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Los Alamos National Laboratory
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memorandum

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FROM: Charles Nylander, ESH-18

DATE: December 17, 2001

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SUBJECT: **QUARTERLY MEETING NOTES – OCTOBER 16-17, 2001**

Attached are the minutes from the October 16-17, 2001 Hydrogeologic Characterization Program Quarterly Meeting held at the Cities of Gold Hotel, Pojoaque, New Mexico. These minutes are being sent to you because you have received a copy of the Laboratory's Hydrogeologic Workplan and a binder for the Annual Reports and Meeting Minutes or you have requested to be on the distribution list. If you are not interested in continuing to receive meeting minutes, please contact me at the address or telephone number listed below.

The action items resulting from the meeting follow. The organization responsible for completion of each action item is given in parentheses.

- Copies of the final DOE Value Engineering Study will be distributed to the Hydrogeologic Characterization Program distribution list. (LANL).

- The FY02 drilling activities described in the September 2001 letter to NMED are still considered accurate:
  - Complete R-8 and R-13.
  - Drill and complete R-14 and R-20.
  - Characterization sampling and analysis in completed wells.

  This schedule is predicated on receiving requested additional funding when the FY02 continuing resolution is resolved in Congress. In the case of continuing resolution, agencies are constrained to last year's level of funding. LANL is still anticipating additional funding from DP. When the FY02 funding levels are known, LANL will notify NMED. (LANL).

Please review these minutes for accuracy. If you identify substantive changes that should be made, please submit your comments to me in writing, or via e-mail at nylander@lanl.gov, or by telephone at 665-4681.

Also enclosed are the following documents: Semi-Annual Report to the Groundwater Integration Team (GIT) of the Los Alamos National Laboratory by the External Advisory Group; and the Master Publication List for the Hydrogeologic Characterization Program. This list includes published documents that describe work resulting from the Hydrogeologic Workplan or documents used directly by the program.

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Attachments: a/s

Distribution:
A. Armijo, NNMCAB, Nambe Pueblo, NM, w/enc
M. Manzanares, NNMCAB, w/enc (2 copies)
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T. Longo, DOE/HQ/EM-45, Germantown, MD, w/enc
W. Holman, ERD/DOE, Oakland, CA, w/enc
E. Anderson, EAG, Sciences International Inc., Alexandria, VA, w/enc
R. Charles, EAG, Ranchester, WY, w/enc
R. Powell, EAG, Powell & Associates, Las Vegas, NV, w/enc
J. Powers, EAG, Murray, UT, w/enc
J. Powers, EAG, Bloomington, MN, w/enc
D. Schafer, EAG, Stillwater, MN, w/enc
C. McLane, EAG, Princeton, NJ, w/enc
R. Mayer, EPA, Dallas, TX, w/enc
D. Neleigh, EPA, Dallas, TX, w/enc
T. Glasco, Los Alamos County, Los Alamos, NM, w/enc
P. Padilla, Los Alamos County, Los Alamos, NM w/end
S. Johnson, LATA, w/enc
M. Bates, Los Alamos Study Group, w/enc
K. Bitner, Neptune & Co., Albuquerque, NM, w/enc
K. Hull, Neptune & Co., Albuquerque, NM, w/enc
J. T. Grubesic, Assistant Attorney General, w/enc
L. Lovejoy, NM Atty Genl Ofc, w/enc
J. Bearzi, NMED/HRMB, Santa Fe, NM, w/enc.
J. Young, NMED/HRMB, Santa Fe, NM, w/enc.
M. Leavitt, NMED/GWQB, Santa Fe, NM, w/enc.
P. Bustamante, NMED/GWQB, Santa Fe, NM, w/enc.
J. Davis, NMED/SWQB, Santa Fe NM, w/enc.
J. Parker, NMED/DOE/OB, Santa Fe, NM, w/enc.
P. Maggiore, NMED Secretary, Santa Fe, NM, w/enc.
J. Mullany, NMED/GWQB, Santa Fe, NM w/enc
G. Lewis, NMED/HRMB, Santa Fe, NM w/enc
C. Ash, NMTC, Santa Fe, NM, w/ enc
B. Jacobs, Bandelier, NM, w/enc
J. Pecos, Cochiti Pueblo, Cochiti, NM, w/enc
D. Gonzalez, Cochiti Pueblo, w/enc
G. Valdo, Pueblo Cochiti, w/enc
D. Duffy, Jemez Pueblo, Jemez, NM, w/enc
J. Chavarria, Santa Clara Pueblo, Espanola, NM, w/enc
R. Gutierrez, Santa Clara Pueblo, Espanola, NM, w/enc
M. Taylor, San Ildefonso Pueblo, Santa Fe, NM, w/enc
N. Weber, San Ildefonso Pueblo, Santa Fe, NM, w/enc
K. Nasser, Revision, Denver, CO, w/enc
F. Lauffer, SNL, w/enc
R. Lewis, Schlumberger, Englewood, CO, w/enc

D. McCann, Westbay, N. Vancouver, w/enc
B. Johnson, Westbay, N. Vancouver, w/enc
C. Abeyta, USGS, w/enc.
Congressman T. Udall, Santa, Fe, NM, w/enc
R. Notini, UC, w/enc
R. Enz. DOE/LAAO, MS A316, w/enc
T. Taylor, LAAME, DOE/LAAO, MS A316, w/enc
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B. Grimes, MS A117, w/enc
T. Gunderson, DLDOPS, MS A100, w/enc
J. Aldrich, EES-16, MS D462, w/enc
D. Broxton, EES-16, MS J462, w/enc
G. Cole, EES-16, MS D462, w/enc
F. Goff, EES-16, MS D462, w/enc
D. Hickmott, EES-16, MS D462, w/enc
P. Longmire, EES-16, MS D469, w/enc
D. Vaniman, EES-16, MS D462, w/enc
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K. Birdsell, EES-16, MS T003, w/enc
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A. Pratt, EES-13, MS M992, w/enc
A. Dorries, EES-13, MS M992, w/enc
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D. Katzman, EES-13, MS M992, w/enc
D. Farley, EES-13, MS H865, w/enc
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J. Skalski, EES-17, MS H865, w/enc

C. Echohawk, EES-9, MS C323, w/enc
M. Baker, EM-DO, MS J591, w/enc
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S. Rae, ESH-18, MS K497, w/enc
S. Kinkead, ESH-18, MS K497, w/enc
S. McLin, ESH-18, MS K497, w/enc
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C. Nylander, ESH-18, MS K497, w/enc
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A. Barr, ESH-19, MS K498, w/enc
C. Bare, ESH-20, MS M887, w/enc, (3 copies)
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P. Wardwell, LC-GL, MS A187, w/enc
C. Thayer, LC-GL, MS A187, w/enc
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Los Alamos National Laboratory
Hydrogeologic Characterization Program
Semiannual Meeting
October 16-17, 2001
Minutes

MEETING PURPOSE, ATTENDEES, AND AGENDA

The Los Alamos National Laboratory Groundwater Integration Team (LANL GIT) met with the New Mexico Environment Department (NMED), the Department of Energy (DOE), and stakeholders on October 16-17, 2001 for the Semiannual Hydrogeologic Characterization Meeting and the semiannual external peer review process. The meeting was held at the Cities of Gold Hotel, Pojoaque, New Mexico. Charlie Nylander (GIT Chairperson) facilitated the meeting.

The following groups and stakeholders were represented (see List of Attendees for specific information):

- NMED-Hazardous and Radioactive Materials Bureau
- NMED-Groundwater Quality Bureau
- NMED-DOE Oversight Bureau
- New Mexico Attorney General
- DOE-Environment, Safety, and Health
- DOE-Environmental Management
- DOE-Defense Programs
- DOE-National Nuclear Security Administration
- San Ildefonso Pueblo
- Northern New Mexico Citizen's Advisory Board
- LANL-Groundwater Integration Team (GIT)
- EAG - External Advisory Group

The purpose of the Quarterly Meeting was to provide NMED, DOE, and stakeholders with information on LANL's groundwater protection efforts and present planned activities for the upcoming fiscal year. The meeting agenda was as follows:

Introductions

Groundwater Integration Team (GIT) Subcommittee Reports
- Information Management
- Well Construction
- Geochemistry
- Hydrology
- Modeling

Hydrogeologic Characterization Program FY01 Performance Review

Interface between ER Risk Assessment and Hydrogeologic Workplan

DQO Iteration Overview
- Geology
- Geochemistry
- Vadose Zone Hydrology and Modeling
- Regional Aquifer Hydrology and Modeling

DQO Iteration Proposal

FY02 Schedule and Planning Session

Los Alamos National Laboratory
Hydrogeologic Characterization Program
Semiannual Meeting
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SUMMARY OF PRESENTATIONS AND DISCUSSIONS

Introduction

C. Nylander (LANL) welcomed participants to the Los Alamos National Laboratory Hydrogeologic Characterization Program Quarterly Meeting. A brief history of the program was given noting that the program is at midpoint. The External Advisory Group (EAG) was introduced.

Information Management Subcommittee Report

S. Kinkead (LANL) provided an overview of information management activities of the last quarter. In response to the September 11, 2001 terror attacks, the Water Quality Database (WQDB) is currently offline for LANL review and is anticipated to be online in the near future. Collaborative efforts between the WQDB and the Environmental Restoration (ER) Database continue. Additional collaborations include sharing the design and electronic data deliverables with NMED and the Jemez Pueblo and data exchange with NMED and USGS. The data in the database has been accessed for various uses including the LANL Environmental Surveillance Report, Risk Assessment Corporation's correlation of flow data with chemistry, LANL contaminant data research, ArcView station maps, and data screening.

Information Management Subcommittee plans include redesigning the well construction module of the WQDB, placing water levels into the database, and incorporating geophysics logs and hydrological properties into the database. R-well construction data will be the first online.

The question of adequate resources to accomplish the planned activities was asked. C. Nylander provided a history and status. The ER database and the WQDB have shared structures for which collaboration began about three years ago. Database design was complete approximately one and a half years ago. ER is to populate the tables with data. The initial database design used Oracle. ER changed platforms to SQL for cost and maintenance reasons; thereby, necessitating reprogramming. NMED began making data requests that consumed ER resources from February through July 2001 resulting in schedule delays in the development of the database. ER resources are currently strained with a 30% budget constraint. Current resources are doing multiple jobs (design, data entry, quality assurance). J. Canepa, ER Program Manager, has stated that information management is high priority in the first quarter of FY02. It is anticipated that the database will by fully operable this year.

Well Construction Subcommittee Report

J. McCann (LANL) provided an overview of accomplishments, planned activities, quarterly sampling, and reporting efforts.

Accomplishments:

- Subcontractor given more responsibility, including quality assurance (QA) program and proactive project management.
- Completed life cycle baseline for DP wells.
- FY01 showed positive cost & schedule variance. ER performance measures on drilling programs reflect efficiencies.
- Participated in a Value Engineering study conducted by DOE. When that study is finalized, it will be distributed.

Drilling accomplishments:

R-5 provided a challenge with flowing sands in the hole and difficult stratigraphy. The current drilling approach is to use open hole drilling unless the borehole is unstable. In unstable borehole situations, the casing advance drilling method is used. EZMud was used in small amounts for lubricity. The total depth of the well is 902 ft and there are four screens in place.

R-13, located in Mortandad Canyon, is going well. It was drilled to a total depth of 1133 ft and was completed with one 50-ft long screen. It is currently being developed.

R-8 is in Los Alamos Canyon. It was started in late FY01 and it is down to 260 ft as of today. The surface casing is set and drilling open hole below. A smaller rig is being used for development at R-13 while the larger rig was moved over for drilling the R-8 borehole.

Two non-Hydrogeologic Workplan intermediate-depth wells were drilled in Mortandad Canyon as part of the Mortandad Canyon RFI Work Plan. These wells are MCOBT 8.5 and MCOBT 4.4. When MCOBT 8.5 was drilled to a total depth of 740 ft, no water was found and the hole was plugged and abandoned. MCOBT 4.4 was drilled to a total depth of 767 ft and was completed with one screen. Another non-Hydrogeologic Workplan well, CdV R-37-2, in Water Canyon, was drilled to a total depth of 1664 ft and was completed with four screens.

FY02 planned drilling activities include:

- Finish R-13
- Complete R-8
- Drill R-14, predicated on receiving sufficient budget

Because planning must reflect know budget, the FY02 drilling activities listed above are not the same as stated in the September 2001 letter to NMED. However, the September 2001 letter is still considered accurate as additional funding is expected when the FY02 continuing resolution is resolved in Congress. In the case of continuing resolution, agencies are constrained to last year's level of funding. LANL is still anticipating additional funding from DP.

Regional well sampling status is as follows:

- R-25, R-31, R-22: Third quarterly sampling is complete.
- R-15, R-9, R-12, R-9i, R-19: Have completed all four quarters of sampling. These wells will be transferred to ESH-18, who has the responsibility for custodial care of the wells and maintaining the monitoring network.
- R-7: First quarter sampling was completed.

Reporting schedule is as follows:

- R-25 and R-31 reports are being peer reviewed internally.
- R-22 report is in preparation with the editors.
- Geochemistry reports contain present year's data. The first report, R-15, is due December 2001. R-9/R-9i reports are combined and due March 2002. The R-12 geochemistry report is scheduled for April 2002.

Geochemistry Subcommittee Report

P. Longmire (LANL) reviewed the quarterly groundwater sampling activities and the focused analyte suites for R-wells.

Fifteen wells have been drilled; generally multiple completion, some single screen.

Highlights of water chemistry (validated data) are:

- CDV-15: Non-detection of high explosives (HE) contaminants; tritium is very low (implies water older than 60 yrs) in perched and regional.
- CDV-37 borehole: No contaminant detection.
- R-9i: Two screens in the perched zone; tritium consistent with conceptual model, low with respect to drinking water standard, but a pathway is indicated by presence of tritium at 246 and 167 pCi/ L.
- R-9: Water from the borehole had uranium at 112 ppb (total) and 48 ppb (dissolved); typically uranium is 1 ppb in water supply/springs. R-9 had a temporary completion in the regional aquifer for approximately two years. When R-9 was permanently completed as a well, the borehole was deepened and drilling fluids were used. The uranium in water collected from the well had uranium matching the concentration typically seen in water supply wells and springs. One possible hypothesis that explains why the uranium concentration decreased between the borehole sample and the well sample is the uranium was reduced to an insoluble form by presence of drilling fluids. Another possible hypothesis is the uranium concentrations measured represents natural variability. There is evidence of chemical reduction: elevated iron and magnesium and lower sulfate. Short-term data shows imprint of drilling fluids.
- R-12: Tritium was found in perched and regional. This indicates that there is a pathway from the surface to the perched zones and to the regional aquifer.
- R-15: Strontium in the water samples was measured by gas proportional counting. There is uncertainty near detection limit, and the measured activity of 1.51 pCi/L may not represent a detection of Sr-90. The nitrate present in the regional aquifer water is similar to what is discharged to Mortandad Canyon and is present in the alluvial system. The source of nitrogen may be nitric acid. The perchlorate measured in the regional aquifer (1.54 mg/L) is near the detection limit, so there is a fair amount of uncertainty. However, the detection of perchlorate is consistent with the water chemistry in the alluvial and perched zones.
- R-19: No contaminants were detected in perched zones or in the regional aquifer.
- R-22: The analytical data from the March 2001 sampling event indicated tritium of 0.11 to 77 pCi/L. Technicium-99 was present at 4.9 pCi/L in water from screen 3 and at 4.3 pCi/L in water from screen 5. These were above the minimal detection activity. However, the most recent sampling indicates the technicium-99 is less than detection. The source of technicium-99 is a puzzle. It could be within the Pajarito Canyon watershed. Technicium-99 was disposed at Area G. If the source of technicium-99 were TA-54, traces would be expected in the regional aquifer, but was found in the perched. It is possible that there may be other sources within Pajarito Canyon watershed. Tritium may be entering regional aquifer west of R-22 as well as technicium-99. Technicium-99 is mobile like chloride and perchlorate. There is another well planned for Pajarito Canyon that is expected to provide more information.

