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NATIONAL LABORATORY
memorandum
Environmental Stewardship (ENV)
Groundwater Protection Program (ENV-GPP)

To/MS: Distribution
From/MS: Charles Nylander, ENV-GPP, MS M992
Phone/Fax: 5-4681/7-9553 Charles L. Nylander
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SUBJECT: MINUTES FROM THE GROUNDWATER PROTECTION PROGRAM QUARTERLY MEETING HELD FEBRUARY 2, 2005

Enclosed please find the minutes from Los Alamos National Laboratory's (LANL) Groundwater Protection Program Quarterly Meeting held February 2, 2005 in Santa Fe at the Courtyard by Marriott. The presentation materials are provided on the CD accompanying these minutes.

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.

CN/bms

Cy(w/attach.):
A. Barr, RRES-SWRC, MS K498, w/enc
A. Crowder, WGI/PMC, Los Alamos, NM, w/enc.
A. Dorries, RRES-ECR, MS M992
A. Gallegos, EES-15, MS J495, w/enc
A. Groffman, RRES-GPP, MS M992 w/enc.
A. Lavine, EES-9, MS D462, w/enc
A. Lee, RRES-R, MS M992, w/enc
A. Lewis, Hydrologist, Santa Fe, NM, w/enc.
A. Ortelli, w/enc
A. Rankin, Albuquerque Journal, Santa fe, NM, w/enc.
A. Williams, CCNS, Santa Fe, NM, w/enc.
B. Beers, RRES-WQH, MS K497, w/enc
B. Bockisch, Kleinfelder, Inc., Albuquerque, NM w/enc.
B. Enz, DOE/OLASO, MS A316
B. Gallaher, RRES-WQH, MS K497, w/enc
B. Gomez, New Mexico Department of Public Education, Santa fe, NM, w/enclosures
B. Grimes, CER-30, MS A117
B. Jacobs, Bandelier, NM, w/enc
B. Jacobs, Hydroanalysis, Inc, Brookline, MA, w/enc.
B. Latham, NNMCAB, w/enc
B. Lowry, Santa Fe, NM, w/enc.

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Cy (w/attach.): cont.
B. Newman, EES-15, MS J495
B. Olson, NMED/GWQB, Santa Fe, NM, w/enc.
B. Poster, Southwest Planning and Marketing, Santa Fe, NM, w/enc.
B. Robinson, EES-6, MS T003
B. Sauter, w/enc
B. Schneider, w/enc.
B. Shields, Amigos Bravos, Taos, NM, w/enc.
B. Stine, ADTS, MS A104, w/enc.
B. Turney, RRES-WQH, MS K497, w/enc
B. Weeks, NMED/DOE OB, Los Alamos, NM w/enc.
C. Ardito, Intera, Inc., Albuquerque, NM, w/enc
C. Ash, NMTC, Santa Fe, NM, w/ enc
C. Behr-Andres, EES-DO, MS D446
C. Borchert, City of Santa Fe, w/enc.
C. Callan, NETS, Albuquerque, NM, w/enc.
C. Frischkorn, NMED/GWQB, Santa Fe, NM, w/enc.
C. Lewis, EES-9, MS D462, w/enc
C. Mangeng, ADTS, MS A104, w/enc.
C. Martinez, Pueblo of San Ildefonso, Santa fe, NM, w/enc.
C. McLane, EAG, Princeton, NJ, w/enc
C. Mechels, w/enc
C. Nylander, RRES-GPP, MS M992, w/enc.
C. Romero, Santa fe, NM, w/enc.
C. Thayer, LC-GL, MS A187, w/enc.
C. Timm, Albuquerque, NM w/enc.
D. Broxton, EES-6, MS D462
D. Erickson, ADWP, MS A106, w/enc
D. Finfrock, Finfrock Engineering, Edgewood, NM, w/enc.
D. Gonzalez, DDG & Assoc, w/enc
D. Hickmott, EES-6, MS D462
D. Hoard, NNMCAB, w/enc.
D. Larrsen, Westbay, N. Vancouver, w/enc
D. McInroy, RRES-R, MS M992, w/enc
D. McQuillan, NMED/GWQB, Santa Fe, NM, w/enc.
D. Porterfield, w/enc
D. Reaber, Daniel B. Stephens and Assoc., Albuquerque, NM, w/enc.
D. Rogers, RRES-WQH, MS K497, w/enc
D. Schafer, EAG, Stillwater, MN, w/enc
D. Stavert, ENV-DO, MS J591, w/enc
D. Thompson, WGI/PMC, Los Alamos, NM, w/enc.
D. Vaniman, EES-6, MS D462
D. Watchman-Moore, NMED Deptury Secretary, Santa Fe, NM, w/enc.
D. Woitte, LC-GL, MS A187, w/enc
E. Anderson, EAG, Sciences International Inc., Alexandria, VA, w/enc
E. Keating, EES-6, MS T003

Cy (w/attach.): cont.
E. Springer, EES-15, MS J495
F. Berting, w/enc.
F. Caporuscio, Eberline Services, MS J979, w/enc.
F. Lauffer, SNL, w/enc
G. Bayless, Santa Fe, NM, w/enc.
G. Butler, w/enc
G. Cole, EES-6, MS D462
G. Gates, CH2M Hill, Albuquerque, NM, w/enc.
G. Real, DOE/ABQ, MS A906
G. Rice, CCNS, San Antonio, TX, w/enc.
G. Valdo, Pueblo Cochiti
G. Valentine, EES-6, MS D462
GPP File, MS M992, w/enc
H. Daneman, w/enc
H. Morrow, USACE, Davis, CA, w/enc.
J. Aanenson, Freeman, SD, w/enc.
J. Ahlquist, UC, w/enc
J. Arends, CCNS, w/enc
J. Bearzi, NMED/HRMB, Santa Fe, NM, w/enc.
J. Brannon, w/enc
J. Chavarria, Santa Clara Pueblo, Espanola, NM, w/enc
J. Fries, NNMCAB, w/enc
J. Kelsey, DB Stephens & Assoc., Albuquerque, NM, w/enc
J. McCann, RRES- WQH, MS M992, w/enc
J. Mohler, Belgrade, MT, w/enc.
J. Pecos, Cochiti Pueblo, Cochiti, NM, w/enc
J. Pinder, Colorado State University, Fort Collins, w/enc.
J. Powers, EAG, Bloomington, MN, w/enc
J. Powers, EAG, Murray, UT, w/enc
J. Sisneros, FWO-SEM, MS P908, w/enc
J. T. Grubesic, Assistant Attorney General, w/enc
J. Trujillo, w/enc
J. Young, NMED/HRMB, Santa Fe, NM, w/enc.
K. Agogino, EPD, DOE/AL, Albuquerque, NM 87116, w/enc
K. Birdsell, EES-6, MS T003, w/enc
K. Bitner, Neptune & Co., Albuquerque, NM, w/enc
K. Burns, Los Alamos, NM, w/enc.
K. Granzow, NMED/DOE OB, White Rock, NM, w/enc.
K. Hargis, RRES-DO, MS J591, w/enc
K. Mullen, RRES-WQH, MS K497, w/enc
L. Beaty, w/enc
L. Goen, ADO-IF&C, MS F627
L. King, EPA, Dallas, Tx, w/enc
L. Maassen, RRES-R, MS M992, w/enc
L. Trevizo, NMED/HWB, Santa Fe, NM, w/enc.

