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memorandum

HSWA LANL G/M/2001

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FROM: Charlie Nylander, ESH-18

DATE: April 19, 2001

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SUBJECT: **MINUTES FROM THE GROUNDWATER ANNUAL MEETING HELD MARCH 20-23, 2001**

Enclosed please find the minutes from the Los Alamos National Laboratory's (LANL) Groundwater Characterization Program Annual Meeting, held on March 20-23, 2001. Several of the discussions at the meeting resulted in the identification of action items. The action items are listed below with responsible parties in parentheses.

1. Drill and complete the following wells in FY02: R-8, R-14, R-20 (DP funded wells) and R-13, R-18, R-21 (Environmental Restoration funded wells). (LANL)
2. Conduct quarterly sampling in FY02 in R-5, R-7, R-8, R-13, R-14, R-18, R-22, R-25, and R-31. (LANL)
3. Develop an annual workplan to be submitted to NMED by April 30. (DOE and LANL)
4. Issue a letter to stakeholders requesting input on the annual plan. The letter will explain the newly instituted annual plan process and the rationale for each well and alternatives. (LANL)
5. Distribute the Groundwater Annual Status Report 10 days before the annual meeting. (LANL)
6. Distribute currently available modeling reports to stakeholders who request them. (LANL)
7. Reserve a section of each quarterly meeting for planning activities. Stakeholders will be welcomed to participate. (LANL)
8. Develop a master list of available publications, update quarterly, and distribute to stakeholders. (LANL)
9. Add to the Environmental Restoration Public Involvement Plan to address the Hydrogeologic Workplan and obtain stakeholder input on that plan. (DOE/LAAO)

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.

CN/tml

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TC

Enclosures: a/s

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MEETING NOTES

from the
Los Alamos National Laboratory's

4th ANNUAL GROUNDWATER MEETING

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), the External Advisory Group (EAG) peer reviewers, and stakeholders on March 20-23, 2001 to host the 4th Annual Groundwater Meeting. The meeting was held at Ghost Ranch, Abiquiu, New Mexico. Charlie Nylander (GIT Chair) 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
Cochiti Pueblo
San Ildefonso Pueblo
Northern New Mexico Citizen's Advisory Board
Concerned Citizens for Nuclear Safety
University of California
Los Alamos County
External Advisory Group (EAG)
LANL-Groundwater Integration Team (GIT)

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

Tuesday, March 20
Introduction
Subcommittee Reports
- Information Management
- Well Construction
- Geochemistry

- Hydrology
- Modeling and Risk

Management Report
- FY00 Accomplishments and FY01 Activities
- FY02 Planned Activities
- Quality Improvements

EAG/Stakeholder Session
Response to Stakeholder Concerns

Wednesday, March 21
Technical Presentations and Poster Viewing
- Evolution of Well Drilling, Construction, Development
- Observations on Geology from Regional Wells
- Well Logs, Geology, and Hydrology
- Hydraulic Conductivity and Geology
- Quantifying Heterogeneity within the Puye Formation
- Databases – Water Quality and Environmental Restoration
- DOE Role in Oversight
- Water Supply Well Sampling
- Results of Quarterly Sampling
- Overview of Modeling Activities and Deliverables
- Los Alamos Canyon Flow and Transport Model
- NMED/DOE-OB Conceptual Model for Los Alamos Canyon
- Validation of Conceptual Models for Vadose Zone Flow and Transport beneath the Pajarito Plateau
- Model Uncertainty, Sensitivity Analysis, and Data Needs

Thursday, March 22
EAG Meetings with GIT Subcommittees

Friday, March 23
EAG/Managers' Closeout Session
EAG Debrief to GIT

SUMMARY OF PRESENTATIONS AND DISCUSSIONS

Introduction

Charlie Nylander (LANL) welcomed attendees to the fourth Annual Meeting for the Los Alamos National Laboratory Hydrogeologic Characterization Program.

Subcommittee Reports

Information Management Subcommittee

Kendra Henning (LANL) described the past year's activities, which have focused on transitioning out of design and into development, testing, and migration. In the past year, the subcommittee has worked on software development, data import and migration, report development, and web site development. The web site can be accessed http://wqdbworld.lanl.gov.

Software development focused on sampling/chain of custody, data validation, data import routines, QA/QC tools for Data Stewards, and discharge monitoring reports. Included in the data import and migration were 40,000+ records of year 2000 analytical chemistry results, 12,000+ records of year 2000 sample tracking/chain-of-custody, 35,000+ records of daily flow data from 1994 to 1999, and 8,000,000+ records of five minute flow and gage height data from 1994 to 1999. Reports developed are gaging stations, chemistry, gage/flow data, sample tracking, and discharge monitoring. The first three reports are available on the web. Significant amount of work went into improving web site performance.

Well Construction Subcommittee

Ted Ball (LANL) described the activities of the Well Construction Subcommittee. The wells installed were:

R-7

- Drilled to total depth of 1,097 feet on 1/12/01; well construction completed on 1/30/01; Westbay equipment installed 2/26/01; surface completion in process
- First sampling planned for summer 2001

R-22

- Total depth of 1,489 on 10/11/00; well construction completed on 11/3/00; Westbay equipment installed on 12/18/00; surface completion in process
- First sampling event on 3/6/01 and second sampling planned for summer 2001

Sampling activities were as follows:

R-9	R-9i	R-12	R-15	R-19	R-25	R-31
Second sampling 9/29/00	First sampling 9/15/00	First sampling 9/20/00	First sampling 2/24/00	First sampling 9/30/00	First sampling on 12/12/00	First sampling 12/19/00
Third sampling 2/13/01	Second sampling 2/21/01	Second sampling 3/12/01	Second sampling 9/12/00	Second sampling 3/19/01	Second sampling 4/01	Second sampling fall 01
Fourth sampling 6/01	Third sampling 6/01	Third sampling 6/01	Third sampling 2/15/01	Third sampling 6/01		
Report 10/01	Fourth sampling 9/01	Fourth sampling 9/01	Fourth sampling 7/01	Fourth sampling 9/01		
	Report 1/02	Report 1/02	Report 10/01	Report 1/02		

A drilling "time out" was implemented in FY01 due to budget constraints, contracting, and anticipated rig standby costs. The objectives of the time out were to revise the project management approach with the subcontractor, transfer quality assurance activities to the subcontractor, and to get planning and contracting in place for future wells. The accomplishments during the "time out" include transfer of project management responsibility to subcontractor, modified Task Order 18 contract to transfer QA to subcontractor, put contracts in place for R-5 and two intermediate wells in Mortandad Canyon, delivered scope of work for R-13 to the subcontractor, and NMED and LANL prioritized the next six wells. Planned restart will begin with a readiness review for R-5 on March 26, with drilling of R-5 beginning in mid-May to mid-June. The two intermediate wells in Mortandad Canyon will be drilled in June and July. Either R-13 or R-18 will be drilled in late July to late September. Priorities for future wells are to keep contracting and preparation ahead of drilling. Efficiency comes from having a set list of wells that do not change. Planning ahead for those six months.

Geochemistry Subcommittee

Pat Longmire (LANL) described the activities of the Geochemistry Subcommittee. The presentation covered quarterly sampling, borehole water sampling at R-22, chemistry of drilling additives, TA-16, and FY01 data collection and interpretation activities, including water quality samples from test wells and supply wells and geochemical modeling.

There have been 10 wells completed to date. Quarterly samples have been collected from R-9, R-9i, R-12, R-15, R-19, R-25, and R-31. The samples have been analyzed for field parameters, radionuclides (filtered and nonfiltered), inorganic constituents (filtered and nonfiltered), organic constituents (nonfiltered), and stable isotopes (nonfiltered).