  Tritium was detected in a screening sample at 109 pCi/L, but was not detected in the most recent sampling event. This is possible due to dilution when the well was completed. Samples will continue to be analyzed for tritium.

  Uranium was detected in screen 3, as well as elevated sodium and components of bentonite. Further analysis shows that the uranium has natural isotopic ratios. Bentonite used in drilling has uranium. In subsequent water samples the uranium has decreased. If the drilling bentonite was not the source of the uranium, it is not clear where it could have originated. TA-18 used enriched uranium, not natural uranium, and there was no indication of reduction of sulfate.

- R-25: The HE concentration continues to decrease in the regional aquifer, which suggests that it was the result of perched zone water mixing with the regional aquifer. The third quarter sample has not yet been validated, but appears that the HE concentration is lower. In the upper saturated zone the HE concentration has stabilized. Toluene was detected in the perched zone and it has several potential sources including the analytical lab procedure. R-25 is slowly equilibrating. Tritium was noted in perched and regional but is decreasing in regional aquifer similar to HE.
- MCOBT–4.4: A sample of water was taken from the borehole at 494 ft. Tritium, nitrate, and perchlorate were present at the interface of the Cerros del Rio basalt and the Puye Formation.

The geochemistry reports will focus on trends in water chemistry data. For analytical results that are near the detection limit, samples have been sent to a second lab. In the case of perchlorate, two different analytical labs are used. At Babcock Lab, the perchlorate detection limit is 2 ppb. At GEL Lab, the perchlorate detection limit is 1 ppb, but the reporting limit is 4 ppb. Thus, all data between 1 and 4 ppb are "J" flagged. None of the perchlorate detected in drinking water are from samples analyzed by Babcock. All are from GEL.

The analytical method for perchlorate involves running water through columns to extract everything except the perchlorate. If there are substances in the water that interfere with this process, the measured values for perchlorate are wrong. For example, perchlorate was found in the Ogalla Aquifer at the Pantex Plant. When the analytical lab used deionized water, the detection limit for perchlorate was 1 ppb. However, when natural water was used, the detection limit was 4 ppb. The chloride ion is a major interfering ion. At LANL the chloride concentration is low and chloride interference is not expected to be a significant concern.

There is not an MCL for perchlorate, but several states have action levels. California action level for perchlorate is 18 ppb. However, levels as low as 4 ppb have been suggested based on effects on children and levels of 18 ppb have been suggested based on adult effects on thyroid. The New Mexico State perspective is that in areas where perchlorate might be expected and analytical results are ambiguous, assume that perchlorate is present even if the results are close to the detection limit. A similar conservative approach to tritium and other conservative constituents is recommended.

In June 2001, the GIT presented a proposed analytical strategy for focused analyte suites for R wells. This has been revised based on meetings with the NMED. The strategy is illustrated by a decision flow diagram (attachment 1). The first portion of the diagram is to ensure the well is developed properly. When well development criteria are met, the well is sampled and the sample is analyzed for field parameters (pH, redox potential, alkalinity, temperature, specific conductance, turbidity, and dissolved oxygen), contaminants of concern, major ions, iron, manganese, total organic carbon, tritium (low-level analysis), total Kjeldahl nitrogen, and EZMud titration. After this preliminary sample, the well is allowed to equilibrate. If it is a single completion well, the equilibration period is three months. If it is a single completion well, the equilibration period is six months. After the equilibration period, the first of four characterization samples are collected from each well screen and analyzed for the full suite. The full suite analysis includes:

- Radionuclides (non filtered)
  - Low-level tritium (non filtered)
  - Strontium-90
  - Uranium and plutonium isotopes
  - Americium-241
  - Gross alpha, beta, gamma
  - Gamma spectroscopy

- Metals (non-filtered)
  - ICPOES analysis: Al, Ba, B, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, SiO2, Ag, Sr, Na, V, and Zn.
  - ICPMS analysis: Sb, Be, Cd, Tl, and U.
  - CVAA analysis: Hg
- General Inorganics (filtered and non-filtered)
  - Alkalinity (HCO3- and CO32-), Br-, PO43-, HN4+, Cl-, F-, TKN, NO3-, NO2-, C2O42-, ClO4-, and SO42-
- Organic Compounds (non- filtered)
  - Volatiles
  - Semivolatiles (PCBs [only in Sandia Canyon and around Area G], PAHs, pesticides)
  - Select Appendix VIII and IX constituents
  - High explosive compounds and degradation products
  - Total Organic Carbon
  - Dissolved Organic Carbon fractionation

Based on the analysis of the first characterization samples, there is the option to delete the radionuclide and/or the organic analytical suites from the subsequent two sampling events if none of the parameters from these suites are detected and those parameters are not contaminants of concern for the area. The deletion of analytical suites will be discussed with NMED prior to subsequent second and third sampling events. The fourth characterization sample will be analyzed for the full suite.

Hydrology Subcommittee Report

D. Rogers (LANL) responded to the EAG June 2001 recommendation of avoiding expense of devoting the cost of an entire R-well for the sole purpose of acquiring hydraulic data. At present, no wells are planned with the single purpose of obtaining hydrologic data. Considering placing two wells near water supply wells to conduct hydrologic testing and a tracer test.

W. Stone (LANL) reviewed the hydrologic activities for the quarter.

- MCOBT-4.4: The well is not fully developed due to pump problems. Have written specifications for a new pump. Not much water is generated. Final development and testing will occur after the new pump is installed.
- MCOBT-8.5: Encountered no water in dry basalt, and the hole was plugged and abandoned.
- CDV R-37-2: Well development is done. Conducted straddle packer/slug-injection tests on bottom two screens. When slug tests are conducted, the volume of the slug injected is measured and five times that amount of water is removed. The results of these tests have not been analyzed.
- R-13: Before well construction, the composite water level stabilized at 833 ft below ground surface with 208 ft of open hole (casing to 850 ft; total depth is 1,058 ft). Construction was just completed; no development or testing has been done. However, more physical development (e.g., swabbing, dual action) is planned for development.

The hydrology and well development sections for the R-22 and R-31 well completion reports were prepared. The same sections for R-25 and CdV-R-15-3 well completion reports were revised.

Other accomplishments include a draft report on hydrologic testing to date, advisement on the content and format for the well construction module in the database, and inquiries to Baski, Inc. regarding pump systems (10-14 week delivery anticipated from order date).

Modeling Subcommittee Report

B. Robinson (LANL) reviewed the Los Alamos Canyon alternate conceptual model, regional aquifer model, and first order groundwater assessment.

Recent activities on the regional aquifer model include:

- Further development of facies models for Puye and Santa Fe Group. Integrating geostatistical models with water level data form R-wells using 2-D cross-section models.
- Uncertainty analysis focusing on how much flow might be entering/leaving the regional aquifer from the north, west, and south.
- Incorporation of recent water level data from R-wells, resulting in much better estimates of large-scale permeability of the Puye Formation.
- Travel time calculations and capture zone analysis in support of the First Order Groundwater Assessment Project.
- Particle tracking simulations in support of "Using a Probabilistic Model of Flow paths in the Regional Aquifer to Site Surveillance Wells on the Pajarito Plateau". Question: can the results of a 3-D process-level model be distilled into a more simple probabilistic model? Preliminary answer: no.

First Order Groundwater Pathway Assessment

The goal of the First Order Groundwater Pathway Assessment is to rank contaminants of potential risk-significance to groundwater receptors on a site-wide basis. The assessment modeled contaminant movement across the plateau on site-wide basis, rather than focusing on one specific area. The approach is to use the regional aquifer model, the geologic model, and GIS tools to synthesize information from contaminant sources and hydrogeologic data to assess transport times and visualize pathways. Components of the analysis include percolation rates, vadose zone flow and transport, regional aquifer flow and transport, and contaminant sources.

Percolation rates

The canyon bottoms are most important. Canyons are categorized with respect to relative percolation rates, assigned based on observable factors: analytical lab applied water, heads on plateau, presence on alluvial groundwater. Categories are expressed as indices and percolation rates for each index are based on more complex studies and modeling at analogous sites (e.g. Los Alamos Canyon). Percolation rates are uncertain at least by a factor of 3. 1-D vertical models were constructed through vadose zone and travel time computed assuming downward flow. Travel time was calculated at 30,000 points. When the water made it through the vadose zone, the regional aquifer model was used for particle tracking. Contaminant sources were identified using the Water Quality Database, where there were contaminants in alluvial, perched, and regional aquifer. The results indicate a travel time of about 10,000 years from the mesa tops. Results show 0-1,000 year travel time for all canyons. Pueblo, Los Alamos, parts of Mortandad, Water, and Pajarito canyons fall in the 0-100 year time frame. Geology and percolation rates are the most sensitive parameters in estimating travel times. Sensitivity to percolation rate was evaluated and the results were illustrated by comparing a base case scenario with a high-flux percolation scenario.

Regional aquifer model

The regional aquifer model (Figure 1) was used to assess the fate of contaminants hitting water table. The simulation used the regional aquifer model, which incorporates all water supply wells pumping, and initiated particle tracking from all points. Most of the water on the plateau goes to the PM well field. A

small portion of upper Los Alamos Canyon is drawn into the Otowi well field. Water in the northern portion of the model is either drawn into the Los Alamos well field in lower Los Alamos Canyon or to the Guaje well field. The non-colored areas indicate water that is not drawn into any of the wells and is eventually discharged to the Rio Grande.

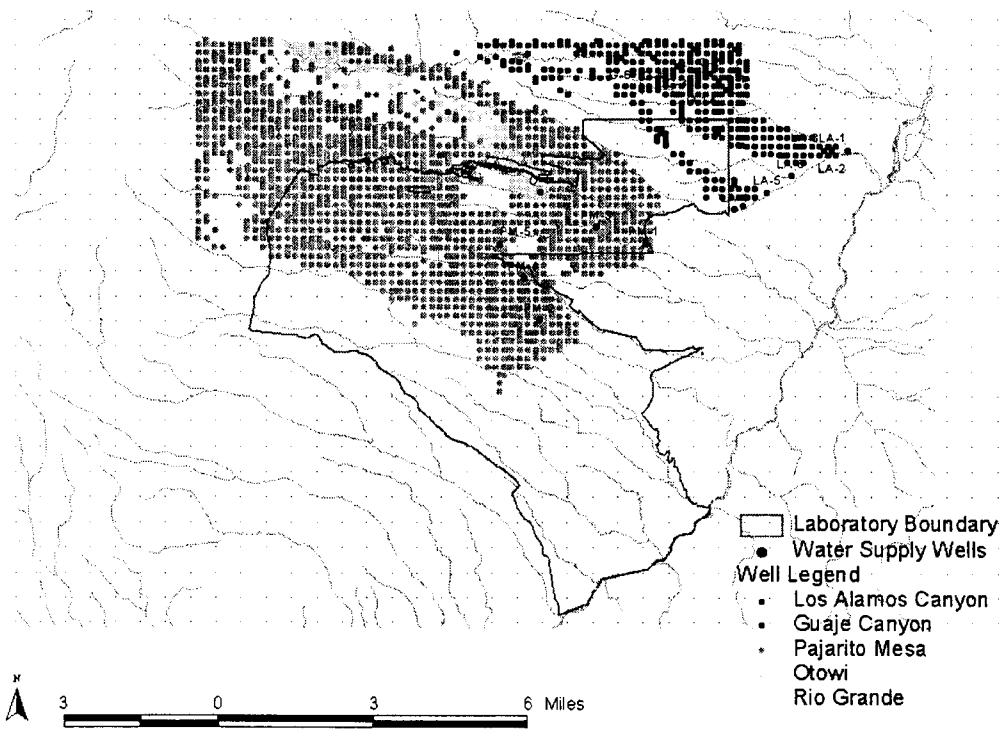


Figure 1 Regional Aquifer Model

Travel times have been calculated only for the PM wells. The results of those calculations suggest that in the regional aquifer, short travel times only occur quite close to the well. Travel time of 100's to 1000's of years were calculated from areas that are not close to a water supply well. The porosity estimate used for these calculations is conservative. If "best guess" porosity estimate were used, the calculated travel times would be longer. Tracer test will help to refine estimates.

Source of Contaminants

To identify areas that are the source of groundwater contamination, the Water Quality Database was accessed for all measured concentrations of contaminants such as tritium, nitrate, perchlorate, strontium, and uranium in alluvial water. As an example, tritium in Los Alamos Canyon was very high in 1993 when the leak from the reactor was discovered. It has dropped to non-detectable levels since then. The

transport times through alluvial groundwater in Los Alamos and Pueblo canyons appears to be very short. Once the source is gone, the alluvial water flushes out quickly.

Hydrogeologic Characterization Program FY01 Performance Review

C. Nylander (LANL) discussed the goal and scope of the Hydrogeologic Characterization Program. The goal is to develop a refined understanding of the hydrogeologic setting adequate to implement detection monitoring or groundwater monitoring waivers. The scope of the program is described in the Hydrogeologic Workplan and includes up to 32 regional aquifer wells, 51 alluvial wells, data management/stakeholder data access, and hydrologic modeling. The regulatory framework of the Hydrogeologic Characterization Program consists of three major elements. The first is the 1990 EPA/NMED RCRA Operating Permit, Task III, and Section A.1, which requires evaluations of hydrogeologic conditions. Second is the 1995 Los Alamos National Laboratory Groundwater Protection Management Program Plan, which identifies groundwater issues due to inadequate characterization. Finally, the 1995 NMED letters identified inadequate characterization as the basis for denial of groundwater monitoring waivers.

The FY01 accomplishments of the Hydrogeologic Characterization Program are divided into five categories: field-based activities, analytical activities, information management activities, quality assurance and reports, and project management.

Field-Based Activities:

- Completed three Hydrogeologic Workplan wells (R-22, R-7, R-5) and three investigation wells (MCOBT-8.5 and -4.4 and CdV-R-37-2).
- Started drilling two Hydrogeologic Workplan wells (R-13, R-8).
- Conducted four rounds of quarterly sampling at R-15, R-9, R-12, R-9i, R-19.
- Drilling program completed FY01 with positive schedule and cost variances to include baseline change proposals reflecting drilling program efficiencies.

Analytical Activities:

- Initiated study of Buckman well field to evaluate potential for Laboratory impacts.
- Held several meetings with NMED to provide detailed information about modeling.
- Compiled and analyzed well log information and outcrop data to develop numerous geostatistical formulations of the Puye Formation.
- Integrated water level data from R wells into regional flow model calibration process.
- Evaluated uncertainty in flow directions in western portion of LANL. Water level data near R-25 was determined to be extremely important.
- Conducted uncertainty analysis on lateral fluxes to aquifer beneath LANL.

Information Management:

- Completed the migration of stream flow data (25 stations, 1994-2000) into WQDB.
- WQDB used to produce annual Environmental Surveillance Report.
- Completed chain of custody and sample tracking system features.

- Improved automatic loading of lab chemistry data into WQDB with new parser.
- Completed migration of 30+ years of ESH-18 analytical chemistry data.
- Implemented advanced chemistry data screening tool comparing new results to historical averages.
- Well construction database design completed.
- ER-ESH data exchange pilot project underway.

Quality Assurance and Reports:

- Published well completion reports for R-9, R-9i, R-12, R-15, R-19.
- Completed peer review drafts of well completion reports for R-25, R-31.
- Drilling program peer review conducted by Schlumberger.
- EAG reviewed sampling SOPs.
- Prepared and presented technical papers for the National Groundwater Association conference.
- Supported Value Engineering study, IG investigation, and internal audit.
- Commented on NMED low flow sampling position paper.