Cy (w/attach.): cont.
LANL Reading Room, MS A117
M. Bates, Los Alamos Study Group, w/enc
M. Blad, Jemez Pueblo, w/enc
M. Dale, NMED/DOE OB, White Rock, NM, w/enc.
M. Everett, Kleinfelder, Inc., w/enc
M. Johansen, DOE/OLASO, MS A316
M. Klahn, RRES-GPP, MS 992, w/enc
M. Leavitt, NMED/SWQB, Santa Fe, NM, w/enc.
M. Manzanares, NNMCAB, w/enc (2 copies)
M. McVey, DB Stephens & Assoc., Albuquerque, NM, w/enc
M. Perrotte, w/enc.
M. Vesselinov, EES-6, MS T003, w/enc
M. Witkowski, EES-DO, MS C306, w/enc
N. Quintana, RRES-R, MS 992, w/enc
N. Weber, San Ildefonso Pueblo, Santa Fe, NM, w/enc
P. Davis, Envirologic Inc, w/enc
P. G. Dye, DOE/AL, Albuquerque, NM, w/enc.
P. Gomez, RRES-WQH, MS K497, w/enc
P. Lagas, Brown and Caldwell, Phoenix, AZ, w/enc.
P. Longmire, EES-6, MS D462
P. Padilla, Los Alamos County, Los Alamos, NM w/end
P. Shanahan, HydroAnalysis, Inc., Acton, MA, w/enc.
P. Stauffer, EES-6, MS T003, w/enc
P. Wardwell, LC-GL, MS A187, w/enc
P. Webber, EES-DO, MS D446
R. Charles, EAG, Ranchester, WY, w/enc
R. Chinana, w/enc
R. Cunningham, URS Corporation, Santa Fe, NM, w/enc.
R. Curry, NMED Secretary, Santa Fe, NM, w/enc.
R. Deutsch, w/enc
R. Ford-Schmid, NMED/DOE OB, Santa Fe, NM w/enc
R. Gallegos, City of Santa Fe PUD, Santa Fe, NM, w/enc.
R. Gutierrez, Santa Clara Pueblo, Espanola, NM, w/enc
R. Hull, LATA, MS M321, w/enc
R. Koch, SAIC, MS J521, w/enc
R. Mayer, EPA, Dallas, TX, w/enc
R. Novabhtian, Santa Fe, NM, w/enc.
R. Warren, EES-6, MS D462
S. Baldridge, EES-11, MS D462, w/enc
S. Bolivar, RRES-ECR, MS M992
S. Kinkead, IM-8, MS M310, w/enc
S. McLin, RRES-WQH, MS K497, w/enc
S. Pearson, RRES-WQH, MS M992, w/enc
S. Rae, RRES-WQH, MS K497, w/enc
S. Rydeen, San Ildefonso Pueblo, w/enc

Cy (w/attach.): cont.
S. Veenis, RRES-WQH, MS K497, w/enc
S. Yanicak, NMED/DOE/OB, MS J993, w/enc.
T. DeLong, w/enc.
T. Glasco, Los Alamos County, Los Alamos, NM, w/enc
T. Longo, DOE/HQ/EM-45, Germantown, MD, w/enc
T. Taylor, LAAME, DOE/OLASO, MS A316, w/enc
T. Whitacre, DOE/OLASO, MS A316
W. Carey, EES-6, MS D462
W. Fetner, NM Office of Natural Resources Trustee, Santa Fe, NM, w/enc.

Los Alamos National Laboratory
Groundwater Protection Program
Quarterly Meeting
February 2, 2005
Santa Fe, New Mexico
Minutes

Meeting Purpose, Attendees, and Agenda
The Los Alamos National Laboratory (LANL) Groundwater Protection Program met with the New Mexico Environment Department (NMED), the Department of Energy (DOE), National Nuclear Security Administration (NNSA), and stakeholders on October 25, 2004 for a Quarterly Groundwater Protection Program meeting. The meeting was held at the Courtyard by Marriott in Santa Fe, New Mexico. Charlie Nylander (Groundwater Protection Program Manager) facilitated the meeting.

The following groups and stakeholders were represented (see list of Participants for specific information):

NMED- Hazardous Waste Bureau
NMED – DOE Oversight Bureau
DOE- Los Alamos Site Operations
DOE –Office of Inspector General
Environmental Protection Agency
San Ildefonso Pueblo
Northern New Mexico Citizens Advisory Board
Concerned Citizens for Nuclear Safety
LANL- Groundwater Integration Team
New Mexico Office of the Natural Resource Trustee
City of Santa Fe
US Army Corps of Engineers
Daniel B. Stephens and Associates
Frinfrock Engineering
Los Alamos Monitor
Nuclear Watch New Mexico
InfraSUR
Lee Wilson and Associates
Kleinfelder
INTERA

The purpose of the Quarterly Meeting was to provide NMED, DOE, and stakeholders with information on LANL's groundwater protection activities during the past quarter. The meeting agenda was as follows:

Introduction and Agenda (C. Nylander)
Drilling Update (T. Whitacre)
Progress Report on Mortandad Canyon Groundwater Investigations (P. Longmire)
Regional Aquifer Water Level Map (E. Keating)
Techniques to Identify Perched Water while Drilling (M. Everett)
Break
Background Groundwater Water Quality (P. Longmire)
New Water Quality Database Queries and Screening Tools (K. Mullen)

Welcome and Agenda (C. Nylander)
Charlie Nylander (LANL) welcomed the participants to the Los Alamos National Laboratory Groundwater Protection Program quarterly meeting. These meetings are to keep regulators and interested stakeholders aware of the work that has been accomplished in the past quarter in the Groundwater Protection Program. Each person in the room introduced themselves (a list of participants is included at the end of these notes).