In R-22 the regional aquifer was encountered at 883 feet on September 30, 2000. Borehole water samples were collected and analyzed for americium-241, gamma spectroscopy, strontium-90, tritium, uranium isotopes, metals, volatile organic compounds, semivolatile organic compounds, and stable isotopes. The activities of strontium-90 were less than detection (0.3 ± 2.4 pCi/L; MDA = 4 pCi/L) as were the activities of Pu-238, Pu-239,240, and Am-241. The concentration of perchlorate was below

detection level. The activity of tritium is 109.2 ± 4.5 (1σ) pCi/L at 883 feet. The source of tritium is being investigated. One line of investigation is other isotopes from Area G that are mobile in water (e.g. TC-99). Another line of investigation is through modeling, because the tritium could be either from Area G or Pajarito Canyon, which has elevated tritium. Movement of tritium form Pajarito Canyon would be a different pathway (through canyon bottom with high infiltration rate).

Quik Foam, a drilling additive, contains isopropyl alcohol that oxidizes to acetone. Acetone is volatile and has a short residence time in aqueous solution. About 60% of Quik Foam is acetone, and this should not be long-term problem because it is volatile. Quik Foam keeps the drill string looser and puts skin on saturated zones. There is some acetone in tanks at R-19.

Water from TA-16 springs were sampled and analyzed for evidence of barium colloids. The analyses suggest that most of the barium is dissolved and estimated colloidal percentages are usually less than 10%. The barium occurs either as barite or adsorbed on other mineral phases.

Data collection activities planned for FY01 include:

- Collection of core and cuttings for geochemical contaminant analyses during drilling of boreholes R-5, R-7, R-22, and intermediate wells in Mortandad Canyon
- Collection of groundwater samples during drilling and from newly completed wells to evaluate natural solute (inorganic-radionuclide) and contaminant distributions in perched zones and the regional aquifer
- Collection of groundwater samples from alluvial wells in Pueblo, Los Alamos, Mortandad, and Canon de Valle canyons to evaluate water and contaminant balance and estimate residence times and mixing of groundwater and surface water
- Collection of water quality samples from test wells and supply wells as part of annual environmental surveillance

Data interpretation activities planned for FY01 include:

- Complete LANL natural solute (background) investigation and final report
- Continue to incorporate effects of monitored natural attenuation into the decision-making process for the Environmental Restoration Project and the Groundwater Integration Team
- Use statistical techniques and geochemical modeling to evaluate distribution of solutes measured at characterization wells
- Refine geochemical conceptual model
- Evaluate and quantify recharge and groundwater chemistry along flow paths based on major ion chemistry and stable isotopes.

Hydrology Subcommittee

David Rogers (LANL) reported on the activities of the Hydrology Subcommittee. He presented information on the Hydrologic Atlas, hydrologic testing, water level data, the low-head weir project, and response to External Advisory Group recommendations. The FY00 Hydrologic Atlas has been completed and encompasses the FY99 geologic model. There will be no future additions to the atlas. Maps are available from the Environmental Restoration Project Facility for Information Management and Display.

Hydrologic testing was done in wells R-9I, R-19, R-15, R-22, R-31, and CdV-R-15-3. Hydraulic properties were determined by straddle packer/injection testing in all wells except R-15. A pumping test was conducted in R-15. Water level data were collected with transducers at three-hour intervals in eight regional aquifer test wells, one former water supply well, six intermediate perched zone wells, six alluvial groundwater wells in Los Alamos Canyon, and 14 alluvial aquifer wells in Mortandad Canyon. Transducers are being installed in the R-wells, and they will be added to the water level program. The water level data are available on the web at

http://www.esh.lanl.gov/~esh18/teams/hydrology/Welldata.htm.

The affect of the low-head weir on groundwater investigation is proceeding. The weir was constructed in Los Alamos Canyon to slow floodwaters. Project to evaluate infiltration below the weir. Three instrumented boreholes (one vertical, two angled beneath the pond behind the weir) will be installed next to the weir to measure hydrologic properties of the basalt underlying the weir. The boreholes will be drilled in late March 2001.

Response to EAG recommendations:

- If there are data quality problems with americium similar to the problems with Sr 90, they should be addressed quickly or analysis should be done by outside labs.
  * Analysis is being done by outside labs
- R-5 hydraulic testing approach should be articulated and reviewed by External Advisory Group
  * The final location of R-5 is too far away from 0-1 for conjunctive testing
- Three comments on measuring hydraulic properties in water supply wells
  * Have not taken steps to make measurements in water supply wells. Expensive to remove pumps - cost estimates of about $1 million.
- Explain how screened zones are selected.
  * A committee decides on location of zones based on: larger perched zone, top of regional aquifer, and deeper portions of regional aquifer depending on chemical needs. Number of screens usually planned in Field Implementation Plan (FIP).
- Well development should follow ASTM guidelines
  * Consistent with ASTM guidelines, and a dual packer system is being developed.

Modeling Subcommittee

Bruce Robinson (LANL) described the activities of the Modeling Subcommittee. The accomplishments include:

Regional Aquifer Model

- Now have a calibrated model, but currently bringing in other lines of evidence to further constrain the model. Have transport simulations for tracers (3H, 14C, 18O, Cl-). Have transient data drawdown in aquifer from pumping and calibrating to those levels.
- Model use incorporates uncertainty analysis for flow direction.
- Geostatistical representation of heterogeneity in Puye to get probability distribution.

MDA and Canyons Models

- Modeling Plan is to be rewritten; generic plan for process model development
- Prioritization of hydrogeologic data collection

FY01 Work:

- Finish Los Alamos Canyon modeling
- First order groundwater pathway assessment
- Quantify plateau-wide infiltration
- Ongoing regional aquifer model development
- Geophysical surveys to supplement well data
- Interpretation of R-well contaminants, e.g. R-22
- Statistical analysis of spatial placement of R-wells

Comments and discussion from the meeting participants about the modeling included the following: Lindsay Lovejoy (NM Attorney General Office) asked when will results of the modeling be published. Bruce Robinson (LANL) commented that some are complete now and a list of what is published could be provided. The completed work is mainly in regional aquifer and vapor phase transport. Others are currently being worked on and they will be published when completed. Joni Arends (Concerned Citizens for Nuclear Safety) asked what the timeline is for completing the site-wide infiltration study. Bruce Robinson (LANL) responded that it will be complete to the stage of internal review at end of the fiscal year. At that point, the Environmental Restoration Project will determine how it will be released for outside distribution. Bob Powell (EAG) noted that there is a current subjective level of surprise in the modeling; e.g., the tritium in R-22. Bruce Robinson (LANL) stated that generally the types of surprises are hydrogeology; for example, basalts in R-22 are thicker than expected. Flow and transport in those units are likely to be more rapid. The Bandelier tuff is not much of a surprise. The Puye Formation has turned out to be interesting. The geostatistical approaches for modeling are expected to provide better representation of the variability in hydrogeology.

Bill Holman (DOE-Oakland) asked how well do existing R-wells collect data needed for modeling. Bruce Robinson (LANL) commented that there are competing priorities and that the choice of well depends on many factors, and modeling is just one. There is a significant amount of hydrologic data. The type of data collected from the R-wells applicable to modeling has improved and is sufficient. Lindsay Lovejoy (NM Attorney General Office) said that in the RFI report for TA-54, there have been detections of metals at depth. How is this incorporated in the modeling at Area G? Bruce Robinson (LANL) responded that two aspects of a model could change based on new data: the conceptual model or calibration. Calibration would only be changed if the new data observations were within the model domain. The metals detected at TA-54 are outside of the model domain. Those data observations would be more likely to change the conceptual model. John Ordaz (DOE-Headquarters) asked if there is a reduced scope due to modeling. Bruce Robinson (LANL) stated that the modeling is just getting to the points where reduction in scope may be possible; for example, it may be possible that hydrologic data in the Santa Fe group are not needed. That could affect drilling depth and screens. It is felt that the pace of regional aquifer modeling is very good for helping the drilling program.