Project Management:

- Completed negotiations with prime contractor to submit and perform against its own quality management plan.
- Completed construction and implementation of the DP-funded well drilling baseline.
- Supported LANL efforts to conclude the unallowable cost issue for R-25.
- Conducted iteration of groundwater characterization DQO process to assure the project remains on track.
- Hosted a portion of NM Bureau of Mines Decision Makers Tour.
- Held GIT bi-weekly meetings, three quarterly meetings, and the annual meeting.

The issues encountered and resolved during FY01 were: analytical strategy, well development, unallowable costs, Value Engineering study, data turnaround and transfer to regulators, and budget.

Issue: Analytical Strategy

The issue with respect to the current strategy for analyses of water samples from R-wells includes determining when samples are representative of the pre-drilling groundwater conditions, the cost associated with analyzing for analytical suites that are not detected on subsequent samples, the cost associated with analysis for both dissolved and total constituents in every sample, and the analytical methods. The resolution to this issue was to revise the current analytical strategy as follows.

- Initial sample is collected as soon as the well is completed and analyzed for geochemical parameters indicative of impacts of drilling fluids and contaminants of concern. This sample functions as a baseline sample to judge if subsequent samples are representative of pre-drilling groundwater conditions.

- An equilibration period is allowed for multiple completion wells to allow the wells to return to pre-drilling groundwater conditions.
- First characterization sample is collected after the equilibration period and analyzed for the full suite. Thus the full suite analysis is conducted on samples that are anticipated to be representative of pre-drilling groundwater conditions.
- If the first full suite analysis does not include contaminants of concern, there is the option to delete radiological and/or organic suites if they are not detected in full suite analysis for the second and third sampling events. This option is only exercised with NMED input.
- Fourth and final characterization sample will be analyzed with full suite analysis. This sample is expected to be most representative of groundwater conditions and will provide a check on decisions to delete suites from the second and third sampling events.

This analytical strategy was discussed with NMED, revised per NMED comments, and submitted for NMED approval.

Issue: Well Development

Well development has not been completely effective at removing drilling additives. Equipment limitations have hampered the well development process such that screened intervals could not be isolated and pumped, which affects wells with multiple screened intervals. The impacts of incomplete well development have included false positives for acetone and HE, and perturbations of the geochemical system. The resolution to this issue was to revise the current well development and sampling process as follows.

- Well development SOPs are followed and development continues until the water reaches <5 NTU (acceptable under EPA's Technical Enforcement Guidance Document).
- Packer system with pump above the isolated interval has been specified for procurement for well development.
- Groundwater samples are analyzed for parameters indicative of drilling additive influences to evaluate potential effects on water chemistry.
- Single completion wells are purged prior to sampling until field parameters indicate groundwater is representative.
- A pump developed by Westbay specifically for purging wells equipped with Westbay will be pilot tested at LANL. If the pump works, it will be used for sampling multiple completion wells.

Issue: Unallowable costs for R-25

DOE has challenged the unallowable costs for R-25: additional time and expense to repair screens 3 and 9 and to recover the well from "dropped tremie pipe". LANL has been required to submit information to DOE explaining and justifying the additional costs. DOE is still considering further action regarding the potential unallowable costs. DOE is weighing the facts and explanations provided by LANL to determine if further action regarding unallowable costs will be taken. LANL continues to prepare for any administrative/judicial actions on the part of DOE.

Issue: Value Engineering Study

DOE/AL requested a Value Engineering (VE) study of the Hydrogeologic Characterization Program.

The VE Team was on-site for four days and was provided an orientation briefing, field trip to well site, and access to individuals for interviews. The draft VE report contained factual errors and the specific recommendations appeared to be based on misunderstanding of regulatory requirements and objectives of the program. The VE recommendations, if published unrevised, could potentially disrupt funding, stakeholder relations, and result in noncompliance with environmental operating permits. The resolution to this issue has been to provide DOE with comments on the draft report and recommend significant revisions. The final resolution is pending DOE action.

Issue: Data Turnaround and Transfer to Regulators

The ER Database is not fully functional and capable of electronic data transfer. Efforts required to comply with an NMED data request created a backlog of data to be validated and approved for release and confounded continuing progress on electronic data transfer. Groundwater data from characterization sampling was caught in the data backlog; therefore, groundwater data could not be transmitted to NMED in a timely manner. However, most groundwater data caught in the backlog has since been transmitted to NMED. The backup in data processing is not expected to occur again and the ER Project has placed high priority on making ERDB fully operational.

Issue: Budget

Funding from DP has been inadequate to maintain the schedule of the Hydrogeologic Workplan. A request for increased funding was submitted to the Readiness in Technical Base Facilities (RTBF) to allow drilling and installation of three DP-funded wells per year. The resolution of this issue is pending as the response from RTBF for FY02/FY03 budget is still pending. The Hydrogeologic Characterization Program continues to work to decrease the cost of well drilling and installation.

In FY01, the Hydrogeologic Characterization Program total costs to date were about $10.5 million. Note that this cost includes about $1 million in costs for MCOBT-4.4 and MCOBT-8.5, which were not within the scope of the Hydrogeologic Workplan. Of this, about 35% ($3,591,847) was DP-funded and 65% ($6,848,143) was ER-funded. The largest costs in FY01 were for R-19 ($1,623,337), R-22 ($1,166,153), R-5 ($1,217,512), and R-7 ($1,675,205).

The total cost of the program, from FY97 - FY01 is about $29 million (deducting the costs of MCOBT-4.4 and MCOBT-8.5, but adding the cost of information management). Note that there is an error on the handout from this presentation titled "Total Cost of the Program - FY 97-01": the costs shown for FY97 and FY98 are not just alluvial wells, but includes the cost of R-9 and R-12. The costs have increased from $4.7 million in FY97/98 to $10.4 million in FY01. About 9% of the total cost of the program to date has funded non-well activities (Groundwater Integration Team, modeling, information management). The Conceptual Design Report estimated the total cost over the 7-year, 32-well program to be $72 million.

Integrated Risk-Based Decision Strategy for Groundwater Protection and Monitoring

C. Nylander (LANL) stated that this integrated risk-based presentation will describe how the ER risk assessment interfaces with the Hydrogeologic Characterization Program. The presentation is aimed particularly at helping the EAG in understanding how the risk component is being addressed and whether it has a place in the Hydrogeologic Workplan. The ER Program is charged with determining if there is an unacceptable risk using risk assessment tools. The Hydrogeologic Workplan is charged with characterizing the hydrogeologic setting. There are common data needs and thus there is shared data between all elements of the ER and Hydrogeologic Workplan programs. However, risk assessment resides in the ER Project. The Hydrogeologic Workplan is not in charge of risk assessment, but provides data to support risk assessment.

D. Hollis (LANL) presented a discussion on integrated risk and informed strategy for groundwater monitoring. The goal for the effort is to improve institutional management of groundwater and to focus resources on the most significant problems.

Steps to accomplish this include:

- Establish a level of protection to be achieved and maintained by LANL: locations where protection must be ensured, time frame during which final risk goal must be demonstrated, and level of confidence that must be demonstrated.
- High-level management team must set the parameters.
- Design groundwater-monitoring network.
- Streamline corrective actions.

The approach will encompass the following:

- Convene core team of decision makers to establish performance standards and define conceptual exposure scenario(s), likelihood of exposure, and associated uncertainties.
- Conduct probabilistic risk assessment to define total risk of groundwater pathway for evaluation against performance standards.
  - Identify significant contributors (if any) to the groundwater pathway.
  - Design optimum monitoring well and sentry well network to ensure compliance with performance standards.
- Conduct data worth and decision analysis to
  - Balance cost of additional characterization with cost of proposed monitoring.
  - Evaluate most cost effective.
- Expected outcomes are
  - Integrated decisions drive action.
  - Optimize groundwater-monitoring network.
  - Reprogram money to accelerate corrective action.

DQO Iteration Overview

C. Nylander (LANL) provided background for DQO iteration. The iteration process was initiated in response to comments from the EAG and their recommendation to bound the scope of the Hydrogeologic Workplan. The FY01 DQO iteration began with a comprehensive evaluation of all groundwater-related data collected, analyzed, and interpreted to date in the program in order to determine what is known and what data are necessary to complete the Hydrogeologic Workplan. The next step is to establish a small core group of LANL, DOE, and NMED decision-makers to review and develop consensus on the proposed revisions.

The comprehensive evaluation took place between June and October 2001. It was intended to familiarize all of the LANL GIT members with the state of groundwater characterization knowledge and to develop a complete and consistent understanding of the hydrogeologic system with the available information. To accomplish this task, each scientific discipline represented on the GIT (as subcommittees) provided a presentation reviewing the information collected to date. The presentations incorporated observations and findings in that discipline on a site-wide basis, what is known on an aggregate basis, and provided a status with respect to resolving the decisions in the Hydrogeologic Workplan. The following presentations are the same as those made during this process.

Los Alamos National Laboratory
Hydrogeologic Characterization Program
Semiannual Meeting
October 16-17, 2001
Minutes

Geology

D. Vaniman (LANL) described the evaluation of data for the geologic system.

- What has to be done to meet the need to understand "basic geology, hydrogeology, and pathways for contaminant transport" (NMED, 1995)?
- Increase the accuracy and relevance of the 3D Geologic Model in defining structure and lithology.
- What are the relations between lithology and permeability? Does lithology play a role in flow (vadose zone and regional aquifer)?
- What role does lithology play in reactive transport?
- What role does lithology play in groundwater chemistry (cation composition, phase saturation, Eh, and colloid formation in particular)?
- Fill the holes in the drilling program (surface geophysics, surface mapping).
- Evaluate the geologic accuracy of borehole sampling (examples: compare core and cuttings at R-8 and compare outcrop data with borehole data).
- Do what needs to be done to avoid surprises (example: alteration systems of anomalous geochemistry superimposed on primary stratigraphy).

Regarding the 3-D Geologic Model, several areas of need were identified.

- Need to put in current drill hole data and other information on structure – still poorly known below site.
- New mapping – e.g., seismic hazards, Frijoles Quadrangle.
- Digital elevation model is available for analysis of fine-scale structures.
- Surface geophysical studies – gravity work in southwest corner of LANL, old seismic lines, aerial electromagnetic survey.

Review of stratigraphy data:

- Know upper Bandelier tuff well; Cerro Toledo member is in unexpectedly thick in some areas and the Otowi is correspondingly thinner—erosional surface between major eruptions. Alteration in the Otowi, especially in canyons, is poorly known.
- Cerros del Rio basalt is more of a problem than anticipated. Where does the Cerros del Rio end and the Tschicoma begin? The Cerros del Rio is unexpectedly thick in some areas, containing more of the regional aquifer than anticipated. The Puye Formation is more consistent in the upper part, and it becomes more siliceous with depth. Depths that were once assumed to be Santa Fe Group are actually older pumiceous deposits. R-7 encountered the transition from non-pumiceous to pumiceous Puye, not the expected sequence of Puye/Totavi/Santa Fe. Santa Fe Group sediments are less prevalent than previously thought. R-19, R-7, CDV-15 encountered Puye Formation that is non-pumiceous. The Puye Formation is telling us about structure under LANL. At this point the pumiceous/non-pumiceous Puye contact is not incorporated into the regional aquifer model because there is not enough data on the distribution of the new units. Finding that pre-Bandelier sediments can not be split into those with a western provenance and those with an eastern provenance. These sediments are overlapping in time and space.

Other aspects:

- Alteration and contaminant systems - The northeastern portion of the LANL site is probably underlain by a fossil hydrothermal system with associated clay, carbonate, and zeolite alteration. This is based on preliminary data from R-5 and reassessment of core from 0-1. This zone is poorly characterized with respect to geochemistry. Possible considerations in this zone are the nature of reactive transport and the anomalous geochemistry that may be reflected in the groundwater chemistry (e.g., host rocks of barium, manganese-rich alteration versus unaltered siliceous glass).
- Pathways and mechanisms of movement - Reactive translocation of clays (colloid and particulate carrier systems) is observable in the near surface. Does this occur at depth? Redox accumulation of heavy metals may be focused at mineral-oxides surfaces, especially manganese -oxides. How does groundwater chemistry differ between different host rocks? What are the systematic differences and are they significant?

Geochemistry

P. Longmire (LANL) provided the geochemical overview. For pathway analysis, it is necessary to understand what the bottom line is time-wise and water body-wise. Geochemical data is necessary for monitored natural attenuation (MNA) and monitoring vadose zone.

Regarding groundwater geochemistry, multiple completion and single completion each have benefits. Short-term geochemical effects of drilling fluids are not seen in single completion wells.

Reactive minerals - It is important to MNA and monitoring in the vadose zone to focus on water, but also to sample and analyze aquifer materials to determine sorption.

Distribution of Kds - Because the Cerros del Rio basalt and Puye Formation have different chemistries than the Bandelier Tuff, adsorption data are needed for each the Cerros del Rio basalt and Puye Formation.

Age of groundwater – Previous estimates of the age of water in the regional aquifer based on ^{14}C assumed marine values for ^{13}C to correct ages. To refine the age estimates it is necessary to obtain good ^{13}C from calcite on the Pajarito Plateau. These data would be used to reinterpret previous ^{14}C ages and newer data from R-wells. It is estimated that this could potentially change the regional aquifer ages by 40-50%.

The Baseline Groundwater Geochemistry Report is currently in peer review and will be published soon.

Vadose Zone Hydrology and Modeling

B. Robinson (LANL) discussed the DQO iteration process in relation to vadose zone hydrology and modeling. The objectives of vadose zone characterization are pathways, percolation, travel times, and contaminant fate.

Pathways – what is known:

- 1-dimensional downward migration under unsaturated conditions.
- Lateral diversion beneath regions of high infiltration where low permeability barriers restrict downward percolation results in alluvial groundwater, saturated zones within basalts and Puye Formation, and saturated zones within the Tshirege member of the Bandelier at TA-16.
- Rapid lateral transport over kilometer distances - tracer test in Mortandad Canyon and tritium transport in Los Alamos and Mortandad Canyons.
- Rapid lateral diversion to canyons within mesas at TA-16 - tracer tests, geochemical monitoring.
- Transport in intermediate perched zones is uncertain - the velocity and direction of flow are unknown.

Pathways – what is not known:

- Velocity in intermediate perched zones. There are three hypothetical models of flow in perched zones:
  - Bathtub model - flow is delayed and the zones contain stagnant water.
  - Lateral diversion model – porous flow is rapid and direction controlled by dip or local features.
  - It is difficult to collect enough data to understand or to distinguish which hypothetical model is operative.
- Direction is controlled by
  - Dip of unit on which perching occurs or
  - Dip of local permeability features not present in geologic model.
- Bottom Line: Although intermediate perched zones provide an opportunity to collect water samples and thus obtain contaminant concentration values, it will be very difficult to collect enough data to map out the paths and predict transport velocity with precision.

To further define pathways, it will be necessary to incorporate perched water representation into vadose zone models, capturing the extremes of behavior. Bracket directions and velocities rather than trying to sort out all the details. There is not a big difference between largest time and shortest time; therefore, there is not much value in figuring the travel time out with a greater degree of certainty.

- Perform site-wide analysis of potential flow path directions based on geologic model and simple conceptual models of lateral diversion. Test this analysis against available data.
- Determine whether uncertainties in lateral transport significantly affect the prediction of the location of contaminant arrival at the water table.
- Bracket the travel times to the water table by using 1-dimensional travel time from surface to regional aquifer (longest) and 1-dimensional travel time to perched zones only, short-circuit to water table after that (shortest time).

