sections on regional geology, seismology, Quaternary geology, and tectonic models for the site description report (part of the PISA report) were completed and submitted for preliminary review. Work continued on preparing more expanded versions of these outlines.

Workshop #2 on hazard methodologies was held October 16-18 in Salt Lake City for the purpose of identifying and outlining methods and approaches for characterizing seismic sources and for assessing ground motion and fault displacement hazards. Meetings were also held during the reporting period to plan the agenda and select participants for Workshop #3 on seismic source models and proponents (to be held in Pahrump, NV, November 17-21). This workshop includes a field trip for participants to visit key outcrop localities and trench sites at Yucca Mountain to observe evidence of Quaternary fault activity. A work plan and agenda are also in preparation for a workshop on methods, models, and preliminary interpretations involving ground motion characterization that is scheduled to be held in January, 1997.

An evaluation of tectonic scenarios for performance assessment was begun, principally with a review of previously acquired data and an initial assembly of information. Reports on the Rock Valley and Cane Spring fault systems were submitted for review.

In a symposium, titled "Neogene and Quaternary Geology of the Yucca Mountain region, Nevada, and its relevance to long-term nuclear waste isolation", that was held during the annual national meeting of the Geological Society of America (Denver, October 28-31), staff scientists presented eight papers on a variety of subjects pertaining to the deformational history and tectonic evolution of Yucca Mountain. Included were talks on (1) extensional deformation related to diapiric uplift of the Calico Hills; (2) Miocene tectonic development of northern Crater Flat basin; (3) geophysical domains of the Nevada Test Site region; (4) tectonic model for Yucca Mountain; (5) potential for Quaternary faulting on the Ghost Dance fault; (6) thermoluminescence dating of surficial deposits; (7) prehistoric rupture on fifteen faults in the Yucca Mountain region; and (8) late Tertiary and Quaternary slip-rates on the Stagecoach Road and Windy Wash faults.

WBS 1.2.3.3 Hydrology

Regional Hydrology

Work has started on the analysis and interpretation of precipitation data. A meeting was held with SAIC and DOE representatives in order to coordinate efforts and establish a timetable for the transfer of hardware and responsibilities. Twenty-one CR10 data loggers were returned to Campbell Scientific Inc. for closing/opening calibrations. Work on closing calibrations of tipping bucket rain gages continues. Work started on formatting 1996FY meteorological data for the two weather stations that were operational during that time period.

The data package for selected streamflow and precipitation data collected during FY 1995 was completed and forwarded to DOE satisfying a 1996FY, Level 4 Milestone 3GRS602M.

Began computing surface-water records collected in 1996FY for three continuous-recording streamflow gages in Fortymile Wash. In addition, began computing surface-water and precipitation records for 6 continuous-recording streamflow gages, 12 crest-stage gages, 5 miscellaneous streamflow sites, and 9 precipitation sites collected in 1995FY, but not published in 1996FY.

Routine maintenance was made on the three streamflow gages located along Fortymile Wash. Project staff

kept vigilance during the month for potential precipitation and runoff as several storms tracked through the southern Nevada area. Runoff was neither observed nor reported during the reporting period for the three gages or for the Yucca Mountain area.

Final hydraulic-conductivity arrays for the flow model were prepared for use in updating the regional framework model. NCAR precipitation data was received for use in the estimation of recharge for the model, but the data are not in a readily usable format and alternative ways to use these data must be explored.

Unsaturated Zone

Continued with the compilation of the figures that will be used in the Main-drift Hydrology report. Forty-two of the approximately 100 figures that will appear in this report have been prepared. A new outline for this report was prepared using revised milestone criteria contained in the 1997FY PACS description.

Approximately 850 data files of pneumatic pressure, thermistor temperature, dry-bulb temperature and water potential along with the standard deviation records for these data for the period April through September 1996 were prepared. Profiles of temperature and water potential for each monitored borehole, as of the last day of record, were also prepared. Sensor status reports are in-progress.

To evaluate the repeatability of the centrifuge method, unsaturated conductivity measurements for a series of water contents have been done 3 times on paired samples of Yucca Mountain Tuff. Additional samples have been prepared but not measured. Moisture retention curves done on the samples are currently being analyzed along with the measured data to predict unsaturated conductivity for comparison with the measured values.

Samples from 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 were processed for physical properties determined from standard 105C oven drying and a data package has been technically reviewed and submitted for QA review. The relative-humidity oven has been repaired and the core samples are being reprocessed to provide physical properties determined from relative-humidity oven drying. Samples from the Ghost Dance Fault Alcove #6 have been requested. A memo was written to request assistance from the TCO to collect a systematic series of samples from the main drift approximately every 40 m to evaluate the spatial distribution and variance of porosity and permeability through the middle nonlithophysal unit.

Monitoring of the HRF prototype holes was discontinued on October 9th after 59 months of continuous operation. 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 as such. All equipment from NRG-6 that was sent to Ball Aerospace on September 9 for calibration was returned on October 9 except for the precision resistor.

A meeting was held in Las Vegas on 10/22/96 to discuss and review a proposed schedule for discontinuing UZ borehole monitoring. Representatives from the USGS, DOE, and the M&O were present and an interim decision was made to continue monitoring NRG-7a, UZ#4, UZ#5, UZ-7a, and SD-12 indefinitely.

The Principal Investigators and support hydrologists continue to prepare the North Ramp Alcoves Testing report. At present the first draft is approximately 75 percent complete.

All alcove 2 and 3 air-permeability testing data collected up to September 30, 1996, has been submitted to DOE. There was no air-permeability testing in Alcove 4. The hydrochemistry data package for alcoves 2 and 3 is presently in technical review and is scheduled for submittal in mid-November. There was no hydrochemistry testing in Alcove 4.

Collection of temperature and relativity humidity data continues at 4 sites in the ESF. Wind speed data is currently being collected at 2 locations (near Alcove 3 and 4). A barometric pressure transducer and temperature/relative humidity probe were installed in the rear of Alcove 4. This instrumentation was installed behind a plastic barrier. Measurements are being collected to determine if the rock surrounding the alcove is experiencing changes in water content. A small evaporation pan was established outside of Alcove 3. The water level of this plastic container is being measured frequently by the Test Coordination Office personnel. These measurements are an independent test of the rate of evaporation of water from a free water surface.

A project designed to preserve the in-situ water content of selected sites in the tunnel was started. Plastic sheets (1.5 m X 1.5 m) are being attached to the tunnel wall (below the spring line) using nails, silicon sealer, and grout. These selected locations may be the site of future sampling and/or instrumentation locations. The selected sites contain the contact between the Topopah Spring crystal rich vitric zone (Tptrv) and the Pre-Pah Canyon Tuff (PTn) and other selected locations within the PTn. To date 11 pieces of plastic have been installed. As the TBM advances, additional plastic will be installed.

A tensiometer was installed in the PTn unit to measure the rate of dry-out from a bare rock surface. The tensiometer was installed 30 cm into the tunnel wall and is being read frequently to monitor the rate of dry-out. This tensiometer is being used as prototype to see if other tensiometers should be installed.

Eleven ESF samples were distilled for tritium analysis. Eight samples have been counted for tritium concentration and the data reduced. Cores from ESF alcoves are too dry to be squeezed for cation-anion and C-14 analyses. A new method is being investigated to measure C-14 from ESF-core pore water. Three SD-7, eight SD-12, and two NRG-7A core samples were distilled for tritium analyses.

Directional permeability and continuum parameter calculations are complete for the frac-flow model. Modifications to the FracMan code have been started. The modifications are to simulate water flow in unsaturated fractured rock. The code will calculate water saturations which will be calibrated to in-situ measured saturations from boreholes NRG 6 and 7a. A 3-D saturation field for a volume with 200 m edge lengths and a table of relative permeability to water vs saturation will be used as input parameters. Currently, all text, figures, and tables for the report are complete, except for the "two-phase flow" section.

Technical reviews for the Borehole Completion Data Report have been completed. Submission of this report will take place upon completion of a technical review of data package for the UZ-14 pump test data. A copy of the UZ-16 Completion Report was submitted for processing.

Saturated Zone

Preparation began of a memorandum describing the planned USGS purely convergent tracer test in which Pyridone will be injected into UE-25 c#1 and 2,6,Difluoro-benzoic acid will be injected into UE-25 c#2. On 10/9/96, LANL started its two-well, partial-recirculation, reactive tracer test between UE-25 c#2 and UE-25 c#3 by injecting 180 kg of lithium bromide, 12 kg of PFBA, and 50 g of fluorescent microspheres in UE-25 c#2. Less than 24 hours later, breakthroughs were observed in the pumped well, UE-25 c#3, of all the

tracers. This early arrival contrasted with results from both the purely convergent iodide tracer test, using the conservative tracer iodide, and the partial-recirculation PFBA test, done in March and May of 1996 between the same two wells, in which the breakthrough occurred within 4 to 5 days of injection, and in which the shapes of the breakthrough curves exhibited more spreading. It will be some time before the meaning of the contrasting results from these tracer tests is fully understood.

The most pressing current issue for the USGS is the initiation of its long-planned purely convergent tracer test with nearly simultaneous injections of Pyridone into UE-25 c#1, and 2,6,Difluoro-benzoic acid into UE-25 c#2, while continuing to pump UE-25 c#3. Interactions between the USGS and DOE's environmental permitting group have been underway to initiate a letter to the State of Nevada to request the injection of these particular tracers. These interactions will intensify in November.

The USGS presented a proposal to DOE to conduct hydraulic and tracer tests in the low-transmissivity Prow Pass Tuff at the C-hole complex, after completion of the planned USGS purely convergent tracer test using UE-25 c#1 and UE-25 c#2. Characterization of the hydraulic and transport properties in a low-transmissivity zone near the water table, a horizon potentially penetrated by radionuclides from a breached repository, would very effectively augment the information passed from the Site Characterization community to the Performance Assessment community, information which so far is derived solely from the high-transmissivity Bullfrog Tuff and Tram Tuff intervals.

Another proposal, to conduct hydraulic and tracer tests in the UE-25 a#1 and UE-25 b#1 borehole pair, is also being prepared by the USGS and will shortly be submitted to the DOE. These tests could be conducted after 3/14/97 in "confirmatory testing". The benefit of these tests would be to obtain hydraulic and transport parameters in the saturated zone at a location other than the C-hole complex.

Water samples obtained from UE-25 c#3 from July 1, 1996, to the present contain the superimposed effects of several tracer injection events. Data from the LANL partial-recirculation tracer test between UE-25 c#1 and UE-25 c#3, initiated on 6/18/96 by the injection of 15 kg of the conservative iodide ion in the form of NaI into UE-25 c#1, are being analyzed by the USGS in preparation for its upcoming purely convergent tracer test, in which Pyridone will be injected into UE-25 c#1. Iodide data produced by LANL for samples collected from UE-25 c#3 between 5/8/96 and the present, which include the effects of both the USGS iodide injection into UE-25 c#2 on 2/13/96 and the LANL iodide injection into UE-25 c#1 on 6/18/96, will be processed to isolate a portion that represents the tail of the breakthrough curve resulting from the USGS 2/13/96 injection. This tail will be used to obtain an antecedent iodide concentration curve, which can be subtracted from the total iodide concentration after 6/18/96, to obtain the iodide concentration at the pumped well that is totally attributable to the 6/18/96 injection. Data from the two-well, partial-recirculation PFBA tracer test between UE-25 c#2 and UE-25 c#3, initiated by LANL on 5/15/96, are also being analyzed by the USGS to compare with its purely convergent iodide tracer test between the same wells initiated on 2/13/96.

