# United States Department of the Interior

U. S. GEOLOGICAL SURVEY
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Denver, Colorado 80225


IN REPLY REFER TO:

QA: N/A

May 13, 2004

Victor W. Trebules
Director, Office of Project Control
U.S. Department of Energy
Office of Repository Development
1551 Hillshire Drive
Las Vegas, NV 89134-6321

SUBJECT: Yucca Mountain Project Branch – U.S. Geological Survey (YMPB-USGS) Progress Report, April, 2004

Attached is the USGS progress report in the required format for the month of April, 2004.

If you have any questions or need further information, please call Raye Ritchey Arnold at (702)236-5050, ext. 296.

Sincerely,

Raye Ritchey Arnold

Robert W. Craig
Technical Project Officer for the
Yucca Mountain Project
U.S. Geological Survey

Enclosure:
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# U.S. GEOLOGICAL SURVEY

## YUCCA MOUNTAIN PROJECT BRANCH

Executive Summary

April 2004

GEOLOGICAL STUDIES

Development and interpretation of Nye County borehole lithostratigraphy by the USGS stratigraphic team continued during April. Particular attention was paid to correlation of subsurface geology and geophysical-log signatures from Nye County early-warning drilling program (EWDP) boreholes NC-EWDP-24P and NC-EWDP-29P. Similar but unscheduled work also occurred, with lithostratigraphic logging of the continuous core samples of the alluvium from borehole NC-EWP-19PB performed at the SMF April 5 through April 9. Samples available for examination were obtained from depths between 350 to 634 feet in that –19PB borehole. (That sonic coring experiment was initiated after finalization of the schedule, hence the "unscheduled" status.)

In related work by the geochemical and isotope-chemistry group, twenty-eight samples of cuttings from Nye County boreholes were analyzed during the second quarter of FY2004 using energy-dispersive X-ray fluorescence. A laboratory standard (specifically, GSP-1) was analyzed for quality control with each batch of samples. Elements analyzed included K, Ca, Ti, Mn, Fe, Rb, Sr, Y, Zr, Nb, Ba, La, and Ce. Those elements are particularly useful in fingerprinting the various volcanic units in the vicinity of Yucca Mountain. Results of the X-ray fluorescence work will be used to aid identification and correlation of units at the southern distal end(s) of ash-flow and ash-fall units with type localities to the north.

In other work on the NC-EWDP-19PB borehole carried out in further isotopic and hydrochemical support to the Nye County EWDP by the USGS, development of method for the extraction and processing of water from the sonic core taken from NC-EWDP-19PB was completed. Analyses of several extractions of water from –19PB core were completed during that developmental phase to identify best practices for processing of the core. In addition, preparation of the summary report on [Yucca Mountain] site hydrochemistry continued. A detailed annotated outline of that report has been completed, and development of the report also continued.

Multiple efforts remained active for characterization of fractures and the lithophysal nature of the repository host horizon (RHH). Fracture analysis continued, with emphasis on evaluation of ground-motion accelerations in the RHH. Revision (rev. 3) of the Drift

Degradation AMR neared completion. The completion of that AMR will produce Q output data that can be included in the Fracture report. Additional refinement of fracture data for the Fracture report will be included as output data from the safety analysis report (SAR) on fracture and lithophysal characteristics. Lithophysal panel maps and surveys remained in review. Due to participation in the "geologic limits on ground-motion studies" by critical staff, however, current estimates of expected-finish dates will be pushed farther into the summer.

During April, a baseline change proposal for FY2004 was approved for lithophysal investigations related to Thermal Tests #4 and #5. The newly approved work will initiate collection of in situ data in concert with the thermal tests and thereby contribute to quantification of lithophysal porosity.

SATURATED-ZONE STUDIES

Extensive work again supported modeling of the Death Valley regional flow system (DVRFS), with particular emphasis on hydrogeologic data integration, flow-model calibration, and development of the project report. Integration of hydrogeologic data remained an important focus of the modeling effort. Staff generated data sets by querying pumpage and water-level data bases used to QC model input and output data sets and tables presented in report Chapter F. Data sets were compared with model and Chapter F content, and appropriate changes were made to finalize flow-model and report chapters. The finalized water-level data base used to generate head observations for the DVRFS transient-flow model was incorporated into Chapter D of the associated report, as was the finalized pumpage data base (used to generate modeled pumping stresses). Tables, figures and model-input files were crosschecked and updated where appropriate to satisfy review comments. C. San Juan met with staff at revision, Inc., to discuss updates associated with GeoPro, version 2.2.3. Modifications to GeoPro, v. 2.2.3, were subsequently requested, and feasibility of implementing changes was explored. Discussion regarding a new approach for integrating documentation of scientific work with spatial data sets managed by GeoPro was explored. Planning associated with transferring property records and physically shipping the GeoPro server from Tucson, AZ, to Denver, CO, continued. Modification of pre- and post-processing codes to integrate the spatial database with the DVRFS flow model continued. Those code modifications provide functionality to support the on-going model-refinement and calibration processes resulting from technical comments made by the reviewers of the DVRFS transient model report. Staff also met with revision, Inc., to review development progress of the Dynamic Report and requested modifications based on responses from numerous demonstrations presented in March.