Regarding travel times, a conclusion can be reached from sensitivity analysis. Available data is consistent with ± factor of 3 above and below the base case estimate; however, do we need to do better? Can we do better? A simple example can be used to evaluate the answer to this question. The following table shows the calculations of assuming matrix flow through 100 meters of Bandelier Tuff:

Undisturbed, Dry Mesa	**Wet Canyon Bottom**
Percolation rate: 1 mm/yr (0.001 m/yr)	Percolation rate: 500 mm/yr (0.5 m/yr)
Water Content: 0.1	Water Content: 0.25
Transport Velocity: 0.001/0.1 = 0.01 m/y	Transport Velocity: 0.5/0.25 = 2 m/y
Travel Time: 100/0.01 = 10,000 years	Travel Time: 100/2 = 50 years
Uncertainty Range: 3,000 to 30,000 years	Uncertainty Range: 15 to 150 years
Do we need to do better? No (close enough)	Do we need to do better? Yes (decisions may depend on the value)

Reducing uncertainty in travel time will require addressing the uncertainty primarily in two different areas: the geologic model and migration rate. To address uncertainties in the geologic model, the current uncertainties must be estimated, the geologic model must continue to be updated with new data, and focus on the uncertainties that matter to travel time. For example, the Bandelier Tuff is important

because percolation is slowest and that affects estimates of travel time. To reduce the uncertainty in migration rate will require additional water budget studies, infiltration monitoring sites, and shallow boreholes to measure water content and migration of chemical fronts.

Tritium transport model validation

- Tritium is not found in aquifer upstream of Los Alamos Canyon-DP Canyon confluence (at well R-7).
- Downstream observations (wells TW-3, R-9, 0-1) of tritium are due to thinning of Bandelier Tuff and inputs from DP Canyon, surface water, and Pueblo Canyon.
- Prediction: Tritium will be found at water table in R-8 at levels approximately 1,000 pCi/L. The model qualitatively reproduces observations, but quantitative matching is not possible because:
  - Lack of model resolution and sparse data
  - Heterogeneities
  - Uncertainty in mixing process in regional aquifer.

Role of R-wells in vadose zone characterization

- Further refines the geologic model
- Moisture content and contaminate distribution have been useful. There is merit in considering a separate set of shallow boreholes for moisture and contaminant measurements selected to reduce uncertainty in flux and travel time at specific locations.
- Further characterization of intermediate groundwater to determine flow directions and velocity may not be warranted given that travel times are not influenced by that –"that" = flow directions and velocity?.
- Chemical samples from regional aquifer reflect transport characteristics of vadose zone; they are an effective means of validating vadose zone models.

Conclusions:

- Current state of knowledge: moisture content measurements and water budgets can only reduce uncertainty in travel times to about one order of magnitude.
- Joint inversion of moisture contents and contaminant front data can reduce this uncertainty.
- More shallow wells would be better than a few deep wells for estimating percolation rates and travel times.
- By focusing on contaminants in the regional aquifer, the R-well drilling program provides important constraints on vadose zone travel times.
- Bounding approaches for handling the intermediate groundwater are needed to overcome the difficulty of characterizing the nature of flow in these water-bearing zones.

Regional Aquifer Hydrology and Modeling

E. Keating (LANL) discussed regional aquifer hydrology and modeling regarding the DQO iteration process. The goals for regional aquifer hydrology and modeling are basic characterization, design monitoring well network, and provide DOE and stakeholders with reasonable prediction of contaminant migration.

Characterization efforts are to improve on the understanding of groundwater flow directions and velocities, including the influence of present and future pumping.

To determine flow directions, the following information is needed:

- Head data (water level)
- Permeability structure
- Permeability data (hydraulic tests)
- Geochemical tracers

The water level map for the upper portion of the regional aquifer has been constructed without data from water supply wells for the first time. There is now sufficient test well and characterization well data to develop the map. The flow is easterly, not southeast. The distribution of spatial data is good and there will be sufficient confidence in understanding flow direction with 15 additional wells. Also with the additional 15 wells, it is anticipated that there will be sufficient information to determine vertical flow directions and gradient. Vertical gradient data is important to monitoring because if there were downward gradients, then monitoring wells would have to be deep in order to detect contamination. So far, vertical gradients confirm conceptual model of flow from east and west toward the Rio Grande. There is a section in the central portion of the Pajarito Plateau that is not yet understood. The data needs for water levels are vertical gradient data in the northwestern portion of LANL and spinner logs from the water supply wells.

Permeability data needs:

- Range of measured permeability in the aquifer
- Permeability values used in models
- Type of information necessary to define: aquifer permeability and how high and low permeability zones are distributed spatially

Why do we care about permeability?

- Variations in permeability will control flow paths (water seeks higher permeability zones).
- Travel times are linearly proportional to permeability.

Large-scale permeability (relation between permeability and stratigraphy) - the "average" permeability of sedimentary rocks varies only slightly. However, the effective permeability of Santa Fe Group rocks is lower than estimates from single-hole pump tests. Data needed to refine the understanding of large-scale permeability are:

- Larger scale (multiple-hole) pump tests to determine effective porosity of Santa Fe Group rocks and for better understanding of relationship between geology and permeability, and estimating connectivity of high or low permeability zones.
- Water levels across Pajarito fault zone to determine the impact of fault zones.

Small-scale permeability is important because both water level and existing permeability data suggest that significant heterogeneity exists within sedimentary rocks. Data needed to refine the understanding of small-scale permeability are:

- Continued single-hole pump tests in the R-wells.
- Re-examine existing geophysical, geologic, and hydrologic data to identify those parameters that are best correlated with permeability estimates.

- Continue to develop conceptual models of how these high and low permeability zones are distributed spatially and test alternative conceptual models against water level data.

To calculate flow velocity the following data are necessary: head gradients, permeability, and porosity. The head gradients and permeability were discussed above. There is essentially no site-specific data on porosity in the saturated zone. Porosity is a major influence on predicted travel times in the regional aquifer. Existing tracer data is inadequate for estimating travel times (i.e., ^{14}C data used, but limited contaminant data is not helpful because entry point is not known). The data necessary to determine porosity are:

- Single well injection-withdrawal (huff puff) tracer tests to evaluate groundwater flux and matrix diffusion.
- Cross-hole forced-gradient tracer test to evaluate effective porosity and longitudinal dispersivity.
- Age dating of water in wells with short screens.

DQO Iteration Proposal

C. Nylander (LANL) described the DQO iteration process. The iteration process is intended to use the data that has been collected and interpreted to adjust the planned data collection efforts. Over the summer of 2001, the Groundwater Integration Team completed a comprehensive evaluation of the data collected to date, compiled data needs and recommended data collection methods, reviewed remaining wells and studies to determine if there is a continued importance, and finally, developed a proposal for revised Hydrogeologic Workplan scope, which was handed out in the meeting. In summary, the revised scope includes:

- Install 15 regional aquifer wells
- Conduct 13 other field-based activities: hydrologic testing, geochemical, geologic mapping and sampling
- Conduct 10 analytical activities: regional aquifer modeling, geochemical modeling, information management
- Conduct three project management activities

The next steps are:

- Establish a core team consisting of DOE, LANL, and NMED to reach consensus on the proposed revision of scope
- Continue to formulate the comprehensive groundwater monitoring program
- Establish a long-term stewardship program to conduct the monitoring

FY02 Annual Plan and Planning Session

C. Nylander (LANL) described the proposed work for FY02 on the Hydrogeologic Characterization Program. This is the opportunity for stakeholders to provide input in the planning of activities in this program. This FY02 proposed scope was included in a letter sent to the distribution list. Stakeholder input on the proposed schedule was requested in the letter as well as at this meeting. The letter to NMED said that if there are cost efficiencies in the ER Project, money could be reprogrammed allowing either R-18 or R-21 to be drilled. The budget request for DP is $7.2 million, but until Congress passes the FY02 budget, operations are under "continuing resolution". Continuing resolution means that all agencies

and programs are funded at the previous year level. Until resolution, the DP budget is $3.0 million. ER requested $6 million for FY02.

FY02 Field Activities:

- Complete R-8 and R-13
- Drill and complete R-14 and R-20
- Characterization sampling and analysis in completed wells

FY02 Non-Field Activities:

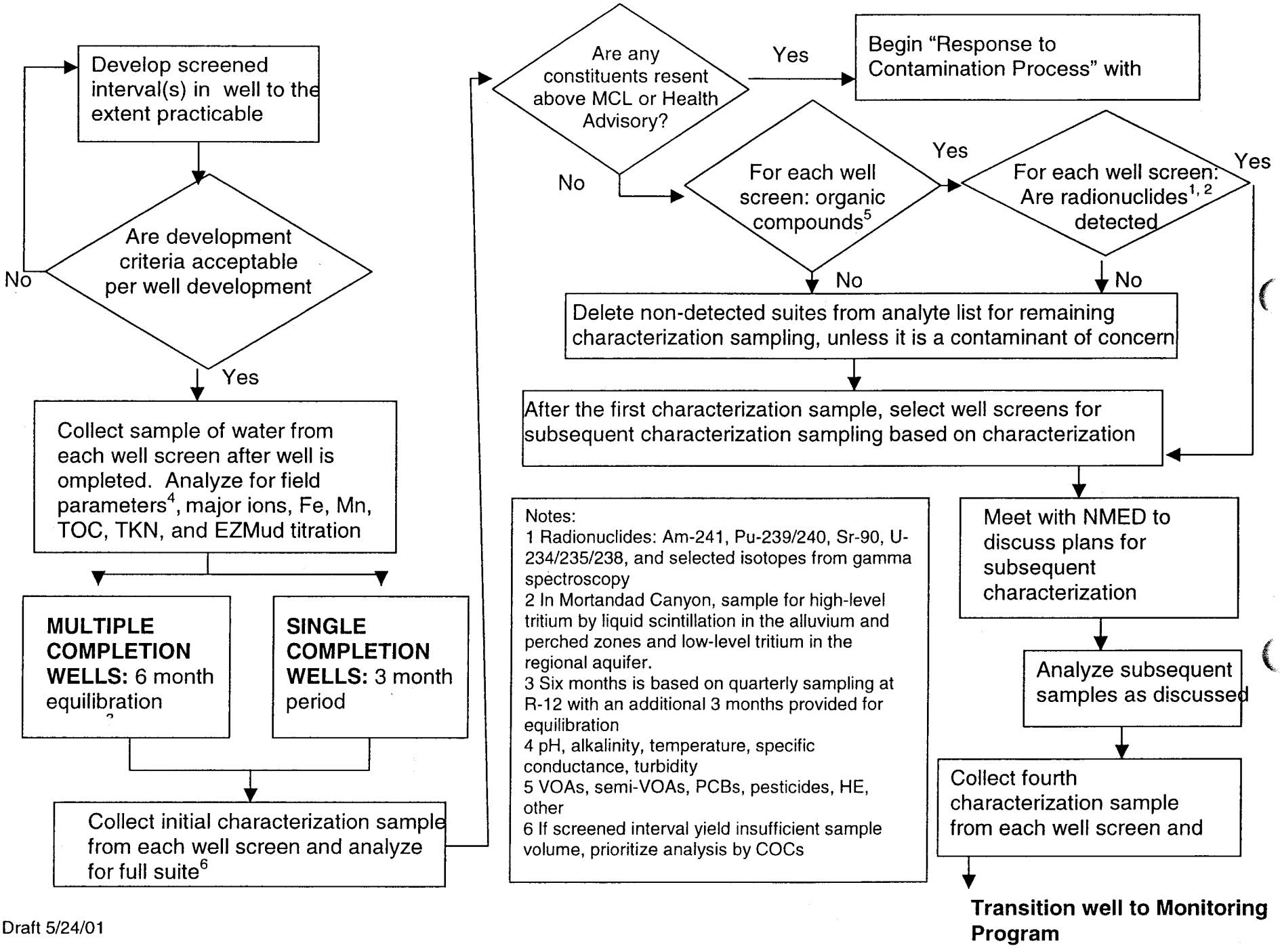
- Information Management: The ER Program must transition data to the ER Database, then transfer data to the Water Quality Database.
- Modeling: Data from the following are used for modeling: first order groundwater assessment, LA/Pueblo canyons vadose zone model, regional aquifer model, capture zone analysis for water supply wells. Models are a tool used to understand the data that are collected. Models are not be used as the sole factor upon which decisions will be made.
- Geologic Model: Integrate new data, calibrate, and update 3-D geologic model complimented by surface field studies.
- Quarterly and Annual Meetings: Meetings will become more focused on presenting cohesive interpretive work. Will continue to have quarterly and annual meetings. Looking for other venues for annual meeting.
- Annual Report: Will try to submit a draft annual report in January 2002 and work to publish before the March 2002 Annual Meeting.
- Project Management Activities, such as External Advisory Group reviews, will continue.

Los Alamos National Laboratory
Hydrogeologic Characterization Program
Semiannual Meeting
October 16-17, 2001
Minutes

Attendance

Name	Organization	E-mail address
Agogino, Karen	DOE	Kagogino@doeal.gov
Anderson, Betty	EAG	Elanderson@sciences.com
Ash, Coila	NMTC	coilaash@mindspring.com
Barr, Alice	LANL	Barra@lanl.gov
Bitner, Kelly	Neptune & Co.	bitner@neptuneandco.com
Bolivar, Stephen	LANL	Bolivar@lanl.gov
Broxton, David	LANL	Broxton@lanl.gov
Charles, Bob	EAG	Couchcad@fiberpipe.net
Coffin, Patricia	DOE/DP-17/SAIC	Patricia.coffin@nnsa.doe.gov
Dale, Michael	NMED	mdale@lanl.gov
Davis, Paul	Envirologic, Inc.	envirologicinc@starbard.net
Fabryka-Martin, June	NNMCAB	fabryka@lanl.gov
Gallaher, Bruce	LANL	Gallaher@lanl.gov
Garcia, Terrence K.	San Ildefonso Pueblo	tgarcia@cnsp.com
Goetz, Catherine	SAIC	goetzc@saic.com
Gonzales, Ryan K.	San Ildefonso Pueblo	rgonzales@cnsp.com
Henning, Kendra	LANL	khenning@lanl.gov
Hollis, Diana	LANL	dhollis@lanl.gov
Johansen, Mat	DOE	Mjohansen@doeal.gov
Johnson, Bruce	Westbay	Bjohnson6@slb.com
Keating, Elizabeth	LANL	Ekeating@lanl.gov
Kinkead, Sue	LANL	suek@lanl.gov
LaDelfe, Carol	LANL	Cladelfe@lanl.gov
Latham, Ben	NNMCAB	blatham@doeal
Lee, Ann	ER/LANL	Annl@lanl.gov
Lewis, Rick	Schlumberger	Lewis2@slb.com
Longmire, Patrick	LANL	plongmire@lanl.gov
Longo, Thomas	DOE/HQ/EM-34	Thomas.longo@em.doe.gov
Lovejoy, Lindsay	NM Attorney General's Office	Llovejoy@ago.state.nm.us
Maez, Suzanne	Los Alamos Technical Assoc	s_maez@lanl.gov
Marin, Jon	SAIC	Jon.r.marin@saic.com
McAtee, Lee	LANL	Jlm3@lanl.gov
McCann, John	LANL	jmccann@lanl.gov
McInroy, Dave	LANL	mcinroy@lanl.gov
McLane, Charlie	EAG	Cmdlane@mclaneenv.com
Mullen, Ken	LANL	Kmullen@lanl.gov
Newman, Brent	LANL	Bnewman@lanl.gov
Nylander, Charlie	LANL	Nylander@lanl.gov
Ordaz, John	DOE/HQ/DP	John.ordaz@nnsa.doe.gov
Padilla, Pete	Los Alamos County	padillap@lac.losalamos.nm.us
Powell, Robert	EAG	Rpowell@powellassociates.com
Powers, Jack	EAG	Jpowersslc@aol.com
Rae, Steve	LANL	Stevenrae@lanl.gov
Robinson, Bruce	LANL	Robinson@lanl.gov
Rogers, David	LANL	Slug@lanl.gov
Schafer, David	EAG	Dschafer@prodigy.net

Stone, William	LANL	Wstone@lanl.gov
Trujillo, Eric	DOE-LAAO	etrujillo@doeal.gov
Trujillo, Tony	DOE/AL	Ltrujillo@doeal.gov
Vaniman, Dave	LANL	vaniman@lanl.gov
Vesselinov, Velimir	LANL	Vuv@lanl.gov
Whitacre, Tom	DOE-LAAO	twhitacre@doeal.gov
Young, John	NMED-HWB	John_young@nmenv.state.nm.us