The water-level data network includes 31 zones in 24 wells to be measured manually. All hourly measurements of wells for the ground-water network were discontinued during September 1996. However, in support of the aquifer testing conducted at well USW G-2 and at the C- hole complex, selected wells will be monitored hourly with transducers and 21X data loggers. This monitoring will continue until aquifer testing at these two sites is complete.

For the month of October 1996, 25 manual measurements were completed. Six zones in five wells (USW G-2, monitored since January 1996 in support of hydraulic testing of the well; UE-25 WT#3 and WT#14, and

USW H-4, with upper and lower intervals instrumented during May 1996 in support of aquifer testing at the C-hole complex) were monitored hourly with transducer measurements. At well UE-25 p#1, the data collector added in September is recording hourly measurements in support of C-hole testing.

Numerous water-level measurements were conducted: UE-25 WT#4, UE-25 WT#6, and UE-25 WT#16 on 10/15/96; USW VH-1, USW H-6 upper interval, USW H-6 lower interval, USW WT-7, USW WT-10, and USW WT-11 on 10/16/96; USW WT-2, UE-25 WT#13, and UE-25 WT#15 on 10/21/96; J-11, UE-25 b#1 upper interval, and USW H-1 tubes 1, 2, 3, and 4 on 10/22/96; USW H-3 upper interval, USW H-3 lower interval, USW H-5 upper interval, USW H-5 lower interval, J-12, and USW WT-1 on 10/23/96; and J-13 on 10/24/96.

Data were downloaded from 21X recorders at USW G-2, USW H-4 upper and lower zones, UE-25 WT#3, UE-25 WT#14, and UE-25 p#1.

Editing was completed of UE-25 p#1 hourly data through 09/03/96, USW H-5 upper interval through 08/27/96, and USW H-5 lower interval through 08/08/96. Preliminary review of water-level data collected during October 1996 was completed.

Preparation of the 1995 water-level data report was started. All 1995 ADAPS data were transferred from Prime to the Data General, and review of data and hydrograph plots begun.

January through June 1996 water-level data were compiled and reviewed. The water-level data package submitted to the TPO on October 18 was approved by QA and submitted to the Reports Processing Center in completion of Level 4 Milestone SPH21CM4.

Staff met on October 7 to discuss organization and indexing of hydrogeologic framework model inputs and outputs. The inputs and outputs are organized as model calibration proceeds, and inputs and outputs are indexed and documented in the Scientific Notebook used to document the modeling progress.

The site hydrogeologic framework model was updated to include data obtained from the Weapons Program and to include inferences for the top of the Paleozoic aquifer from the regional seismic reflection profiling. This updated framework was sent to LANL for use in generation of a new site flow model mesh. Work resumed on analyzing water-level fluctuations at Yucca Mountain to estimate hydraulic properties of the saturated-zone rock units.

Discussions were held among the modeling unit staff to discuss re-sizing the model area to a smaller area that will allow for quicker run times. A new mesh was generated, based on the updated framework model, to be used for the flow model. Staff met with LANL on 10/15 to 10/18/96, to put together a new, smaller site flow model and to discuss future calibration strategies. Temperature test runs were conducted on the new meshes of the smaller site model for both singly and doubly defined nodes.

Staff discussed the preparation of the annotated outline of the saturated-zone synthesis report and authorship for that report on October 7. The paper that was prepared for the ModelCare '96 conference will be used as a starting point for the outline and report.

Czarnecki, J.B., Faunt, C.C., Gable, C.W., and Zyvoloski, G.A., 1996, On the development of a three-dimensional finite-element ground-water flow model of the saturated zone, Yucca Mountain, Nevada: *Proceedings, International Conference on Calibration and Reliability in Groundwater*

Modelling, International Ground Water Modeling Center, Colorado School of Mines, Golden, Colorado, September 24 to 26, 1996, p. 51-59.

USGS staff met with SNL staff on October 17 to discuss use of output from the parameter-estimation package (PEST) for use as a method of sensitivity analysis. Statistical output from the program should work well for providing sensitivity and uncertainty analyses for modeling.

Saturated-zone modeling staff began investigating possible perched water occurrence at well USW G-2, through use of a small-scale flow model using FEHMN and the site hydrogeologic framework model.

USGS and SNL staff discussed organization of a workshop, to be held in Denver in February, that will address critical issues in SZ flow modeling and the transfer of information obtained in process modeling for use by PA modelers. Key participants were identified, as were several issues to be discussed, and the general organization and format for the workshop were discussed.

USGS staff worked with LANL staff on the site flow model that will be used as a basis for transport modeling by LANL. USGS staff also met with SNL staff to discuss transfer of information from the site flow model to the PA modelers.

WBS 1.2.3.6 Climatology and Paleohydrology

Staff counted additional samples of Owens Lake core OL92/1 and OL 92/2 to provide higher- resolution paleoclimate analyses back to 400 ka than currently available. Resolution is expected to be about one sample per 500 years.

A talk was prepared for the Geological Society of America meetings that compares the Owens Lake climate record between 55 and 25 ka (oxygen isotope stage 3) to similar records farther north (in Oregon) and to continental shelf marine records off California at the latitude of Owens Lake. The comparison suggests that the probable climatic scenario for stage 3 was increased summer precipitation in the area of Owens Lake due to a strengthened subtropical high-pressure system in the eastern Pacific Ocean and a corresponding increased and more persistent continental low-pressure system over eastern California and Nevada that increased monsoonal circulation (transportation of moisture from the eastern Pacific to southern Nevada). Because stage 3 precedes the last glaciation, this or similar climatic scenarios may reflect future climates at Yucca Mountain. The diatom record at Owens Lake associated with stage 10, the most logical future climatic analog for Yucca Mountain, also suggests increased summer precipitation and mild winter temperatures.

Bradbury, J.P., Dean, W.E., Rosenbaum, J.E., and Reynolds, R.L., 1996, Abrupt warm and cold climate oscillations during isotope stage 3 at Klamath Lake, Oregon: Geological Society of America *Abstracts with Programs*, v. 28, no. 7, p. A-232.

Compilation of the ostracode dataset from Owens Lake continued. The ostracode data should confirm the results from the diatom dataset and may provide more information to our general understanding of the climate history at this site. Additional samples were prepared from the Owens Lake core and from modern diatom analogs of hydroclimatic conditions in Owens Valley and elsewhere in the western United States.

Staff attended an organizational meeting for preparation of PISA chapter on climate.

Staff continued to assemble hydrologic and climatic data for the Owens Lake region to develop analog models to determine precipitation and temperature changes for the past 400 ky.

Staff presented a talk at GSA on the ostracode record from Death Valley. That record suggests that the penultimate glacial lake in Death Valley was very large and may have been largely supported by discharge from the Amargosa. The relative size differences between the lakes has not been placed into mean annual precipitation or temperature terms.

Forester, Richard M., 1996, A Death Valley ostracode glacial lake geochemical history: Geological Society of America *Abstracts with Programs*, v. 28, no. 7, p. A-457.

Work continued on refining ages from the Station 6 section at the Highway 95 white-bed deposit. Additional subsamples from the lower portion of the gray diatomite bed and the upper and lower portions of the green sand unit were prepared for uranium-series disequilibrium dating. Chemical treatment and isotopic measurements were completed. Data await reduction and age calculation. Thermoluminescence and uranium-series disequilibrium studies during FY96 resulted in discordance for these samples. These materials will provide additional $^{230}Th/U$ ages to verify the small number of previously obtained ages and will be used to evaluate the age of discharge associated with the lower parts of the deposit.

Staff prepared and presented a paper entitled "Thermoluminescence dating of surface deposits at Yucca Mountain, southern Nevada" at the annual meeting of the Geological Society of America.

Mahan, Shannon A., Paces, James B., and Peterman, Zell E., 1996, Thermoluminescence dating of surface deposits at Yucca Mountain, southern Nevada, USA: Geological Society of America *Abstracts with Programs*, v. 28, no. 7, p. A-193.

Staff discussed and investigated the possibility of shallow auger holes and shallow water table holes at past-discharge sites. This work would be designed to address several issues including 1) total stratigraphic thickness of fine-grained discharge deposits, 2) moisture profile through present-day sediments that support saltgrass (*Distichlis stricta*), a species of phreatophytic plant that typically occurs were the water table is within 4 to 5 meters of the surface (to address the possibility of present-day perched water zones), and 3) pumping of water samples from the shallow saturated-zone aquifers at several sites to obtain chemical and isotopic data from the present-day saturated-zone for comparison with past water compositions derived through analysis of authigenic minerals. A preliminary proposal was completed that proposes this work to augment the current study activities.

Analysis of H, O and C stable isotopic data of waters collected as part of the regional ostracode distribution map was completed and compiled. In addition, staff compiled O and H data from lake and spring discharge samples from the Owens Lake drainage for micropaleontological studies.

Staff completed analysis and compiled data for waters collected in the Washoe Lakes area of Nevada. These data are being used to describe the response of snail-shell carbonate stable isotopic compositions to annual variability in lake water isotopic compositions and will provide a critical baseline for interpretation of fossil snail-shell data from lacustrine sedimentary sequences.

Two talks entitled "Mixed isotopic ages as a consequence of very slow rates of deposition in Quaternary subsurface fracture-coatings" and "U-series dating of secondary minerals in unsaturated-zone tuffs indicating low paleo water flux through Yucca Mountain, Nevada" were prepared and presented at the annual meeting of the Geological Society of America. The talks summarized much of the progress made in the last fiscal year

analyzing subsurface opal and calcite in the ESF and interpreting ages and inferred fluxes through the unsaturated zone.

Neymark, Leonid A., and Paces, James B., 1996, Mixed isotopic ages as a consequence of very slow rates of deposition in Quaternary subsurface fracture coatings: Geological Society of America *Abstracts with Programs*, v. 28, no. 7, p. A-139.

Paces, James B., Neymark, Leonid A., Kwak, Loretta M., and Peterman, Zell E., 1996, U-series dating of secondary minerals in unsaturated-zone tuffs indicating low paleo water flux through Yucca Mountain, Nevada: Geological Society of America *Abstracts with Programs*, v. 28, no. 7, p. A-139 - A-140.

Staff met in Las Vegas to discuss data and models of local infiltration and deep percolation through the unsaturated zone in the ESF in order to explain the distribution of high ^{36}Cl. A model of shallow infiltration based on the depth to bedrock, slope angle and attitude coupled with major fault traces mapped at the surface combine to provide a mechanism that allows rapid transmission of water into bedrock fractures and through the porous nonwelded ash units of the PTn into deep portions of the welded TSw. The model can account for some, but not all, of the observed high ^{36}Cl occurrences. Further tests of this model were discussed as were other areas of data needs for FY97.

Two days were spent in the ESF mapping the distribution of secondary minerals and collecting samples for age and isotopic study. Line surveys documenting the occurrences of fracture and cavity minerals were completed between stations 49 and 63. This leaves a gap of 1800 m between stations 30 and 48 to be completed during the next sampling trip. Observations from this survey were entered into the secondary mineral distribution database. Initial efforts to compare secondary mineral distribution data to mapped fractures and surface structures were discussed. Fifteen samples of calcite and opal in fractures and cavities were collected between stations 63+64 and 56+93. The number of calcite and opal occurrences increases significantly as the ESF enters the southern turn cutting upward through stratigraphy relative to the bulk of the largely barren north-south drift from about stations 40 to 60. Samples will be examined and sampled for geochronological and isotopic study. Samples were collected in coordination with LANL feature-based sample sites for ^{36}Cl studies.