Flow-model calibration and evaluation also continued. Responses to comments from review of the conceptual model chapter were completed, and the report was submitted to the editor. Work continued on updating of illustrations based upon comments from the editor. Staff addressed resolution of several post-processing issues, and model runs examining effects of depth decay, recharge, and updated discharge values continued.

The DVRFS knowledge-exchange protocol remained a very important segment of the DVRFS effort. Work on the flow-model report continued, as staff prepared responses to review comments on the transient numerical model (Chapter F) and edited report chapters (including geology, data sets, hydrology, and hydrogeologic framework construction). Those chapters were sent on to the Publications Specialist for technical editing. Editor's comments were incorporated into chapters on data and HFM construction, and illustrations and tabular presentations were refined. The hydrology chapter of the transient-model report was finalized and submitted to the report editor; finalized figures and tables were sent to the illustrator prior to submittal to Region for review. Other efforts followed, including responses and re-writing after review comments, finalization of illustrations after review, and submittal to the editor. Extensive internal meetings and discussions throughout April addressed issues regarding merging finalized data between chapters in the DVRFS transient flow model report, including final checks and comparisons between chapter tables, figures and model input files, and finalizing comment responses and text in respective chapters. Particular focus, not surprisingly, was placed on the hydrology chapter. The April knowledge-exchange meeting was cancelled to emphasize focus on report issues.

Finally, work continued on development and evaluation of the predictive capability of the DVRFS model. The current decision-analysis contractor (Newfields) continued work on an improved version of their "dynamic systems model" (using the transient model) by continued evaluation of possible predictions, developing workflow, testing, and prediction-evaluation techniques. Staff attended a pre-proposal conference concerning the Decision Analysis contract currently out for bid and demonstrated GeoPro to potential bidders.

## UNSATURATED-ZONE STUDIES

Output from the array of sensors and measurements collected in the Alcove #8/Niche #3 infiltration experiment were received and processed following the routine transfer of those data from the TCO. (See previous reports for detailed citation of specific instruments.) Water was applied to the large plot continuously throughout April. Activity in the tracer experiment (begun March 1) is detailed in the accompanying table (see below). Some 609 liters of tracer solution, which did not infiltrate, was collected in a waste tank and removed. After the tracer water was removed from each zone, the permeameters (filled with non-tracer water) were brought back on-line, and non-traced water application resumed. The scaled "ruler" system installed on March 1 continued to be used for measuring change in the height of ponded water in each plot. Measurements collected from the ruler system have been used in estimating the volume of tracer water that has infiltrated. The changes in height as measured from the rulers are also compared to the pressure-transducer data for each plot. That comparison allows staff to gauge how well the pressure transducers are measuring the continuous water levels within each plot. Monitoring of the collection system in Niche 3 continued.

| Plot # | Zone # | Tracer | Liter of Tracer Solution | Concentration (ppm) | Start Date | End Date (If applicable) | Applied Volume (l) | Amount removed and disposed of (l) |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2-6-Difluorobenzoic Acid | 1000 | 50 | 3/1/2004 | 4/13/04 | 837 | 163 |
| 2 | | Potassium Iodide | | 10 | | | | |
| 3 | 2 | 2, 5-Difluorobenzoic Acid | 500 | 50 | 3/1/2004 | 3/17/2004 | 310 | 190 |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | Calcium Bromide | | 500 | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | 3 | 2, 4, 5-Trifluorobenzoic Acid | 1000 | 50 | 3/1/2004 | 4/13/04 | 744 | 256 |
| 11 | | | | | | | | |
| 12 | | Potassium Fluoride | | 50 | | | | |

Emphasis in bulkhead moisture monitoring during April remained on assembly of data packages. Compilation and review of several packages continued, in some cases with large packages resulting from hundreds of instrument-calibration records. Specific effort was focused on the neutron logging and calibration equation. A thermocouple data package has been sent for additional preparation. Calibration data for the heat-dissipation probe data are being prepared. Additional effort is required to finalize calibration equations; when those equations are complete, work will begin on the RTD/HDP (resistance temperature device/heat-dissipation probe) ring data. In spite of that focus on preparation of data packages, active moisture monitoring continued. Equipment maintenance was performed, and processing of data continued. Preparation of bulkhead moisture-monitoring data packages is linked to re-entry dates behind closed bulkheads.

In work on the characterization of the chemical and isotopic composition of pore water, preparation of data tables for the complete pore-water chemistry data set was finished, including reviewing the tables for consistency and adding stratigraphic information where necessary. The tables were sent to LBNL staff to facilitate preparation of materials for the May NWTRB meeting in Washington. Because there are no indications of gaps in the data that could be resolved by extraction of additional samples on hand, no additional core samples have been selected for analysis. Staff participated in a preparatory meeting at LBNL on April 28 to support presentations by C. Steefel that will discuss chemical analysis of pore water and dust.