Los Alamos National Laboratory
Groundwater Protection Program
Quarterly Meeting
February 2, 2005
Santa Fe, New Mexico
Minutes

Drilling Update (T. Whitacre)

Tom Whitacre (DOE/LASO) described the deep well drilling accomplishments:

- R-6 in Los Alamos Canyon, near TA-21; 1303 feet deep, completed with one screen; full Schlumberger geophysical suite and video log.
- R-6i in Los Alamos Canyon, near R-6; 697 feet deep completed with one screen; LANL geophysical suite (gamma and induction logs) and video log.
- R-18 in upper Pajarito Canyon in the DX area with limited access; 1440 feet deep completed with one screen; full Schlumberger geophysical suite and video log.
- I-1 in upper Mortandad Canyon, down from the TA-50 liquid radioactive waste treatment plant outfall; 770 feet of core collected; completed with one screen; LANL geophysics suite and video log. The coring is accomplished by coring from the surface to the top of the basalt; then a borehole for the well is drilled offset from the corehole by 30-80 ft.
- I-4 in Mortandad Canyon near MCOBT-4.4, near confluence with Ten Site Canyon; 450 feet deep, completed with one screen; LANL geophysics suite and video log.
- I-5 is in Mortandad Canyon, adjacent to R-15. The objective was to find the perched zone encountered when R-15 was drilled. The well is 717 feet deep and was completed with a single screen in the perched zone. LANL geophysical suite and video log.
- I-6 is in Mortandad Canyon, located in the center of the canyon. It is 727 feet deep and 488 feet of core was collected. The well was completed with one screen and the LANL geophysical suite and a video log were run.
- I-8 is in Mortandad Canyon, up the canyon near the permeable reactive barrier, above the Mortandad/Ten Site confluence. The well is 745 feet deep and was completed with a single screen. 500 feet of core was collected. The LANL geophysical suite and video log were run.
- I-10 in Mortandad Canyon, near the confluence of Mortandad and Ten Site canyons and the sediment traps. The borehole was 1040 feet deep and 428 feet of core was collected. LANL geophysical suite and video log were run.

Well development and testing activities in the last quarter were:

- R-33: development and hydrologic testing completed; about 148,000 gallons removed
- R-6: development and hydrologic testing completed; about 20,000 gallons removed
- R-18: development and hydrologic testing are ongoing; about 19,000 gallons removed to date
- R-6i: awaiting development and hydrologic testing
- I-1 is currently dry
- I-4: development and hydrologic testing are ongoing; about 120 gallons removed to date.
- I-5: development and hydrologic testing are ongoing; about 620 gallons removed to date
- I-6: awaiting development and hydrologic testing
- I-8: development and hydrologic testing are ongoing; about 36 gallons removed to date.

The perched intermediate zones have very low water yield. We remove all the water and then have to wait several days for the water to come back. There is water, but very low flow rates and it takes a long time to recover.

The status of drilling activities in Mortandad Canyon is:

- All planned intermediate wells ("I" holes) are completed: I-1, I-4, I-5, I-6, I-8, and I-10. I-3 was moved to become R-6i.
- A total of about 2185 feet of core has been collected from "I" hole locations

- All planned alluvial wells ("A" holes) have been completed and 410 feet of core has been collected.
- Planned boreholes ("B" holes) have been completed with the exception of B-3 and B-4 which can not be done because the canyon is too narrow to get equipment in at those locations.
- The planned resistivity validation boreholes ("RES" holes), RES-2, -3, and -4 have been completed and 590 feet of core was collected.
- Regional aquifer wells R-33, R-28, and R-1 have been completed.

There was an intermediate well planned for near R-33, but no perched water was encountered while drilling R-33. With the concurrence of NMED, the I-3 well was moved to Los Alamos Canyon and was drilled as R-6i. These field activities have resulted in a large data set and the analysis of the data has begun.

The field work remaining includes:

- Complete well development and hydrologic testing of R-6i, I-6, I-8, and all alluvial wells in Mortandad Canyon.
- Install sampling pumps in R-6, R-18, R-6i, I-4, I-5, I-6, I-8, and the Mortandad alluvial wells.
- Install the BARCAD sampling system in R-33
- Site restoration

The status of reporting activities is:

- Fact sheets for R-6, R-18, R-33, and R-34 have been submitted to NMED
- The well completion report for R-34 was submitted to NMED
- Remainder of well completion reports are due later this spring and summer.

Drilling Update Questions, Comments, and Responses

Q: Where is I-10 in relation to the sediment traps?
R: I-10 is located close to the sediment traps.

Q: When you say perched water, what do you mean – small or large?
R: Perched water refers to saturated conditions encountered while drilling. There is no way to know if the perched water encountered is in small pockets or interconnected layers. We do know that they are areas of saturation about 200-300 feet above the regional aquifer.

Q: How were the wells drilled?
R: The intermediate wells in Mortandad Canyon were drilled with about 2% foam and water mixture. Just enough foam to get the cuttings up out of the borehole. The R-6 regional aquifer well was drilled with mud rotary after problems were encountered. However, R-6 was developed within one week of completion and the development parameters (temperature, pH, conductivity, turbidity, and total organic carbon) were below the development criteria. The R-6 well cleaned up right away. The key is to develop right after drilling.

Q: Why is R-33 not listed in the drilling accomplishments?
R: R-33 was complete before the last quarterly meeting and was reported then. Two zones in R-33 have been developed since the last quarterly. Development continues until the development criteria are met.

Q: Was the well development protocol and criteria always this strict?
R: We have always followed EPA well development protocols, but we added Total Organic Carbon as an indicator parameter after identifying the need to monitor the drilling fluid residuals.