Staff traveled to the University of Minnesota, Minneapolis to discuss data collection with Dr. R.L. Edwards. This laboratory is one of only several that are currently capable of analyzing protactinium isotopes by mass spectrometry. Opals with high U contents contain several uranium-series disequilibrium clocks that behave predictably with time. Because the parent isotopes of the $^{231}Pa/^{235}U$ and $^{230}Th/U$ systems have different half-lives, the resulting ages should differ in a systematic way if the models of continuous deposition proposed in last year's milestone report are operative in the deep unsaturated-zone environment. Therefore, $^{231}Pa/^{235}U$ dating represents an important test of the continuous deposition model. Talks were held to investigate the viability of applying this chronometer in terms of both technical and QA issues. Conclusions were that the work is technically feasible. Further planning will occur in the next several months.

USGS staff met with staff from Australia National University (ANU) to investigate the feasibility of analyzing high-U opal by ion microprobe in order to obtain $^{230}Th/U$ isotopes for dating smaller portions of opal coatings that are impossible to obtain by conventional sampling and analytical techniques. The ion probe is capable of analyzing spots on the order of 15 to 20 microns in diameter on cross-sections of grains that have been cut and polished. Although this is still larger than the scale of individual layers that can be observed in the layered opals, traverses across a grain should provide definitive evidence of the contrasting

continuous versus episodic depositional models. Since this type of analysis has not been attempted on opals before, several small bubbles were given to ANU for scoping purposes in order to determine the possibility of working with this material. Results will be obtained in several months which will determine whether or not additional work is advisable.

Work continued on microsampling of calcite from polished plates of secondary mineral occurrences for stable isotope analysis. This sampling is intended to verify the frequency distribution of $\delta^{13}C$ and $\delta^{18}O$ values in the calcite, especially the suggestion of a mode of intermediate $\delta^{13}C$ in the calcite that could represent another climate state whose infiltration led to significant formation of calcite. Approximately 200 analyses (including standards) were performed.

Kiel carbonate data were transferred from spreadsheets to the database.

Staff completed ESF sample processing from the most recent collection trip including cleaning, photographing and database input for sample tracking purposes. Preparation of 31 chips for commercial preparation of polished thick sections from the last two ESF sampling trips was completed.

Staff began researching the possible controls of microbes and solution chemistry on the crystal morphology of unsaturated-zone secondary calcite. Mild etching experiments will be performed to test for SEM textural evidence of bacterial involvement.

WBS 1.2.8.4.7 Water-Resources Monitoring

USGS staff discussed DOE's planned timeframe for beginning preparation of the Environmental Impact Statement and anticipated workscope of USGS support with SAIC personnel on October 11 and 28. Accounting and reporting procedures were discussed with USGS-YMPB personnel on October 15 and 31. A USGS-NV District account number was established to track labor and charges.

Ground-water levels were measured at 28 sites, and discharge was measured at one flowing well. Corrections for water-level measurements made with electric tapes were determined on the basis of calibration data collected in September. Ground-water data collected in September were checked and filed.

Periodic measurements and pressure-sensor calibration information were obtained from site-characterization personnel. Site-characterization data on ground-water levels from seven sites were compiled. Ground-water level and discharge data from July though September 1996 at monitoring sites were collected and reviewed

A letter report was prepared and delivered to DOE on October 31 in completion of Level 3 Milestone SSH13BM3 [Monitoring Report 4th Quarter FY96] associated with this activity.

Environmental Program support was provided in several ways. Potential sampling sites, programmatic requirements, and operational considerations were discussed with USGS-Nevada District personnel in preparation for USGS participation in the FY97 radiological ground-water sampling program. Plans for water-level monitoring as part of the FY97 site-characterization program were discussed with USGS-ESIP staff on October 9. Geologic logs for five wells in the Amargosa Desert were received and reviewed for consistency with previously reported information. Comparability of USGS and U.S. Fish and Wildlife Service (USFWS) data collection procedures was evaluated in a meeting at Ash Meadows National Wildlife Refuge with USFWS staff on October 29; staff developed potential procedures to increase comparability of

water-level and discharge data collected in Ash Meadows.

USGS-YMPB approval of the 1995 summary monitoring report (completed Milestone 3GWR622M) was received on October 17; the report was delivered to DOE for concurrence review.

WBS 1.2.3.9 Special Studies

USGS staff attended the kickoff meeting with DOE and the M&O for development of the PISA report and met with USGS staff (some 12 scientists) to make writing assignments for sections and subsections of the report. Assignments were made for the draft of the annotated outline due in November. Arrangements were made for staff attendance at future scheduled meetings with writers from LANL, SNL, LBL, and M&O.

After transition of responsibilities, the new USGS lead for the Site Characterization Plan Review began interaction with M&O SCPR coordinators to resolve comments on USGS input to SCPR #15. About seven such comments were dispatched expeditiously. Other work associated with the SCPR included 1) preparation of a "responsibility matrix" for USGS input to the SCPR for SCP studies and activities, 2) preparation of a plan for compilation of USGS input for SCPR #16, and 3) formal review of the Executive Summary and Chapter 3 of SCPR #15.

The USGS SCPR lead attended a meeting in Las Vegas on October 17 with M&O staff to review preliminary input to Appendix A of SCPR #15. Appendix A is intended to describe, in summary fashion, the changes that have occurred in the Site Characterization Program since issuance of the SCP in December 1988. The summaries are to be at the SCP Investigation level but need also to capture the fundamental aspects of the characterization program at the study and activity levels. The group decided to simplify format of the write-ups, and the USGS lead volunteered to prepare a "prototype" using the regional hydrology investigation. This prototype was submitted to and accepted by the group on Monday October 21. Revisions to the investigation-level summaries for USGS work are underway.

USGS SCPR staff attended the Interactive Review of SCPR #15 held in Las Vegas October 30 through November 1.

Development of the staffing plan for the Hydrology Site Description (PISA Section 2.4) was initiated on October 1. Use of personnel who primarily support WBS 1.2.3.3 and 1.2.3.6 investigations was made more difficult by the six-month advance of the starting date for this activity last August. Lead authors for the major subsections -- surface water, regional hydrogeology, and site hydrogeology -- have been assigned. Also, many of the contributing authors have been tentatively identified, although many scheduling conflicts remain to be resolved.

USGS and LBNL authors began preparation of the detailed outline and approach for the PISA hydrology chapter.

The lead author for the Hydrology Site Description attended a PISA Chapter 2 guidance and planning meeting in Las Vegas on October 8. Staff also attended selected sessions (hydrology and site characterization) of the Geological Society of America annual meeting held October 21 through 24 in Denver.

USGS Level 3 Milestone Report

October 1, 1996 - October 31, 1996

Sorted by Baseline Date

Deliverable	Due Date	Expected Date	Completed Date	Comments
Milestone Number:				

USGS Level 4 Milestone Report

October 1, 1996 - October 31, 1996

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	

WBS Status Sheet (WBS02) | Inc. Dollars in Thousands

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	956	898	820	-58	78	956	898	820	-58	78	11387	11494	-107
1.2.5	Regulatory	35	35	22	0	13	35	35	22	0	13	504	503	1
1.2.8	Environment, Safety, and H	50	50	39	0	11	50	50	39	0	11	612	611	1
1.2.9	Project Management	62	62	46	0	16	62	62	46	0	16	664	664	0
1.2.12	Information Management	8	8	4	0	4	8	8	4	0	4	80	80	0
1.2.15	Support Services	142	142	140	0	2	142	142	140	0	2	1722	1724	-2
Total		1253	1195	1071	-58	124	1253	1195	1071	-58	124	14969	15076	-107

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	19700	19598	19688	18418	19440	19475	19473	19447	18775	18204	231357
LABOR	885	899	900	905	899	885	877	880	870	877	856	848	10581
SUBS	139	143	142	137	134	135	129	135	133	135	135	125	1622
TRAVEL	25	43	42	44	42	46	35	35	38	34	36	31	451
PM&E	7	6	8	5	9	6	7	5	9	7	5	4	78
OTHER	197	201	200	204	196	183	179	181	176	178	170	172	2237
Total BCWS	1253	1292	1292	1295	1280	1255	1227	1236	1226	1231	1202	1180	14969

Actual Cost of Work Performed

LBRHRS	19283	0	0	0	0	0	0	0	0	0	0	0	19283
LABOR	771	0	0	0	0	0	0	0	0	0	0	0	771
SUBS	127	0	0	0	0	0	0	0	0	0	0	0	127
TRAVEL	11	0	0	0	0	0	0	0	0	0	0	0	11
PM&E	43	0	0	0	0	0	0	0	0	0	0	0	43
OTHER	119	0	0	0	0	0	0	0	0	0	0	0	119
Total ACWP	1071	0	0	0	0	0	0	0	0	0	0	0	1071

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	20494	19978	19713	19803	18458	19440	19475	19473	19447	18775	18204	213260
LABOR	0	950	912	910	905	900	884	881	878	883	873	863	9839
SUBS	0	134	141	136	133	137	132	139	138	140	145	133	1508
TRAVEL	0	44	42	45	42	47	36	36	38	36	38	32	436
PM&E	0	6	9	5	9	6	9	5	9	7	5	4	74
OTHER	0	203	202	223	227	185	180	183	178	180	173	214	2148
Total ETC	0	1337	1306	1319	1316	1275	1241	1244	1241	1246	1234	1246	14005

Resource Distributions

Fiscal Year 1997	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
BCWS	1253	1292	1292	1295	1280	1255	1227	1236	1226	1231	1202	1180	14969
BCWP	1195	0	0	0	0	0	0	0	0	0	0	0	1195
ACWP	1071	0	0	0	0	0	0	0	0	0	0	0	1071
ETC	0	1337	1306	1319	1316	1275	1241	1244	1241	1246	1234	1246	14005

Fiscal Year Distribution

	Prior	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	Future	At Complete
BCWS	15914	14969	8525	980	0	0	0	0	0	0	0	0	40388
BCWP	15609	1195	0	0	0	0	0	0	0	0	0	0	
ACWP	15908	1071	0	0	0	0	0	0	0	0	0	0	
ETC	0	14005	8525	980	0	0	0	0	0	0	0	0	40489

YMP PLANNING AND CONTROL SYSTEM (PACS)

Participant U.S. Geological Survey
Date Prepared 11/15/96 08:56

MONTHLY COST/FTE REPORT

Fiscal Month/Year OCTOBER 1996
Page 1 of 1

	CURRENT MONTH END						FISCAL YEAR		
WBS ELEMENT	ACTUAL COSTS	PARTICIPANT HOURS	SUBCON HOURS	PURCHASE COMMITMENTS	SUBCON COMMITMENTS	ACCRUED COSTS	APPROVED BUDGET	APPROVED FUNDS	CUMMULATIVE COSTS
1.2.3	817	15896	2024	0	1348	0	11838	0	817
1.2.5	21	184	368	0	267	0	53	0	21
1.2.8	39	707	0	0	0	0	612	0	39
1.2.9	46	941	184	0	88	0	664	0	46
1.2.12	4	184	0	0	0	0	80	0	4
1.2.15	138	1371	368	0	113	0	1722	0	138
TOTALS	1065	19283	2944	0	1816	0	14969	0	1065