Support by the isotope team to thermal testing also continued. In anticipation of forwarding the Thermal Testing Analysis Report for licensing review, additional traceability information was requested for figures that show strontium and uranium isotope analyses of waters collected from the Drift Scale Test. USGS staff began to assemble the required information, consisting of detailed citations of data in the TDMS as well as one additional data package submittal for samples of introduced materials collected from the ESF and AOD (the Access Observation Drift, the mined access to the

thermal test block). Most of the required information has been assembled for that data package, which will be submitted as non-Q due to lack of sample traceability documentation.

The isotope team also completed a full chemical analysis of a centrifuged water sample from HD-PERM-3 core that was stored for many years. Preliminary comparison of results with those determined by LLNL staff indicates agreement for most constituents with the exception of nitrate and silica, both of which are higher in this new analysis. The increased silica is likely due to sample storage in a borosilicate glass vial, but the higher nitrate is not readily explained. It has been noted, however, that the previous analyses of HD-PERM centrifuged water by LLNL were rather low in nitrate compared to other pore-water samples. Bicarbonate alkalinity was determined in the new analysis, allowing determination of cation-anion balance at about +4%, indicating an acceptable chemical analysis. B. Marshall prepared slides summarizing moisture content measurements and mineral saturations calculated from chemical analyses of HD-CHEMSAMP core samples for M. Peters and the upcoming presentation at the May meeting of the NWTRB.

Several applications of U-series delineation of UZ flow zones continued during April. Core samples from ESF boreholes across the Drill Hole Wash fault zone were requested for U-series and chemical analyses. Core was previously used as sample material for vacuum distillation of water for tritium analyses as part of the Chlorine-36 Validation activity. The current samples were selected to look for evidence of greater fluxes at the repository horizon, corresponding to greater modeled infiltration along the Drill Hole Wash feature. Additional U-series isotope ($^{234}U/^{238}U$, $^{230}Th/^{238}U$, and $^{232}Th/^{230}Th$) analyses of ECRB (Enhanced Characterization of the Repository Block) rock samples associated with the Solitario Canyon fault were made. Compilation and reduction of data continued. Chemical analyses of whole-rock samples were completed for a suite of Solitario Canyon fault rock samples submitted to USGS Analytical Services. Additional analyses of water-soluble ions were requested.

Investigation of microclimate records in fracture materials also proceeded during April. Additional mounts of secondary ESF mineral coatings were prepared for analysis by ion microprobe. Results from previous analytical sessions were used to select coatings with outermost ages between 20 and 50 ka, to allow more comprehensive determination of age-depth profiles. In addition, mounts were prepared from ESF mineral coatings taken from the Drill Hole Wash fault zone, also to search for evidence of greater fluxes at the repository horizon corresponding to greater modeled infiltration along the Drill Hole Wash feature. Those mounts are expected to be analyzed at the Stanford-USGS ion microprobe in mid-May. The technical procedure for micro-XRF analyses of secondary mineral coatings received official QA review, and minor comments were returned to the author.

Additional effort by the geochemical/isotope team was focused on characterization of ESF dust, a characterization currently with little data. Collection of atmospheric dust samples was discussed with the TCO. Natural and man-made dust collectors such as

rock cavities and rooftops will be used to collect samples of atmospheric dust for chemical and mineralogic analyses. Staff (largely Z. Peterman) compiled and synthesized compositional information on atmospheric dust from published and unpublished sources. Those compilations will be used immediately by the Yucca Mountain Project (as a sort of baseline) in presentations by C. Steefel, M. Peters, and R. Andrews at the upcoming Nuclear Waste Technical Review Board meeting in Washington, D.C., to be held May 18 and 19. Published data from previous USGS reports by Marith Reheis were synthesized to give average values for key parameters and indications of their variability. Mean values determined from atmospheric dust collected in the vicinity of Yucca Mountain are: organic carbon, 8.7±1.1; soluble salts, 13.3±2.0; gypsum, 2.5±0.4; and calcium carbonate, 1.7±0.4 weight percent. The remainder of the dust is composed of silicates. Analyses of anions in soluble salts were supplied by John Izbicki (USGS San Diego) and Greg Michalski (UC San Diego). Two data sets for samples collected in 2002 agree well, and the means of Izbicki's analyses in relative percentages include: Cl, 10.1±4.3; $NO_3$, 58.1±10.3; and $SO_4$, 31.8±8.0. Further collection and examination of appropriate samples may support several investigations. A critical parameter for corrosion issues, for example, is the $NO_3$/Cl ratio, for which (in those data sets) the mean is 5.6±2.2, well above the critical value of 0.2. Below that critical ratio, corrosive $CaCl_2$ brines might form from deliquescing salts.