FY00 Accomplishments and FY01 Activities

Charlie Nylander (LANL) described the FY00 accomplishments and the FY01 activities. The FY00 accomplishments include:

Field Activities:
Drilled and constructed four wells (R-19, R-9I, CdV-R-15-3, R-31) and completed four wells (R-15, R-25, R-9, R-12) and started drilling one well (R-22)

- Conducted two rounds of quarterly sampling
- Completed well completion reports for R-9, R-9I, R-12, R-15, R-19
- Awarded task order for new drilling/field support subcontractor
- Implemented well head protection after Cerro Grande fire

Documents and assessments:

- Data reports on mechanical testing of samples from R-9, R-12, and R-25
- Expanded Hydrologic Atlas
- Database run off flow and chemistry modules available on the web site
- Management assessment for compliance with Environmental Restoration Project Quality Assurance Plan
- Audit for compliance with Laboratory Implementation Requirements (LIRs) by the Project Management Division

Regional Aquifer Modeling

- Developed stochastic approach to modeling variations on hydraulic conductivity within the Puye Formation
- Evaluated pump test simulations for possible O-1/R-5 possible cross-hole testing in support of R-5 siting decision
- Analyzed site-wide hydraulic conductivity trends using hydraulic conductivity data, water levels, and inverse modeling

Vadose Zone Modeling

- Updated Los Alamos Canyon model including predicting impacts from Cerro Grande fire
- Completed Area L organic vapor plume study and documented in a written report and web-based presentation

GIT Activities

- Biweekly meetings with every other meeting a technical meeting, three quarterly meetings, and the annual meeting
- External Advisory Group conducted two reviews, resulting in two reports and two corresponding action plans
- Produced the FY99 Status Report, published as a LANL status report (LA-13710-SR)
- Participated in ESH Division review and the presentation was rated as outstanding and received Los Alamos Achievement Award
-

Project Management Activities

- Incorporated DP Monitoring Well Project into the Environmental Restoration Project's Project Planning and Control system.

- Produced monthly joint DP/ER status reports

The FY01 activities are:

- Field work
  - Drill and complete R-22, R-7, R-5 and two intermediate wells in Mortandad Canyon. One intermediate well may be deepened depending on site conditions
  - Quarterly sampling in R-5, R-7, R-9, R-9I, R-12, R-15, R-19, R-22, R-25, R-31.
  - Well completion reports for R-25 and R-31
  - Airborne electromagnetic survey

- Information Management
  - Software development
  - Migration of data: legacy chemistry, water levels, hydrologic properties
  - Report/Web site development
  - Environmental Restoration Database and Water Quality Database Exchange

- Modeling
  - Model parameters
  - Uncertainty analysis
  - Pathway analysis

- GIT activities
  - Develop annual report, support interpretive tasks
  - Three quarterly meetings, one annual meeting, biweekly GIT meetings
  - External Advisory Group reviews, reports, and corresponding action plans

FY02 Planned Activities

Charlie Nylander (LANL) outlined the planned activities for FY02. The wells that will be drilled and completed are R-8, R-14, R-20 (DP funded wells) and R-13, R-18, R-21 (Environmental Restoration funded wells). Quarterly sampling will occur in R-5, R-7, R-8, R-13, R-14, R-18, R-22, R-25, and R-31. FY02 activities also include information management, modeling, and GIT activities. Note: since R-24 on the fault will not be drilled in FY02, the modeling of faults may not happen until FY03. Attempting to find funding for tracer tests.

Charlie Nylander (LANL) discussed how wells are selected and prioritized. In the Hydrogeologic Workplan and Annual Report, the wells are ranked in priority order, based on criteria in the Hydrogeologic Workplan. When looking at next year, the next wells in the list are reviewed, and internal discussions with the Groundwater Integration Team subcommittees are conducted about what wells would be most valuable at this time. A preliminary list is made and brought to NMED. NMED has their own concerns such as watersheds and stakeholder concerns. A best compromise list is developed.
John Ordaz (DOE-Headquarters) asked if there was a more formal way for Pueblos and stakeholders to influence the well list. Charlie Nylander (LANL) responded that this annual meeting is the forum for stakeholders to express concerns. At the Senior Managers Meeting held March 19, a process was

developed to formalize the annual plan for wells, which allows the time period between June and September to plan for an October 1st start date. Mike Taylor (San Ildefonso Pueblo) asked why NMED gets an additional look prior to the annual meeting. Charlie Nylander (LANL) noted that it is a compliance document, thus NMED has a compliance responsibility. The time frame to get comments regarding well priorities back to Charlie Nylander (LANL) is by the third week in April. Will need to send out a separate letter explaining this process. Lindsay Lovejoy (NM Attorney General Office) asked that the letter include a rationale for each well and alternatives. The annual report has a table with wells; however, noted Ted Taylor (DOE-Los Alamos Area Office), the report is not generally sent out in a timely fashion. If any entities would like to review this newly established annual plan, they should have governing officials send a letter requesting a review. John Young (NMED-HMB) stated he is available to talk to people about their concerns regarding the wells. John Ordaz (DOE-Headquarters) suggested that any comments sent to LANL should also be sent to NMED.

Mat Johansen (DOE-Los Alamos Area Office) asked if the Hydrogeologic Workplan DQOs are still guiding well selection. Charlie Nylander (LANL) responded that the DQOs are still guiding well selection and planning to re-iterate the DQOs in the Hydrogeologic Workplan this spring. Regarding the letter to NMED describing the annual plan, if LANL does not have budget for the wells, then the Lab expects a response from NMED. Joni Arends (Concerned Citizens for Nuclear Safety) asked what efforts are being made toward not having budget cuts. Charlie Nylander (LANL) stated that the budget was discussed at Senior Managers Meeting, however, there are no magic answers. Joni Arends (Concerned Citizens for Nuclear Safety) said that citizen groups are frustrated that money can be found for weapons programs but not for environmental programs. John Ordaz (DOE-Headquarters) agreed to work with DOE, LANL, and NMED to get the appropriate funding.

Quality Assurance Program

Larry Maassen (LANL) said that quality is conformance to mutually agreed upon requirements. A quality plan is made up of the requirements and the agreement. The Quality Program Matrix includes the Federal requirements and states the need for a QA plan. Work processes are governed by field procedures. Health and Safety is an important part of the work. There was a management assessment of drilling program. The Groundwater Investigation Focus Area made 23 commitments in response to the findings of the assessment. The status of the findings is:

- Two for training: completed
- QAPP preparation: overcome by events - contractor will do their own QA
- Hire QA assistance: Pat Ortiz hired, he has drilling and QA experience
- Lessons Learned: In process, have formal lessons learned procedure, R-25 will be formal
- Eight Standard Operating Procedure (SOP) commitments: working feverishly
- Two personnel qualifications - completed
- Four design control example: the selection of screens, have to have a formalized process, documentation, and change control
- Two document control/records: complete organizational roles and responsibility - complete
- Procurement - complete

The Groundwater Investigation Focus Area has a new contracting initiative wherein the subcontractor is responsible for their QA and will adopt LANL ER SOPs. Any deviations from SOPs will be reviewed and approved by LANL. The Washington Group is the subcontractor and their QA plan has

been received and reviewed. John Ordaz (DOE-Headquarters) said he has seen contractors have responsibility for QA, but subcontractors do not follow the QA plan. How will we assure the contractors will actually conduct QA? Larry Maassen (LANL) responded that previously we have been resource limited. The QA staff will now have more time for oversight since the SOP writing is the contractor's responsibility. The contractor can audit themselves and can catch problems sooner. John Ordaz (DOE-Headquarters) asked if there are penalties for nonconformance in the contracts. Julie Canepa (LANL) responded that she could not answer in detail. The previous QA program was in pieces. Contractor responsibility will allow for a more comprehensive QA program. Tony Trujillo (DOE-Albuquerque) said he will not approve baseline changes due to QA problems and funding to address those problems would be UC responsibility. John Ordaz (DOE-Headquarters) asked about the roles and responsibilities outside LANL with respect to safety. Larry Maaseen (LANL) responded that safety is internal to the LANL.