Notes:
1 Radionuclides: Am-241, Pu-239/240, Sr-90, U-234/235/238, and selected isotopes from gamma spectroscopy
2 In Mortandad Canyon, sample for high-level tritium by liquid scintillation in the alluvium and perched zones and low-level tritium in the regional aquifer.
3 Six months is based on quarterly sampling at R-12 with an additional 3 months provided for equilibration
4 pH, alkalinity, temperature, specific conductance, turbidity
5 VOAs, semi-VOAs, PCBs, pesticides, HE, other
6 If screened interval yield insufficient sample volume, prioritize analysis by COCs

Draft 5/24/01

Los Alamos National Laboratory
Hydrogeologic Characterization Program
Master Publication List

Revised 12-Dec-01

Primary Author	Co-Authors	Date	Title	Report Number	Publishing Information
Ball, T.T.		2001	Use of Modern Project Management Techniques for the Hydrological Characterization Project at Los Alamos National Laboratory	ER2001-0930 and LA UR-01-6171	Department of Energy Technical Information Exchange Workshop, November 13, 2001 Albuquerque, New Mexico
Broxton, D.E.		2001	Geology of the Pajarito Plateau and Vicinity, North-Central New Mexico		P. Johnson, ed., Water, Watersheds, and Land Use in New MexicoNew Mexico Decision-Makers Field Guide No. 1, New Mexico Bureau Mines and Min Res.
Broxton, D.E.	R. E. Lewis	2001	Use of Borehole Geophysics for Hydrogeological Characterization at Los Alamos National Laboratory		US DOE 13th Technical Information Conference Abstracts, Albuquerque, New Mexico
Broxton, D.E.	C. Nylander	2001	Groundwater Investigations to Support EnviroNew Mexicoental Decisions at Los Alamos National Laboratory		US DOE 13th Technical Information Conference Abstracts, Albuquerque, New Mexico
Broxton, D.E.	P. Longmire, D. Counce, B. Newman	2001	Hydrochemical Characterization at R-15, Mortandad Canyon, Los Alamos National Laboratory		US DOE 13th Technical Information Conference Abstracts, Albuquerque, New Mexico
Broxton, D.E.	R. Gilkeson, P. Longmire, D. Vaniman, J. Marin, R. Warren, A. Crowder, B. Newman, B. Lowry, D. Daymon, D. Wycoff	2000	Completion Report for Characterization Well R-9	ER2000-0218 and LA UR-00-4120	Los Alamos National Laboratory, Los Alamos, New Mexico
Broxton, D.E.	R. Warren, D. Vaniman, B. Newman, A. Crowder, M. Everett, R. Gilkeson, P. Longmire, J. Marin, W.J. Stone, S. McLin, D. B. Rogers	2000	Characterization Well R-12 Completion Report	ER2000-0290 and LA UR-00-3785	Los Alamos National Laboratory, Los Alamos, New Mexico
Broxton, D.E.	D. Vaniman, W. Stone, S. McLin, M. Everett, A. Crowder	2000	Characterization Well R-9i Completion Report	ER2000-0446 and LA UR-00-4255	Los Alamos National Laboratory, Los Alamos, New Mexico
Broxton, D.E.	D. Vaniman, W. Stone, S. McLin, J. Marin, R. Koch, R. Warren, P. Longmire, D. Rogers, N. Tapia	2000	Characterization Well R-19 Completion Report	ER2000-0398 and LA UR-00-4085	Los Alamos National Laboratory, Los Alamos, New Mexico
Broxton, D.E.	A. Crowder, M. Everett, R. Gilkeson, P. Longmire, J. Marin, D. Rogers, W. Stone, R. Warren	1999	Interim Completion Report for Characterization Well R-25	Draft Report	Los Alamos National Laboratory, Los Alamos, New Mexico
Broxton, D.E.	C. Nylander, R. Gilkeson, P. Longmire, W. Stone, D. Rogers	1999	Groundwater Issues on the Pajarito Plateau		EOS, American Geophysical Union Transactions, 79
Broxton, D.E.	S. L. Reneau	1996	Buried early Pleistocene landscapes beneath the Pajarito Plateau, northern New Mexico		Goff, F., Kues, B. S., Rogers, M. A., McFadden, L. D., and Gardner, J. N., eds,The Jemez Mountains Region: New Mexico Geological Society 47th Field Conference Guidebook
External Advisory Group		2000	Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory		Report submitted to Hydrogeologic Characterization Program, Los Alamos National Laboratory, June 26, 2000
External Advisory Group		2000	Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory		Report submitted to Hydrogeologic Characterization Program, Los Alamos National Laboratory, December 5, 2000
External Advisory Group		1999	Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory		Report submitted to Hydrogeologic Characterization Program, Los Alamos National Laboratory, July 20, 1999
External Advisory Group		1999	Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory		Report submitted to Hydrogeologic Characterization Program, Los Alamos National Laboratory, December 23 1999
External Evaluation Group		1998	Semi-Annual Report, Groundwater Integration Team		Report submitted to Hydrogeologic Characterization Program, Los Alamos National Laboratory, October 31, 2000

Los Alamos National Laboratory
Hydrogeologic Characterization Program
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Primary Author	Co-Authors	Date	Title	Report Number	Publishing Information
Hickmott, D.		2000	Progress Report for Plume-Chasing and Characterization Well Canon de Valle R-15-3	LA-UR-00-4527	Los Alamos National Laboratory, Los Alamos, New Mexico
Keating, E.H.	E. Kwicklis, V. Vesselinov, A. Idar, Z. Lu, G. Zyvoloski, M. Witkowski	2000	A Regional Flow Model and Transport Model for Groundwater at Los Alamos National Laboratory. Progress Report		Progress Report submitted to Hydrogeologic Characterization Program, Los Alamos National Laboratory, October 31, 2000
Keating, E.H.	E. Kwicklis, M. Witkowski, T. Ballantine	1999	A Regional Flow Model for the Regional Aquifer beneath the Pajarito Plateau. Progress Report	LA-UR-00-1029	Los Alamos National Laboratory, Los Alamos, New Mexico
Keating, E.H.	G. Zyvoloski, C. Gable, M. Witkowski, K. Bower, K. Manley	1998	A Steady-State Regional Flow Model for the Saturated Zone in the Espanola Basin		Los Alamos National Laboratory, Los Alamos, New Mexico
Koch, R.J.	P. Longmire, D.B. Rogers, K. Mullen	1999	Report of Testing and Sampling Municipal Supply Well PM-4	LA-13648	Los Alamos National Laboratory, Los Alamos, New Mexico
LANL	Groundwater Integration Team	2001	Action Plan for External Advisory Group December 2000 Recommendations		Report for Hydrogeologic Characterization Program, Los Alamos National Laboratory, March 15, 2001
LANL	Groundwater Integration Team	2000	Action Plan for External Advisory Group December 1999 Recommendations		Report for Hydrogeologic Characterization Program, Los Alamos National Laboratory, March 2000
LANL	Groundwater Integration Team	2000	Action Plan for External Advisory Group June 2000 Recommendations		Report for Hydrogeologic Characterization Program, Los Alamos National Laboratory, September 2000
LANL	Groundwater Integration Team	1999	Action Plan for External Advisory Group July 1999 Recommendations		Report for Hydrogeologic Characterization Program, Los Alamos National Laboratory, November 30, 1999
LANL		1998	Hydrogeologic Workplan		Los Alamos National Laboratory, Los Alamos, New Mexico
LANL		1998	Field Implementation Plan for Drilling and Testing of LANL Regional Characterization Well R-25		Hydrogeologic Characterization Program Plan, Los Alamos National Laboratory, March 1998
LANL		1997	Conceptual Design Report Monitoring Well Installation Project, 100% Conceptual Design Report		Los Alamos National Laboratory, Los Alamos, New Mexico
LANL		1997	Field Implementation Plan for Drilling and Testing of LANL Regional Characterization Well R-9		Hydrogeologic Characterization Program Plan, Los Alamos National Laboratory, March 1998
LANL		1996	Groundwater Protection Management Program Plan		Los Alamos National Laboratory, Los Alamos, New Mexico
Longmire, P.	D. E. Broxton, W. Stone, B. Newman, R. Gilkeson, J. Marin, D. Vaniman, D. Counce, D. Rogers, R. Hull, S. McLin, R. Warren	2000	Characterization Well R-15 Completion Report	ER2000-0308 and LA-UR-00-4139	Los Alamos National Laboratory, Los Alamos, New Mexico
Newman, B.D.	R.H. Gilkeson, B.M. Gallaher	1997	Vadose Zone Water Movement at TA-49, Los Alamos National Laboratory: Interpretations based on Chloride and Stable Isotope Profiles	LA-UR-97-3924	Los Alamos National Laboratory, Los Alamos, New Mexico
Nylander, C.L.	K.A. Bitner, D.E. Broxton, K. Henning, R. Hull, A.S. Johnson, E.H. Keating, P. Longmire, B.D. Newman, B. Robinson, D.B. Rogers, W.J. Stone, D. Vaniman	2001	Groundwater Annual Status Report for Fiscal Year 2000	LA-138-SR	Los Alamos National Laboratory, Los Alamos, New Mexico
Nylander, C.L.	K.A. Bitner, D.E. Broxton, K. Henning, A.S. Johnson, E.H. Keating, P. Longmire, B.D. Newman, B. Robinson, D.B. Rogers, W.J. Stone, D. Vaniman	2000	Groundwater Annual Status Report for Fiscal Year 1999	LA-13710-SR	Los Alamos National Laboratory, Los Alamos, New Mexico
Nylander, C.L.	Groundwater Integration Team	2000	Utilizing Models on Multiple Scales to Enhance the Hydrogeologic Characterization of the Pajarito Plateau	LA-UR-00-2900	Los Alamos National Laboratory, Los Alamos, New Mexico

Los Alamos National Laboratory
Hydrogeologic Characterization Program
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Primary Author	Co-Authors	Date	Title	Report Number	Publishing Information
Nylander, C.L.	K.A. Bitner, D.E. Broxton, G.L. Cole, B.M. Gallaher, A.S. Johnson, D. Katzman, E.H. Keating, P. Longmire, S.G. McLin, K.I. Mullen, B.D. Newman, D.B. Rogers, A.K. Stoker, W.J. Stone	1999	Groundwater Annual Status Report for Fiscal Year 1998	LA-13598-SR	Los Alamos National Laboratory, Los Alamos, New Mexico
Nylander, C.L.		1999	EEG Action Plan		Los Alamos National Laboratory, Los Alamos, New Mexico
Nylander, C.L.	K.A. Bitner, D.E. Broxton, B.M. Gallaher, P. Longmire, McLin, S.G, B.D. Newman, D.B. Rogers	1998	Groundwater Annual Status Summary Report FY97		Hydrogeologic Characterization Program, Los Alamos National Laboratory, Los Alamos, New Mexico
Stauffer, P.	K. Birdsell, M. Witkowski, T. Cherry, J. Hopkins	2000	Subsurface Vapor-Phase Transport of TCA at MDA L: Model Predictions	LA-UR-00-2080	Los Alamos National Laboratory, Los Alamos, New Mexico
Stone, W. J.	G. Cole, W. Carey, M. Jones	2001	Los Alamos National Laboratory Expanded Hydrogeologic Atlas	LA-UR-01-70	Los Alamos National Laboratory, Los Alamos, New Mexico
Stone, W. J.		2000	Laboratory-derived hydraulic propertiesof selected materials from wells R-9, R-12, and R-25	LA-UR-00-3587	Los Alamos National Laboratory, Los Alamos, New Mexico
Stone, W. J.	G. Cole, M. Jones	1999	Preliminary Hydrogeologic Atlas for Los Alamos National Laboratory	LA-UR-99-4619	Los Alamos National Laboratory, Los Alamos, New Mexico

Semi-Annual Report
to the
Groundwater Integration Team (GIT)
of the
Los Alamos National Laboratory
by the
External Advisory Group

meeting dates - 16-18 October, 2001

External Advisory Group

Elizabeth L. Anderson, Sciences International, Inc.

Robert W. Charles, Consultant, Geochemistry and Management

Charles F. McLane, McLane Environmental, L. L. C.

Robert M. Powell, Powell & Associates Science Services

Jack D. Powers, Consulting Engineer

David C. Schafer, David Schafer and Associates

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EXECUTIVE SUMMARY

The External Advisory Group (EAG) for the Groundwater Integration Team (GIT) of Los Alamos National Laboratory met during the period October 16-18, 2001, in Pojoaque and Los Alamos, New Mexico. The following summarizes our major comments.

Management and Global Issues:

- The hydrogeologic characterization accomplished under the Workplan has important implications for Laboratory operations past, present, and future.
- The studies are bounded by schedule and budget limitations currently contemplated for the Workplan; a clear definition to define beneficial uses is needed to substantively bound the Workplan. This is a risk-based definition.
- The GIT is working this bounding issue through a revised scope, a management Core Team, and, ultimately, upper management decision making.
- Management needs to provide structure without impeding the flexibility of the GIT to pursue characterization activities with the long-term goals of the laboratory in mind. This structure can be provided by agreement among the major parties concerning definition of the term "characterization."
- The EAG supports a broad view of the mission as stated in the original Workplan.
- While a start, the new proposed scope appears too restrictive and uses the DQO process to set and alter goals rather than respond to the goals themselves.

Technical Issues:

- Database development seems to be proceeding reasonably well. We hope requests for data reports will not unduly impact this development effort. A balance is needed.
- The GIT needs to provide a basis for setting the number of desired additional wells at 15.
- The modeling is showing good use of sensitivity analyses and the first order assessment is commendable.
- Modeling data needs should be examined in the context of long term Laboratory risk-based management policy.
- The geochemistry data gathering and analysis is positively viewed.
- Better understanding of the effects of drilling contaminants indicates that the effects of additives should dissipate in 1.5 to 2 years based on predictions using the gathered data.
- We recommend the addition of adsorption studies if they can be performed within the time frame of the Workplan.
- Drilling and completion has shown remarkable savings due to the decrease in the number of planned wells and variation of techniques to meet the situations encountered. LANL costs do not appear out of line.
- We continue to recommend not drilling R wells or deep piezometers for the sole purpose of acquiring hydraulic data.
- We agree with the methodology limiting sampling analyte suites and the number of samples being collected show good progress on monitoring.
- The EAG continues to recommend low-flow sampling and more complete SOP's.
- Risk management decisions should be considered as viable drivers defining the scope of the Workplan and for decision making, yielding a prioritized set of actions agreeable to all stakeholders.

1.0 INTRODUCTION

The Hydrogeologic Workplan (Workplan) describes activities proposed by Los Alamos National Laboratory (LANL) to characterize the hydrogeologic setting beneath the Laboratory, and to enhance the Laboratory's groundwater monitoring program. As stated in Section 1.6 of the Workplan, where the language implies a risk-based management approach:

> "The goal of the Strategy [LANL Groundwater Protection Strategy] is to describe a dynamic approach to protecting the groundwater resource from unacceptable impacts resulting from past, present, and future operations."

This protection strategy is "to protect...beneficial uses" including "potable water supply, irrigation, livestock, and wildlife watering." The Workplan states that the "highest priority is the protection of groundwater of the regional aquifer because of its beneficial use as a source of drinking water." The Workplan also states that "the regional aquifer also contributes flow via springs and seeps into New Mexico's surface water, e.g., the Rio Grande, which also has incumbent beneficial uses..."