Q: How much core was collected from B-2?
R: 100 feet of core was collected from each "B" hole, with the exception of two "B" holes which had more core.

Q: How much core was collected from A-5?
R: About 60 feet of core.

Q: What is the next major drilling campaign?
R: We will be meeting with the state soon to propose the next set of drilling activities because now we have a budget. We plan to get into the field this spring. The next major work plan is Pajarito Canyon. A report on all the work done in Mortandad Canyon is due in June 2006.

Q: Are you getting contaminant profiles from the core?
R: Yes, we are measuring the concentration of selected contaminants at intervals of 10 to 20 feet. We are just beginning to plot the data now.

Q: Where will the contaminant profile results be reported?
R: In the RFI report due in June 2006.

Q: What will be done with the core that was collected?
R: The core will be curated for at least 3 years, because that seemed to be adequate time to respond to comments on the report.

Q: Would the USGS or some other agency like the core?
R: it is possible the USGS would like the core. However, we previously tried to store the core in Socorro, but even low contaminant levels were too high for their facility.

C: CCNS is very concerned about the core because in other cases the core has been disposed of.
R: The core from R-wells will be stored in perpetuity. The core that was disposed of before was shallow core from ER projects.

Progress Report on Mortandad Canyon Groundwater Investigations (P. Longmire)
Pat Longmire (LANL) said that the purpose of the presentation is to provide an update on the screening analytical results obtained during drilling of perched intermediate wells (I-4, I-5, I-6 and I-8) and regional aquifer wells (R-33, R-34) in Mortandad Canyon. Screening data are analytically correct; the charge balances are within accepted limits. However, the samples are collected boreholes, not completed wells. Screening samples are used mainly as a guide for drilling, to monitor the progress of development, and to determine the presence/absence of contaminants. This presentation focuses on conservative contaminants (nitrate, perchlorate, and tritium) that are expected to move the quickest and farthest in the environment.

The analytical methods that were used on the screening samples were:

- Inductively coupled plasma optical emission spectroscopy (ICPOES) for Al, Ca, Fe, Mg, Mn, Na, K, and Si

- Inductively coupled plasma mass spectrometry (ICPMS) for Sb, As, B, Ba, Be, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, Se, Sr, Th, Tl, U, V, and Zn
- Ion chromatography for Cl, Br, F, NO_3, NO_2, PO4, and SO_4
- Titration for alkalinity.

When the groundwater investigation workplan for Mortandad Canyon was developed it was based on a conceptual model of flow and transport in the canyon. As new data are collected, the conceptual model is revised and refined. A hydrogeologic cross section of selected wells in Mortandad Canyon shows the intermediate depth wells in between TW-8 and R-15. The original conceptual model hypothesized that recharge must be occurring in Mortandad Canyon, but determining the areas where recharge occurs was a primary goal of the investigation. From the intermediate wells, it appears that the recharge area is in the vicinity of the Mortandad/Ten Site Canyon confluence and the sediment traps. This is based on the following hydrologic observations:

- R-1 has no perched zone and the regional aquifer at a depth of 1003 feet is dead with respect to tritium.
- TW-8 has no perched zone
- I-8 has perched water in the Cerros del Rio basalt, about 650 to 700 feet below the surface. The perched water appears to be discontinuous with flow controlled by fractures
- I-4 there is perched water in the Puye Formation, at the interface of the Puye Formation and Cerros del Rio basalt
- MCOBT-4.4 had perched water in the Puye Formation and in the basalt
- I-6 in the center of the canyon has perched water in the Cerros del Rio basalt
- I-5 on the south side of the canyon has 100 feet of saturated thickness.

The analytical results from the screening samples show:

- I-4 and I-5 have nitrate and perchlorate in the perched zone. New data in this week show that I-4 and I-5 also have tritium, 5400 pCi/L and 8400 pCi/L, respectively. The nitrate, perchlorate and tritium support the conceptual model of recharge occurring where Mortandad Canyon widens out at the confluence with Ten Site Canyon and contaminants moving through the perched system.
- I-8 has no nitrate or perchlorate. No tritium data are available for I-8 yet. Since it is located upstream from the widened area, it is consistent with the conceptual model that recharge occurs in the widened part of the canyon.
- R-33 has no detectable nitrate or perchlorate in the regional aquifer. R-33 is also upstream from the apparent recharge area. However, samples of the regional aquifer from R-33 have cerium in them. Cerium is a lanthanide and was a by-product of production at TA-35. The presence of cerium has a geochemical interest and maybe useful in tracing pathways; it indicates little mixing is occurring. However, there is no standard for cerium and is it not a health risk.
- No contaminants have been detected in R-1 and R-33, which suggests that contaminants in the regional aquifer begin near the sediment traps, from R-15 to R-28.

The summary and preliminary conclusions based on these screening level data are:

- The new regional aquifer well R-33 shows no contamination with respect to nitrate, perchlorate, and tritium based on initial analytical results.
- The intermediate wells show concentrations of perchlorate and nitrate (N) that are of similar magnitude or lower than previously drilled intermediate wells (e.g., MCOBT-4.4)
- Contamination is no worse than we had previously thought in Mortandad Canyon.

- Borehole I-8 did not contain contaminants based on initial analytical results, suggesting recharge has reached perched intermediate zones east of R-8 within Mortandad Canyon.

Progress Report on Mortandad Canyon Groundwater Investigations Questions, Comments, and Responses

Q: TW-8 has tritium in it, but R-1 does not. Does this indicate that TW-8 is a leaky well?
R: The presence of tritium in TW-8 but not R-1 supports the idea that the annulus of TW-8 is leaky. There will be further testing to evaluate this.

Q: Where is TW-8, it is not on the map.
R: TW-8 is just east of R-1 on the map.

Q: I-4 and MCOBT-4.4 are very close together – is that the same perched zone?
R: It could be the same, but it could also be in different flows within the Cerros del Rio basalt.

C: The only 2 samples from the same aquifer are from MCOBT-4.4 and I-4. Further the results from I-4 may be low because it has not been developed yet.
R: The results from I-4 could be low, the nitrate has gone up in MCOBT-4.4.

Q: You still have movement through the regional aquifer, although slow, and that shows interconnection.
R: There is interconnection based on the signature of nitrate, perchlorate, and tritium.