The geochemical group also contributed to other issues. Z. Peterman compiled chemical analyses of pore water from the Topopah Spring Tuff welded unit (TSw) to illustrate the scale of parameter variability. Compositions of six samples each were compared from a Cross-Drift borehole (ECRB-SYS-CS1000) and a Main-Drift borehole at the southern bend (ESF-THERMALK-017). Coefficients of variation (CV) for parameters in pore water from ECRB-SYS-CS1000 range from 69 percent for nitrate to 37 percent for sulfate and sodium. In contrast, CV values for samples from ESF-THERMALK-017 range from 4 percent for nitrate to 13 percent for chloride and sulfate. The variability in dissolved silica is low in both boreholes, ranging from 15 percent to 9 percent and suggesting saturation in the pore waters. Effort to complete the chlorine-36 ($^{36}Cl$) validation continued. Revision of the $^{36}Cl$ report officially started on May 3. Guidance on the scope of that report is being sought from the DOE.

Work to improve understanding of the thermal history of Yucca Mountain using mineralogical relationships continued. All previously received sections now have been mapped to identify fluid-inclusion assemblages containing evidence of elevated depositional temperatures and to evaluate the presence and orientation of strain twinning in calcite. Preliminary observations indicate that some sections contain fluid inclusions formed at slightly elevated temperatures (perhaps as high as 60°C). An array of thin sections will be examined for cathodoluminescence indicating growth layering, most typically caused by compositional variation over time. Several sections have been mapped to identify targets for micro-sampling of material for study of stable C and O isotope relations. One sample contains relatively young opal which may be suitable for geochronology.

WATER-RESOURCES MONITORING

Preparation of second-quarter water-resources monitoring work culminated in production of a letter report to the TPO and to DOE describing compiled data collected from January through March 2004 regarding ground-water levels and spring-discharge information. That letter report was prepared, and later delivered to DOE on **April 28,** in completion of **milestone PAGSW270M4 [Conduct Ground-Water/Spring-Flow Monitoring 3rd Quarter 2004].** In routine, on-going water-resources monitoring, ground-water levels were measured at 34 sites, and ground-water discharge was measured at five springs and at one flowing well. Ground-water and spring-discharge data collected during March were checked and filed.

Compilation by **W. Clay Hunter, U.S. Geological Survey,** Yucca Mountain Project Branch.

# USGS Milestone Report

## October 1, 2003 April 30, 2004

Sorted by Milestone Level and Baseline Date

**Level: 3**

| Deliverable | | Due Date | Expected Date | Completed Date |
|---|---|---|---|---|
| FY2004 | | | | |
| **PAGSC2070D** | Training Cost Information Annual Update | 12/19/2003 | 12/19/2003 | 12/19/2003 |

# USGS Milestone Report

## October 1, 2003 April 30, 2004

Sorted by Milestone Level and Baseline Date

**Level: 4**

| Deliverable | | Due Date | Expected Date | Completed Date |
|---|---|---|---|---|
| FY2004 | | | | |
| **PAGSW266M4** | Letter Report: 4th Qtr FY03 | 10/31/2003 | 10/31/2003 | 10/31/2003 |
| **PAGSW268M4** | Letter Report: 1st Qtr FY04 | 1/30/2004 | 1/30/2004 | 1/30/2004 |
| **PAGSW610M4** | Rev 00A of Report | 1/30/2004 | 7/30/2004 | |
| **PAGSW605M4** | Fract & Lithophysal Char Final Data to TDMS/RPC | 3/8/2004 | 6/15/2004 | |
| **PAGSZ705M4** | Data to TDMS/RPC | 3/12/2004 | 3/25/2004 | 3/25/2004 |
| **PAGSW270M4** | Letter Report: 2nd Qtr FY04 | 4/30/2004 | 4/28/2004 | 4/28/2004 |