Stakeholder Session Response

Bob Charles (EAG) said that the Stakeholder Session focus was on communication. The positives noted during the session were Schlumberger, the annual meeting, the GIT, and chairperson. Stakeholders are receiving some letters and reports.

How do Stakeholders gather information?

Stakeholder	Gathers information from:
CAB	DOE NMED
NM AG	Difficult time getting info
CCNS	State DOE LANL
NMED	DOE/LANL

Technical communication is good; however, management communication is not good. Stakeholder requests were to:

- Receive annual report 10 days before annual meeting
- Receive modeling reports that are currently available within one week of annual meeting
- Be involved in planning - attending GIT meetings where planning occurs was suggested
- Receive a master list of available publications

An example of difficult/inadequate management communication is that of having a detection in a sample and managers being more conservative in releasing data. Suggested that in-between quarterly meetings, stakeholders should meet with the GIT to learn more about what is happening more timely. Or, if possible, more presentations made to the Citizens Advisory Board or establish a group similar to the Community Radiation Monitoring Group. Developing trust requires regular and consistent communication.

Charlie Nylander (LANL) stated that it is possible to give updates at the CAB meetings in an effort to bring people up to speed. At the quarterly meetings, a session for planning could be included. However, need to be cautious about time for monthly meetings. Also, the air-monitoring group goes

to different communities. If this went to different communities, they would not understand the program. Joni Arends (Concerned Citizens for Nuclear Safety) expressed concern about the LANL's reluctance to bring people up to speed. Water issues are important. Charlie Nylander (LANL) stated that lots of outreach is done now and willing to look at even more. With the current resources, not sure a commitment to monthly meetings can be made. Will discuss the Community Radiation Monitoring Group with Jean Dewart (LANL) in the Air Quality Group to see how that works. The annual report was late and was sent as a draft for review. We can commit to getting the report out 10 days before the annual meeting. Charlie Nylander (LANL) will talk to Bruce Robinson (LANL) about the modeling reports and will try to develop a master list of publications from Hydrogeologic Workplan activities. Lindsay Lovejoy (NM Attorney General Office) requested a publication list more frequently than once a year. Charlie Nylander (LANL) said the list could be updated on quarterly. Need to indicate where the publications could be procured; some may be available online.

Ted Taylor (DOE-Los Alamos Area Office) suggested that a public involvement plan for the Hydrogeologic Workplan could be developed and obtain stakeholder input on that plan. Additionally, if a stakeholder has an interest, that person can volunteer to be on the CAB or the monitoring and surveillance committee. Lindsay Lovejoy (NM Attorney General Office) stated that the idea of a public involvement plan is very good.

Regarding the distribution of reports, Charlie Nylander (LANL) stated that there was an awkward fiscal year transition as a result of catching up from Cerro Grande fire. For example, the run off monitoring delayed some groundwater work, but we believe we are caught up now. Also, some of the management systems required validated data in reports. In regards to validation and report release, as previously noted, managers have been made aware of stakeholders' desire to have data more quickly. There has been direction from management not to release data that might not be correct or that could be used inappropriately. For example, after the last quarterly meeting, the R-22 results were in the newspapers, which surprised LANL managers. LANL managers agree with the communication, but they want to know about it, too.

Charlie Nylander (LANL) said with respect to the desire to be more involved in planning, a planning section will be added to the quarterly meetings. The stakeholders are urged to call or send an email when they read in a report or hear something at a meeting that causes concern.

Charlie Nylander (LANL) described the results of the Senior Managers' meeting that was held on March 19. Shortly after the EAG was formed, the EAG expressed a desire to meet with senior managers regarding their perspective on the Hydrogeologic Workplan. The senior managers met with the EAG and continue to meet and discuss issues that are raised. This year, the Senior Managers' meeting was a full day with 23 attendees. Three entities, LANL, DOE, and NMED, had the opportunity to communicate. Three issues were discussed. Initial feedback from the meeting was that the invitation list was too large and requested that only senior managers are invited. Stakeholders have also expressed a desire to attend; however, it is appropriate that only senior managers attend. One item that all the senior managers concurred on was a concern about the funding level for the Hydrogeologic Workplan.

Charlie Nylander (LANL) responded to the stakeholder concern about participation by the pueblos. When the program first started, invitations were extended to six pueblos. There has been a decline in attendance from pueblos. Their attendance would be desirable.

Charlie Nylander (LANL) responded to the concern raised by the stakeholder that NMED has priority for communication and planning in the Hydrogeologic Characterization Program. The Hydrogeologic Workplan was requested by NMED, and it is a compliance document, so they must have that priority. Since the beginning of the program we have extended the invitation to stakeholders to participate and provide us with input. There are advantages to NMED of getting stakeholder input in that NMED can better understand stakeholder concerns. When a letter is submitted with the FY02 annual plan to NMED, would like to get stakeholder review. To achieve this, the letter could be sent to all folks on the distribution list.

Charlie Nylander (LANL) addressed the concern expressed by stakeholders about the process to communicate QA/QC findings and issues. This process would hopefully be accomplished with the transfer of responsibilities to the contractor combined with increased LANL oversight. Don Diego Gonzalez (Cochiti Pueblo) asked if the drilling is the only part of the Hydrogeologic Characterization Program that the QA program is being applied. Larry Maassen (LANL) responded that everything in the Environmental Restoration Project is under the QA program.

Charlie Nylander (LANL) requested specific concerns regarding the issue of trust raised by the stakeholders. Mike Taylor (San Ildefonso Pueblo) stated he is not getting data fast enough. Don Diego Gonzalez (Cochiti Pueblo) stated that it is important that pueblos be invited to participate in preplanning activities. They are interested in the groundwater program and want to be involved. He suggested inviting the Governors to attend the Senior Managers' meeting.

Evolution of Well Drilling, Construction, and Development

Ted Ball (LANL) discussed the documented history on boreholes; the evolution through time of drilling techniques, borehole depth, drilling additives, casing, construction/screen type, core, and impacts.