Q: There are only two places in Mortandad Canyon where the regional aquifer is impacted?
R: R-15 and R-28 are the only two places. None of the contaminants have reached R-14 and the flow in the aquifer may not be in that direction. The water supply pumping may be pulling the water more to the east rather than southeast.

Q: Can you make a conclusion based on a single sample?
R: The "B" holes have perchlorate within the vadose zone, but it has not reached the intermediate perched water until east of I-8. Additional data will help refine the conceptual model for recharge. The boreholes and samples that have been collected will be very successful in guiding future efforts.

Q: The permeable reactive barrier is installed in Mortandad and now a permeable reactive barrier is proposed for the 260 outfall. However, it has not been proven that the permeable reactive barrier in Mortandad works.
R: It is not important to know the source of the contaminants in order for the permeable reactive barrier to work, just that all the water flows through it.

Q: On the field trip to see the permeable reactive barrier, you indicated that more wells would be installed. What is the status of that?
R: We are doing more analysis in order to make a recommendation on the locations for more shallow (30-foot) wells.

Q: Was the sample from R-33 taken after the well was developed?
R: The sample was taken after development and the analytical results shown for R-33 are not screening level data. The water met the development criteria: Total Organic Carbon less than 2. We also looked for nitrate, but it wasn't there. The carbonate/bicarbonate was consistent.

Q: So there were no effects of drilling fluids in the R-33 samples?
R: The water met all the development criteria. The conclusions may change as more data are collected.

Q: Do you have an inventory of contaminants for Mortandad Canyon?
R: Work is continuing on an inventory. The best inventory so far is for nitrate, but work is proceeding on the others.

Q: Do you have analytical results from the tuff core?
R: We have results from the "B" hole core and the alluvial groundwater. There is nitrate and perchlorate present in both. We are also looking at the other ions. Samples were collected every 10 feet and they were analyzed for pore moisture, Those data are being compiled now. We are trying to get an understanding of where the contaminant inventory is partitioned. All chemical data is obtained by leaching the core and analyzing the leachate.

Q: Have you made progress on our request to know how much perchlorate went up the hill?
R: Don't know the answer to that.

Q: How many gallons of water does one gallon of perchlorate contaminate?
R: I have done the calculations, but I will go over them with you because the answer depends on a number of assumptions that have to be made.

Regional Aquifer Water Level Map (E. Keating)
Elizabeth Keating (LANL) explained that updating the water table map is a continuous process, each time a new well is drilled. The results are not published as often as the map is revised. The newest version will be discussed in this presentation.

Comparing today's map to the water table map published by Purtymun in 1975, there is no big difference in the water table contours. However, there is a big difference in the data used to construct the map. The 1975 map was based largely on water supply wells, so the water table elevations were not the top of the water table and the measurements represented composite heads, the composite head over hundreds of feet of screen. The most recent map is constructed using only R-well data from short screens at the top of the water table.

The map shows steep gradients along the western part of the Lab. This maybe because the rocks are tighter. In the central part of the Lab, the gradient is flatter, perhaps because the rocks are more permeable. There is more curvature to the contour lines around pumping wells, because of the influence of the pumping. There is a groundwater mound at TW-1, which may be caused by enhanced infiltration of Bayo wastewater treatment plant discharge. There is a relative low at R-9 and R-12. The eastern portion of the map is poorly controlled. The Los Alamos well field may still be recovering.

There is a map of the geology at the water table that may help explain some of the features in the water table map. Generally the geologic transitions are not reflected in the contours of the water table map. An exception is where Tertiary Basalt (TB-2) is exposed. That coincides with the low surrounding R-9 and R-12. The pumping may effect the basalt to a greater extent than the surrounding rocks.

Permeability measurements are also shown on a map. The measurements shown on the map are from the uppermost screen only. There are two zones of higher permeability in the central

part of the map, which may explain why the gradient flattens out. However, the more permeable zones do not correlate with the rock types at the surface. The higher permeability zones do not appear to be a single continuous trough as Purtymun thought.

David Rogers (LANL) presented information on the rate of decline of the regional aquifer. LANL has 50 years of mostly manual water table measurements, although the data collection has increased significantly in the last decade. A report was compiled showing water level decline across the Lab. The oldest wells, with data since 1950, show that most of the 8 wells have declined 5-10 feet to 30-45 feet. The one exception is TW-1 in Pueblo Canyon which has increased. On the map, the rates of decline are highest (ft/yr) in a bubble in middle part of the Lab.

NMED asked for an updated map with more recent data. The map was revised by adding data from wells that have 1 -6 years of data. The map generally looks the same, with rapid decline in the central part of the Lab, although the new well data extends the zone to the south. The new map mixes data from manual sampling, transducers, and pressure measurements in WESTBAY ports. R-5 has a high rate of decline, about 1.7 ft/yr.

Looking at the trend in the water level data, as seen in R-5, the trend is down. At TW-1 there is a decline, but it is much less than the decline seen in nearby R-5. This may be due to the addition of water from enhanced recharge of the Bayo wastewater treatment plant effluent. R-20 is a fairly new well in Pajarito Canyon and it has had a decline of a few feet. R-23 at the east end of Pajarito Canyon has had a decline of 2-3 feet. R-22, located at the east end of Area G, has two sets of data: measurements during sampling and transducer data. Both sets of data have similar slopes. Some wells with short records or problems with the data were not included in the map. We need to do more looking at these data. Recent aquifer pumping shows that different zones within the regional aquifer respond differently to pumping and generally the top does not respond as much.

Regional Aquifer Water Level Map Questions, Comments, and Responses

Q: Which wells have the highest production?
R: Otowi-4, Pajarito Mesa (PM)-4, -5, and -2.

Q: The aquifer has not dropped much.
R: It has more than Los Alamos County would like, more than 100 feet in some places.

Q: Have you looked at the rainfall to see if there is a correlation between decline and rainfall?
R: We have not looked at that in detail. There are other complexities, such as irrigation of fields and storm water runoff.

Q: TW-1 has had a decline, is that because there is less recharge from the plant?
R: There has been a decline in the mound at TW-1. Of the deep wells with long records, only TW-1 has shown an increase, not a decline. Chloride levels increased in about 1980, the same time that the Bayo wastewater treatment plant effluent increased and the County graded the canyon floor to slow runoff and enhance infiltration.