The original Workplan provides a process for drilling up to 32 deep (aquifer-penetrating) wells and shallower wells as needed, including 51 alluvial wells, to 1) reduce hydrologic uncertainties; 2) reduce stratigraphic and structural uncertainties; 3) detect contamination of the water supply system; and 4) assess the nature and extent of potential contamination of the groundwater. Funding for the program is from Environmental Restoration and Defense Programs, depending upon the location and objectives of the designated well. With its inception in FY1998, the Workplan is managed by the Program Manager and the Groundwater Integration Team (GIT) matrixed with the Environmental Restoration (ER) and Defense Programs Program Offices. An External Advisory Group (EAG) was formed in August 1998. The purpose of the EAG is to function as an independent peer review body, comprised of professionals with education, expertise and experience germane to the Hydrogeologic Workplan activities.

The current document represents the seventh semi-annual report by the EAG based on the meetings held in Pojoaque and Los Alamos on 16-18 October, 2001. The EAG heard technical presentations, facilitated a Stakeholders meeting, and participated in subsequent discussions with the GIT. The EAG reviewing team consisted of Elizabeth L. Anderson, Robert W. Charles, Charles F. McLane, Robert M. Powell, Jack D. Powers, and David C. Schafer. All participated in the review and the preparation of this document. This report summarizes the discussions, impressions, and recommendations of the EAG as of the date of the meeting.

2.0 MANAGEMENT AND GLOBAL ISSUES

2.1 PROGRAM MANAGEMENT

Positives:

- *Attempt to refine the scope of the program by the PM and the GIT*
- *Proposed schedule for completion of the Workplan*
- *Better focus on needs to complete the Workplan*
- *Adequate, simple method to monitor progress*

The focus of management discussions centered around bounding conditions, definition of terms, and end products for the Workplan. Current bounds are schedule and budget driven which are not entirely desirable. The GIT has presented a new scope, which is an attempt to provide bounds. Definitions of indefinite terms such as `characterization' were extensively discussed. End products such as wells, an extensive database, and modeling only partially fulfill the needs for end products. Our analysis deals with the 1) goal conflicts of the principal organizations, 2) attempts to sharpen the mission and products, 3) balance of long vs. short term goals, 4) some possible directions the GIT may wish to consider, and 5) how to prioritize these actions.

Promulgation of the Workplan is showing some of the stresses of a program in mid completion. This is normal. The conflicts of a time-goal nature among the principal funding, regulating, and working organizations are apparent: The PM and GIT have a relatively long term perspective for the results of the Workplan and a more indefinite goal - "characterization." ER has a shorter time perspective dealing with goals of actual clean-up and monitoring. DP, while having some environmental responsibilities, is primarily focused on addressing weapons related work. Regulators are torn between long term welfare of the public and immediate definition/remediation of contamination issues. The goals of each are valid, but conflict with one another *in tota*. The EAG observes that the extensive and continuous negotiations among the organizations have not resulted in a concrete consensus for the issues outlined above.

Discussions with Management and the GIT over the past two years to sharpen the mission of the Workplan have begun to bear some fruit. The GIT has taken the initiative and issued a revised scope reducing the number of wells planned for in the Workplan as well as reiterating that the program is going to be completed on schedule. They are beginning to take a leadership position in setting the agenda. Table 3 in the revised scope document, Summary of Hydrogeologic... (Bagel Chart), is an effective way to monitor progress. The management Core Team plans to be more active. Unfortunately, the new Workplan scope states "The ultimate objective of the Hydrogeologic Workplan is to understand the hydrogeologic setting in order to design a monitoring network." While this is an example of a possible end product, the objective of the Workplan, as demonstrated in the introduction above, taken directly from the Workplan as approved by upper management and the regulators, greatly transcends this prosaic goal. We add that the initial drivers for the Workplan in the appendices of the original document support just this type of broad investigation. We support the GIT in preparing this document but have some technical advice of a more extensive nature, which will become apparent throughout the appropriate sections of this report.

A major issue is resolving the paradox of more clearly defining the long term applicability of the Workplan results, while presenting aspects of importance to the shorter term goals of the funding agencies and regulators. Although it might reduce friction within parts of the program, total focus on short-term goals is not appropriate. The positioning of the Workplan in ESH is an organizational statement that the Laboratory wishes to take a more long term perspective. The long-term perspective has also been clearly stated by the ESH Division leadership. The EAG regards the goal of the Workplan as quoted above as inclusive of both short-term and long-term protection goals; of both known and unknown contaminants; of not only past and current operations, but of long term future operations of the nation's principal facility charged with safeguarding our nuclear stockpile and being responsible for related future production and ongoing research.

Recommendation:

- *The EAG recommends revisions of the new scope to emphasize the broader nature of the mission of the Workplan.*

Where shall the GIT proceed from here? A balanced approach, which addresses some of the shorter term desires of the end users while positioning for the future is appropriate, and we understand that this is the goal of the GIT. Negotiation of issues among the principals with upper management as an arbiter is the substantive procedure which the GIT is planning to follow and, in which, the EAG concurs. Certainly, shorter term goals such as the positioning of future monitoring wells, determining current contamination, drilling 'wet' canyons and some placement of deep wells to insure pursuit of these goals can occur as long as the management does not forget the long term aspects of the program. The GIT aids in this process with the third and fourth columns of Table 3 in the revised scope (data needs and planned data collection).

Prioritization is necessary. If the GIT tries to please everyone, stalemate can result. We concur with the comments that valid end products and a path to them are still indistinct. We, as well as others, have proposed risk drivers to aid in this prioritization (see Section 3.7). There have been no risk drivers in the promulgation of the Workplan thus far. The planned risk assessment in ER is too narrowly focused to support the Workplan. We continue to suggest a hierarchy of decision making as expressed in the last report (recommendation 6-01-01). One pathway is to produce a strawman product in the form of a proposed final report.

Recommendation:

- *The EAG (as well as others present at the fall meeting) recommends the preparation of a draft final document, initially in outline and abstract form, showing the deliverables for the Workplan and balancing long and short term goals.*

Retirement/Combining of EAG recommendations relevant to this section:

References to 6-01-3 appear incorrect as this refers to the agreement of management to help sharpen the focus of the Workplan. The recommendation was in an early draft of the 6-01 report and we do concur with the objective, but it was left as a recommendation by management. Still, it is good that this be monitored (as in 7-00-01 and 12-99-01). We suggest that a number of references to completed activities should really be ongoing. Examples are 7-99-04 and 12-00-01. Page 49 of the action plan combines 7-99-04 and 11-98-01 of the same ilk for 'further action.'

2.2 MANAGEMENT OF STAKEHOLDER ISSUES

Positives:

(from Stakeholders):

- *Geology*
- *3D geologic modeling*
- *Use of modeling to designate R-13 replacement well*
- *Overall technical expertise of GIT*

- *Geochemical data interpretation*
- *Well cost decreasing*
- *Quarterly sampling and results from the R-wells*
- *First order modeling of transport*
- *R-8 coring and DQO coring methodology*
- *Advances in regional hydrology understanding*

(from EAG):

- *Opportunity to discuss issues with the external stakeholders*
- *Frank and substantive responses to stakeholder issues by the PM*

The semi annual meeting with the external stakeholders (i.e., exclusive of LANL and DOE personnel) was held Tuesday, 16 October, in Pojoaque. Attendance was down from previous meetings. Representatives of NMED, CAB, and the NM Attorney General's Office were in attendance. The attendee's enthusiasm made up for what they lacked in numbers. Concerns are presented in the order in which they were received.

Data acquisition: There is a desire to understand the status of data collection and how to proceed to completion. The PM reiterated the list of wells desired as shown in the revised scope and the list of tasks to be performed. A specific example was the need for more data control in the area of TA-54. The GIT would like more control to define the flow lines in the direction of the Rio Grande as these may bend toward the river.

Program Management: There is still a lack of understanding how decisions are made and how they are communicated to stakeholders. The PM reminded those in attendance that changes are made to the Workplan through quarterly meetings and associated reports, not revision of the original Workplan document. The stakeholders are invited to these meetings to provide input. The revised scope is another document that addresses potential changes to the Workplan.

Communication: The stakeholders still perceive communication problems: no completion reports, weekly drilling reports, or biweekly meetings. The document release policy is still not clear although promised. The State Attorney General's office suggested a draft final report to guide the completion of the program and provide some overall guidance to stakeholders (and others) as to the direction to completion. There is a perception by some that the EAG is either ignored or too accommodating to LANL.

In addition to the comments on communications in the previous issue, the PM referred the stakeholders to the ER Program which owns the RFI Workplans, explained the relation of the Workplan to ER, and the relations to findings for current as well as legacy waste. The PM stated well completion reports for R-31 and R-25 would be forthcoming in early November. Concerning document release, a bibliography was compiled last summer and will be provided with the minutes of this meeting. The ER website has a virtual library with most of the reports on line. There is no formal policy for document release, but there seems to be a great deal of information already published. The PM will ask the Washington Group for weekly drilling updates. The GIT would like to begin outlining a final report format that will evolve into a formal document over the next year or two.

The EAG would be willing to entertain suggestions as to how its perception with regard to the Laboratory can be clarified. The position of consultant is one of remuneration by LANL, but the impression that the advice is somehow too accommodating to LANL positions is in basic

conflict with the purpose of our consulting activities. Stated in a different way, consultants are not hired for their acquiescence but their expertise, whether the messenger presents good or bad news. Enlightened organizations welcome the opportunity to examine differing points of view. We have found that LANL examines our advice and either accepts or rejects it in light of their perspective of Laboratory goals, as is their prerogative.

Well Construction: The use of gravity grouting instead of pressure sealing is a concern. Do we need to develop all drill holes as wells? Some may be for characterization or monitoring and may be of smaller internal diameter.

The PM stated that the backfill has been found to have very little void space due to settling after gravity grouting. Pressure grouting is avoided so as not to push grout into the sand pack. The GIT will continue to monitor this issue. While there may be advantages to not automatically converting all boreholes into monitoring wells, currently planned characterization borings are generally sited at locations that require long-term water level data, and will therefore require the construction of a monitoring well. For future characterization borings, decisions may be made on a case-by-case basis regarding the need to construct and sample a monitoring well.

Well Development: The types of screens used currently might inhibit development due to cleanup issues. How well are the zones isolated by the Westbay system? The PM noted that pressure checks on each Westbay zone yield great differences, which is one indication of isolation of zones. Differing water chemistry is another.

Scope: The scope of the Workplan was one of the major issues discussed. NMED would like to see characterization limited to 'important' (i.e. wet canyons) locations. They seem to doubt the need to drill 15 more wells for this purpose. Does each hole need to be a 'well'? There still is a perception that intermediate wells are being ignored. What is the long term purpose of the wells - characterization or monitoring? They wonder if it would be better to begin transition to monitoring. They hope the Core Team will help define these issues.

The PM feels a focus on historical discharges, permitting, and wet canyons is a great and inappropriate change in the scope of the Workplan from one of general characterization of the setting of the Plateau. The broader focus is the agreed upon scope. The lack of commitment to planned project scope has been an endemic problem throughout environmental restoration history. The same can be said about wishes to ramp down to a monitoring format in the last years of the Workplan. The GIT plans to continue characterization until there is enough site wide information for the long term. The GIT is not insensitive to cost issues as is shown in the decreased cost of drilling and the more focused coring of drill holes in the recent past. The revised scope projects fewer wells, on schedule completion, and some focus on data needs and data gathering to fulfill these needs.

While the PM agrees that the understanding of perched zones is incomplete, in the context of the Workplan, intermediate well studies are adequate. In some cases perched zones are ephemeral, disappearing during drilling. Two more intermediate wells were drilled this summer. It would be helpful if NMED would define what they mean by accurate and complete. Perhaps these needs lie outside the scope of the Workplan, but lie elsewhere at LANL.

The PM wants to work with the state to better clarify these issues in conjunction with the Core Team. Should conflict remain, management will be asked for a decision.

Modeling: Stakeholders would like to see more determination of the critical parameters and their consequent effect on sensitivity of the results. The comment was general for hydrology, geochemistry or risk assessment. They see a conflict in the use of the microgeology around outfalls vs. the macrogeology of the plateau.

The PM will continue to encourage publication of assumptions/sensitivities for review with the public.

Contamination: Stakeholders would like more information regarding LANL's current understanding of subsurface (especially ground water) contamination. Is contamination present? Which chemicals? Where is it going? How fast? What will be the likely impacts? There is concern that the Workplan will not answer these questions, and this was cited as one of the problems of the Workplan.

The PM described how the First Order Assessment currently being conducted under the Workplan will, over the next year, identify primary chemicals of concern, ground water flow directions and velocities, capture zones of potential receptor wells, and other information relevant to determining potential impacts of contamination.

Geochemistry: The State appears to be concerned that the proper geochemistry studies be performed to examine chemical sorption processes in the ground water system. Are dissolved chemicals (especially radionuclides) sorbing, and if so to what; to the geologic matrix or to colloids?

The PM suggested that modeling sensitivity analyses could be used, with conservative overestimates of the percentage of mass being transported via colloids. If no unacceptable risks were identified for these conservative scenarios, then it might be unnecessary to more completely characterize colloid geochemistry. The State responded that under the current Laboratory regulatory program, chemical breakthrough in ground water might be sufficient to trigger corrective action whether risk-based standards had been exceeded or not. This issue may require further exploration by the Core Team.

Recommendation:

- *The EAG should become more of a participant in the dialogue to clarify and crystallize stakeholder concerns rather than a passive gatherer of observations at the Stakeholder's meeting.*

2.3 DATA QUALITY OBJECTIVES

Positive:

- *The GIT convened meetings in an attempt to reiterate and refine the Workplan DQOs in terms of what is currently known and what data needs remain.*

Periodic reassessment of the data quality objectives and their state of attainment is an important aspect of any complex, long-term project. Such a process refocuses the project on its ultimate goals, reminds those performing the work what those goals are and their progress towards achieving them, and provides documentation at that point in time of accomplishments,

modifications, and the planned path forward to DQO completion. The DQO process is rarely used to justify a fundamental shift in the overall objectives of a complex project but usually deals with the processes and components required to achieve the overall objectives. It appears to the EAG that the process of evaluating the DQOs that was undertaken by the GIT this summer was also used to limit the scope of the Workplan goal from that of a site-wide characterization that included the development of a monitoring well network to being primarily focused only on the monitoring well component. The Executive Summary of the Workplan states the expected outcomes of the project to be:

- Refined understanding of the hydrogeologic framework at the Laboratory, including recharge areas, hydraulic interconnections, flow paths, and flow rates, synthesized by modeling simulations;
- Information sufficient either to design and implement a detection monitoring program that meets applicable requirements and/or to demonstrate that groundwater monitoring requirements can be waived; and
- Defined areas of existing or potential groundwater contamination, and the potential pathways of contaminant transport from the surface to the regional aquifer, with predictions of directions and rates of movement and risk based on modeling simulations.

In contrast, the recently distributed document purported to result from this summer's DQO evaluation, titled "Los Alamos National Laboratory Hydrogeologic Characterization Program Proposed Hydrogeologic Workplan Scope" states:

- The ultimate objective of Hydrogeologic Workplan is to understand the hydrogeologic setting in order to design a monitoring network

The re-stated goal is inconsistent with the original short and long-term goals as stated in the original Workplan (see Section 1.0, Introduction).

Recommendation:

- *Decisions are needed as to what the goals and outputs of the Workplan will be, in a very specific sense. These should result from the "Core Team" meetings discussed during the presentations. These decisions will allow iteration of the relevant DQOs.*

This Workplan revision seems to eliminate two of the three originally anticipated outcomes of the Workplan project and such an alteration seems inconsistent with the DQO process. This might not be true if the design of the monitoring network incorporates all of the site characterization information entailed in the other two originally planned outcomes. However, if this is the case it is not apparent from the materials provided. The EAG is aware of monitoring networks at other sites that have been established in the absence of such thorough characterization information. Such an alteration in project scope would have to result from a management decision followed by a DQO iteration that removed data needs and objectives related to the two outcomes that were eliminated. In other words, the DQO process itself should not set nor alter the overall project goals but should only respond to such changes. There is some concern within the EAG that neither the original nor the iterated DQOs provide an adequate basis (under EPA and DOE guidance) to guide the Workplan program to a successful conclusion. The previous DQO process (especially the key "driver" decisions) should be revisited as part of the Core Team meetings with the objectives of those meetings being to establish:

1. Clearly stated purpose and objectives of the Workplan; and

2. A means of communicating the Workplan purpose and objectives through the project management process to the technical task level and to stakeholders

Recommendation:

- *When the DQO iteration process is invoked, appropriate procedures should be followed to ascertain that all relevant aspects are addressed and that adequate documentation of changes results.*

The DQO iteration process, although repeatedly invoked in the presentations on the DQO iteration overview, does not appear to have been formally followed during the proposed Workplan scope revision. Although it was stated that the "spirit" of the DQO process was present, it seems that the decisions were more of a consensus-based discussion among technical staff in the absence of clear risk management decisions as drivers. It should be noted that DOE is very firmly behind the application of DQOs in general in its site investigation and remediation programs (see for example the Grumbly DOE memo dated 9/7/94 regarding "Institutionalizing the Data Quality Objectives Process for EM's Environmental Data Collection Activities"). DOE is also very firmly behind the application of DQOs in risk assessment (see for example DOE Office of Environmental Guidance document EH-231-023/0794 July 1994, "Using the Data Quality Objectives Process in Risk Assessment"). The EAG has repeatedly requested that a more formal and well-documented approach be used during these types of decision-making processes. The implementation of a somewhat more formal DQO iteration process would have provided such an approach.

Retirement/Combining of EAG recommendations relevant to this section:

None.

2.4 ADMINISTRATIVE

Positives:

- *Management of meeting logistics*
- *Collection of view graphs, notes for prior distribution*
- *Name tags*
- *Many open, positive, revealing discussions with all attendees which is encouraged by the PM and GIT*

Our thanks to Suzanne Maez for her help with the logistics of the meeting. The compilation of the view graphs and abstracts was very helpful to the EAG. The EAG thanks Suzanne Maez, Kelly Bitner and the GIT for their efforts in the compilation.

Recommendation:

- *Designated time for report outlining and scheduling by the EAG at the end of the meeting with all EAG members participating.*

Retirement/Combining of EAG recommendations relevant to this section:

None.

3.0 TECHNICAL ISSUES

3.1 DATA GATHERING AND DATABASE

Positives:

- *The presence of the WQDB information on an easy-to-use website.*
- *Large quantities of information have been added to the WQDB.*
- *Increased focus on development of the WQDB during FY02.*
- *Collaborations between ER and ESH-18, as well as external groups.*
- *Transfer of functions previously done by ancillary programs into the database itself.*
- *Data collection continues to be extensively done and in a timely manner.*

The EAG considers the development of the WQDB to be an extremely positive aspect of the Workplan. Input of information into the database seems to be occurring at a good rate. It is important that the information therein be accessible to the public at large in an easy to use manner. Great improvements have been made in this regard. Establishing the database in such a manner that queries, etc., normally accomplished by a variety of individual programs, are built into the database access routines themselves is a good approach and should greatly simplify access for end users. The planned increased focus on resources for the WQDB during FY02 should garner very positive results.

There are some issues that have surfaced with regard to the WQDB, especially with regard to delays, that will be addressed with the following recommendations.

Recommendation:

- *Data transfer between ER and the WQDB needs to be accomplished in a smoother manner.*

Problems in data transfer may exist with the originator, i.e. ERDB. We will examine this issue more closely at the next review.

Recommendation:

- *Resources should be managed such that data requests do not interfere with the development of the database.*

It is an unfortunate circumstance that data requests from external entities and LANL staff, sufficient to create a backlog of data to be processed, have interfered with the development of the database that, when completed, could manage these requests automatically. Steps should be taken to address this issue, either through the addition of personnel to handle the data requests, an attempt to work with the requesters to minimize their immediate requests for data, or both.

Recommendation:

- *Sufficient resources should be provided to maintain the expertise necessary for constructing and maintaining the database.*

There was evidently a significant amount of lost time during this year due to the transition within ER from Oracle to SQL Server. This was attributed to the inability to hire and keep Oracle experts on staff. Since numerous corporations, universities, and agencies maintain trained Oracle staff, this seems to have been a resource issue. It is perhaps a moot point, because the transition is apparently complete, but it is important that staff expertise with the database be maintained from this point forward.

Data gathering under the auspices of the Workplan seems to be picking up momentum as more of the R-wells become completed. Specific issues regarding data gathering activities will be addressed in other sections of this report. There is an important issue relative to data gathering in general, however, that will be addressed in the following recommendation and discussion.

Recommendation:

- *Some means of identifying and communicating which well installations and activities are most relevant to accomplishing Workplan goals should be devised.*

The proposed revisions to the Workplan and DQOs, e.g., to install 15 more wells, 13 other field-based activities, etc., might be adequate to provide sufficient hydrogeologic characterization of the subsurface but the EAG sees no indication of any metrics that would support this conclusion. It is not clear, in the absence of a risk-based decision-making process, with well-defined end states, how it can be known if this number of wells or the other delineated tasks in the revised scope can address data needs sufficient for the ultimate goal of assessing risk to human health and the environment or the characterization goals of long-term stewardship. Also, within the new delineation of tasks/objectives, it is not clear which are more significant or relevant in relation to the others. Again, this will require defined end-states and sensitivity analyses to evaluate which parameters are more influential for contaminant transport and fate assessments, etc. This is an issue that should be addressed by the Core Team discussed during the recent meetings.

Retirement/Combining of EAG recommendations relevant to this section:

None.

3.2 MODELING

Positives:

- *Interaction between GIT modelers and NMED in examining alternative conceptual hydrogeologic models for Los Alamos Canyon, with planned testing of conceptual models via sensitivity analyses.*
- *Use of recently collected water level data in the regional model to significantly constrain hydraulic conductivity estimates for the Puye Formation.*
- *Successful completion of first phase of First Order Pathways Assessment modeling.*
- *Use of modeling to develop preliminary concept (to be tested) that further characterization of intermediate ground water may not be warranted based on:*
    - *sensitivity analyses from First Order Pathways Assessment; and*
    - *scale of effort and cost required to attempt to more completely characterize intermediate ground water zones*

- *Input from the regional modeling task to the drilling and data collection planning effort that suggests that, while approximately 15 additional characterization / monitoring wells may adequately constrain lateral ground water flow directions, the number may not be sufficient to constrain vertical flow paths if vertical gradients are found to be significant.*
- *Plans to build on First Order Pathways Assessment modeling by incorporating source zone information, and regional process model information on chemical fate and transport*
    - *to begin to rank chemicals of potential risk significance to ground water receptors on a site-wide basis*
    - *possibly to begin to evaluate appropriate responses to chemicals detected in ground water during drilling activities*
    - *to provide further guidance to well siting and hydrogeologic characterization relative to significant ground water flowpaths*
    - *to continue the formulation of a modeling strategy that will effectively incorporate both system-level and physical-process hydrologic models.*
- *Proposal from the modeling program that a few shallow wells may more cost effectively provide data necessary to further refine understanding of the distribution and rates of percolation, than would the more costly deep wells that are currently being planned as part of the deep monitoring well installation program.*

Recommendation:

- *Reexamine modeling "data needs" identified in Appendix A of Revised Hydrogeologic Workplan Scope in light of ultimate end uses of data in risk assessment (i.e. protecting beneficial uses of groundwater), remedial decision making, and higher Laboratory risk management functions.*

While there appears to have been progress over the past several months in using modeling results and insights to identify data needs and to begin to communicate those data needs to the field data collection teams of the hydrogeologic characterization program, it is difficult to determine to what extent the DQO process was followed in the recent DQO iteration, and to what extent (if any) risk assessment and risk management decisions were used as drivers for the iteration (as per Section 2.3 of this report). While the EAG is not necessarily, at this point, suggesting that the entire DQO iteration for data and activities related to hydrologic modeling be redone, we recommend that risk assessment/risk management end uses for the data be identified and used in a review of the results of the DQO iteration to identify any needed revisions.

Retirement/Combining of EAG recommendations relevant to this section:

None

Recommendations Requiring Additional Action:

6-01-11: The EAG recommended a simple modeling approach wherever possible, and suggested that this be communicated to NMED (who had expressed a preference for such an approach) and to stakeholders. The GIT response stressed the "communication" aspect, did not address the "simple" aspect. The EAG would like clarification as to whether the GIT intends to perform the simplest modeling that will meet program objectives (once those are a little more clearly defined.

3.3 GEOCHEMISTRY AND GEOCHEMICAL MODELING

Positives:

- *Excellent data analyses and interpretations in general*
- *Tritium data for wells R-9i, R-9, R-12 perched, and R-12 regional that are supportive of conceptual models and indicate a pathway between the perched zones and the regional aquifer for tritium.*
- *The application of structured analytical suites to the wells is a very positive action that should save money, time, and result in data that are protective of human health and the environment.*
- *The evaluation of data that show the use of EZ-Mud is impacting the groundwater samples, but that the effects will probably become insignificant after 1.5 to 2 years is an excellent use of the early data from these wells.*

Comprehension of the geochemistry of the subsurface at LANL is progressing very rapidly, as is an appreciation of the effects of various well drilling techniques on monitoring well water quality. The EAG appreciates the level of expertise and understanding that has gone into evaluation of the available data and is aware that there are aspects of the subsurface geochemistry that will need to be addressed using the mineralogical phases to fully assess the potential for contaminant transport and fate beneath LANL. Although the mineralogical aspects of the subsurface characterization have not yet been gauged using risk sensitivity analyses and working backwards to such tasks, it is likely that in almost any scenario some aspects of the mineralogic factors influencing contaminant transport and fate will be significant, especially for metals and radionuclides. This is at least somewhat apparent from other DOE sites that have insufficiently understood the geochemical aspects of the subsurface and have misunderstood, typically overestimating, actual contaminant transport times.

Recommendation:

- *Carry out the adsorption studies requested for the Cerros del Rio basalt and Puye formation, as discussed during the presentations, provided some level of risk analysis improvement can be demonstrated and that the work is completed within three years, i.e., by the end of the program.*

This work might contribute significantly to the understanding of the subsurface geochemistry at LANL. The EAG recommends that, if done, this work be accomplished in conjunction with the canyon percolation rates study to achieve greater cost effectiveness.

Retirement/Combining of EAG recommendations relevant to this section:

None.

3.4 DRILLING AND WELL COMPLETION

Positives:

- *The downward revision of the number of wells required to complete the Workplan to the extent this is consistent with the DQO's, will reduce project costs by many millions of dollars.*

- *Mobilization of a second, smaller drill rig for use in developing the R wells, as well as other activities, to help reduce overall project costs because of the lower billing rate structure of the smaller rig. This change will be beneficial so long as there is ample work to keep the second rig busy and justify its presence on site.*
- *Plans for completing a higher percentage of single screen completions, to the extent this is consistent with the DQOs, to reduce drilling costs and development and hydraulic testing costs. It is likely that both development and testing will be more effective in the single screen completions.*
- *Temporary hiring of the Schlumberger drilling consultant provided value to LANL in terms of training of personnel and assisting with drilling decisions.*
- *Drilling costs have continued to come down as the project advances.*

An analysis of drilling costs of R-7 and R-22 (based on LANL accounting information) compared to Nevada Test Site (NTS) costs showed that while per-foot costs at LANL were higher, the per-day costs were lower than those at NTS. This suggests that the LANL cost structure is not out of line. The higher per-foot cost at LANL is a result of the tougher drilling conditions. This is demonstrated by the fact that it takes about one month to drill a 3000 to 5000 foot deep well at the NTS (personal communication) compared to about two months to complete a 1000 to 1500 foot deep well at LANL, based on recent drilling experiences there. Further evidence of the tough drilling conditions at LANL is presented in the recently completed Value Engineering Report. According to the report, deep well drilling costs at INEEL have been averaging $272 per foot, yet the same vendor who is providing wells at that price in Idaho recently bid $600 per foot for the LANL wells, according to LANL personnel. Also, it is the EAG's understanding that another prominent national drilling contractor declined to even submit a bid for drilling at LANL.

Well Drilling

Recommendation:

- *Track the drilling environment as well as the cost consequences of open hole drilling versus casing advance methods so that optimum decisions regarding drilling method can be made on subsequent R wells on a case by case basis.*

It is the EAG's understanding that drilling plans for future R wells call for drilling open-hole with air in the vadose zone, a form of open-hole, flooded reverse below the water table, and casing advance as a last resort. While the open hole methods can be less expensive than casing advance drilling in situations where they work effectively, open hole drilling can expose the borehole to the risk of collapse, causing costly re-drilling and occasionally requiring efforts to retrieve stuck tools. Naturally, the success and costs of open-hole drilling should be tracked and compared to costs of casing advance so that, ultimately, the most cost-effective approach to drilling will be used on a case-by-case basis.

Recommendation:

- *Document costs, both direct and indirect, and other deleterious consequences associated with funding-related shutdown and restarting of the R well drilling program.*

A continuing threat to drilling efficiency is the question of program funding. It seems that the amount of available funding is unknown until the fiscal year has already started. This makes it

difficult to plan with certainty and can lead to drilling shutdown, demobilization, remobilization, and repeated training of new drilling personnel. All of this adds to the cost of drilling. Management should be cognizant of both apparent and hidden costs associated with drilling inefficiency related to the funding question and look for ways to ameliorate the situation to the extent possible.

Recommendation:

- *Apprise NMED representatives of the rationale for the current well screen/casing design, so they understand the properties of the materials and their suitability for use in the R wells.*

One detail worth pointing out, related to well design, arose at the Stakeholders' meeting. It seems that the NMED representatives have been told that the well screens being used in the R wells are hydraulically inferior and that rod base screens should be used instead to facilitate well development and sampling. Some effort might be considered to provide information to the NMED representatives on the design, rationale, and facts concerning well efficiency and development and the fact the screens selected for the project are appropriate.

Well Development

Development of the R wells has been time-consuming, expensive and sometimes ineffective. Contributing factors that make the R wells especially difficult to develop include:

1. The wells are extremely deep.
2. The wells are small in diameter.
3. The static water levels are very deep.
4. Some of the screen zones are tight and low yielding.
5. Multiple zones have substantially different piezometric heads.

These factors, taken together, complicate the development process enormously, drive costs up, and make effective development difficult at best. The EAG is preparing a separate report on development and sampling procedures to address these issues, so they will not be discussed in detail here.

3.5 HYDROLOGY

Positive:

- *It is the EAG's understanding that a contract has been let to have specialized equipment manufactured for the purpose of running packer pumping tests.*

This will allow running pumping tests on individual screen zones in multi-screened wells, rather than slug tests, thereby providing better hydraulic data.

Multiple Well Pumping Tests

Recommendation:

- *Avoid the expense of devoting the cost of R wells or new piezometers for the sole purpose of acquiring hydraulic data from the regional aquifer.*

There continues to be consideration for conducting a multiple well pumping test at LANL, using a high capacity municipal well as the pumped well and newly installed observation wells (either R wells or wells drilled solely as piezometers). We understand that one of the drivers for this is the need for "large-scale" hydraulic information.

If the fortuitous placement of new wells, drilled for other purposes, makes such testing possible, the EAG would not object to it. At that point, the incremental cost of obtaining the information would be just the nominal cost of conducting a pumping test. However, we continue to advise against earmarking a major expenditure of funds to drill new wells solely for this kind of testing. This opinion has already been introduced as a recommendation in a previous EAG report, but was retired as specifically referring to R-5 which turned out to not be located near a municipal well. Therefore, it is appropriate to re-introduce it as a recommendation. In addition, some discussion and explanation is appropriate.