TIME	TECH-NIQUES	DEPTH	ADDITIVES	CASING	CONSTRUCTION/ SCREEN TYPE	CORE	IMPACTS
	Dry/ Casing Advance R-9, R-12	R-9 771 ft, R-12 886 ft	None	R-9 Casing from surface to 728 ft. R-12 829 ft of casing	R-9 Single Completion, Wire Based Screen; R-12 Three Screens, Westbay System, Wire Based Screens	R-9 Cored 244 ft; R-12 Cored to 101 ft	Pros: Hydrogeologic data for modelers, faster accurate samples of perched groundwater Cons: High cost. Due to drill casing frequently stuck due to drilling dry and waiting to sample borehole waters
	Additive Assisted /Casing Advance R-25, R-15, R-31, R-19	R-25 1942 ft, R-15 1107 ft, R-31 1103 ft, R-19 1903 ft	R-19 EZ Mud, Quick Foam,TORKease R-15 EZ Mud, TORKease	R-19 Casing from 143 to 227 ft. R-15 Casing from surface to TD	R-25 Nine Screens, Westbay System, Wire Based Screens; R-15 Single Completion, Wire Based Screen; R-31 Five Screens, Westbay System, Wire Based Screens; R-19 Seven Screens, Westbay System, Pipe Based Screens	R-15 cored 430 ft; R-19 cored 126 ft R-25 30 percent core	Pros: Water results usable for initial screening, costs lower than dry drilling approach Cons: No definitive information on groundwater until after Westbay installed, groundwater may take months to be free of drilling additives. Casing frequently stuck, costing time and dollars
	Additive Assisted/ Open Hole/Limited Casing Advance R-22, R-7, CdV-15-3	R-22 1489 ft, R-7 1097 ft, CdV-15-3 1722 ft,	EZ Mud & Quick Foam	R-22 390 ft casing; R-7 290 ft casing; CdV-15-3 open to 500 ft, casing to 1722 ft	CdV-15-3 Six Screens, Westbay System, Pipe Based Screens; R-22 Five Screens, Westbay System, Pipe Based Screens; R-7 Three Screens, Westbay System, Pipe Based Screens	None	Pros: Water results usable for initial screening, costs lower than complete casing advance Cons: No definitive information on groundwater until after Westbay installed,

TIME	TECH-NIQUES	DEPTH	ADDITIVES	CASING	CONSTRUCTION/ SCREEN TYPE	CORE	IMPACTS
							groundwater may take months to be free of drilling additives
	Additive Assisted/ Open Hole R-9i R-5?	R-9i 323 ft, R-5 1200 ft (planned)	R-9i EZ Mud & Quick Foam	R-9i None	R-9i, Single Screen, Wire Based, R-5 Planned for Five Screens, Westbay System, Pipe Based Screens	None	Pros: Water results usable for initial screening, costs lower than complete casing advance Cons: No definitive information on groundwater until after Westbay installed, groundwater may take months to be free of drilling additives

Ted Ball (LANL) also described the data collection in each borehole.

Well #	Geologic Suite			Geochemistry				Water Sampling		Geo-physics		Hydrologic Testing on Completed Well				
	Petrograp	Mineralo gy	Ar-Ar Age	Anion Profile	Moisture Content	Matric Potential	Geochemi stry on	Borehole	Cyclone	Limited Suite	Full Suite	Hydraulic Properties	Air Permeabil	Injection test	Aquifer pumping	Pressure Transduc
R-9	X	X	X	X	X	X	X	X		X		X	X	X		X
R-12	X	X	X	X	X	X	X	X		X		X		X		X
R-25	X	X	X						X	X	X			X	X	X
R-15	X	X	X	X	X	X	X	X		X				X	X	X
R-31	X	X	X				X		X	X	X			X	X	X
R-19	X	X	X	X	X	X	X		X		X			X	X	X
CdV-15-3	X	X	X				X		X		X			X		
R-22	X	X	X	X			X		X		X			X		X
R-7	X	X					X		X		X			X	X	X
R-9i														X		

Observations on Geology from Regional Wells: New Data and Inclusion of Mineralogic Analysis

David Vaniman (LANL) said that the geologic information from the regional wells R-19, CdV-R-15-3, R-22, and R-7 would require modifications to the LANL 3-dimensional geologic model. These modifications include thickening of the Cerros del Rio basalts in paleochannels west of the present Rio

Grande and recognition of a pumiceous volcaniclastic unit beneath the Puye Formation fanglomerates, that is tentatively considered part of the Puye Formation. Within the pumiceous volcaniclastic unit, there has been complete alteration to clay in the east (between LANL technical areas and the Rio Grande) but not beneath the Rio Grande. Mineralogic data will have an impact a hydrogeologic conceptual model of Puye Formation because the current understanding of the Puye is based on surface mapping up north where it is exposed. Regional wells R-9 and R-12 encountered Puye Formation that is very similar to the Puye Formation exposed to the north. There is a distinct difference in hydrologic properties in clay-altered zones.

Three specific features of hydrogeologic significance are shown on a west-to-east conceptual cross section.

1) From west to east, perched zones beneath the canyon bottoms occur at horizons near the Bandelier/Puye contact and then within the Cerros del Rio basalts. Intermediate perched zones are generally occurring above relatively impermeable clay zones.
2) Thick fill of Cerros del Rio basalt in paleocanyons may affect flow paths both in perched horizons within the basalts and in the upper part of the regional aquifer.
3) Impermeable clay zone at R-9 and R-12 may be quite thick; the depth and form of zone are not known.

Well Logs, Geology, and Hydrology

David Broxton (LANL) said the use of geophysics has evolved and increased over the course of the program. However, the use of geophysics depends on how the holes are drilled. Now there is more open-hole drilling which makes it possible to use more downhole geophysical tools. Earlier boreholes have multiple casings, so most geophysical tools could not be used. Fluid-assisted drilling makes drilling faster, but limits data collection. For example, samples from boreholes drilled with added fluids are not representative of the in situ moisture content, which is an important parameter for calibration of vadose zone models. Geophysical tools can be used to measure moisture content. The current focus for downhole geophysics is to identify perched zones because the addition of fluid while drilling makes it difficult to identify perched zones. The geophysical tools will also be used to measure moisture, porosity, and lithologic data.

David Broxton (LANL) discussed key uses of geophysics in placement of screened zones. About one week before reaching the total depth in a borehole, Schlumberger is contacted and given a list of the information needed from the specific well. Schlumberger then selects the appropriate geophysical tools that will provide the information needed. Schlumberger arrives on site within a day of reaching the total depth; they log the hole, and send data to Denver. Compilation of logging results (montages) and information are received back within one day. The team at LANL use this data to determine the number of screens, depths, and lengths. The subcontractor then designs the well. The entire process takes about three to four days after reaching total depth.

Rick Lewis (Schlumberger) described the types of geophysical tools that are being used in the regional aquifer wells.

- Spectral gamma ray is used to map lithology. The tool works by resolving the gamma ray spectrum into three naturally occurring members - K, Th, and U. Potassium is common in the crust

as part of potassium feldspar, mica, and clay. Thorium is rare, it is relatively insoluble, concentrated in clay with high cation exchange capacity, and is retained from the decomposition of igneous rocks. Uranium is rare; it is soluble and mobile in oxidized state and precipitates in reducing environments.

- Fullbore Formation Microimager provides an oriented electrical image of the borehole wall. It maps sedimentary and structural features such as the strike and dip of beds, fractures, and rock textures. It also is used to measure borehole deviation. It provides excellent vertical and horizontal resolution.
- Density logging tool measures electron density and Pe (atomic number) in the rock. The electron density can be converted to bulk density and porosity, although it requires an estimate of matrix density. This tool has high vertical resolution but has limited depth of resolution (only penetrates one inch into rock).
- Combinable magnetic resonance uses nuclear magnetic resonance to measure pore size distribution. This tool can be used to estimate total and effective porosity, hydraulic conductivity, and moisture content in the vadose zone. The quality of these estimates is enhanced with core from the same intervals.
- Accelerator porosity tool is a neutron to neutron measurement that is sensitive to the hydrogen content of the rock. It is used to estimate porosity in the saturated zone and moisture content in the vadose zone. This tool can not distinguish between water and hydroxyl.
- Electrical induction tool measures the electrical resistivity of the rock and is used primarily for formation correlation and lithology. This tool has five depths of penetration into the rock and three vertical resolutions.