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

		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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.7
1.2.3.1.1		15.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.7
0G312FA1	Nevada Operations/Earth Science Investig	55.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.0
1.2.3.1.2		55.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.0
*1.2.3.1		70.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	70.7
0G32211FB1	Review & Revision of Lithostratigraphy B	14.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.1
1.2.3.2.2.1.1		14.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.1
0G32212FB2	Complete Site Area Geologic Map	36.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.9
0G32212FB3	Fracture Studies	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3
0G32212FB4	Geologic Mapping of the Exploratory Stud	119.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	119.7
1.2.3.2.2.1.2		162.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	162.9
0G3252FB1	Evalute Tectonic Scenarios for PA	10.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.6
1.2.3.2.5.2		10.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.6
0G32836FB1	Conduct Probabilistic Seismic Hazards An	88.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88.3
1.2.3.2.8.3.6		88.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88.3
*1.2.3.2		275.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	275.9
0G33111FB4	Collection of Site Meteor. Data for Hydr	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8
1.2.3.3.1.1.1		7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8
0G33112FB1	Collection of Site Streamflow Data	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
0G33112FB2	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
0G33114FB3	Regional Saturated Zone Synthesis Report	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6
1.2.3.3.1.1.4		7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6
0G33121FB1	Infiltration Processes	21.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.5
1.2.3.3.1.2.1		21.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.5
0G33123FB4	Integrated Analysis & Interpretation	14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5
0G33123FB5	Matrix Properties of Hydrologic Units	14.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.1
0G33123FBA	Unsaturated Zone Borehole Instrumentatio	31.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.9
0G33123FBB	Unsaturated Zone Borehole Instrumentatio	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
0G33123FBC	Integrated Analysis & Interpretation	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
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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.5
0G33124E96	Air-K and Hydrochemisty Test - North Ram	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5
0G33124FB7	Air Permeability & Hydrochem Testing ESF	46.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.1
0G33124FB8	Percolation Flux across Repository Horiz	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
0G33124FBA	Moisture Monitorning in the ESF	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4
0G33124FBB	Air-Permeability & Hydrochem Testing ESF	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

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

		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
OG33124FBD	Moisture Monitoring in the ESF	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
1.2.3.3.1.2.4		54.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.0
OG33127FBA	UZ Hydrochemistry	23.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.0
OG33127FBB	UZ Hydrochemistry	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
1.2.3.3.1.2.7		23.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.0
OG33128FBD	Fluid Flow in Unsaturated Zone Fractured	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6
1.2.3.3.1.2.8		7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6
OG33129FBG	Site Unsaturated Zone Flow Model	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8
OG33129FBK	Support UZ Model Expert Elicitation	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
1.2.3.3.1.2.9		7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8
OG33131FBA	C-Well Complex Hydraulic & Conservative	46.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.5
OG33131FBB	C-Well Complex Hydraulic & Tracer Test	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
OG33131FBC	Water-Level Monitoring	20.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.7
OG33131FBD	Water-Level Monitoring	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.2
OG33133FB3	Site Saturated Zone Flow Model	16.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.5
OG33133FB4	Site Saturated Zone Synthesis Report	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
OG33133FB5	Conduct VA SZ Flow Model Sensitivity An	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
OG33133FB6	Confirm SZ Hydrologic Flow Models	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
1.2.3.3.1.3.3		21.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.8
*1.2.3.3		284.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	284.4
OG3521FA1	Tracer Gas Support	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7
1.2.3.5.2.1		5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7
*1.2.3.5		5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7
OG36212FB1	Confirmatory Aquatic Investigations	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
1.2.3.6.2.1.2		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
OG36215FB2	Paleoclimate/Paleoenvironmental Synthesi	40.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.1
1.2.3.6.2.1.5		40.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.1
OG36221FB1	Evaluation of Paleo Ground-Water Dischar	17.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.4
OG36221FB2	Geo. Fract. Fill Mater, ESF & Est Past W	57.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.0
OG36221FB3	Syn.Dist.&Anal Geochron. Age Dets Potent	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
1.2.3.6.2.2.1		74.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	74.4
*1.2.3.6		114.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.5
OG39BFA1D	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
OG39BFA1F	Data & Del Mgt., QA Compl, Oversite Sup,	14.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.6
OG39BFB1	Support Development of PISA Ch 2.3 (Geol	30.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.1
OG39BFB1C	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

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OG39BFB1E	Provide Input to SC Progress Report 16	9.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.9
OG39BFB2	Develop PISA Chapter 2.4 (Hydrology)	11.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.6
OG39BFB2E	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
OG39BFB4	Dev Climate/Meteorologic Sys Desc (PISA	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
1.2.3.9.11		66.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.2
*1.2.3.9		66.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.2
**1.2.3		817.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	817.4
OG535FA1	Provide FY97 Technical Data Base Input	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.3
1.2.5.3.5		21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.3
*1.2.5.3		21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.3
OG541FA2	Viability Assessment Scenarios Developme	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
1.2.5.4.1		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
OG544FA1	UZ Flow Model Abstractions for VA	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
OG544FA2	SZ Flow Model Abstractions for VA	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
1.2.5.4.4		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
*1.2.5.4		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
**1.2.5		21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.3
OG825FA1	Federal Occupation Safety & Health	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.8
1.2.8.2.5		8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.8
*1.2.8.2		8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.8
OG845FA1	Radiation Protection	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
1.2.8.4.5		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
OG847FA1	Water Resources Envir Impact Stmt Suppor	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
OG847FA2	Rad Water Quality Sample Collection	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
OG847FB1	Water Resources	30.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.4
1.2.8.4.7		30.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.4
*1.2.8.4		30.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.4
**1.2.8		39.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.2
OG9121FA1	Participant Technical Project Office	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0
1.2.9.1.2.1		25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0
*1.2.9.1		25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0
OG922FA1	Participant Project Control - USGS	21.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.4
1.2.9.2.2		21.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.4
*1.2.9.2		21.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.4
**1.2.9		46.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.4
OGC522FA1	Satellite Records Operations	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
1.2.12.5.2.2		3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8

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*1.2.12.5		3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
**1.2.12		3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
OGF23FA1	Support/Personnel Services	32.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.4
OGF23FA2	Facilities Management - Space	61.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.7
OGF23FA3	Facilities Management - Computers/Phones	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
OGF23FA4	Facilities Management - Other	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5
OGF23FA5	Procurement/Property Management - USGS	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.2
1.2.15.2.3		133.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	133.5
*1.2.15.2		133.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	133.5
OGF3FA1	USGS Training Support	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5
1.2.15.3		4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5
*1.2.15.3		4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5
**1.2.15		138.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138.0
1.2 OPERATING		1066.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1066.1
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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1066.1
FTEs														
FEDERAL		112.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CONTRACT		17.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOTAL		129.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

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

United States Department of the Interior

U. S. GEOLOGICAL SURVEY
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Denver Federal Center
Denver, Colorado 80225

IN REPLY REFER TO:

INFORMATION ONLY

December 18, 1996

Wayne Kozai
Yucca Mountain Site Characterization
Project Office
U. S. Department of Energy
P.O. Box 98608
Las Vegas, Nevada 89193-8608

SUBJECT: Yucca Mountain Project Branch - U.S. Geological Survey (YMPB-USGS) Progress Report, November, 1996

Attached is the USGS progress report in the required format for the month of November, 1996.

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
U.S. Geological Survey

Enclosure:
cc: S. Hanauer, DOE/Forrestal
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U. S. GEOLOGICAL SURVEY

EXECUTIVE SUMMARY
November, 1996

WBS 1.2.3.1 Coordination and Planning

U. S. Geological Survey - Yucca Mountain Project Branch is currently processing 207 scientific papers authored by USGS authors. Of these, 117 are related to hydrologic studies and 90 to geologic studies. In addition, 51 abstracts are being processed, as well as 17 reports from LBL.

WBS 1.2.3.2 Geology

Geologic Framework

Work continued on the review and revision of the ten lithostratigraphic contacts in the 4th (and last) group of boreholes being studied in support of the 3-D modeling effort. Many of the boreholes currently being examined have only drill cuttings as samples, but many of the contacts can be identified where the cuttings are not too contaminated with fragments from higher in the boreholes. Many of the contacts also correlate well with geophysical logs, but the signatures of several of the contacts can change slightly between boreholes. In further support of 3-D modeling, project staff supplied information on several lithostratigraphic contacts in addition to the usual ten contacts, and met with the M&O modeling staff to review the thickness and geometry of the various units being modeled.

As part of the investigations in the ESF, project staff: (1) examined the exposed bedrock and geologic structures in the North Ghost Dance Alcove, (2) reviewed the video tape of the subhorizontal borehole NAD-GTB#1A, and (3) examined cores and video of cores from the borehole. Based on these studies, the Ghost Dance fault was identified at a location beginning about 149 m from the center line of the ESF and marked by a 10 m-wide zone of more broken rock as compared to the adjacent rock.

Project staff also participated in the planning for the southern Ghost Dance fault alcove (Alcove #7), by providing data on the location and geometry of the fault based on the new geologic mapping in the central block of Yucca Mountain. As identified at the surface, there are two splays of the Ghost Dance fault, the eastern one of which dies out to the south and is considered to be the main trace. At the location of Alcove #7, this eastern splay contains the majority of the fault displacement and is the main target for the forthcoming hydrologic tests. Current plans for Alcove #7 are to drift due east off the main ESF for about 125 m and then drill horizontally to the projected location of the fault, which is expected to be an additional 60 m. The western splay of the Ghost Dance fault, which has been intersected in the ESF, has relatively minor offset (10-20 ft) and seems to connect with the Abandoned Wash fault to the southwest.

The central block geologic map is being converted from the AutoCad draft into ARC/INFO to produce a robust spatial geologic map digital. This conversion will enable a faster and more

efficient preparation of the final geologic map for formal publication as a USGS Miscellaneous Investigation Series map, as well as being made available for wider use throughout the Yucca Mountain site characterization program.

Geologic mapping of Fran Ridge, Bow Ridge, the southern part of Boundary Ridge, and parts of Dune Wash and Busted Butte has been completed, and the map data digitized for inclusion in the site area geologic map. Many modifications of previous mapping have been made, particularly in areas of complex structure. Accordingly, mapping efforts are concentrating on those areas to help construct a more accurate and internally consistent map at the 1:24,000 scale. A 1:6,000-scale digital version of the geologic map of the Paintbrush Canyon area, which is at the northeast corner of the site area geologic map, is being finalized.

Fracture data was provided as input to LBL's unsaturated zone flow model. The input consisted of the principal results of the collection and integration of surface and borehole fracture data for the zeolitically altered Calico Hills Formation and Prow Pass Tuff. Data on the Calico Hills Formation were collected from surface exposures in the vicinity of Prow Pass using both detailed line survey and areal set survey techniques. Television videos of QA'd boreholes USW SD-7, USW SD-12, and USW UZ-14 were observed to obtain fracture data for both formations. Assistance was given to LANL scientists collecting samples in the ESF by directing sample selection to potentially conductive features and providing descriptions of the structural relations at the sample locations. Comparisons between surface geologic mapping and full periphery mapping and detailed line survey data in the ESF, and evaluations of the structural controls of ^{36}Cl distribution continued.

Project staff prepared annotated outlines for the sections on site stratigraphy and site structure for the Site Description Report (part of PISA). They also participated in the PSHA workshop held at Pahrump, Nevada, and led field trips to study bedrock structures at Yucca Mountain.

Geologic mapping of south ramp of the ESF was accomplished as follows: (1) full periphery geologic mapping was completed to station 69+90, (2) detailed line survey was completed to station 69+95, and (3) stereophotography was completed to station Project staff conducted tours of the ESF for participants in the PSHA workshop that was held in Pahrump, Nevada.

Seismotectonic Studies

The Seismic Source Models and Proponents Workshop (Workshop #3) and the associated field trip for the Probabilistic Seismic Hazards Analysis (PSHA) project was held November 18-22, at Pahrump in the Amargosa Valley. This workshop accomplished two goals: (1) presentation and discussion of alternative models, hypotheses, and interpretations of data that could be used to characterize seismic sources for PSHA; and (2) a visit to the Yucca Mountain site, the ESF tunnel, and key exposures in the area so as to introduce participants in PSHA to the geology and tectonic setting of the region and to provide an in-the-field forum to debate alternatives. The workshop discussions centered upon five specific issues of importance to ground motion and fault displacement hazards: tectonic models, three-dimensional geometry of faults, definition and synchroneity of faulting events, characterization of faulting and fracturing in the potential

repository block, and maximum background earthquakes. During the two-and-one-half-day field trip, observations and discussions focused principally on fault characteristics.

Final versions of the annotated outlines for the sections on regional geology, seismology, Quaternary geology, and tectonic models were completed and submitted for review.

WBS 1.2.3.3 HYDROLOGY

Regional Hydrology

Work continued on the analysis and interpretation of regional precipitation data.

Closing calibrations of the tipping-bucket rain gages also continued during the reporting period. Sites for the location of the 14 precipitation gages are being identified.

Work continued on formatting the meteorological data from FY96 for the two weather stations that were active during that time. The data package is expected to be ready for technical review by middle December.

Staff completed computing and checking daily discharge data for the three recording streamgage sites on Fortymile Wash. Staff also continued to compute and check records for streamflow and precipitation data collected in FY95 which were not published in the USGS Nevada District annual data report for 1995.

Final hydraulic-conductivity arrays for the regional flow model were converted to ARC/INFO coverages for updating of the regional framework model.

Staff met on November 6 to discuss NCAR precipitation data for future-climate scenarios and possible alternatives for using those data, which are at far too gross a scale to be useful to estimating recharge for the regional flow model.

Modeling staff met with paleoclimate staff to discuss past-discharge areas and past climatic conditions. A map of past-discharge areas, which will be used as part of the "reality check" on future-climate simulations, was received from the USGS Climate Team.

The report documenting the construction and calibration of the regional flow model received USGS Director's approval as Water-Resources Investigations Report 96-4300 on November 26. Staff examined comments from USGS Headquarters and began revisions.

> Agnese, F.A., Faunt, C.C., Turner, A.K., and Hill, M.C., *Hydrogeologic evaluation and numerical simulation of the Death Valley regional ground-water flow system, Nevada and California*, U.S. Geological Survey Water-Resources Investigations Report 96-4300, *in press*.

A report documenting the construction of a regional potentiometric-surface map was returned from the USGS Central Region Office for additional work. Staff reviewed the comments, discussed possible changes, and began working on the changes.

Unsaturated-Zone Hydrology

Work continued on the numerical infiltration model with comparison of results of simulated precipitation obtained from the Global Climate Model to the results obtained using historical data from the regional precipitation gage network.

Development of an improved version of the bucket sub-model also continued, using a cascading bucket approach which would allow for an improved modeling of the root zone. Work also continued on improving the Richards-equation sub-model.

Staff prepared 10 additional figures for inclusion in the Main Drift Hydrology report. Additional efforts went to preparation and review of the basic data submittal due at the end of December.

A data package (reduced borehole data) was reviewed and submitted to the USGS data management group.

Pneumatic data from instrument station "B" located in the basal vitrophyre of the Topopah Spring Tuff at SD-12 indicate the presence of diurnal and synoptic signals in the pressure record. These signals have been present in the pressure record from this station since this borehole was first instrumented in November, 1995, but they have only recently been recognized. These signals appear to be superimposed on a seasonal pressure signal that is severely lagged and damped with respect to the surface barometric pressure signal. The phase of the synoptic and diurnal signals that are present in this record are, however, coincident with the phase of the surface synoptic and diurnal signals. These signals also lead the synoptic and diurnal pressure signals that are present in all of the overlying Topopah Spring stations. A preliminary analysis of these data suggests that the superimposed signals may be the result of atmospheric loading and/or Earth tide effects. These observations will be addressed in the Main Drift Hydrogeology report.

Approximately 80 man hours were spent in the preparation of overheads and handouts for the Expert Elicitation (3-D site-scale model) meeting held in Berkeley, CA, on November 14 and 15.

Preliminary analysis has been completed on the unsaturated conductivity measurements for two core samples. Using moisture retention data collected from subsamples of the core, various methods were used to fit curves to the moisture retention data and then to predict unsaturated conductivity. These curves were compared to the measured data. The comparisons indicate that the predicted conductivities are lower than the measured values suggesting that more water may travel through the matrix under unsaturated conditions than currently estimated in flow models. Additional issues brought forth with the analysis include the need to evaluate other methods to collect moisture retention data, such as pressure-plate and centrifuge methods, to see how sensitive the curve-fitting techniques and the curve shapes are to the prediction of unsaturated conductivities. Samples have been prepared for these measurements. A piece of the rotor apparatus on the centrifuge has broken and is currently being replaced.

Samples from 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 were reprocessed for physical properties determined from

relative-humidity oven drying. Processing of samples from the Ghost Dance Fault Alcove #6 has been completed, and the data are being organized. Collection of systematic samples from the main drift will begin the second week of December. All core samples in cans and lexan, approximately 450 core boxes, with the exclusion of the Ghost Dance Fault samples, have been returned to the Sample Management Facility for long term storage.

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.

Several trips were made to field sites. Three trips were made for routine generator maintenance. Five trips were made to retrieve data manually when the radio communication link from the field sites to the HRF failed. These failures resulted from shutdowns of the Novell network at the HRF because of power failures or from malfunctioning of the field site radio modems.

Four trips were made to exercise the generator at UZ#4 and UZ#5. For several weeks, there have been periods of high noise levels from most or all sensors at UZ#4 and UZ#5 - periods lasting several hours or several days, then mysteriously ending. Although the generator was suspected as the source of the noise, the malfunction was not actually observed until October 16. After several days of steady output, the generator frequency and voltage would become unstable, varying 1% to 2% several times per minute, but not quite enough variation to trip the UPS alarms. Cause of the problem has been tentatively attributed to carbon loading on the generator engine, a result of running under light loads for extended periods of time. To circumvent this problem, routine trips are being made to UZ#4 and UZ#5 to exercise the generator using a load bank. Recurring problems with the generator at UZ#4 and UZ#5 persisted throughout the month of November.

Two glass thermometers were calibrated for the Regional Saturated Zone Hydrology Group.

Air-permeability and hydrochemical testing continued in the Ghost Dance fault (GDF) alcove. The GDF was identified in a 60-m borehole. USGS geologists have located the fault at 154-m distance from the ESF centerline. The 60-m borehole temperature log shows a 0.1-degree Celsius drop in temperature in the broken zone of the fault. The alcove has been excavated an additional 30 m, and hydrochemical and pneumatic testing is scheduled to begin on December 2.

Analysis of air-permeability data from the ESF produced interesting results. The GDF has a brecciated zone that extends from 143 to 155 meters from the ESF centerline. Most of the brecciated zone is clast-supported breccia. There are four subzones, however, of fine-grained matrix-supported breccia. Based on the location at ESF depth of the main trace of the Ghost Dance fault (154 m from ESF centerline) and its surface location, the GDF is nearly vertical. The geothermal temperature drop in the breccia zone may indicate downward transport of gas or water.

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 Alcove 3 and 4). One wind-speed

sensor (Alcove 4) was replaced on November 6 because the other unit experienced an electronic malfunction.

A project designed to preserve the in-situ water content of selected sites in the tunnel continued. Plastic sheets (1.5 m by 1.5 m) are being attached to the tunnel wall (below the spring line) using nails, silicon sealer, and grout. These selected locations may be the site of future sampling and/or instrumentation locations. The new selected sites contain the contact between the Bedded Tuff (PTn) and the Tiva Canyon (Tpcpv). To date, 13 pieces of plastic have been installed. As the TBM advances, additional plastic will be installed.

A tensiometer was installed in October in the PTn unit to measure the rate of dry-out from a bare rock surface. The tensiometer was installed 30 cm into the tunnel wall and is being read frequently to monitor the rate of dry-out. A second set of tensiometers were installed on November 14 at the contact between the Bedded Tuff (PTn) and the Tiva Canyon (Tpcpv). In addition, heat-dissipation probes were installed at each of these locations.

Standard data formats have been developed for the various types of moisture data being collected. These data are being assembled into a data package for submittal.

Results of hydrochemical analyses were compiled. Water collection by compression and distillation during November was recorded in the water collection database. Water samples analyzed for tritium during November were likewise recorded in the tritium database. Seven ESF water samples were prepared for tritium analysis and counted for tritium concentration. The data have been reduced.

Twenty-four molecular sieve cylinders were leak-tested and heat-evacuated to remove residual CO_2 gas and H_2O vapor. The evacuated cylinders were pressurized with nitrogen gas and prepared for shipment to the NTS for collection efforts from the SD-12 borehole. Staff training on heat evacuation of collection cylinders and preparation of cylinders for field use was conducted.

Hydrochemical analysis continued. Five core-compression water samples and one disguised USGS Standard Water Reference Sample were prepared and delivered to Huffman Laboratories for anion and cation analyses. Eight SD-12 cores, four SD-7 cores, two SD-9 cores, and four ESF core samples were distilled. The extracted pore water will be analyzed for tritium.

Twenty UZ water samples (seven from the ESF, three from SD-7, and 10 from SD-12) were prepared for tritium analysis and counted for tritium concentration. The data have been reduced.

Seven gas samples, collected from instrumented borehole SD-12 and sent to Desert Research Institute for $^{13}C/^{12}C$ and ^{14}C analyses, were received in early November.

One set of core-compression water samples was prepared and shipped to Beta Analytical Laboratory for ^{14}C analysis.

The LKB Liquid Scintillation Counter was calibrated.

Staff training covered the distillation method for extracting pore water from core samples, preparation of tritium samples for counting, operation and calibration of the LKB liquid scintillation counter, and reduction of counting data.

Several unscheduled activities were accomplished. UZ hydrochemical staff, along with PIs from the Environmental Science Team, attended a whole-day meeting with M&O/LLNL staff to update recent progress in hydrologic investigations at Yucca Mountain. The USGS safety officer inspected UZ Hydrochemistry Laboratory fume hoods for efficiency of operation.

A new distillation rack, designed to extract dissolved CO_2 and inorganic carbon from pore water in Topopah Spring Tuff core, was constructed. This was necessary because no water can be extracted from low-moisture-content core by the compression method. Staff training for the new method was conducted. Three tests have been conducted; all of the tests were successful in extracting enough CO_2 for ^{14}C dating by Tandem Accelerator Mass Spectrometer. The extracted CO_2 will be sent to Beta Analytical Laboratory in Miami, Florida, for analysis.

In unscheduled work, staff prepared and presented results of preliminary fracture modeling at the Expert Elicitation Workshop for unsaturated-zone studies in Berkeley, California.

Based solely on pneumatic testing of unsaturated zone boreholes, data concerning the degree to which fracturing has enhanced the permeability of the nonwelded tuffs in the lower part of the unsaturated zone must be considered sparse to nonexistent. To supplement the little that is known concerning secondary permeability in the Calico Hills, Prow Pass and Bullfrog Tuffs, permeabilities determined from in-situ hydraulic testing where these units are submerged beneath the water table were compared with permeabilities determined on core retrieved from the test boreholes or boreholes in close proximity. These comparisons showed that, despite the potential for sealing of secondary permeability by zeolites and other alteration products, considerable secondary permeability exists within these units at some borehole locations.

A presentation entitled *A conceptual model of unsaturated zone flow at Yucca Mountain, Nevada* was made to the UZ experts at the first Expert Elicitation workshop held in Berkeley on November 14 and 15. Staff also participated in a Management Team meeting held in Las Vegas on November 26 to help outline the agenda for the second workshop to be held in Berkeley December 18 to 20.

Saturated-Zone Hydrology

Preparation of a memorandum describing the planned USGS purely convergent tracer test in C-hole wells continued during November. Data are being analyzed to isolate the tail of the breakthrough curve from prior injections, to obtain antecedent iodide concentration curves. The data analysis will be used to predict results from the upcoming purely convergent tracer test using Pyridone.

In planning for the purely convergent test, interactions between the USGS and DOE's environmental permitting group continued with preparation (completed November 21) of a letter to the State of Nevada requesting injection of these Pyridone and 2,6 Difluoro-benzoic acid tracers into UE-25 c#1 and c#2, respectively.

The partial recirculation of water from the pumped well UE-25 c#3 into UE-25 c#2 performed by LANL as part of their lithium bromide-PFBA-microspheres reactive tracer test was halted on November 19 in response to a request from the USGS. The USGS sought discontinuation of recirculation so that the flow regime could return to the purely convergent flow field that would result from pumping of 150 gallon per minute from UE-25 c#3. This is the flow field over which the nearly simultaneous injection of Pyridone and 2,6 Difluoro-benzoic acid will be superposed.

A proposal to conduct hydraulic and tracer tests in the UE-25 a#1 and UE-25 b#1 borehole pair was submitted to DOE and the M&O on November 8. These tests would be conducted after March 14, 1997, in confirmatory testing to obtain hydraulic and transport parameters in a saturated-zone location other than the C-hole complex.

Several efforts in water-level measurements, equipment calibration, and data compilation continued. In support of the aquifer testing conducted at well USW G-2 and at the C-hole complex, 25 manual measurements were completed in November. Six zones in five wells were monitored hourly with transducer measurements and data recorders.

Water-level measurements were obtained in boreholes UE-25 WT#6 and UE-25 WT#16 on November 5; in USW WT-2, UE-25 WT#4, UE-25 WT#13, UE-25 WT#15, and UE-25 b#1 (upper interval) on November 6; in USW H-1 tubes 1, 2, 3, and 4 on November 7; in USW WT-1 on November 12; in USW VH-1, USW WT-7, USW WT-10, USW WT-11, and USW H-6 (upper and lower intervals) on November 13; in USW H-3 (upper and lower intervals) and USW H-5 (upper and lower intervals) on November 14; and in J-11, J-12, and J-13 on November 18. Data were downloaded from 21X recorders at wells USW G-2, H-4 (upper and lower zones), UE-25 WT #3, UE-25 WT #14, and UE-25 p#1. Editing was completed of hourly data from UE-25 p#1 through September 3, from USW H-5 (upper interval) through August 27, and USW H-5 (lower interval) through August 8. Review of all manual water-level data collected from July through November 1996 was completed. Field notes for the same time frame were also reviewed.

The first draft of report section "Well data and water levels" for the 1995 water-level data report was completed and reviewed. Staff began working on the remainder of the report which includes discussion of data collection systems.

Efforts to finalize SZ numerical flow model inputs and outputs continued. Work began on completion of a potentiometric-surface map for the site model area. Previous work by others is being compiled and checked. Screened or open intervals of wells are being matched with hydrogeologic units to be used for comparison with model output. Staff continued analysis of water-level fluctuations at Yucca Mountain to estimate hydraulic properties of the saturated zone rock units.

Development of the Site hydrogeologic framework model continued with discussion of refinement of the grid-spacing of the framework model for use in the construction of input data sets for a finite-difference flow model of the site area. A cell spacing of 250 m was determined to be adequate for that purpose.

In work to calibrate the Site flow model, staff continued efforts with C. Gable and G. Zvoloski (LANL) to solve problems with the finite-element mesh to be used with the FEHMN flow model. At the end of this reporting period, problems with the mesh remained.

Staff discussed construction of a finite-difference flow model of the site area, using MODFLOWP. This will be a parallel effort to the modeling using FEHMN and is intended to test alternate conceptual models of the large hydraulic gradient, as well as to obtain model results that can be used by PA should the FEHMN modeling efforts continue to be delayed by mesh problems. A finite-difference grid was designed, and a layering scheme for the model was developed.

In unscheduled work, a poster on hydraulic testing and conceptual models of flow at well USW G-2 was presented by SZ modeling staff at a USGS Workshop on Advanced Geophysical Techniques. Staff attended several of the sessions at the workshop. A staff hydrologist provided technical review of an SZ report.

Revisions were made to an approved report that documents results of aquifer tests conducted last fiscal year at three wells at Yucca Mountain, and the report was submitted for final publication preparation.

> O'Brien, Grady M., *Analysis of aquifer tests conducted in boreholes USW WT-10, UE-25 WT#12, and USW SD-7, 1995-96, Yucca Mountain, Nevada*, U.S. Geological Survey Water-Resources Investigations Report 96-4293, *in press*.

USGS staff met with B. Arnold, J. Gauthier, and M. Wilson (SNL) on November 21 in Albuquerque to discuss organization of a workshop that will address critical issues in SZ flow modeling and transfer of the information obtained in process modeling for use by PA modelers. Key participants were identified, as were key issues to be addressed by the participants during the workshop. The organization and format for the workshop were discussed. Current plans are to hold the workshop in Denver in early April. Background information (past TSPA reports and plans for other workshops) was provided by SNL staff.

WBS 1.2.3.6 Climatology and Paleohydrology

Staff continued to collect and compile diatom data from Owens Lake to establish a regional climate history for the past 500 ky. Staff also continued preparation of diatom samples from Owens Lake cores and from analog sites. Sample preparation has been impeded by partial shutdown of the lab in preparation for relocation to Bldg. 56.

Interpretive efforts for the Owens Lake region continued. Compilation of hydrologic and climatic data for the Owens Lake region to develop analog models to determine precipitation and temperature changes for the past 400 ky continued during the reporting period. Conversion was

begun of the multispecies ostracode dataset from Owens Lake into a single limnologic/climatic curve. Once properly calibrated, such a curve will provide a long (500 ky) regional climate history.

A proposal to acquire high-resolution climate data from cores taken by DRI from the Pahranagat Marshes was prepared. Collection of high-resolution data from the Pahranagats would provide a means to evaluate possible climate change during the next one or two millennia when a repository would be very hot.

Staff has initiated extraction of ostracodes from prepared sediment residues for inclusion in the baseline dataset, and other sample extraction efforts focused on ostracodes from prepared paleowetland sediments for stable isotopic analyses.

A preliminary map was prepared to show areas near Yucca Mountain where ground-water discharge from the regional and alluvial aquifers occurred about 21 ka. This activity fulfills a requisite data transfer from the Climate/Quaternary Hydrology group to the SZ group in support of the 3-D hydrologic model.

The time and agenda for a climate roundtable meeting involving USGS, DRI, and Dames and Moore participants are being arranged. The purpose of the initial meeting will be to discuss the methods used by the participants to reconstruct past climate from proxy datasets and to discuss potential strengths and weaknesses of those methods.

U and Th isotopic analyses were completed of nine subsamples of authigenic cements from three horizons within the Station 6 section at the Highway 95 white-bed deposit. Resulting ages tend to confirm previously reported U-series data that indicate a major age break between the overlying gray diatomite bed (basal materials with ages between 33 and 55 ka) and the underlying green-sand unit (upper portion ~130 ka; lower portion ~180 ka). The reason for discordance between TL and U-series ages for the green-sand unit is still unknown, although additional information bearing on the mineralogy of the fine silts from this unit used for TL age determination is currently being collected.

Staff mapped the distribution of discharge sites during the last full-glacial period (10 to 30 ka) on a regional scale in support of the three-dimensional saturated-zone hydrologic model. Sites were located on a 1:250,000 base map and briefly described in terms of the type of discharge system and the source of water. Data will be used to test the SZ model under pluvial conditions
An assessment was completed of isotopic (Sr, O, H, C) variations in ground water as a function of flow paths predicted by the regional hydrologic model constructed by the USGS. The objective was to determine if the isotope hydrology was consistent with modeled flow paths.

A field trip to the Amargosa Valley discharge sites was planned for geological description and sample collection. In addition to examination of sites in light of FY96 data, hand augering to a depth of about 6 meters is planned to determine the vertical extent of the deposits and to collect samples from the deepest portions of the deposits. In addition, samples will be collected to determine moisture profiles in order to assess the possibility of present-day water perching that

might be supporting the scattered population of *Distichlis* (salt grass) at one of the sites (the Crater Flat deposit).

Work continued on samples TL-77 and TL-78, but no ages are being released until a data review is completed.

Fifteen subsamples of outermost opal and calcite from six secondary mineral occurrences in the ESF between stations 57 and 64 were prepared. Chemical separation of U and Th for nine of these samples was completed, and isotopic measurements were completed on six subsamples. Resulting ages range from 69 to 380 ka with two ages of about 160 ka and two of 240 ka. Calculated initial $^{234}U/^{238}U$ ratios range from 5.4 to 1.5 and show a general negative correlation with subsample age. These results are consistent with previously reported data and indicate similar distributions of secondary materials and ages in the middle lithophysal unit of the Topopah Spring Tuff between the northern and southern bends in the ESF.

Staff met in Denver with M&O coordinator for climate and hydrology to discuss current status and future work of climate and UZ hydrology.

Modifications were completed to technical procedure GCP-13 that accommodate U-Pb analysis of very small samples of high-U opals from the ESF. Staff at the Jack Satterly Geochronology Lab, Royal Ontario Museum, will provide a limited number of analyses of opal and chalcedony from various microstratigraphic positions within secondary mineral coatings. The technique allows dating of high-U, low-Pb materials in the range of several hundreds of thousands of years to >13 million years (age of host tuffs) and will provide some indication of whether secondary mineral coatings were initiated shortly after emplacement of the tuffs, or whether deposition reflects a more-recent phenomenon related to the arid climate typical of the Quaternary period (the last 2 million years).

Staff discussed reconnaissance fluid-inclusion observations from secondary calcite occurrences in the ESF in light of at least two published abstracts by Dublyansky and coworkers that report observations from ESF occurrences. These abstracts conclude that early calcite may have formed during a comparatively mild hydrothermal event, which is consistent with earlier reported findings of Roedder and others (1994, IHLRWM Conference, ANS), but those abstracts are also mildly critical of some of the conclusions of that work. Four samples of ESF calcite were prepared for fluid-inclusion analysis.

Calcite from 11 secondary occurrences within the ESF (17 total samples) was sampled for determination of modern carbon contents by AMS at Beta Analytical Laboratory; two blind blanks were included.

Staff met for an afternoon with Mike Reddy, a WRD carbonate geochemist, for interchange of information concerning conditions of calcite precipitation and controls on calcite crystal morphology. Reddy, like all others so far, had never seen calcite crystal forms similar to those commonly found in the unsaturated zone of the ESF.

All of the Past Discharge stable isotope data from carbonate microfossils was compiled for incorporation into FY97 reports.

XRD traces from 13 samples of carbonate from ESF secondary mineral occurrences were collected to check for the presence of aragonite. This was prompted by the unusual calcite crystal morphologies that have been observed; calcite samples spanned a wide range of paragenetic positions and were mostly from bladed occurrences. No aragonite was observed, which confirms past mineralogic studies by LANL but does not provide any further clues to the origin of the unusual calcite forms.

XRD traces were also obtained from 10 TL separates of samples from the Lathrop Wells diatomite. TL and ^{230}Th/U ages of these samples do not agree well. The XRD patterns of these samples, in contrast to TL separates from other localities, show only a handful of sharp peaks (generally the most intense of peaks of the minerals quartz, feldspar, and mica) and broad humps between 2□ angles of 20° to 30°. These humps are characteristic of amorphous opal and probably indicate that the bulk of the material in the separates is diatomaceous.

Some 130 samples of calcite were extracted from ESF samples, largely from between stations 40 and 50, and mass-spectrometer analyses were performed. These occurrences contain early calcite with anomalously heavy □^{13}C values.

ESF samples of secondary mineralization from the past two collecting trips were examined, and 38 chips were cut and impregnated for preparation of polished thick sections. These sections are used for both petrographic analysis and microsampling of carbonate for Kiel automated stable isotope analysis. In addition, five roughly polished sections from G-2 drill core were prepared for carbonate microsampling.

Strontium isotopic analyses of pore water salts in a suite of 27 core samples from drill hole USW SD-7 were completed. □^{87}Sr values increase gradually through the intercepted portion of TCw, increase dramatically in the PTn, and remain nearly constant in TSw. The pore salts (which precipitated from pore water when the core dried) are extracted from coarsely crushed pieces of core using de-ionized water. □^{87}Sr for pore water in the TSw are similar to those of calcite fracture fillings. If the kinetics of water-rock interaction can be reasonably constrained on experimental and theoretical grounds, the observed systematic trends offer hope of estimating residence time of the pore fluids.

Several unplanned efforts were conducted. Technical review was completed of a data package (titled "Chemical and isotopic composition of pore water and pore gas, 1994-96, from boreholes UZ-1, UZ-14, UZ-16, NRG-6, NRG-7A, SD-7, SD-9, SD-12 and the ESF"). An inventory of all radioactive materials in YMP-Isotope Hydrology labs was completed as requested by the USGS Radiation Safety Officer. Technical review was performed of an FY96 milestone [Interpretations of Chemical and Isotopic Compositions Data and Geochemical Modeling (NETPATH) in the Unsaturated Zone, Yucca Mountain, Nevada]. Staff attended the Unsaturated Zone Expert Elicitation meeting in Berkeley on November 13 and 14 and presented an overview of age and isotopic results obtained in the ESF dating task. Considerable time was spent preparing data for

review for December TDIFs. These samples are to be included in the paleodischarge milestone due March 1997. Revisions to Technical Procedure GCP-29 were also prepared.

WBS 1.2.13.4.7 Water Resources Monitoring

Ground-water levels were measured at 29 sites. Discharge was measured at five springs and at one flowing well. Ground-water data collected during October were checked and filed.

Support was provided to the Environmental Program in several ways. Owner contacts and detailed information on site locations were provided, and sampling configurations at selected sites in the region were discussed with USGS-Nevada District personnel (in preparation for USGS participation in SAIC's radiological ground-water sampling program). In consultation with U.S. Fish and Wildlife Service (USFWS) personnel at Ash Meadows National Wildlife Refuge, discharge-monitoring locations at two springs in Ash Meadows selected and modified to improve data-collection activities. Potential methods for improved water-use monitoring in the Amargosa Desert were discussed with National Park Service (NPS) personnel. Checking of the NWIS database for consistency with previously stored and reported data following a merge of USGS-NV District and USGS-ESIP databases was initiated. Staff met with USGS-ESIP personnel on November 6 and 7 to complete final processing of the data-records package for 1995 data and submitted the package to the YMP Records Processing Center. Preparation of electronic data files for 1995 data to be submitted to the YMP Technical Data Base is also now underway. USDOE approval for the 1995 summary monitoring report was received on November 12 (completed milestone 3GWR622M). Camera-ready copy of the report was reviewed and delivered on November 20 to USGS-ESIP for publication.

WBS 1.2.3.9 Special Studies

The Principal Investigator and nine other staff members from the USGS attended a meeting with DOE and the M&O on November 5 to review draft outlines of chapter 2.3 (Geological Systems).

Revised outlines of subsections on site stratigraphy, site structure, regional geology and seismicity were submitted to the M&O in preparation for the December 2 meeting where an annotated outline for chapter 2.3 is expected to be finalized.

In conjunction with the disparity in interpretations of the geophysical data about the configuration of the Paleozoic-Tertiary contact, a proposal to deepen USW H-4 was developed.

The USGS lead for the Site Characterization Progress Report (SCPR) presented plans for compilation of SCPR input at the USGS monthly planning meetings held in Denver November 6. In addition to describing how routine "progress" information will be compiled, the presentation also described the current process for documenting the differences between the Site Characterization Plan (SCP) and the current program.

The USGS SCPR lead compiled input for Appendix A of SCPR #15 and transmitted it to the M&O staff to compile the complete text. This Appendix A is intended to describe, in summary

fashion, the changes that have occurred in the Site Characterization Program since the SCP was issued in December 1988 and to compare the content of the SCP to the current YMP Long-Range Plan. The summaries were written at the SCP Investigation level but capture the fundamental aspects of the characterization program at the SCP study and activity levels. Write-ups for Appendix A consist of two sections: "Overview of Testing Proposed in the SCP" and "Changes Through Time." Each section contains a series of numbered, paragraph-sized bullets that correspond to the SCP studies that comprise the Investigation. In the "Overview" section, an introductory paragraph summarizes the overall objectives for the SCP Investigation. Each bullet then summarizes the combined objectives of the SCP study and the activities that comprise the study. To ensure that the "overview" section accurately describes SCP objectives, word-processing files for chapter 8 of the SCP were obtained and abstracted. For the "changes" section, information was compiled by researching previous SCPRs, interviewing Principal Investigators (PI), and by soliciting written material from PIs and other members of the technical staff. Investigation-level write-ups were prepared for 11 SCP Investigations: three in Geohydrology, one in Rock Characteristics, two in Climate, one in Postclosure Tectonics, one in Thermal and Mechanical Rock Properties, and three in Preclosure Tectonics. This USGS input to Appendix A consisted of about 50 pages of text, which represented about 40 percent of the text of Appendix A for Site Programs. USGS input was well received by the M&O staff and generated very few comments during the initial management-level review.

First drafts were completed for the PISA Site Description sections on Surface Water and Regional Hydrogeology. Drafts for the Site Hydrogeology section, including both unsaturated-zone and saturated-zone hydrology, were in preparation. Unresolved staff-scheduling conflicts continue to hamper the development of this outline.

USGS Level 3 Milestone Report

October 1, 1996 - November 30, 1996

Sorted by Baseline Date

Deliverable	Due Date	Expected Date	Completed Date	Comments
LETTER REPORT	11/1/96	10/30/96	10/30/96	
Milestone Number: SSII13BM3				

USGS Level 4 Milestone Report

October 1, 1996 - November 30, 1996

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	11/15/96	11/15/96	
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	

Yucca Mountain Project
Variance Analysis Report

Entered on: 12/17/96 11:42 AM **Entered by:** Raye Arnold
WBS: 1.2.3.1.2
WBS Title: Participant Management and Integration
AM: JONES S. **OM:** HAYES L.
Subject: *Cost/Schedule Variance Analysis*

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 11/96

Data:

Cumulative Cost Variance: ($-120K / %)
Cause:
The negative cumulative cost variance is due largely to the FY 1996 budget and funding being at below the minimum level to manage the USGS site program. Initial budgets indicated that a potential overrun of $426K was possible. This account was not funded at a level adequate even for basic staffing requirements, leaving no funding for supplies & materials, office machine maintenance, secretarial support, publications, vehicle support, etc. Additional funding of $50K was received via an Approved Funding Change, but because there was no change in scope, no C/SCR was required and therefore, this amount is not reflected in the BCWS.

Impact:
There was an actual FY1996 cost overrun in this P&S account of $143K (less the additional funding of $50K, resulting in a cost overrun of funding of $93K). Cost underruns were identified elsewhere in WBS 1.2.3 offset this cost overrun. There is a small cost underrun in this account for October 1996 resulting in a net negative cumulative cost variance of $120K.

Corrective Action:
No corrective action possible. Account is closed with a cost overrun. Overruns were offset by compensating underruns within the third level WBS. This FY1996 cost overrun cannot be recovered in FY1997.

Cumulative Schedule Variance: ($0K / %)
Variance is within threshold.

Variance at Complete: ($-143K / %)
See "Cumulative Cost Variance"

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

INFORMAL INPUT

INFORMAL INPUT

Yucca Mountain Project
Variance Analysis Report

Entered on: 12/17/96 11:45 AM **Entered by:** Raye Arnold
WBS: 1.2.3.2.8.3.6
WBS Title: Probabilistic Seismic Hazards Analyses
AM: JONES S. **OM:** HAYES L.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 11/96

Data:

Cumulative Cost Variance: ($-182K / %)
Cause:
$120K of the negative cumulative cost variance is due cost overruns in FY1996 resulting from the hiring of additional staff to complete the seismotectonic synthesis report level 3 milestone. $45K of the negative cumulative cost variance results from the costing of an FY1997 consulting agreement in the month of October. This was spread linearly in the budget plan rather than as a one time cost in October.

Impact:
There was an actual FY1996 cost overrun of $120K in this P&S account; however, there were adequate FY1997 cost underruns within the USGS 1.2.3 WBS element to offset these cost overruns. There was no FY1996 schedule variance; the milestone was completed by the due date of August 1, 1996. There is no impact from the FY1997 overrun. The budget plan did not reflect spending obligations.

Corrective Action:
No corrective action possible for FY1996. Account closed with a cost overrun. There were adequate cost underruns within the third level WBS to cover this cost overrun. No recovery of this FY1996 overrun is possible in FY1997. No corrective action is necessary for the FY1997 cost variance. There is no projected FY1997 variance at complete.

Cumulative Schedule Variance: ($0K / %)
Variance is within threshold.

Variance at Complete: ($-132K / %)
See "Cumulative Cost Variance"

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

INFORMAL INPUT

INFORMAL INPUT

Yucca Mountain Project
Variance Analysis Report

Entered on: 12/17/96 11:48 AM **Entered by:** Raye Arnold
WBS: 1.2.3.2.8.4.6
WBS Title: Quaternary Faulting within the Site Area
AM: JONES S. **OM:** HAYES L.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 11/96

Data:

Cumulative Cost Variance: ($-80K / %)
Variance is within threshold.

Cumulative Schedule Variance: ($0K / %)
Variance is within threshold.

Variance at Complete: ($-80K / %)
Cause:
This negative variance at complete is due to significantly more field work being required in FY1996 than had been planned or funded for that fiscal year. Additionally, $15K from this account was transferred to USBR to complete an FY1995 milestone report, 3GTQ530M, which was submitted on July 22, 1996. This was not part of the planned FY1996 budget.

Impact:
There is an actual cost overrun of $80K in this P&S account in FY1996; however, there were adequate projected FY1996 cost underruns within the USGS 1.2.3 WBS element to offset these cost overruns.

Corrective Action:
No corrective action possible. Account is closed with a cost overrun. There were adequate FY1996 cost underruns within the third level WBS to cover this cost overrun. Cost overrun cannot be recovered in FY1997.

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

Yucca Mountain Project
Variance Analysis Report

Entered on: 12/17/96 11:50 AM **Entered by:** Raye Arnold
WBS: 1.2.3.3.1.2.4
WBS Title: Percolation in the Unsaturated Zone - ESF Study
AM: JONES S. **OM:** HAYES L.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 11/96

Data:

Cumulative Cost Variance: ($-169K / %)
Cause:
The negative cumulative cost variance results primarily from the negative cumulative schedule variance. Funds have been expended for staff costs at nearly the planned rate although planned work has been delayed.

Impact:
There is minimal impact resulting from the cost variance. There was a slight cost underrun ($21K) for this P&S account in FY1996, although it is estimated that it will cost an additional $35K to complete resulting in a cost overrun for the P&S account of $13K at the end of FY1997.

Recovery Plan:
None possible. The majority of the cost variance will be negated when scheduled work is completed or rescheduled eliminating the schedule variance. The actual cost overrun is expected to be $13K.

Cumulative Schedule Variance: ($-219K / %)
Cause:
A portion of this negative schedule variance is due to FY1996 delays in completion of level 3 milestone 3GUS619M as well as delays in Alcove 4 testing. The milestone was delayed due to delays in construction of alcove boreholes, drilling, cleaning, borehole logging, etc., along with restricted field support, access, electrical power, resulting in both delays and additional time requirements for field testing. Further schedule delays have occurred in FY1997 due to difficulties in locating the Ghostdance Fault and construction delays resulting in a projected delay of at least two months for milestone SP3500M3, "Initiate North GDF Testing".

Impact:
Collection of field data, analysis and report preparation were delayed. Milestone 3GUS619M currently is scheduled for completion on 12/31/96, and milestone SP3500M3 is scheduled for completion 5/13/97.

Recovery Plan:
Expedite completion and review of milestone report 3GUS619M. A Change Request is being prepared by the M&O to reschedule work relating to the North Ghost Dance Fault alcove.

Variance at Complete: ($-11K / %)
Variance is within tolerance.

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

Yucca Mountain Project
Variance Analysis Report

Entered on: 12/17/96 02:43 PM **Entered by:** Raye Arnold
WBS: 1.2.3.3.1.2.7
WBS Title: Unsaturated Zone Hydrochemistry
AM: JONES S. **OM:** HAYES L.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 11/96

Data:

Cumulative Cost Variance: ($-119K / %)
Cause:
The primary cause of this negative cumulative cost variance is the negative cumulative schedule variance resulting from delays in completing milestone 3GUH607M in FY1996. Staff costs continued to be incurred for report preparation while waiting for gaseous-phase C-14 data.

Impact:
There is some impact from this cost variance. The P&S account had a slight underrun ($6K) in FY1996 and it is estimated that it will cost $30K to complete the milestone resulting in a cost overrun at the P&S level of $24K at the end of FY1997.

Recovery Plan:
None possible. The majority of the cost variance will be negated when the work is completed eliminating the schedule variance. The actual cost overrun is expected to be $24K.

Cumulative Schedule Variance: ($-94K / %)
Variances are within threshold.

Variance at Complete: ($-49K / %)
Variances are within threshold.

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

Yucca Mountain Project
Variance Analysis Report

Entered on: 12/17/96 03:08 PM **Entered by:** Raye Arnold
WBS: 1.2.3.3.1.3.1
WBS Title: Site Saturated Zone Ground-Water Flow System
AM: JONES S. **OM:** HAYES L.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 11/96

Data:

Cumulative Cost Variance: ($122K / %)
Cause:
This positive cost variance is due primarily to the cleanout of WT-12 requiring less time and resources than was budgeted for the effort in FY1996.

Impact:
There is no schedule impact to this cost variance. FY1996 work was completed with less time and resources than budgeted. There was an actual cost underrun in this P&S account of $114K. These funds were identified to help offset the FY1996 overrun in other 1.2.3 P&S accounts.

Corrective Action:
No corrective action required. Projected underrun will be used to help offset projected overrun. Funds were used to cover overruns in other accounts in FY1996. Cost recovery is not possible in FY1997.

Cumulative Schedule Variance: ($0K / %)
Variances are within threshold.

Variance at Complete: ($118K / %)
See "Cumulative Cost Variance".

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

Yucca Mountain Project
Variance Analysis Report

Entered on: 12/17/96 03:14 PM **Entered by:** Raye Arnold
WBS: 1.2.3.6.2.2.1
WBS Title: Quaternary Regional Hydrology
AM: JONES S. **OM:** HAYES L.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 11/96

Data:

Cumulative Cost Variance: ($116K / %)
Cause:
Positive cumulative cost variance results from the FY1996 positive cost variance of $28K, with the remaining $88K occurring in FY1997. The primary cause for the FY1997 cost variance is errors in time-phasing the budget for this account. The heaviest costs occur in the last quarter of the fiscal year due to laboratory costs, etc. This is not reflected in the time phasing.

Impact:
There is no impact resulting from this cost variance.

Recovery Plan:
Correct time-phasing of budget for remaining months to more accurately reflect planned spending.

Cumulative Schedule Variance: ($0K / %)
Variances are within threshold.

Variance at Complete: ($38K / %)
Variances are within threshold.

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

Prepared - 12/12/96:07:23:25 | WBS Status Sheet (WBS02) | Inc. Dollars in Thousands

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	989	942	783	-47	159	1945	1840	1603	-105	237	11387	11491	-104
1.2.5	Regulatory	44	44	18	0	26	79	79	40	0	39	504	491	13
1.2.8	Environment, Safety, and H	49	49	37	0	12	99	99	76	0	23	612	605	7
1.2.9	Project Management	60	60	42	0	18	122	122	88	0	34	664	660	4
1.2.12	Information Management	5	5	3	0	2	13	13	7	0	6	80	78	2
1.2.15	Support Services	145	145	137	0	8	287	287	277	0	10	1722	1722	0
Total		1292	1245	1020	-47	225	2545	2440	2091	-105	349	14969	15047	-78

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	19867	19764	19855	18584	19318	19353	19352	19325	18653	18082	231292
LABOR	885	899	908	913	907	893	872	874	865	872	851	842	10581
SUBS	139	143	145	140	137	137	128	133	131	133	133	123	1622
TRAVEL	25	43	42	45	43	47	35	34	37	34	35	31	451
PM&E	7	6	8	5	9	6	7	5	9	7	5	4	78
OTHER	197	201	202	206	197	184	178	180	175	177	169	171	2237
Total BCWS	1253	1292	1305	1309	1293	1267	1220	1226	1217	1223	1193	1171	14969

Actual Cost of Work Performed

LBRHRS	19283	18578	0	0	0	0	0	0	0	0	0	0	37861
LABOR	771	712	0	0	0	0	0	0	0	0	0	0	1483
SUBS	127	139	0	0	0	0	0	0	0	0	0	0	266
TRAVEL	11	24	0	0	0	0	0	0	0	0	0	0	35
PM&E	43	16	0	0	0	0	0	0	0	0	0	0	59
OTHER	119	129	0	0	0	0	0	0	0	0	0	0	248
Total ACWP	1071	1020	0	0	0	0	0	0	0	0	0	0	2091

Prepared - 12/12/96:07:23:25 | 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	20037	19771	19862	18601	19318	19353	19352	19325	18653	18082	192354
LABOR	0	0	931	910	888	931	894	876	882	885	878	869	8944
SUBS	0	0	145	153	148	151	144	144	149	151	155	138	1478
TRAVEL	0	0	44	48	44	48	36	35	39	37	39	32	402
PM&E	0	0	9	5	8	6	9	5	9	7	2	1	61
OTHER	0	0	204	229	258	225	179	182	192	192	188	222	2071
Total ETC	0	0	1333	1345	1346	1361	1262	1242	1271	1272	1262	1262	12956

Resource Distributions

Fiscal Year 1997	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
BCWS	1253	1292	1305	1309	1293	1267	1220	1226	1217	1223	1193	1171	14969
BCWP	1195	1245	0	0	0	0	0	0	0	0	0	0	2440
ACWP	1071	1020	0	0	0	0	0	0	0	0	0	0	2091
ETC	0	0	1333	1345	1346	1361	1262	1242	1271	1272	1262	1262	12956

Fiscal Year Distribution

	Prior	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	Future	At Complete
BCWS	15914	14969	9432	980	0	0	0	0	0	0	0	0	41295
BCWP	15609	2440	0	0	0	0	0	0	0	0	0	0	
ACWP	15908	2091	0	0	0	0	0	0	0	0	0	0	
ETC	0	12956	9432	980	0	0	0	0	0	0	0	0	41367

YMP PLANNING AND CONTROL SYSTEM (PACS)

Participant U.S. Geological Survey
Date Prepared 12/11/96 15:48

MONTHLY COST/FTE REPORT

Fiscal Month/Year NOVEMBER 1996

	CURRENT MONTH END						FISCAL YEAR		
WBS ELEMENT	ACTUAL COSTS	PARTICIPANT HOURS	SUBCON HOURS	PURCHASE COMMITMENTS	SUBCON COMMITMENTS	ACCRUED COSTS	APPROVED BUDGET	APPROVED FUNDS	CUMMULATIVE COSTS
1.2.3	787	15581	2264	0	1207	32	11838	4176	1604
1.2.5	18	168	336	0	242	0	53	200	39
1.2.8	37	619	0	0	0	0	612	400	76
1.2.9	42	840	168	0	73	4	664	300	88
1.2.12	3	168	0	0	0	7	80	20	7
1.2.15	135	1201	336	0	93	25	1722	700	273
TOTALS	1022	18577	3104	0	1615	68	14969	5796	2087

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR 10/1/96 - 11/30/96

		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
OG39BFB1E	Provide Input to SC Progress Report 16	9.9	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.9
OG39BFB2	Develop PISA Chapter 2.4 (Hydrology)	11.6	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.1
OG39BFB2E	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
OG39BFB4	Dev Climate/Meteorologic Sys Desc (PISA	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
1.2.3.9.11		66.2	66.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	132.4
*1.2.3.9		66.2	66.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	132.4
**1.2.3		817.4	786.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1603.7
OG535FA1	Provide FY97 Technical Data Base Input	21.3	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.3
1.2.5.3.5		21.3	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.3
*1.2.5.3		21.3	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.3
OG541FA2	Viability Assessment Scenarios Developme	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
1.2.5.4.1		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
OG544FA1	UZ Flow Model Abstractions for VA	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
OG544FA2	SZ Flow Model Abstractions for VA	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
1.2.5.4.4		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
*1.2.5.4		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
**1.2.5		21.3	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.3
OG825FA1	Federal Occupation Safety & Health	8.8	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.9
1.2.8.2.5		8.8	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.9
*1.2.8.2		8.8	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.9
OG845FA1	Radiation Protection	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
1.2.8.4.5		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
OG847FA1	Water Resources Envir Impact Stmt Suppor	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
OG847FA2	Rad Water Quality Sample Collection	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
OG847FB1	Water Resources	30.4	29.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0
1.2.8.4.7		30.4	29.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0
*1.2.8.4		30.4	29.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0
**1.2.8		39.2	36.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.9
OG912FA1	Participant Technical Project Office	25.0	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.2
1.2.9.1.2		25.0	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.2
*1.2.9.1		25.0	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.2
OG922FA1	Participant Project Control - USGS	21.4	18.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0
1.2.9.2.2		21.4	18.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0
*1.2.9.2		21.4	18.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0
**1.2.9		46.4	41.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88.2
OGC522FA1	Satellite Records Operations	3.8	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3
1.2.12.5.2.2		3.8	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR 10/1/96 - 11/30/96

		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
*1.2.12.5		3.8	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3
**1.2.12		3.8	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3
OGF23FA1	Support/Personnel Services	32.4	28.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.1
OGF23FA2	Facilities Management - Space	61.7	61.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	123.4
OGF23FA3	Facilities Management - Computers/Phones	16.7	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.4
OGF23FA4	Facilities Management - Other	12.5	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0
OGF23FA5	Procurement/Property Management - USGS	10.2	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.2
1.2.15.2.3		133.5	130.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	264.1
*1.2.15.2		133.5	130.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	264.1
OGF3FA1	USGS Training Support	4.5	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.7
1.2.15.3		4.5	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.7
*1.2.15.3		4.5	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.7
**1.2.15		138.0	134.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	272.8
1.2 OPERATING		1066.1	1021.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2087.2
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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2087.2
FTEs														
FEDERAL		112.7	108.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CONTRACT		17.0	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOTAL		129.7	126.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

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