As the GIT has pointed out, one of the data needs at LANL is resolution of apparently contradictory hydraulic conductivity calculations for the site. Average hydraulic conductivity values calculated from pumping tests on high capacity municipal wells are about an order of magnitude greater than the average hydraulic conductivity inferred from site-wide groundwater flux and hydraulic gradient information. This apparent discrepancy can be explained either by a "patchy" aquifer (or layers of "patchy" zones) or by a severely laterally anisotropic aquifer in which the east-west hydraulic conductivity is far less than the north-south hydraulic conductivity. The hypothesized anisotropy could be caused, for example, by north-south trending faults. It was hoped that multiple well testing could quantify the broad-scale lateral anisotropy, if present.

Unfortunately, in most hydrologic settings, measuring broad-scale hydraulic effects is difficult or impossible using pumping tests. In this instance, to detect broad-scale anisotropy would require widely spaced observation wells, i.e., far from the pumped well. It is possible that such observation wells would exhibit very little drawdown response to pumping, which would make it difficult to distinguish whether the observed drawdown differences in the observation wells were caused by the hypothesized anisotropy or by background noise or local heterogeneities. In relatively simple hydrogeologic settings, determination of broad-scale effects such as this would already be difficult, while in a complex, multi-layer system such as exists at LANL, the task would be even more daunting.

To overcome the problem of limited drawdown response, the observation wells could be located closer to the pumped well. Closely spaced wells, however, would fail to provide a response representative of the large-scale hydraulic conditions. Instead, the responses would be strongly affected by the local heterogeneous features responsible for causing the overall system anisotropy.

For example, an observation well located across a fault from the pumped well would show a very different response than an observation well on the same side of the fault as the pumped well. The

latter location would support a miscalculation of the preferred permeability direction, 90 degrees off the true direction, while the former would support calculation of the correct anisotropy direction, but an exaggerated magnitude. Neither well configuration would allow calculation of the actual site-wide anisotropy. Meanwhile, a pumping test well array that was not located near a fault would likely support the conclusion that the site was isotropic.

A summary of the hydrologic information that can be acquired from incorporating observation wells in a conventional pumping test is as follows:

1. Using one observation well provides storage coefficient data only, without any other benefit.
2. Using two observation wells, depending on the particular well configuration employed, can provide transmissivity information or anisotropy information, but not both.
3. The transmissivity and/or anisotropy information acquired is limited to a small area, essentially that spanned by the well network itself.
4. In seeking anisotropy information over a broad area, the required large well spacing results in minimal observation well drawdown response that can be lost in the background noise or differences in response attributable to aquifer heterogeneities. This usually leads to ambiguous solutions.
5. Reducing the well spacing to maximize the drawdown response will result in a failure to obtain representative broad-scale response.
6. Three observation wells are required to determine anisotropy direction and magnitude.
7. If the principal direction of anisotropy is known in advance, two observation wells are required to determine the magnitude of anisotropy, subject to the severe limitations listed above.
8. Analysis of observation well test data is complicated by the multi-aquifer hydrologic setting that exists at LANL. It is assumed that the piezometers would be screened in just one strata, whereas the pumped well would penetrate multiple zones. At a minimum, in addition to the other test data collected, it would be essential to conduct a spinner-type survey, or heat pulse survey, under both non-pumping and pumping conditions, to identify inter-aquifer fluxes within the pumped well prior to pumping and during pumping, so that the flow to or from the zone penetrated by the piezometer could be quantified under both pumping and non-pumping conditions.

If observation wells already exist, the cost of conducting a multiple well pumping test is sufficiently inconsequential that it need not be precluded. However, because of the very high cost of well installation at LANL, if separate observation wells are considered for the sole purpose of supporting pumping tests, the cost of installing the wells should be weighed carefully in light of the information that could be gained from such tests. The goals of such testing should be scrutinized closely to see if they are practical and achievable. It would be unwise to launch a pumping test effort merely hoping for a fruitful outcome. Instead, it is essential to articulate exactly what information is desired/expected from the test (clear, predefined objectives) and to determine ahead of time if that need can be met by the planned pumping test. With respect to the hypothesized broad-scale anisotropy effects described by the GIT, it seems unlikely that a conventional pumping test utilizing observation wells would be useful in accurately quantifying this property.

The above information is admittedly brief and, as a result, may lack sufficient clarity. The EAG is available to discuss this issue in greater detail with the GIT to address the capabilities and practical limitations of pumping tests.

Forced Gradient Tracer Tests

Recommendation:

- *Caution is warranted if the GIT decides to perform a forced gradient tracer test and personnel experienced in these types of tests should be used.*

Forced gradient tracer tests are difficult to do sometimes even in shallow aquifers. At these depths it will probably extremely difficult to do and obtain good data (if tracers are recovered at all). This will be a very expensive test and, if it is done, should be done by a group, company, or university that has experience successfully performing these tests.

Colloidal Borescope Flow Measurements

Recommendation:

- Demonstrate that data obtained from colloidal borescope flow measurements will provide useful information to the Workplan project, regardless of the inherent limitations of this method.

We understand that measurements might be made of horizontal groundwater velocities within boreholes and water supply wells, possibly via the use of a colloidal borescope but also likely using some sort of flowmeter(s). The EAG wonders if the purpose of these tests is to try to quantify hydraulic conductivity and Darcian velocity. If so, LANL should be aware that misleading results can be obtained from these types of tests. There are two primary influences that affect these readings. First, in wells with long screens or multiple screens, vertical gradients will induce vertical flow and turbulence within the well casing and screen. Second, regardless of the number or length of screens, the horizontal velocity within the screen is affected by the well efficiency, because it is more difficult for water to enter and exit a borehole that is plugged than one that is open; the lower the efficiency is, the greater this effect will be. Based on efficiencies not atypical of wells that are difficult to develop, such as the R wells, it would not be surprising for horizontal velocities inside the well to be biased downward by an order of magnitude by the well efficiency.

The EAG is not aware of the colloidal borescope being used in wells as large in diameter as water supply wells. We have witnessed its use in two-inch diameter monitoring wells and interpretation even in that scenario was somewhat difficult. This was, however, about 10 years ago and it is possible that the technology is better refined. Having said that, it seems probable that thermal gradients and other effects might be significant across the diameter of a large borehole, potentially resulting in random movement of the colloids within the well rather than being predominantly unidirectional.

The GIT should be aware of and consider these limitations of the colloidal borescope measurements. The EAG is not fully familiar with the intended use, interpretation and

application of the desired flow data. Also, we do not know the cost of performing these tests. We would like to know more about projected costs of these tests and planned use of the data, and will formulate this as an information request in Section 4.0.

3.6 GROUND WATER MONITORING

Positive:

- *A significant number of sampling events have been accomplished for 10 of the 15 wells drilled.*

The sampling of completed monitoring wells is being accomplished and a realization has developed among the data users that drilling fluids can indeed affect sample quality, at least for some finite period. It is also apparent that vigorous well development is needed to shorten the time that residual drilling materials will impact sample quality.

Recommendation:

- *Sampling of the single completion wells should be accomplished using low-flow rate purging and sampling techniques, not by purging 3 well volumes.*

The sampling approach for the single completion wells is inappropriate (purge 3 well volumes then sample) but may be constrained at this time by the lack of formalized low-flow purging and sampling guidance from NMED. Since NMED has guidance under development, the GIT should request from the NMED the concurrence to use low-flow techniques on these wells.

Recommendation:

- *Sampling SOPs should be completed.*

There was no indication at the recent meeting that the new or modified SOPs for sampling were yet available. SOPs are an important part of any QA/QC program, providing guidance and some assurance that procedures are being replicated in a similar manner even by different practitioners. This needs to be addressed as soon as possible.

Retirement/Combining of EAG recommendations relevant to this section:

None.

3.7 RISK ASSESSMENT

Introduction

In all previous EAG reports, the need to develop a risk-based approach for implementing the Hydrogeologic Workplan has been a central focus. This recommendation has emerged because of the EAG's understanding of the Workplan's goals and objectives that are clearly articulated in Section 1.6 (see Section 1.0, Introduction); protecting beneficial uses of the groundwater is a risk-related goal.

The unique responsibilities of LANL place the laboratory in the compelling position of needing to characterize the hydrogeologic setting beneath the laboratory to meet the overall risk-based objective of groundwater protection. The use of health and environmental standards such as MCLs, ACLs, WQCC standards are appropriate concentrations to ensure specific water use protection. As noted in Section 1 of this report, the original Workplan articulated four specific objectives of the well drilling program. The EAG has made note of management statements that the long term mission of LANL is more important than its immediate DOE site risk ranking

With these goals, objectives, and strategies in mind, the EAG recommends a return to a risk-based management strategy to assist in defining the practical definition of "characterization" in terms of Workplan completion goals. This strategy will ultimately allow LANL to answer the essential risk questions of: (1) How likely is an event to occur [i.e., specific impacts to the beneficial use of groundwater from past, present, and future activities]; and (2) If so, what is the likely impact in quantitative terms [i.e., will MCLs, ACLs, WQCC's or other health and ecological indicators be exceeded at the site boundaries now or in future years, e.g., 100-1,000 years?].

In this context, the EAG recognizes that the Workplan must serve multiple needs at LANL including the ER program, the design and long-term groundwater monitoring program, and the higher risk-based responsibility of ensuring that the nation's central nuclear research facility will not reduce the beneficial uses of the groundwater. The DOE has placed a high degree of emphasis on safety and risk management in general; the responsibilities of LANL make this focus even more compelling.

Recommendations:

- *The goals of the Workplan should reflect the broader risk perspectives of LANL and not just support of a monitoring objective or a more limited role of supporting only the ER mission.*
- *The term "characterization" needs to be defined as a practical matter to meet the risk- based objectives of the Workplan and to give the Workplan a clear set of parameters for defining when the Workplan goals have been met, i.e., define characterization in terms of scientific adequacy to meet the Workplan goal of protecting beneficial groundwater uses.*
- *A hierarchy of risk-based decision criteria taken from the recommendation above, can productively yield the remaining steps of modeling which drives data collection which drives well siting and drilling, defining endpoints and a ranking of the most important data required to meet the "characterization" objectives.*
- *Risk-based decision drivers should be used to set priorities amongst the various data needs (presented in the management meeting,), i.e., the use of a sensitivity analysis to determine which data gaps will likely have the greatest impact on the "characterization" program as defined in risk-based terms recommended above. The EAG recommends a more structured approach is needed for setting data need priorities than a "gut feel" approach.*
- *To the extent that the EAG understands the risk-based approach presented at the quarterly meeting, there is some implication that the current state of subsurface characterization is sufficient to satisfy a risk-based decision framework with no more characterization required. If this understanding is correct, the EAG is concerned that this might not be an accurate assessment and recommends that this hypothesis be tested to ascertain if this conclusion is correct.*

- *The Workplan repeatedly invokes the term "risk." In this regard, the EAG recommends that an effort needs to be commenced to set risk limits for contaminants of greatest concern.*
- *Risk drivers are identified in Appendix A of the revised Workplan scope: "Perchlorate, RDX, and TNT are the present day risk drivers for groundwater at the laboratory because their action and/or health advisory levels are less than 20μg/l." This statement should be re-assessed to relate the term "risk driver" not just to a health advisory level, but to potential off-site receptor exposure levels. It is the combination of the two factors, toxicity and potential exposure (levels associated with transport and fate), that will ultimately determine the drivers. Conversely, levels of other agents could also be risk drivers even if their health-based levels are higher but corresponding potential exposures are also higher. The EAG recommends revisiting the current approach as it is outlined in Appendix A.*

Retirement/Combining of EAG Recommendations Relevant to this Section:

None

Recommendation Requiring Additional Action:

All prior recommendations remain current. In particular, the earlier recommendation that a risk sub-committee of the GIT be formed to formulate a risk-based management strategy to guide the risk objectives of the Workplan is current and its role should be expanded beyond the short-term risk objectives of the ER program to address the longer term, global LANL risk objectives (i.e. 12-00-07 is not complete).

4 .0 EAG INFORMATION REQUESTS:

Top-Down Modeling Approach

In Recommendation 6-01-12 in the June 2001 report, the EAG recommended a top-down modeling approach (as had been proposed by ER) guided by clear decision points. The GIT response stated that the First Order Pathways Assessment was the first step in a "top-down look at the hydrogeologic system." The EAG requests additional information on what form the top-down modeling program will take, what models will likely be used, and how they will be integrated. Two or three slides on this topic in one of the ER modeling presentations at the next meeting should be sufficient to address this request.

NMED Modeling Information Request

In Recommendation 6-01-17 in the June 2001 report, the EAG recommended an approach for responding to what was potentially a burdensome request from NMED for modeling-related data and information. The GIT response stated that LANL sent NMED a letter requesting clarification of the request. The EAG requests information on any clarification provided by NMED, and the status of the GIT's efforts in resolving or responding to the clarified request. A one-paragraph e-mail to the EAG Chairman for distribution to the EAG on this topic should be sufficient to address this request.

Integration of Hydrogeologic Characterization and ER Modeling

In the Modeling section of its June 2001 report, the EAG identified Recommendation 12-00-33 as requiring additional action. This recommendation called for a meeting among EAG, GIT, and ER project representatives to discuss scope and integration of modeling activities, preferably prior to the March 2001 meeting. The EAG is not clear on the manner in which the GIT believes it addressed this recommendation, but Table A-2 in the GIT Action Plan for the June 2001 EAG report shows this recommendation flagged as "Complete". Nevertheless, given the recent presentations by the Workplan PM, and ER representatives and their consultants, regarding integrating Hydrogeologic Characterization and ER projects, the EAG would like to renew its request for information regarding the integration of these projects in general, and specifically the manner in which modeling activities and analysis results will be integrated in the programs to meet DQOs and to support Laboratory risk management decisions. When and if this topic is addressed at one of the upcoming LANL/NMED modeling technical exchange meetings described in the recent Action Plan, the EAG requests a copy of any presentation materials and a brief reprise of the presentation at a subsequent GIT/EAG meeting.

Hydrology

Please provide the EAG with colloidal borescope testing plans, including 1) target wells/zones, 2) objectives of the tests, 3) proposed data interpretation approach, and 4) projected costs.

ER Risk Activities

The EAG has reviewed the initial risk strategies of the ER program and the interface of this program with the Workplan. The EAG recognizes the importance of an effective risk-based, iterative, interface to ensure that the Workplan can effectively collect the necessary information to support ER risk activities. At the same time, the Workplan must address the broader risk-based goals of LANL. With respect to the presentation materials we have reviewed entitled, "Integration of Aquifer Characterization and ER Needs," the EAG has the following comments associated with information requests:

1) It appears that the interface between the two programs is defined on the third overhead entitled, "Monitoring Program" and the Workplan would likely fall in the diamond labeled "Can additional regional characterization reduce monitoring costs?" The EAG generally requests additional information on how this determination will be made.

2) More specifically, the EAG requests the following related information:

- Definition of monitoring in the context of this presentation;
- Criteria for determining the cost tradeoffs between more characterization and monitoring
- Clarification of approach to monitoring well placement (if statistical, the EAG has already articulated concerns about this approach).

The EAG also requests more information on why the goal of the monitoring network is set as minimizing risk of an undetected, offsite release.

- Is the risk in the presentation the risk of missing a detection or a risk of cancer to the farmer.
- Why is the term 10^{-6} per year used instead of 10^{-6} per lifetime? Is this level chosen so that the risk target over the hundred years of analysis is 10^{-4}?
- Why is the certainty goal set at 95%?
- How does the well diagram regarding risk to the residential farmer differ from the earlier diagram presumably for the same farmer.
- On the last overhead, the EAG requests a definition of "long-term mortgage."

Does the monitoring network proposal anticipate continued interaction with the Workplan input or does the monitoring network plan anticipate an end to the characterization program so far as ER is concerned? If the latter is the case, the EAG requests further information on how to determine whether or not the ER program has sufficient characterization data to fill its needs and by what measures this is being determined. The EAG warns that a premature judgment about characterization being complete could be disastrous if, after closure, several years later more characterization is deemed necessary.