Hydraulic Conductivity vs Geology in Los Alamos Wells

Bill Stone (LANL) discussed hydrologic testing in R9, R-19, R-31, and CDV-15-3, which are test results from slug injection tests. Most wells have multiple screens and each screen is tested in isolation. A straddle packer system is used. Formations tested are Cerros del Rio and Puye Formation. Based on the results so far, it appears that the hydraulic conductivity is not related to the formations, as the hydraulic conductivity numbers vary between and within formations

Geologic Unit	Hydraulic Conductivity (ft/day)	Well	Screen
Cerros del Rio basalt	37.07	R-9i	1
	0.78		2
	1.07	R-31	1
	0.42		2
	3.62		3
Puye Formation	17.50	R-19	6
	19.60		7
	0.009	R-31	4
	0.007		5
	0.25	CdV-R-15-3	4
	0.10		5

Instead of stratigraphic formations, the hydraulic conductivity estimates have been divided into hydraulic conductivity categories.

Hydraulic Conductivity (ft/day)	Lithology	Well	Screen
0 - 1	clayey base of basalt flow unit	R-9i	2
	clayey unit between basalt flow units	R-31	2
	axial river gravel	R-31	4, 5
	gravel	CdV-R-15-3	4, 5
1 - 10	fractured base of basalt flow unit	R-31	1
	highly fractured thick basalt flow unit	R-31	3
10-20	unaltered pumiceous gravel	R-19	6, 7
>20	basalt with open, clay-coated fractures	R-9i	1

One hypothesis for why the gravels appear to have low hydraulic conductivity is that the higher hydraulic conductivity zones dominate when water is removed (the well is pumped), but the lower hydraulic conductivity zones dominate when water is injected into the well.

Conclusions are:

- Hydraulic conductivity values obtained by slug injection tests in new wells at LANL vary over several orders of magnitude.
- The variation in hydraulic conductivity occurs not only between but also within major geologic units.
- Geologic unit, despite major rock- and permeability-type differences (basalt vs fanglomerate) provides no obvious control on hydraulic conductivity.
- Hydraulic conductivity is more dependent on the specific lithology of material behind the screen tested.
- Both vertical and horizontal continuity of free pore water are necessary for higher hydraulic conductivity test results.
- Further analysis of the preliminary testing data will no doubt prove beneficial.

Quantifying Heterogeneity within the Puye Formation

Elizabeth Keating (LANL) said that the hydraulic conductivity in the Puye Formation ranges widely and by several orders of magnitude; even within the two recognized facies (fanglomerate and axial gravels [Totavi lentil]). We are currently experimenting with different methods to incorporate the wide range of hydraulic conductivity into the regional aquifer modeling. This degree of heterogeneity can not be modeled explicitly; but if the unit expected to have the fastest travel times (gravel deposits)

can be modeled, which would be the most conservative estimates of flow and transport, then our job will be done.

In the Puye Formation, the depositional facies have been mapped from outcrops exposed to the north of LANL. The different facies are stacked and the order and thickness of individual facies depends on location. This complexity can not be explicitly modeled (deterministic modeling approach) because there can never be enough data to know where every different unit is. For example, if a stream deposit were encountered in two boreholes, a guess based on professional judgement would be made about whether the unit is connected or not connected. In a deterministic modeling approach, a decision to connect the two units would be made and then proceed with that until more data is received. There is movement towards a stochastic approach, which uses thousands of possible ways to connect the streambed and running the flow and transport through each (each run through is called a realization). Last year, a Gaussian model was used, which assumes hydraulic conductivity is randomly distributed. It is believed that a better way to represent this complex sedimentary deposit is patterns of hydraulic conductivity based on outcrop patterns rather than random distribution. A different geostatistical model, called a Markoff Chain model, is more useful in representing these patterns, and incorporation of that geostatistical model into the regional aquifer modeling is being worked on. It is believed that this approach may produce some different results.

The transport simulations completed using the stochastic modeling approach and the Gaussian distribution of hydraulic conductivity had the following results in answering the question: where is HE contamination detected in R-25 going to go?

- Most particles are captured in PM-4 or PM-2 and some reached the Rio Grande.
- The first particle hits Rio Grande in 1000 years.
- All of the particles not captured by the PM well field would be in the Rio Grande in 2000 years.
- Half the particles are captured by PM-1 and PM-2.
- This approach shows that no matter how the data is connected, some of the particles would be captured in the PM wells in 150 years and some would reach the Rio Grande is about 1000 years.

David Vaniman (LANL) added that the altered zones in the Puye Formation he described earlier emphasize the difficulty of characterizing the hydraulic conductivity in the Puye. Every gravel deposit and clay can not be mapped. The importance of clay is that it creates perching horizons. And it is believed that zones with over 90% clay are not transmissive, but have no data. Water supply well 0-1 went through the altered zone in the Puye, which is why water could not be extracted out of that zone in 0-1. The zone of clay alteration in the Puye Formation was seen in 0-1, R-9, and R-12, which are wells that are fairly close together. It is not known how extensive this altered zone is, but it does not go as far as R-15 or R-22. Bill Stone (LANL) commented that the area is not a bathtub that water moves through at the same speed. It is better that clays be understood. This could possibly be a fossil hydrothermal system, and clay can be used to test this.

Databases – Water Quality and Environmental Restoration

Steve Bolivar (LANL) discussed two databases, the Water Quality Database (WQDB) and the Environmental Restoration Database (ERDB). ERDB has four million pieces of data. The R-well chemistry and construction data goes into ERDB, which is where the WQDB gets that specific data. In 1997 there was a User Needs Survey which was used to develop the Information Management Plan

completed in 1999. The Information Management Plan is being implemented this year. The User Needs Survey identified the following needs:

- Formal processes to track information flow
- Effective infrastructure for information storage and retrieval
- Robust information audit trail processes
- Qualified team for information management
- Effective data sharing with stakeholders
- Defined strategy to implement an information management system

Accomplishments so far are:
- Reengineer business processes
- Implement hardware/software infrastructure
- Design and build database
- Clean up and migrate legacy data
- Design and build software applications

The goal is to make ER and ESH environmental data available to all LANL employees and the public through a single interface.

DOE Role in Oversight

Karen Agogino (DOE-AL) provided an organization chart and discussed the DOE's role and how all DOE offices work together.

Water Supply Well Sampling

David Rogers (LANL) said that all water supply wells were sampled in the past year for high explosives (HE), perchlorate, strontium-90, and tritium. HE was not found. Perchlorate was found in Pueblo Canyon well Otowi - 1 (O-1) at a detectable level and at a maximum value of 5 ppb. The source may be the former TA-45 outfall. No strontium-90 was detected, despite a low detection limit. Tritium was found at 40 pci/L (about 1/500 of the drinking water standard) in O-1. O-1 was sampled every month last year. The source of tritium is probably from past LANL releases. The concern regarding O-1 is the reason that R-5 was placed where it was.

John Ordaz (DOE-Headquarters) asked if there is enough data to analyze trends. David Rogers (LANL) responded that perchlorate was noted only last year and most values are below the detection limit. There is no Maximum Contaminant Level (MCL) for perchlorate, but California has set a provisional cleanup level between 4 and 18 ppb. Joni Arends (Concerned Citizens for Nuclear Safety) asked if there are plans to model where the contaminants in O-1 are coming from. David Rogers (LANL) responded that the R-5 results will be incorporated in the modeling, but no special modeling is planned. Ken Mullen (LANL) added that there is no indication of a health risk. The values are below any standard.

Results of Quarterly Sampling at R-9, R-9I, R-12, R-15, and R-19

Pat Longmire (LANL) was too ill to present this information. The following points provide a summary of the poster.