Q: Why is the mound not shown as a trough?
R: It could also be contoured as a trough, based on the data points that we have. However, the geology suggests a localized feature.

Q: Can the effects of Buckman pumping be seen at R-16?
R: The modeling suggests that the Buckman pumping effects do extend as far as R-16, but the water level data is ambiguous. It is not the right kind of data to be able to identify Buckman effects. The model has estimated the area of Buckman influences west of the river and the area of subsidence also extends west of the river.

Q: Within a few short years of the enhanced infiltration work by the County, the chloride levels increased?
R: The timing of the change in water chemistry does coincide with the grading in Bayo Canyon by the County to enhance infiltration.

Q: Is the LA-UR number on the slide the same for the map?
R: The LA-UR number for the map is one up from the slides. The map was a special submittal to NMED.

Techniques to Identify Perched Water while Drilling (M. Everett)
Mark Everett (Kleinfelder, Inc.) explained how perched water is identified while drilling. Perched water is a zone of saturation that is underlain by relatively impervious material and separated from the regional groundwater body by a zone of non-saturated material. They are probably not laterally continuous and usually occur beneath canyons.

Perched groundwater is important because it is the first groundwater to be impacted by potential contaminants and it is the most likely groundwater to find the highest concentration of potential contaminants. Understanding the distribution of perched water aids in the understanding of potential pathways for contaminant movement.

Beneath the Pajarito Plateau, perched water is likely to be found in following stratigraphic units:

- Cerro Toledo interval which is a sedimentary unit between Bandelier ash flow. Haven't seen much water there.
- Guaje Pumice Bed
- Cerros del Rio basalt. These are a series of basalt flows separated by sedimentary interflow zones. Both the interflow zones and the fractured portions of the flows are good candidates for perched water.

The methods used for detecting perched water at LANL are:

- Drillers/geologist observations
- Tag for water at beginning/end of each day
- Potassium/bromide (salt) tracer tests
- Drilling fluid temperature monitoring
- Borehole geophysics
- Borehole video camera observations
- Quick analysis of groundwater samples

Driller/geologists can observe additional water in the discharge if there is enough extra water, but it is hard to tell when fluids are being added or with some drilling methodologies.

The drill string is tripped out of the borehole at the end of each day and the water level is measured ("tagged") at that time. The next morning the water level is measured again. If the

water level has risen over night then a saturated zone has been penetrated. One difficulty is that the drilling fluids get foamy and the foamy interface makes the water level sounder go off, resulting in an incorrect water level measurement in the evening.

Potassium-Bromide is added to the drilling fluid at a known concentration. The discharge fluid is analyzed for Br and if the concentration has decreased that indicates the drilling fluid has been diluted by incoming water. Examples of using this are provided for R-26 (air rotary with foam) and R-2 (mud rotary). In R-26 the upper part was drilled with foam and water. The K-Br tracer was added at a known concentration. Samples of discharge water were collected every 5 feet. A Br probe was used to measure the concentration of Br. There was a significant drop off in Br concentration at 600 feet. But the analysis was not done onsite and we got the data the next day. Now the measurements are being done real time onsite, but the instruments don't work as well due to the vibration from the drill rig. Also, it is hard to monitor influent concentrations. Minor perched water zones probably won't be detected this way. R-2 was drilled with mud, but the tracer does not show up well in the regional aquifer data.

The temperature of the drilling fluid changes when there is a significant addition of groundwater. An example of this monitoring is shown for R-6. A temperature probe is kept in the mud effluent and the probe is connected to a data logger. This did not work very well in R-6. Perhaps because it was cool at night in November but the mud warms up during the day.

The natural gamma and conductivity can be used to identify water. Gamma measures natural radiation. Bandelier has high gamma, Cerros del Rio basalt has low gamma, and Puye has intermediate gamma. Conductivity is a measure of how well the formation conducts electricity, which is related to the amount of water content of the rock. For example, in the I-8 borehole there was a spike in conductivity and a drop in gamma. The borehole video showed this interval to be damp, but not saturated. Further down in the borehole there were saturated conditions.

In summary, the identification and characterization of perched groundwater is a high priority. A combination of techniques are used to characterize perched groundwater and current methodologies allow for identification of more productive zones.

Techniques to Identify Perched Water while Drilling Questions, Comments, and Responses

Q: What happens when you measure conductance with the potassium-bromide in the fluid?
R: The conductance of the natural materials overshadows the amount of potassium-bromide in the fluid.

Q: What is the concentration of bromide and could you use a bromide-specific probe to measure the concentration?
R: The bromide concentration is about 200 ppm. A bromide probe is being used, but the vibrations from the drilling rig disturb the equipment.

Q: When did you start using these techniques?
R: We used some of these techniques before, but have added all those described in the last 18 months. Some of these techniques add expense to the drilling, e.g. tripping out and in every day. In the earlier wells the video, borehole geophysics, and examination of the cuttings were used to identify perched zones. Additionally, the upper 400 feet of many of the early wells was cored.

Los Alamos National Laboratory
Groundwater Protection Program
Quarterly Meeting
February 2, 2005
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Minutes

Background Groundwater Water Quality (P. Longmire)

Pat Longmire (LANL) explained the approach and purpose of the groundwater background study:

- Background is measured in natural waters from springs or wells not impacted by LANL or other human activities and is representative of groundwater from their respective aquifer material.
- To establish background (or baseline) water chemistry data and information.
- Used to distinguish between contaminated and non-contaminated waters for LANL environmental investigations.

The data from the background study will support investigations (environmental restoration, surveillance, and groundwater protection). It can be used for

- Supporting environmental risk assessments
- RCRA site investigations
- Evaluating hydrogeochemical processes occurring along water flow paths
- Defining recharge zones and hydrological pathways
- Establishing cleanup levels in conjunction with maximum contaminant levels (MCLs) during remediation of contaminated water

Background sampling sites were selected integrating hydrogeology and chemistry data. The areas that were selected are:

- Jemez Mountains/Pajarito Plateau: sampling locations based on previously published knowledge and recent data sampling data collected by LANL and NMED; all sampling stations provide chemical data that are not impacted from Laboratory discharges; supply and monitor wells show background concentrations of tritium (e.g. the water is dead with respect to tritium indicating the water is greater than 60 years old).
- Sierra de los Valles: springs and well LAO-B are hydraulically upgradient from groundwater beneath the Laboratory.
- White Rock Canyon: selected springs discharging show background concentrations of tritium, uranium, chloride, and nitrate.

The sampling locations also represent three aquifer types: alluvial, perched intermediate volcanic rocks (Bandelier Tuff, Tschicoma Formation, hydro(phreatic)-magmatic deposits, and Cerros del Rio basalt; and regional aquifer (Puye Formation and Santa Fe Group sediments.

There were six sampling rounds and the samples were sent to both contract analytical laboratories and the internal EES-6 analytical laboratory. The analytical methods that were used on the background groundwater samples were:

- Graphite Furnace Atomic Adsorption Spectroscopy for Ag, Cd, Co, Cr, Cs, Cu, Mo, Ni, Pb, Sn, Tl
- Inductively coupled plasma atomic emission spectroscopy (ICP-AES) for Al, B, Ba, Be, Ca, Fe, Li, Mg, Mn, Si, Sr, Tl, V, and Zn
- Inductively coupled plasma mass spectrometry (ICP-MS) for U and trace elements
- Ion chromatography for Br, Cl, ClO_3, F, I, NO_3, NO_2, PO_4, S_2O3 and SO_4.
- Hydride Atomic Adsorption Spectroscopy: As, Sb, Se
- Titration for alkalinity.(CO_3, HCO_3, OH)
- Electrode for conductivity, pH, NH.
- Calculated: hardness, and Total Dissolved Solids
- Filtration: total suspended solids

The charge balance is an important check on the quality of the analytical data. Filtered samples from pre-1997 were evaluated for charge balance. Filtered samples are used because when nonfiltered samples are preserved with acid it dissolves some sediment and that will alter the charge balance. EPA protocols require that the charge balance be +/- 10%. Most of the pre-1997 data fall within the +/- 10% error on charge balance. Some points fall outside of the acceptable error, but the data are acceptable for use in the background study.

The chemistry of groundwater varies with the length of time the water is in the aquifer. Within natural waters, there are different groupings of Total Dissolved Solids (TDS) and bicarbonate that are associated with different rock types. A graph of TDS vs bicarbonate shows six groupings of water samples. The pre-1997 data were used in selecting background sampling locations.

Data Collection:

- Groundwater samples were collected and analyzed for chemical constituents in 1997, 1998, 1999, and 2000 during six sampling events
- Both filtered and nonfiltered groundwater samples were collected for analyses of major solutes, trace elements, and radionuclides.
- Nonfiltered groundwater samples were collected for stable isotope (hydrogen, oxygen, and nitrogen) analysis. Stable isotopes are good for fingerprinting flow paths.

After the analytical results were received, the data were statistically analyzed:

- Data were subject to routine data validation
- Data were inspected for suspect values that are exceptionally high or low relative to the rest of the data
- Data qualifiers were reviewed and any rejected (R qualifiers) were not used in statistical analysis
- Non-detected sample results for inorganic and other analytes were typically reported as less than ("<") the method detection limit (MDL) for that chemical. Values that were reported as non detected by the analytical laboratory were replaced by one-half the detection limit value for statistical analysis (following EPA 1992 protocol). An example is antimony, which is not naturally concentrated in groundwater and is usually not detected. Half the detection limit was used in the antimony data set for statistical analysis.

Statistical results for selected analytes were presented in tabular format. Regression analysis and scatter plots were prepared for each analyte. Nitrate is naturally occurring but also is added by LANL discharges, so it is good to focus on nitrate to distinguish background from anthropogenic contamination. Nitrate was detected in about 91% of the samples. Concentrations of nitrate varied by location but did not vary significantly by rock type or location groups. Nitrate concentrations are multimodal (perhaps bimodal). Box and whisker plots show the analysis of nitrate by aquifer type. There is nitrate in La Mesita spring where the water is very old and mineralized. The lowest value for nitrate is in the alluvial aquifer and the values are more spread out in the intermediate and regional aquifer. The quantile plot shows the normal quantile versus concentration. The diagonal line indicates a normal distribution. Most geochemical data are not normally distributed. Statistical analysis has to be integrated with the hydrogeology.

A comparison of major ion chemistries reported by EES-6 analytical laboratory, Paragon Analytics, Inc. and NMED for La Mesita spring show that they plot close and that indicates good precision between the labs.

Spatial trends in the background data show that specific conductance is low in the west and increases eastward. The highest specific conductance is in Apache spring. Some of this may be the impact of road salt.

Conclusions:

- Background groundwater chemistry for LANL is established
- We can distinguish between background and LANL contamination
- Increasing residence times lead to increasing solute concentrations in groundwater
- Background concentrations of arsenic and uranium increase near and east of the Rio Grande.

Recommendations:

- The detailed lithology, the criteria for stratigraphic divisions, and the nomenclature of sedimentary units remains poorly described.
- The LANL conceptual hydrologic model should continually be revised
- LANL should continue to sample and analyze the waters from these sites (perhaps on a yearly basis)
- Additional sampling at wells R-2, R-7 (screen 1), R-19, R-26 and other deep wells (DEPOGW4, Santa Clara Pueblo) not impacted by LANL will provide better coverage.
- An additional shallow well should be drilled in upper Pajarito Canyon west of State Road 501 to provide more coverage for alluvial groundwater
- Additional sampling of Spring 4A is justified, based on recent detection of nitrate, tritium, and possibly perchlorate. If these solutes are present, then the spring should be removed as a background station
- Grouping the current background water chemistry data set together is strongly recommended.
- Separating alluvial, perched intermediate depth, and regional aquifer groundwater in terms of analyte distribution (mean, median, range, and other statistical properties) is recommended as additional data are aquired.
- Impacts of the Cerro Grande fire are negligible for Apache Spring, water Canyon Gallery, upper Cañon de Valle Spring, and Pine Spring.

Background Groundwater Water Quality Questions, Comments, and Responses

Q: Was the criteria for selecting springs that they contain no tritium?
R: No detectable tritium at the time of sampling. Also no nitrate or perchlorate.

Q: By including the data points that fall outside the acceptable charge balance error, the background is biased low?
R: Yes it is.

Q: Are cesium and strontium present?
R: They were not detected.

Q: Were the samples from 2000 collected before or after the fire?
R: Both. There was a recommendation that sampling be continued to track the effects and recovery from the fire.

Q: What type of replicate was used?
R: Field replicates analyzed by different labs.

Q: Have you done isotopic analysis to determine what is from LANL and what is not?
R: For uranium we would need TIMS analysis because the concentration of uranium is generally low. There is naturally elevated uranium in Pojoaque Valley along the Rio Grande valley.

C: CCNS thinks there should be quarterly sampling of springs along the river to see seasonal variation.

Q: Who will peer review the report?
R: Groundwater Protection Program, Canyons, Environmental Restoration, Legal

Q: The peer review will be internal only?
R: The first review will be internal only. It will have external peer review before regulatory submittal.

New Water Quality Database Queries and Screening Tools (K. Mullen)
Ken Mullen (LANL) explained that the Water Quality Database (WQDB) used to be accessed at http://wqdbworld.lanl.gov. Now discoverer has been added to the external web site, so the new URL is http://wqdbworld.lanl.gov/discoverer. To set up discoverer, go to the new web site and install JInitiator. It is about 10 mb, so be patient because it can take up to 10 minutes. Then install Disco4i.jar, which is about 5 mb. Each time you log in you will see "Loading Java Applet". Once Discoverer is opened, go to "open/create workbook" and choose "open an existing workbook". Then you will have a choice of workbooks to open, e.g. 5 minute flow, easy screening, get data, screening with more options. The next screen will allow the choice of date, time, location parameters. It also has a drop down menu choice of standards to compare the data to. When those are submitted, a table of data with the standards that were selected displayed.

Note that the user is responsible for understanding the validation flag codes. All data are included in the WQDB, even those with rejected ("R") flags, so the user has to beware that it is important to pay attention to the validation flags. Also pay attention to the QC field, because the spikes and field blanks are included in there.

If the user chooses "screening with more options", there are more options for screening the data. The resulting data table can be exported to an excel file using the "file" drop down menu. Note that discoverer will make the excel file, but you won't know where it is. So, tell it to make the excel file a second time and you will get an alert that says: "Overwrite file?" and this alert box will tell you the name of the file that it made the first time, so note the file name and overwrite it.

In order to save your queries, you must set up an account. You cannot save the files to your PC. Set up an account from the discoverer file drop down menu.

The new discoverer is a powerful query interface to WQDB. It is available from your desktop, but you should set up an account to save your queries. The user is responsible for developing queries to pull accurate data, checking the qualification codes and validation flags and checking the field QC type code. The old WQDB interface (http://wqdbworld.lanl.gov) is still available.

New Water Quality Database Queries and Screening Tools Questions, Comments, and Responses

C: The Aroclor method is much less sensitive than the standard.
R: The state standards specify the method of analysis and the criteria is much lower than the method detection limit. There are other methods of analysis (congener) that have lower detection limits, but they are not allowed by the state standards.

Q: Is the congener method data in the WQDB?
R: There are too many and they are too messy, so we haven't done it yet. They will probably be added.

C: This new screening tool with the comparison to standards is really great. It is just what we have been asking for. CCNS would like to see all the data in the WQDB, especially the dioxin data.

Los Alamos National Laboratory
Groundwater Protection Program
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Minutes

Participants:

NAME	ORGANIZATION	PHONE	E-MAIL
Kelly Bitner	Neptune & Co.	884-8455	bitner@neptuneinc.org
Tom Whitacre	DOE	665-5042	twhitacre@doeal.gob
Ted Taylor	DOE	665-7203	ttaylor@doeal.gov
Neil Weber	Pueblo de San Ildefonso	455-4119	nweber@sanipueblo.org
Steve Rydeen	Pueblo de San Ildefonso	455-4120	srydeen@sanipueblo.org
Alice Barr	LANL	667-0820	barra@lanl.gov
Patrick Longmire	LANL	665-1264	plongmire@lanl.gov
Bruce Robinson	LANL	667-1910	robinson@lanl.gov
Rich Mayer	US Environmental Protection Agency	214-665-7442	mayer.richard@epa.gov
Roger Snodgrass	Los Alamos Monitor	662-4185	roger@lamonitor.com
Scott Kovac	NuclearWatch NM	989-7342	scott@nukewatch.org
Doug Reaber	Daniel B. Stephens & Assoc.	822-9400	dreaber@dbstephens.com
Lorrie Bonds-Lopez	LANL	667-2211	lorriel@lanl.gov
Jim Studer	InfraSUR, LLC	858-3136	jstuder@infrasur-llc.com
JD Campbell	NNMCAB	776-0805	jd@campy.com
Tom Parker	Lee Wilson & Assoc.	988-9811	lwa@lwasf.com
Marc Sydow	US Corps of Engineers, Sacramento District	916-557-7078	marc.w.sydow@usace.army.mil
Laurie Trevizo	NMED-HWB	428-2500	laurie_trevizo@nmenv.state.nm.us
Kathryn Lynnes	NMED-HWB	428-2556	kate_lynnes@nmenv.state.nm.us
Charlie Nylander	LANL-ENV-GPP	665-4681	nylander@lanl.gov
Mark Everett	Kleinfelder	344-7373	meverett@kleinfelder.com
Mat Johansen	NNSA-LASO	665-5046	mjohansen@doeal.gov
Danny Katzman	LANL	667-6333	katzman@lanl.gov
Steve Rae	LANL	665-1859	stevenrae@lanl.gov
Kim Granzow	NMED DOE-OB	672-0447	kgranzow@lanl.gov
Michael Dale	NMED DOE-OB	672-0449	mdale@lanl.gov
Joni Arends	CCNS	986-1973	jarends@nuclearactive.org
Will Fetner	NM ONRT	505-243-8087	william_fetner@nmenv.state.nm.us
Jeff Mills	DOE	845-5130	jmills@doeal.gov
Elizabeth Keating	LANL	665-6714	ekeating@lanl.gov
Debbie Frinfrock	Frinfrock Engineering	286-6458	dfrinkfrock@yahoo.com
Michael Rodriquez	City of Santa Fe	955-4205	marodriquez@santafenm.gov
Chris Timm	NNMCAB	505-323-8355	cmtimmpe@aol.com
Cindy Ardito	INTERA	505-246-1600	cardito@intera.com
Ken Mullen	LANL	667-0818	kmullen@lanl.gov