# USGS Milestone Report

## October 1, 2003 April 30, 2004

Sorted by Milestone Level and Baseline Date

**Level: 5**

| Deliverable | | Due Date | Expected Date | Completed Date |
|---|---|---|---|---|
| FY2004 | | | | |
| **PAGSM38EM5** | Mtg Summary to TPO: Oct03 | 10/31/2003 | 10/31/2003 | 10/31/2003 |
| **PAGSM38FM5** | Mtg Summary to TPO: Nov03 | 11/28/2003 | 11/30/2003 | 11/30/2003 |
| **PAGSM31AM5** | Memo to TPO: Data Mgmt Progress Report | 12/31/2003 | 12/23/2003 | 12/23/2003 |
| **PAGSM33AM5** | Memo to TPO: Progress Report HFM Updates | 12/31/2003 | 12/31/2003 | 12/31/2003 |
| **PAGSM35AM5** | Memo to TPO: Prg Rpt Transient Model Calibration | 12/31/2003 | 12/31/2003 | 12/31/2003 |
| **PAGSM38GM5** | Mtg Summary to TPO: Dec03 | 12/31/2003 | 12/31/2003 | 12/31/2003 |
| **PAGSM38HM5** | Mtg Summary to TPO: Jan04 | 1/30/2004 | 1/31/2004 | 1/31/2004 |
| **PAGSM36CM5** | Update on Predictive Capability Progress | 2/27/2004 | 2/27/2004 | 2/27/2004 |
| **PAGSM38IM5** | Mtg Summary to TPO: Feb04 | 2/27/2004 | 2/27/2004 | 2/27/2004 |
| **PAGSZ305M5** | LANL Input to USGS | 3/29/2004 | 6/14/2004 | |
| **PAGSM38AM5** | Memo to TPO: Submit Revised Transient Model Rpt | 3/31/2004 | 3/30/2004 | 3/30/2004 |
| **PAGSM38BM5** | Memo to TPO: Complete Response Reviewer Comments | 3/31/2004 | 3/30/2004 | 3/30/2004 |
| **PAGSM38JM5** | Mtg Summary to TPO: Mar04 | 3/31/2004 | 3/30/2004 | 3/30/2004 |
| **PAGSZ306M5** | Review Draft to Checking | 4/19/2004 | 7/6/2004 | |
| **PAGSM38KM5** | Mtg Summary to TPO: Apr04 | 4/30/2004 | 4/30/2004 | 4/30/2004 |

YMP PLANNING AND CONTROL SYSTEM (PACS)

MONTHLY COST/FTE REPORT

Participant U.S. Geological Survey
Date Prepared 5/13/2004 07:07 AM

Fiscal Month/Year April 30, 2004


| | CURRENT MONTH END | | | | | | FISCAL YEAR | | |
|---|---|---|---|---|---|---|---|---|---|
| WBS ELEMENT | ACTUAL COSTS | PARTICIPANT HOURS | SUBCONTRACT HOURS | PURCHASE COMMITMENTS | SUBCONTRACT COMMITMENTS | ACCRUED COSTS | APPROVED BUDGET | APPROVED FUNDS | CUMMULATIVE COSTS |
| 1.5.01.01 | 201 | 2379 | 616 | 0 | 184 | 0 | 2833 | 0 | 1339 |
| 1.5.01.05 | 31 | 452 | 327 | 0 | 76 | 0 | 444 | 0 | 276 |
| 1.5.01.06 | 27 | 334 | 309 | 0 | 68 | 0 | 291 | 0 | 203 |
| 1.5.01.07 | 51 | 499 | 0 | 0 | 0 | 0 | 579 | 0 | 310 |
| 1.5.01.09 | 256 | 1112 | 1659 | 0 | 363 | 0 | 2499 | 0 | 1185 |
| 1.5.03.01 | -3 | 0 | 0 | 0 | 0 | 0 | 575 | 0 | 22 |
| 1.5.03.03 | 91 | 1069 | 982 | 0 | 261 | 0 | 1341 | 0 | 726 |
| 1.5.03.04 | 89 | 804 | 168 | 0 | 33 | 0 | 1230 | 0 | 515 |
| 1.5.03.07 | 75 | 1439 | 0 | 0 | 0 | 0 | 493 | 0 | 363 |
| 1.5.03.12 | 5 | 345 | 0 | 0 | 0 | 0 | 250 | 0 | 47 |
| 1.5.03.13 | 49 | 307 | 981 | 0 | 259 | 0 | 675 | 0 | 342 |
| 1.5.03.14 | -7 | 58 | 0 | 0 | 11 | 0 | 146 | 0 | 43 |
| | 865 | 8798 | 5042 | 0 | 1255 | 0 | 11356 | 0 | 5371 |

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR October 1, 2003 - April 30, 2004
5/13/2004 7:08:02 AM

| | | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4568-9U001 | Science Advisors | 22.1 | 13.1 | 19.9 | 13.0 | 21.9 | 25.9 | -21.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 94.40 |
| 4568-9U010 | Publications | 13.1 | 0.2 | 4.8 | 3.2 | 8.0 | 17.4 | 41.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 88.33 |
| 4568-9U035 | Chemical Thermodynamic Data Review o | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.3 | 3.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 22.46 |
| 4568-9U040 | Tectonics | 8.1 | 7.3 | 7.0 | 11.8 | 6.0 | 3.7 | 3.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 47.00 |
| 4568-9U041 | Water Levels | 5.0 | 5.4 | 2.2 | 2.6 | 2.4 | 3.3 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 24.99 |
| 4568-9U042 | Geophysics | 0.0 | 1.5 | 6.6 | 1.2 | 0.0 | 4.9 | 3.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 17.82 |
| 4568-9U060 | Mapping Expertise (USBR) | 4.5 | 5.5 | 7.4 | 22.7 | -3.0 | 4.2 | 35.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 77.22 |
| 4568-9U081 | Geochemistry | 67.7 | 47.2 | 40.2 | 98.9 | 70.9 | 93.3 | 17.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 435.30 |
| **819Y01** | USGS Technical Advisory Capability | 120.5 | 80.1 | 88.1 | 153.6 | 106.2 | 172.1 | 86.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 807.53 |
| 4568-9U002 | Br Chief, Asst Br Chief, Deputy TPO, Tea | 32.0 | 15.8 | 43.7 | 43.7 | 21.8 | 61.8 | 68.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 286.91 |
| **819Y11** | USGS Branch Management | 32.0 | 15.8 | 43.7 | 43.7 | 21.8 | 61.8 | 68.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 286.91 |
| 4568-9U003 | Planning & Project Control | 29.7 | 24.7 | 21.4 | 37.1 | 36.5 | 49.9 | 45.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 244.86 |
| **819Y21** | USGS Planning & Project Control | 29.7 | 24.7 | 21.4 | 37.1 | 36.5 | 49.9 | 45.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 244.86 |
| **1.5.01.01** | Project Support - Project Manageme | 182.3 | 120.5 | 153.3 | 234.4 | 164.5 | 283.7 | 200.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1,339.30 |
| 4568-9U030 | Regulatory Compliance Support | 41.0 | 27.3 | 33.0 | 40.5 | 43.3 | 60.0 | 31.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 276.09 |
| **819Y31** | USGS Regulatory Compliance Support | 41.0 | 27.3 | 33.0 | 40.5 | 43.3 | 60.0 | 31.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 276.09 |
| **1.5.01.05** | Project Support - Compliance Manag | 41.0 | 27.3 | 33.0 | 40.5 | 43.3 | 60.0 | 31.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 276.09 |
| 4568-9U024 | Computer/Network Support | 30.0 | 21.4 | 30.0 | 30.8 | 30.5 | 33.8 | 26.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 203.12 |
| **819Y15** | USGS Commputer/Network Support | 30.0 | 21.4 | 30.0 | 30.8 | 30.5 | 33.8 | 26.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 203.12 |
| **1.5.01.06** | Project Support - Information Manag | 30.0 | 21.4 | 30.0 | 30.8 | 30.5 | 33.8 | 26.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 203.12 |
| 4568-9U061 | Water Resources Monitoring | 20.3 | 17.0 | 33.7 | 18.8 | 91.3 | 30.0 | 36.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 247.81 |
| **819Y41** | USGS Water Resources Monitoring | 20.3 | 17.0 | 33.7 | 18.8 | 91.3 | 30.0 | 36.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 247.81 |
| 4568-9U062 | Safety | 9.1 | 3.7 | 7.0 | 7.8 | 5.9 | 14.0 | 14.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 62.00 |
| **819Y51** | USGS Safety | 9.1 | 3.7 | 7.0 | 7.8 | 5.9 | 14.0 | 14.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 62.00 |
| **1.5.01.07** | Project Support - Environmental, Saf | 29.4 | 20.6 | 40.7 | 26.6 | 97.2 | 44.0 | 51.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 309.81 |
| 4568-9U011 | Reports Specialists | 13.3 | 7.2 | 8.9 | 9.6 | 6.6 | 15.2 | 24.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 85.38 |
| 4568-9U012 | Data Management | 36.0 | 16.5 | 30.1 | 30.6 | 28.9 | 42.2 | 29.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 213.93 |