- Quarterly samples have been collected by the Geochemistry Subcommittee Members from R-9, R-9I, R-12, R-15, and R-19.
- Constituents of concern in R-wells include: nitrate (R-15), perchlorate (R-9 and R-15), and HE compounds (R-25).
- Measurable tritium occurs at R-9, R-9I, and R-12. These wells contain groundwater that is less than 60 years of age.
- Residual drilling fluids must be removed from R wells prior to sampling. EZ Mud has resulted in false positives for HE compounds and degradation products (contains nitro and amino functional groups). TKN and TOC are indicators of residual EZ Mud.
- Groundwater mixing information is provided by tritium, anions, and stable isotopes within multi-completed wells.

Integrated ER/ESH Hydrology Modeling Tasks

Diana Hollis (LANL) introduced the overview of hydrologic modeling by pointing out that models are accepted by EPA and NMED. There is no intention of replacing data with models. A description of modeling tasks/analysis was provided.

Modular process-level models of different hydrologic regimes include:
- Wet/Dry mesa - dry mesa model done and calibrated; may use system model on TA-16
- Wet/Dry Canyon
- Regional Aquifer

Coupled pathway level (system model)
- Surface water → Vadose zone → regional aquifer →receptor
- MDA G, TA-16 decided process level model was better because more conservation could be added

FY01 Integrated Modeling Tasks
- First order groundwater pathway assessment
- Plateau-wide infiltration mapping
- 3D geologic model uncertainty assessment
- Geophysical surveys to supplement drilling program
- Probabilistic assessment of sentry well placement
- First order groundwater assessment

Los Alamos Canyon Flow and Transport Model

Bruce Robinson (LANL) reported that there are new model results. The flow model and tritium transport models are improving. Migration of contaminant from alluvial ground water to regional aquifer has been evaluated over a range of scenarios. In regards to flow model calibration and

moisture content, the conceptual model of focused infiltration (several 100 mm/yr) in canyons and little infiltration on mesa (>1mm/yr). Infiltration rate can be narrowed down to factor of +/- 3 of base case, based on sensitivity to hydrologic properties. The sensitivity analysis will take high, middle, low values and run the model to see the difference in outcome. Sensitivity indicates a factor of $^{+/-}$ 3 for hydrologic properties.

Bruce Robinson (LANL) continued with a discussion of tritium concentrations. In the part of Los Alamos Canyon underlain by Bandelier tuff, it is believed that there is a matrix-dominated flow. In this part of the canyon there are expected to be long travel times compared to the part of the canyon where basalts and Puye formation are underlying the alluvium. The tritium mass flux is the amount reaching regional aquifer through time. The concentrations of tritium reaching the regional aquifer at three locations are:

1) LADP-3: 50 years, lots of decay so 1 pci/L.
2) By R-9: travel times shorter and concentrations higher
3) In high infiltration zone: concentration of tritium in water in the vadose zone feeding into regional aquifer

The impact of Cerro Grande fire is expected to be increased infiltration due to ponding and more water. The longer the duration, ponds will have slugs of water that go deeper and potentially carry contaminants.

Ongoing efforts include:

- Model is sufficiently constrained
- Using R-7 data and Los Alamos Canyon weir site, chemical profiles of water in LADP-3 and LA01(A)1-1
- Consider alternate conceptual model

NMED/DOE-OB Conceptual Model for Los Alamos Canyon

Michael Dale (NMED/DOE-OB) discussed a conceptual model of the Los Alamos Canyon alluvial aquifer. Michael Dale (NMED/DOE-OB) noted that the previous presentation of modeling in Los Alamos Canyon by Bruce Robinson (LANL) assumes complete saturation of Los Alamos Canyon alluvium. An alternate conceptual model is that there are two segments of the alluvial aquifer. Historical data for alluvial wells indicate different chemistry in wells in the upper part and lower part of the modeled area.

Two years of water levels in the canyon LAO1.2 and LAO1.8 (installed in the mid-50s) were reviewed. LAO1.8 is always dry except when there is snowmelt. LAO1.2 has a variable amount of water. LAO1.6 (g) was put in by ER and six wells had to be drilled to find water. LAO 1.6(g) is downstream of TA-53 cooling tower outfalls. The chemistry of LAO1.6 (g) was found to be different. Elevated molybdenum was found. TA-53 uses molybdenum as a tracer. The outfall was shut off in December last year, and it is not known if water levels have been measured in that well.

Must be a physical reason for the segmentation. Perhaps the water is infiltrating the Cerro Toledo. Bruce Robinson (LANL) stated that the range in the infiltration rate and tritium concentration used in the modeling would encompass changes that would occur if this alternate conceptual model were used. To check this, the results from using the alternate conceptual model will be evaluated with sensitivity analysis.

Validation of Conceptual Models for Vadose Zone Flow and Transport beneath the Pajarito Plateau

Kay Birdsell (LANL) discussed the hydrogeologic conceptual model, which includes wet canyons, dry canyons, and dry mesas. The rate of hydrologic processes is expected to be different in each of these settings. For example, infiltration beneath wet canyons is the highest, with rates on the order of meters per year (100-1000 mm/y). Transport to the regional aquifer beneath wet canyons may be on the order of decades to hundreds of years. Fracture flow, often through basalt units, may play a key role in transporting contaminants beneath wet canyons. In contrast, infiltration beneath dry canyons and dry mesas is much slower with infiltration rates generally believed to be less than tens of millimeters per year. Transport time to the regional aquifer from these settings is expected to be hundreds to several thousands of years. Slow matrix flow through the Bandelier tuff is generally believed to be the dominant transport mechanism. However, in some cases liquid disposal on the mesa-top may have driven short-term flow and transport.

Comparing field data to numerical modeling predictions can validate such conceptual models of vadose zone processes. Validation is ongoing at five sites on the Laboratory. The validation process is:

- Input data - stratigraphy, hydrologic properties, boundary conditions, source terms, etc.
- Compare predicted to field data
- Follow up with additional data

The five sites for validation are:

1) TA-50 injection test: Model matched results. Matrix flow model is sufficient to predict flow. Fractures not necessary
2) MDA AB at TA-49: Disturbed dry mesa conditions.
3) MDA T at TA-21: The infiltration beds stopped working in 1950's because they were saturated. But rads are associated in fractures. Use dual permeability/porosity in fracture although matrix flow also captured it.
4) TA-16: Started with one-dimensional model, which did not predict flow. Went to 3-D model.
5) LA Weir Site: Basalt is exposed at the surface, so assumed fracture flow. Assume two-day pond once a month. See a cyclic response.

All five sites confirm aspects of conceptual model value of validation. This gives confidence in conceptual model and supports predictive models.

Model Uncertainty, Sensitivity Analysis, and Data Needs

Elizabeth Keating (LANL) discussed how uncertainty in the regional aquifer model is being handled. New R-wells have not changed general groundwater flow direction. Water level data is the number one type of data in modeling. Flow is three-dimensional; there are vertical gradients which flow down from the west, mostly horizontal on middle, and upward near Rio Grande. Simulated particle tracks is a way to visualize flow and transport. If you release 10 particles, the PM well field captures half and the rest go towards the Rio Grande. Travel times vary spatially. How certain are we of these flow and transport predictions? The types of data (e.g., water level, static (pre-pumping) and drawdown, geometry of rock layers, pumping rates) are used to estimate of total volume of water flowing through aquifer. There is some uncertainty in all these data.

- Water levels - uncertainty due to limited spatial coverage. R-wells helping.
- Pumping rates - good data, but there is uncertainty in future pumping rates, new wells; or withdrawals outside the Los Alamos and Buckman well fields.
- Geometry of rocks - 3-D geologic model
- Water in aquifer - stream flow data. In Rio Grande, in 44 years it varies from gaining to losing and this provides an important constraint.

To make predictions, need to incorporate data and use model. For example, particles from R-25 went to PM-2. The prediction is consistent with known data sensitivity analysis: permeability - used pump test data last year and distribution of recharge. This year, inverse modeling is being used with water levels and boundary fluxes. The inverse modeling will give estimates of permeability in each unit and an estimate of uncertainty. For example, in the Santa Fe group, there is a fairly small range of permeability, so there is enough data existing data. However, there is large uncertainty in Puye Formation. Getting water level data from wells screened in this formation is the highest priority.

To develop a predictive analysis, all parameters are varied. With particles from R-25, no matter what is assumed about recharge and permeability, the flow direction does not change much. What well location would reduce the uncertainty in the prediction - R-25. R-25 has the most variability in vertical dimension. Estimates of "large scale" permeability.

Charlie McLane (EAG) asked what are the error bars on outward flux. Elizabeth Keating (LANL) responded to this question by stating about 15 cfs, although it is attributable to measurement error in Rio Grande, not transient base flow. Greg Lewis (NMED) asked what effect does the lack of data have on the vertical gradient. Is the vertical component important? Elizabeth Keating (LANL) stated that the vertical head measurements generally confirm the conceptual model. But in the center of the Laboratory where a flat gradient is expected, there are some downward vertical gradients. Charlie Nylander (LANL) added that the multi-screened wells are important in measuring vertical gradients.

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EAG Closeout with the GIT

Bob Charles (EAG) began the closeout session with a review of the annual meeting. The first item addressed in the close out was the Senior Managers' meeting where three issues were discussed:

1) Schedule:
   - Schedule work on annual basis
2) Matrix management between DOE, LANL, NMED:
   - Need upper management communication
3) Transition to monitoring:
   - A team will develop a plan for transition

The EAG is pleased with senior managers working together and found parallelism between the goals of the three organizations. However, the EAG feels that the Hydrogeologic Workplan scope is unbounded. Technical growth is the place to start. Managers have to make the bounding decisions, but technical folks have to provide the bases.

The second item discussed in the closeout session was a review of the stakeholder session. Communications were the focus of that session.

- Stakeholders want to be involved in planning decisions.
- The timeliness of the annual report was noted.
- Stakeholders want to be in on other planning meetings.
- Stakeholders asked for publications list.

Positive notes include:

- Community relations program was extended to Hydrogeologic Workplan. This is a good example of teamwork.
- Program Manager's accommodations of stakeholder requests.
- Stakeholder participation in annual and quarterly meetings.

The third item discussed in the closeout session was the breakout sessions. This effort did not turn out well. There were good discussions, but these discussions should have happened March 20 and 21at Ghost Ranch. The breakout sessions were intended for one-on-one discussions; however, too many people attended to accomplish this. The philosophy of the breakout sessions is a good one.

With respect to the technical portion of the Annual Meeting, the EAG liked the poster sessions and felt that communication during meetings was good. It was recommended that staff cut back on jargon. The EAG thanked the administrative staff for pulling the meeting together.

David Schafer (EAG) noted the great progress on reducing costs on drilling. Jack Powers (EAG) and David Schafer (EAG) will look at costs further. Well development at $300,000 seems high, although multiple screens in one well is just like developing multiple wells. There may be ways to improve the hydrologic testing. Injection tests may not work well because some wells do not take water. Need to have the dual packer for pumping tests. Have not had a chance to review calculations from the tests, particularly municipal wells. Hydrology/modeling interaction seems good - communication is

working. Spinner tests in municipal wells should still be considered. Julie Canepa (LANL) asked for David Schafer's view on the importance of multiple well hydrologic testing. David Schafer (EAG) responded that it is true that in evaluating hydraulic conductivity, observation wells are useful. But is nervous when observation wells cost $1 million. Need to look at whether spinner test can get the same data. Observation wells are very good, but we need to evaluate bang for buck.

Charlie McLane (EAG) added that the need for hydraulic conductivity data cannot be downplayed, but he was struck by the need for water levels in the modeling. So if there are other ways to get the hydraulic conductivity data, they should be evaluated. We are faced with scale here. With a pump test in one part LANL, can it be applied across the plateau? So many observation wells are necessary and they have to be near municipal wells because only those wells are big enough to stress the aquifer. Regulations are bent on lots of field measurements, but that is not the way to build a model. Water levels seem to be much more important. Bruce Robinson (LANL) stated that there is a diversity of opinion on the value of these types of data. The bottom line is transport. If we could nail the head, could achieve a good handle on water moving in the system. But travel times need to be predicted.

Bob Powell (EAG) stated that a lot of information has been given in the past five days and hopes the EAG report pulls it together.

- There is an increased interest from DOE, which could have positive affects, for example, in funding. However, too much DOE involvement could overburden the Project Manager.
- There is increased QA/QC interest from ER. Tool for thinking through activities and for management.
- Technological aspects have progressed.
- Stochastic modeling is good.
- Implementation of wells is caught up
- Drilling additives are still existent after development. Consider using port pump and open port measure at surface until field parameters are stabilized.

Elizabeth Anderson (EAG) addressed risk assessment. Regarding the Annual Report chart showing progress with respect to decisions, all the decisions are risk questions. With no breakout session on risk assessment, it will be necessary to review risk assessment as applied to the program. However, three primary banners were noted:

1) Hydrogeologic Workplan can benefit from enhancing risk focus. Take all information and continuously ask if what is being learned can inform and focus the program. The last EAG report discussed what was meant by risk based approach.
2) Risk-based goals need to be clearly articulated. The decisions are broad statements and need to be stated quite clearly. Go to the heart of the use of models. Identify what is nice to do vs what is needed.
3) There needs to be recognition/clarification of where risk assessment roles will be carried out. Models connect one to the other. Need to think through what part of the puzzle is being quantified. Exposure: is it Rio Grande? Need to address how to connect with ER and where to draw the line between them and how to use the data to the benefit of all programs.

Charlie McLane (EAG) agreed with Elizabeth Anderson (EAG). The Hydrogeologic Workplan is not intended to be an RFI, although there is a risk component. Modeling presentations were good and the posters were well received. Observations from stakeholders about the posters included:

- Indicate "preliminary" when data is preliminary; for example, Elizabeth Keating's (LANL) stochastic modeling.
- Make clear the internal policy on work-in-progress.
- Feel information is held back.
- Databases linked to modeling.
- Good meeting with Bruce Robinson (LANL) on the first-order groundwater pathway analysis. Focus future modeling beginning of design of monitoring. Respond to NMED request for sampler modeling.
- Regarding statistical analysis of number of monitoring wells, try some scoping analysis. Large uncertainties could result in large number of wells.
- Quarterly meetings on modeling are a good step. It is an opportunity to bring stakeholders along.
- Consider using simpler models when possible. There is a spectrum of modeling resources. Perhaps can be applied in a graded way to PRSs.
- Caution on the use of jargon when describing making these descriptions.

Julie Canepa (LANL) noted that she is hoping that the EAG will address the statistical analysis for well spacing and whether this is the appropriate time to begin, considering the large uncertainty. There is pressure from DOE to do this.

Bob Powell (EAG) stated that he believes professional judgement will be more important than geostatistics in designing the monitoring network. Russel Edge (DOE-AL) noted that caution should be taken to not get drawn into discussions about knocking wells off. Do no know what the real number of wells.

Charlie Nylander (LANL) provided comments on behalf of GIT:

- Thanks for EAG participation and preparation. They are a great value to institution.
- GIT members thanked for the annual report, posters, and presentations.
- Support from Kelly Bitner (Neptune), Sue Johnson (LATA), and Suzanne Maez (LATA). Tremendous amount of logistics in preparing for the meeting.

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