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| | | OCT EST | NOV EST | DEC EST | JAN EST | FEB EST | MAR EST | APR EST | MAY EST | JUN EST | JUL EST | AUG EST | SEP EST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4568-9U013 | Records Support | 7.6 | 5.1 | 7.3 | 6.2 | 6.5 | 7.7 | 7.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 47.62 |
| 4568-9U014 | QAS Support | 22.5 | 18.0 | 23.0 | 20.8 | 21.4 | 28.3 | 26.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 160.84 |
| **819Y12** | USGS Data, Records & Reports | 79.4 | 46.8 | 69.3 | 67.2 | 63.4 | 93.5 | 88.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 507.76 |
| 4568-9U021 | Administrative Support & Personnel Servi | 29.7 | 8.9 | 19.0 | 17.4 | 13.3 | 24.2 | 20.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 132.58 |
| 4568-9U022 | Facilities Management | 0.0 | 114.4 | 52.2 | 98.6 | 53.1 | -59.7 | 110.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 368.92 |
| 4568-9U026 | Facilities Other | 1.6 | 0.1 | 0.0 | -0.7 | 1.7 | 0.1 | 19.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 21.77 |
| **819Y13** | USGS Administration & Facilities | 31.3 | 123.3 | 71.2 | 115.2 | 68.0 | -35.4 | 149.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 523.27 |
| 4568-9U023 | Training | 19.9 | 10.8 | 14.4 | 12.9 | 17.3 | 11.1 | 10.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 96.56 |
| **819Y14** | USGS Training | 19.9 | 10.8 | 14.4 | 12.9 | 17.3 | 11.1 | 10.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 96.56 |
| 4568-9U025 | Property Management | 7.9 | 7.1 | 7.1 | 7.7 | 8.6 | 10.3 | 8.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 57.02 |
| **819Y16** | USGS Property Management | 7.9 | 7.1 | 7.1 | 7.7 | 8.6 | 10.3 | 8.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 57.02 |
| **1.5.01.09** | Project Support - General Project Ser | 138.6 | 188.0 | 162.0 | 203.0 | 157.4 | 79.4 | 256.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1,184.62 |
| **1.5.01** | | **421.2** | **377.9** | **419.0** | **535.2** | **492.9** | **500.9** | **565.8** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **3,312.94** |
| 4568-9U017 | Legacy Software Support | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.01 |
| **APAG01** | USGS Legacy Software Support | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.01 |
| 4568-9U008 | LA Chapter Preparation | 10.3 | 5.3 | 5.9 | -0.6 | 0.0 | 1.5 | -2.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.09 |
| **APAG03** | USGS LA Chapter Preparation Support | 10.3 | 5.3 | 5.9 | -0.6 | 0.0 | 1.5 | -2.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.09 |
| 4568-9U007 | KTI Support | 0.0 | 2.9 | -0.4 | 0.0 | 0.0 | 0.2 | -0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.08 |
| **APAG04** | USGS KTI Support | 0.0 | 2.9 | -0.4 | 0.0 | 0.0 | 0.2 | -0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.08 |
| **1.5.03.01** | Integration | 10.3 | 8.1 | 5.5 | -0.6 | 0.0 | 1.7 | -2.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 22.18 |
| 4568-9U063 | Alcove 8/Niche 3 Infiltration | 16.6 | 15.3 | 21.7 | 44.9 | 26.2 | 52.0 | 36.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 212.94 |
| 4568-9U064 | Moisture Monitoring ESF/X-Drift Closeout | 8.2 | 5.7 | 7.4 | 11.7 | 18.3 | 11.5 | 7.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 70.16 |
| 4568-9U065 | Bulkhead Moisture Monitoring | 34.5 | 14.4 | 18.0 | 9.8 | 11.2 | 16.1 | -0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 103.39 |
| 4568-9U073 | Alcove 7 Moisture Monitoring | 3.2 | 1.7 | 0.6 | 2.4 | 0.5 | 1.1 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.16 |
| **AUZG01** | USGS UZ Moisture Studies | 62.4 | 37.0 | 47.8 | 68.9 | 56.1 | 80.7 | 43.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 396.66 |
| 4568-9U085 | Geochemical Testing of UZ Flow | 15.8 | 8.8 | 3.6 | 18.8 | 5.7 | 17.0 | 7.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 76.85 |
| 4568-9U086 | Complete Chlorine 36 Validation | 0.0 | 4.2 | 0.3 | 2.7 | 0.0 | 0.6 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 8.75 |

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| | | OCT EST | NOV EST | DEC EST | JAN EST | FEB EST | MAR EST | APR EST | MAY EST | JUN EST | JUL EST | AUG EST | SEP EST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4568-9U087 | Chemical & Isotopic Composition of Pore | 9.7 | 6.9 | 15.6 | 9.2 | 9.3 | 21.2 | 19.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 91.05 |
| 4568-9U089 | Mineral Records of UZ Flow | 8.8 | 18.4 | -17.8 | 30.2 | 5.1 | 4.3 | 6.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 55.07 |
| 4568-9U094 | Thermal History of Yucca Mountain | 2.3 | 5.3 | 5.9 | 7.8 | 2.4 | 4.2 | 6.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 34.30 |
| **AUZG02** | USGS UZ Isotope Hydrology | 36.6 | 43.7 | 7.7 | 68.7 | 22.5 | 47.2 | 39.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 266.02 |
| 4568-9U090 | Isotope Support for Thermal Testing | 4.0 | 11.4 | 15.2 | 13.0 | 6.1 | 6.3 | 7.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 63.50 |
| **AUZG03** | USGS Drift-Scale Test ESF | 4.0 | 11.4 | 15.2 | 13.0 | 6.1 | 6.3 | 7.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 63.50 |
| **1.5.03.03** | Safety Analyses - Unsaturated Zone | 103.1 | 92.1 | 70.7 | 150.6 | 84.7 | 134.2 | 90.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 726.17 |
| 4568-9U043 | Hydrogeologic Data Integration | 0.0 | 1.7 | -0.2 | 11.7 | -3.5 | 0.5 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.14 |
| 4568-9U044 | 3D Hydrogeologic Model Development | 0.0 | 0.0 | 0.6 | 18.9 | 1.1 | 8.8 | 18.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 47.49 |
| 4568-9U045 | Flow Model Calibration and Evaluation | 5.2 | 5.1 | 9.0 | 6.7 | 18.0 | 7.2 | 7.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 58.13 |
| 4568-9U046 | DVRFS Knowledge Exchange Protocol | 0.0 | 0.0 | 0.0 | 0.0 | 16.1 | 52.2 | 4.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 72.72 |
| 4568-9U047 | DVRFS Predictive Capability | 0.0 | 3.6 | -0.5 | 0.0 | 0.0 | 0.2 | -0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.61 |
| **819Y61** | USGS Death Valley Regional Flow Mod | 5.2 | 10.3 | 8.8 | 37.2 | 31.7 | 68.9 | 32.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 195.08 |
| 4568-9U049 | Nye County EWDP Borehole Lithostratigr | 8.0 | 9.0 | 24.3 | 10.3 | 11.8 | 18.4 | 14.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 96.07 |
| **ASZG01** | USGS SZ Investigations | 8.0 | 9.0 | 24.3 | 10.3 | 11.8 | 18.4 | 14.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 96.07 |
| 4568-9U055 | Site HFM - AMR | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 4568-9U092 | Hydrochemistry/Support to Nye Co. EWD | 33.4 | 15.0 | 28.6 | 37.8 | 31.3 | 35.5 | 41.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 223.39 |
| 4568-9U093 | Geochemistry of Nye Co. Borehole Sampl | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |
| **ASZG02** | USGS SZ Isotope Hydrology | 33.4 | 15.0 | 28.6 | 37.8 | 31.3 | 35.5 | 41.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 223.39 |
| **1.5.03.04** | Safety Analyses - Saturated Zone Flo | 46.6 | 34.3 | 61.7 | 85.3 | 74.8 | 122.9 | 89.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 514.54 |
| 4568-9U069 | Fracture & Lithophysal Characteristics of | 77.0 | 38.1 | 57.1 | 60.9 | -12.9 | 68.0 | 74.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 362.72 |
| **AEBG03** | USBR Testing Activities in Support of D | 77.0 | 38.1 | 57.1 | 60.9 | -12.9 | 68.0 | 74.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 362.72 |
| **1.5.03.07** | Safety Analyses - EBS Performance | 77.0 | 38.1 | 57.1 | 60.9 | -12.9 | 68.0 | 74.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 362.72 |
| 4568-9U005 | YMP Performance Confirmation | 13.0 | 8.5 | 5.0 | 3.5 | 5.7 | 6.6 | 5.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 47.49 |
| **APAG02** | USGS Performance Confirmation Supp | 13.0 | 8.5 | 5.0 | 3.5 | 5.7 | 6.6 | 5.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 47.49 |
| **1.5.03.12** | Performance Confirmation Support | 13.0 | 8.5 | 5.0 | 3.5 | 5.7 | 6.6 | 5.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 47.49 |
| 4568-9U016 | USGS Data Verification | 49.7 | 29.8 | 53.5 | 47.8 | 47.3 | 64.8 | 49.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 341.97 |

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| | | OCT EST | NOV EST | DEC EST | JAN EST | FEB EST | MAR EST | APR EST | MAY EST | JUN EST | JUL EST | AUG EST | SEP EST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| APAGD5 | USGS Data Verification | 49.7 | 29.8 | 53.5 | 47.8 | 47.3 | 64.8 | 49.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 341.97 |
| 1.5.03.13 | Safety Analyses - Technical Data Ma | 49.7 | 29.8 | 53.5 | 47.8 | 47.3 | 64.8 | 49.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 341.97 |
| 4568-9U004 | USGS Support to Site Description | 6.2 | 7.7 | 23.4 | 2.9 | 3.3 | 6.2 | -6.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 42.81 |
| ANSG01 | USGS Support to Site Description | 6.2 | 7.7 | 23.4 | 2.9 | 3.3 | 6.2 | -6.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 42.81 |
| 1.5.03.14 | Safety Analyses - Yucca Mountain SI | 6.2 | 7.7 | 23.4 | 2.9 | 3.3 | 6.2 | -6.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 42.81 |
| 1.5.03 | | 305.9 | 218.6 | 276.9 | 350.3 | 202.9 | 404.3 | 298.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2,057.88 |
| | 1.5 | 727.2 | 596.5 | 695.9 | 885.5 | 695.8 | 905.3 | 864.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5,370.82 |
| 1.5 OPERATING | | 727.2 | 596.5 | 695.9 | 885.5 | 695.8 | 905.3 | 864.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5,370.82 |
| 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 | | 727.2 | 596.5 | 695.9 | 885.5 | 695.8 | 905.3 | 864.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5,370.82 |
| FTEs | | | | | | | | | | | | | | |
| FEDERAL | | 48.6 | 43.3 | 49.0 | 44.4 | 43.8 | 49.5 | 50.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| CONTRACT | | 31.9 | 25.1 | 29.3 | 29.4 | 30.4 | 36.7 | 32.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| TOTAL | | 80.6 | 68.5 | 78.3 | 73.8 | 74.2 | 86.2 | 82.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |