Los Alamos National Laboratory

HYDROGEOLOGIC CHARACTERIZATION PROGRAM

ANNUAL MEETING

April 10-12, 2002

Viewgraph Presentations

Hydrogeologic Characterization Program
Master Publications List

Action Plan for External Advisory Group
December 2001 Recommendations

Agenda
Los Alamos National Laboratory
Hydrogeologic Characterization Program
Annual Meeting
April 10-12, 2002

Wednesday, April 10
Bishop's Lodge, Santa Fe

8:00 Welcome and Introductions (Charlie Nylander)

8:15 Groundwater Integration Team Subcommittee Status Reports

Information Management (Sue Kinkead)

Well Construction (John McCann)

Geochemistry (Pat Longmire)

Hydrology (David Rogers)

Modeling (Bruce Robinson)

10:45 Break

11:00 FY03 Work Plan and Planning Session (Charlie Nylander)

12:00 Lunch

Technical Presentations/Posters (titles and presenters subject to change)

1:00 Status of Groundwater Protection Plan (Charlie Nylander and Diana Hollis)

1:20 Single-Well testing of R Wells at LANL -- From Hydrologic Constraints to Conductivity (William J. Stone and Stephen G. McLin).

1:40 Discussion of Regional Aquifer Modeling Results with Reference to the Buckman Well Field (Elizabeth Keating and Velimir Vesselinov)

2:40 Vadose Zone Geochemistry (Brent Newman and Pat Longmire)

3:00 Poster Viewing

4:00 Permeable Reactive Barrier in Mortandad Canyon (Pat Longmire)

4:20 Incorporating Uncertainty in the Regional Aquifer Modeling (Elizabeth Keating)

4:40 Groundwater Pathways Assessment (Bruce Robinson)

5:00 Well Development Survey (Bob Powell and David Schafer)

5:20 Adjourn

Agenda
Los Alamos National Laboratory
Hydrogeologic Characterization Program
Annual Meeting
April 10-12, 2002

Thursday, April 11
Bishop's Lodge, Santa Fe

Technical presentations/Posters (titles and presenters subject to change)

9:00 WQDB and ER Databases (Sue Kinkead, Ann Lee, Carol LaDelfe)

9:20 Updated 3-D Geologic Model (Greg Cole)

9:40 Poster Viewing

10:40 Seismic Hazards Program results (Alexis Lavine)

11:00 TA-16 High Resolution Resistivity Survey (Scott Baldridge)

11:20 Permeability of fault zones (Jennifer Wilson)

11:40 Fracture Characterization of the Bandelier Tuff in Canon de Valle for Seismic Hazards and Flow and Transport Analysis (Ryan Channell)

12:00 Lunch and Poster Viewing

1:00 Stakeholder session with EAG; concurrent GIT meeting

3:15 Break

3:30 LANL response to Stakeholder Issues

5:15 Adjourn

Friday, April 12
LATA conference room, Los Alamos

9:00 Manager's close out with EAG

10:30 Break

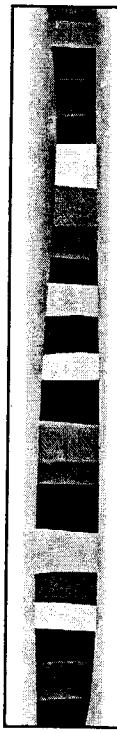
11:00 GIT close out with EAG

12:00 Lunch

1:00 EAG working session

Information Management Subcommittee Status Report

Hydrogeologic Characterization Program Annual Meeting
April 10 , 2002



Year in Review

- Software Development
- Data Import/Migration
- ER/ESH Data Exchange
- Report Development

Software Development

- Sampling/Chain of Custody
- Sample Planning
- Data Tracking
- Data Validation

FY 2001 Data Import/Migration

Data Set Description	Quantity
ESH-18 Legacy Data Migration	30+ years (300,000+ records)
Water Levels	27 wells (10 yrs)
2001 ESH-18 Analytical Chemistry (monitoring samples)	1400 Samples (~ 40,000 records)

FY 2001 ER/ESH Data Exchange

Data Set Description	Quantity
Well Construction	5 wells (R-9, 9i, 12, 15, 19)
Geophysical Logs	5 wells (R-9, 9i, 12, 15, 19)
Chemistry (in progress)	R-9i

Report Development

- **Chemistry ***
- **Well Construction ***
- **Water Levels ***
- **Sample Tracking**

*** = available on WQDB website**

Looking Ahead

- More ER/ESH Data Exchange (Well construction, geopyhsics & chemistry for additional R-wells)
- R-well Water Levels
- Web-Based Validation Data Entry Tool
- Web-Based Data Screening Report
- Invoice Tracking
- GIS (dependent on funding)

Accessing the WQDB Website

http://wqdb.lanl.gov
(LANL internal)

http://wqdbworld.lanl.gov
(public)

Question & Answer

Annual GIT Meeting

Well Construction Subcommittee Report

John McCann

April 10, 2002

Overview

- Drilling Accomplishments this Last Year
- Current Funded Drilling Activities
- Status of Quarterly Sampling Activities
- Status of Reporting Activities
- New Toolbox and Strategy

Drilling Accomplishments Last Year

Well	Watershed	Date Drilled	T.D. (ft)	No. Screens
R-5	LA/Pueblo	May 01	902	4
MCOBT-8.5	Mortandad	Jun 01	740	P&A'd
MCOBT-4.4	Mortandad	Jun 01	767	1
CdV-R-37-2	Water/Valle	Aug 01	1664	4
R-13	Mortandad	Oct 01	1133	1
R-8/-8a	LA/Pueblo	Jan 02	1020/ 860	0/2

Current Funded Drilling Activities

- R-14
  - DP-funded well in Ten Site Canyon (Mortandad Canyon system)
  - Drilled in May timeframe following T&E exclusion period
- R-21
  - ER-funded well on mesa in Pajarito Canyon
  - Drilled in July timeframe following completion of R-14
- Other wells may be potentially funded

Status of Quarterly Sampling

- Sampling program continues successfully. Current schedule includes CdV-15, CdV-37, MCOBT-4.4, and R-13 beginning this month
- Quarterly sampling has been completed for nine wells: R-7, R-9, R-9i, R-12, R-15, R-19, R-22, R-25, and CdV-R-15-3

Status of Reporting Activities

Well Completion Rpts	Completion Date
R-22	Feb 02
R-31	Feb 02
R-25	Mar 02
R-7	Apr 02
MCOBT-8.5 -4.4	Oct 02
R-13	Dec 02
Geochem Rpts	
R-15	Feb 02
R-9/R-9i	Mar 02
R-12	Apr 02
R-19	May 02
R-7	Aug 02
R-22	Sep 02

Drilling Tool Box and Strategy

- New Tools have been added to the toolbox:
  1. Bentonite-based mud drilling
  2. Thin-wall casing placement with sealing
- New drilling strategy includes the following elements:
  - Start drilling using air -- rotary or downhole hammer
  - Drill to approximately 100 feet above the anticipated depth of the regional water table (700 to 800 feet)

Drilling Tool Box and Strategy (cont.)

- Run geophysics in open borehole
- Set casing through this interval and seal the casing
- Continue drilling with air until the regional water table is reached and measure the static water level
- Switch to drilling with a flooded reverse bentonite mud-based system until TD is reached
- Run geophysics in the lower portion of the borehole
- Finish with single completion or multiple completion wells in the regional aquifer

STATUS REPORT FOR GEOCHEMISTRY SUBCOMMITTEE, GROUNDWATER INTEGRATION TEAM

BY

PATRICK LONGMIRE, DALE COUNCE,
BRENT NEWMAN, AND DAVID ROGERS

APRIL 10, 2002

OBJECTIVES OF PRESENTATION

Present a summary of geochemical investigations conducted at Los Alamos National Laboratory during FY 2001. Topics of interest include:

- Scope of Geochemistry Subcommittee
- Quarterly Groundwater (Characterization) Sampling
- R-9i Geochemistry

SCOPE OF GEOCHEMISTRY SUBCOMMITTEE

CHARACTERIZATION

- Provide geochemical support for selecting well locations, drilling methods, well construction, and characterization sampling.
- Determine baseline groundwater conditions at LANL.
- Identify and evaluate chemicals of interest present in groundwater.

ANALYTICAL METHODS

- Identify and evaluate analytical methods for inorganic and organic analytes.
- Provide consistency in analytical methods.

GEOCHEMICAL INPUT PARAMETERS FOR TRANSPORT MODELING

- Provide input parameters (speciation, adsorption, and mineral solubility) based on field, experimental, and literature citations for geochemical and reactive transport simulations.

GEOCHEMICAL CALCULATIONS

- Perform geochemical calculations quantifying water-rock interactions as part of characterization, monitored natural attenuation, pathway analysis for risk assessment, and groundwater remediation (for example, permeable reactive barrier technology).

R-WELL SCREENS, SAMPLING PORT DEPTHS, AND SAMPLING ROUNDS DURING FY2001 AND FY2002

- R-5 Four Screens; 169 ft, 375 ft, 678 ft, and 860 ft; 1 Round
- R-7 Three Screens; 378 ft, 744 ft, and 915 ft; 4 Rounds
- R-8A Two Screens; 731 ft, 825 ft; *0 Rounds (8/02)*
- R-9 *Single Screen*; 700 ft; 4 Rounds

- R-9i Two Screens; 199 ft and 279 ft; 4 Rounds
- R-12 Three Screens; 468 ft, 507 ft, and 811 ft; 4 Rounds
- R-13 *Single Screen*; 940 ft; *0 Round (06/02)*
- R-15 *Single Screen*; 1015 ft; 4 Rounds

- R-19 Seven Screens; 844 ft (dry), 909 ft, 1190 ft,1412 ft, 1586 ft, 1730 ft, and 1834 ft; 4 Rounds
- R-22 Five Screens; 906 ft, 962 ft, 1273 ft, 1379 ft, and 1449 ft; 4 Rounds
- R-25 Eight Screens; 755 ft, 892 ft, 1063 ft, 1192 ft, 1303 ft, 1406 ft, 1605, and 1796 ft; 4 Rounds
- R-31 Five Screens; 439 ft, 515 ft, 666 ft, 827 ft, 1007 ft; 2 Rounds

- MCO-BT-4.4 *Single Screen*; 493 ft; *0 Round (06/02)*
- CDV-15 Six Screens; 624 ft (dry), 806 ft (dry), 980 ft (dry), 1254 ft, 1350 ft, 1640 ft; 5 Rounds
- CDV-37 Four Screens; 927 ft, 1201 ft, 1365 ft, 1553 ft; 1 Round

SUMMARY OF SELECTED CONSTITUENTS OF INTEREST IDENTIFIED AT R-WELLS DURING FY2001

Well	Zone	Sample	Chemical	Concentration
R-8	Regional	Borehole	Tritium	16.0 pCi/L
R-9i	Perched	Well	Tritium	246 and 167 pCi/L
R-9	Regional	Well	Tritium	14.7 pCi/L
R-12	Perched	Well	Tritium	187 and 98 pCi/L
R-12	Regional	Well	Tritium	57 pCi/L
R-13	Regional	Borehole	Tritium	0.64 pCi/L
R-15	Regional	Well	Tritium	3.29 pCi/L
		Well	Sr-90	-0.10 pCi/L
		Well	Nitrate (N)	2.40 mg/L
		Well	Perchlorate	4.19 µg/L
R-22	Regional	Well	Tritium	2.87, -0.1 pCi/L, 0.89 -0.13 and 14.24 pCi/L
			Tc-99	[2] (3) and [0.8] (5) pCi/L
			U	8.44 (3) µg/L
R-25	Perched	Well	Tritium	52.0, 56.8, 39.6 pCi/L
R-25	Perched	Well	HMX, RDX, TNT	4.50, 30, 1.10 µg/L
R-25	Regional	Well	HMX, RDX, TNT	1.4, 7.8, and 0.92 µg/L
R-25	Regional	Well	Tritium	9.8, 5.8, 6.4 pCi/L

ND means not detected, (3) means screen number, and [0.8] means less than detection.

NICKEL DISTRIBUTIONS AT WELL R-9i

- Average concentrations of nickel observed in groundwater samples collected from the upper and lower screens at well R-9i were 0.083 mg/L (range: 0.039 to 0.140 mg/L) and 0.043 mg/L (range: 0.022 to 0.110 mg/L), respectively.
- Sampling took place from September 14, 2000 through September 6, 2001 at well R-9i. The EPA maximum contaminant level (MCL) for nickel is 0.1 mg/L.
- Olivine, a mineral within the Cerros del Rio basalt, contains natural concentrations of nickel at R-9, R-9i, R-15, and R-31 (35 to 154 ppm; 31 solid samples). Abundance of olivine ranged from 2.4 to 8.8 weight percent at R-9 within the Cerros del Rio basalt.
- At R-9i, olivine has oxidized to iddingsite, which consists of amorphous $Fe(OH)_3$, goethite, hematite, smectite, and chlorite. Nickel has partitioned into amorphous $Fe(OH)_3$and goethite.
- Dissolution of amorphous $Fe(OH)_3$ and goethite under reducing conditions at well R-9i results in release of nickel, iron, and manganese to groundwater.
- Concentrations of nickel (less than MCL of 0.1 mg/L) and iron are generally decreasing during characterization sampling at well R-9i.

ENVIRONMENTAL RESTORATION PROJECT AND ESH-18

SUMMARY

Geochemistry Subcommittee members have collected characterization groundwater samples from R-5, R-7, R-9, R-9i, R-12, R-15, R-19, R-22, R-25, R-31, CdV-15, CdV-37, and MCOBT-4.4. Borehole water samples have been collected from R-8 and R-13.

Constituents of interest in R wells include nitrate (R-15 and MCOBT-4.4), perchlorate (R-15 and MCOBT-4.4), and HE compounds (R-25).

Groundwater with measurable tritium occurs at MCOBT-4.4, R-5, R-7, R-8, R-9, R-9i, R-12, R-15, and R-25. These wells contain a component of groundwater less than 60 years old.

Natural concentrations of iron, manganese, and nickel occurring at well R-9i result from reduction of hydrous ferric oxide and amorphous ferric hydroxide, constituents of the Cerros del Rio Basalt.

SUPPLEMENTAL MATERIAL FOR GEOCHEMISTRY SUBCOMMITTEE

ANALYTICAL METHODS EPA SW846

- Metals- Inductively Coupled Plasma Optical Emission Spectroscopy and Inductively Coupled Plasma Mass Spectrometry
- Anions- Ion Chromatography
- Organic Compounds- Gas Chromatography and Gas Chromatography-Mass Spectrometry
- High Explosive Compounds- High Pressure Liquid Chromatography and Diode Array Detector
- Radionuclides- Alpha Spectrometry, Gas Proportional Counting, Gamma Spectroscopy, Direct Counting, Electrolytic Enrichment
- Stable Isotopes- Isotope Ratio Mass Spectrometry

SAMPLING PROTOCALS AT R-WELLS

- Purge single completed wells, removing at least 3 well bore volumes; measure field parameters; collect; filter; and preserve (if required).
- Collect groundwater samples at multicompleted wells; measure field parameters; filter; and preserve (if required). Groundwater samples are collected using the Westbay Instruments at a rate of four liters per hour (one trip per hour).

PERCHLORATE AND CHLORO-OXYANION CHEMISTRY

Perchlorate (ClO_4^-) is a very stable compound that eventually reduces to chloride in presence of microbes and other reactive reductants.

Reaction	E^0(V)	Eh at pH7
$ClO_4^- + 8H^+ + 8e^- = Cl^- + 4H_2O$	1.39	1.306
$ClO_4^- + 2H^+ + 2e^- = ClO_3^- + H_2O$	1.23	0.816
$ClO_3^- + 2H^+ + 2e^- = ClO_2^- + H_2O$	1.10	0.686
$ClO_2^0 + 2H^+ + 3e^- = ClO^- + H_2O$	1.36	1.083
$ClO_2^- + 2H^+ + 2e^- = ClO^- + H_2O$	1.51	1.096
$ClO^- + 2H^+ + 2e^- = Cl^- + H_2O$	1.72	1.096
$O_2(g) + 4H^+ + 4e^- = 2H_2O$	1.23	0.816

Chlorate (ClO_3^-) is a degradation product of perchlorate and is observed in Los Alamos Canyon. Thermochemical data used in calculations are from: Wagman et al., 1982, The NBS tables of chemical thermodynamic properties: Selected values for inorganic and C_1 and C_2 organic substances in SI units: National Bureau of Standards, Washington DC.

GIT Hydrology Subcommittee Report for FY 01

LANL Hydrogeologic Characterization

Program Annual Meeting

April 10, 2002

David B. Rogers
Hydrology & Water Quality Group
Risk Reduction & Environmental
Stewardship Division

Water Level Data

- Water levels are being used in groundwater models
- Over the next few months we will look at wells to devise a stronger scheme for measuring water levels
- Water level data are on the web at:
  http://wqdbworld.lanl.gov
- We plan to bring database water levels up to date during the next two months

Water Level Data

Water levels are collected with transducers at 3 hr intervals:

- R wells are being added to water level program
- R wells with transducers are R-5, R-7, R-9i, R-12, CDV-R-15, R-25, and R-31
- R-9, R-15, and R-19 do not have transducers
- We are working on equipping R-13

Water Level Data

Water levels are collected with transducers at 3 hr intervals:

- 8 Regional aquifer test wells and 1 former supply well
- 5 intermediate perched zone wells
- 6 alluvial groundwater wells in Los Alamos Canyon
- 15 alluvial groundwater wells in Mortandad Canyon

Hydrologic Properties

- Hydrologic properties are being used in groundwater models
- Geophysical logs from recent wells contain this information
- The geophysical logs are included in well completion reports for wells R-19, R-31, and R-22

Hydrologic Testing

- NMED requested LANL to suspend falling-head slug tests in a December 14, 2001 letter
- NMED said introducing water into any well is problematic
- LANL is evaluating hydrologic testing methods and preparing a response
- LANL has asked the EAG for recommendations on hydrologic testing

Well Development

- Are LANL's well development procedures up to industry standard?
- LANL asked the EAG to evaluate our well development process
- EAG has prepared recommendations for well development
- LANL asked the EAG to finalize their report

Well Development

- LANL previously planned to utilize a dual packer device to aid development of multiple completion wells
- LANL has not been able to obtain a dual packer device to fit our wells

Well Development

LANL's steps in primary development for each screen:

- Wire brushing for coarse cleaning of screen
- Bailing well to remove material loosened by wire brush
- Surging, jetting, or swabbing to further clean screen
- Bailing to remove fines produced by these activities

LANL's steps in secondary development for each screen:

- Pumping to remove fines from primary development

Well Development

- Effectiveness of development is determined by field parameters
- Development goal is reproducible turbidity <5 NTU
- Development is halted when this goal is reached or turbidity cannot be improved
- LANL's development approach follows industry standards and EPA guidelines

Well Development

- LANL's development has successfully cleaned screens and achieved low turbidity in R wells
- Chemical development would be required to completely mitigate effects of drilling fluids on water samples
- LANL does not use chemicals in development to avoid other impacts on water chemistry

GIT Modeling Subcommittee Report Annual Meeting

Bruce Robinson
Elizabeth Keating
Kay Birdsell
Marc Witkowski
Velimir Vesselinov
Diana Hollis

April 10-12, 2002

Modeling Subcommittee Activities

- Regional Aquifer Model
- Preliminary First Order Groundwater Assessment
- Current work in Groundwater Pathways Assessment Project

Regional Aquifer Model

- Further development of facies models for Puye and Santa Fe Group
- Predictive analysis, focusing on how much flow might be entering/leaving the regional aquifer from the north, west, and south?
- Incorporation of recent water level data from R-wells, resulting in much better estimates of large-scale permeability of the Puye Formation.
- Travel time calculations and capture zone analyses in support of First order GW Assessment Project
- Study of potential impact of Laboratory operations on Buckman wellfield

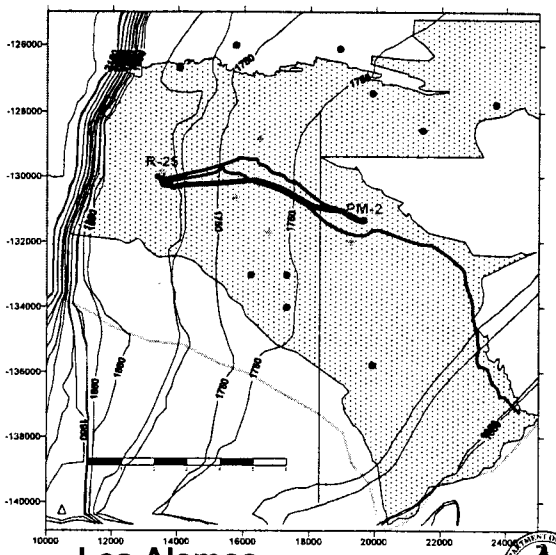
Predictive Analysis

- Predictive Analysis: A modeling technique to determine the range of possible behavior of a model *under the restriction that the model remain in calibration*
- Possible applications for the regional aquifer model:
  - What is the minimum travel time to the LANL boundary from a given release point?
  - What is the most northerly pathline between a release point and a downstream location?
- The user-defined question is evaluated by making a model predictions (e.g. travel time, maximum north coordinate of path, etc.) for a range of values of each uncertain parameter and finding the extreme value of the prediction for all calibrated models

Using Predictive Analysis to Estimate Uncertainty in Flow Path Direction

Point source at R-25

Analysis predicts the most northerly and most southerly pathlines between R-25 and PM-2



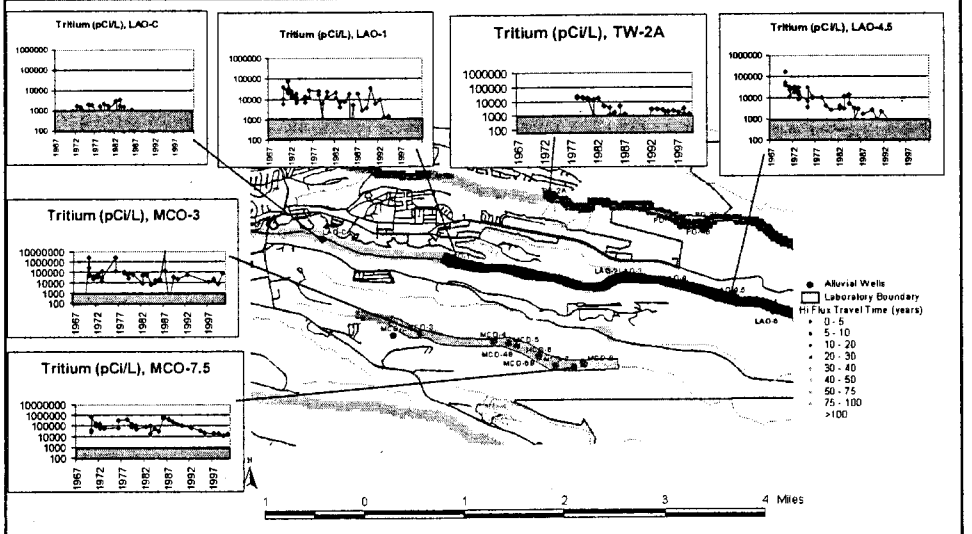
Preliminary First Order Groundwater Assessment

- Examine potential contaminants that might pose a risk to groundwater receptors on a site-wide basis
- Approach: Use GIS tools to synthesize information from contaminant sources and hydrogeologic data to assess transport times and pathways. Components of the analysis include:
  - Contaminant sources
  - Percolation rates
  - Vadose Zone flow and transport
  - Regional Aquifer flow and transport

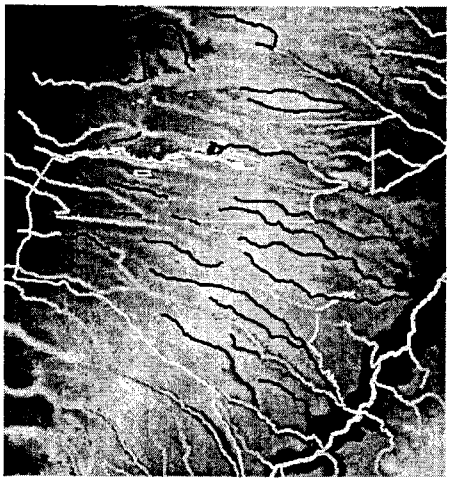
First Order Groundwater Pathway Assessment: Technical Approach

- Contaminant sources
  - Outline source term areas for key contaminants based on Water Quality Database entries for the alluvial, intermediate, and regional aquifer wells
- Percolation Rates
  - Categorize canyon drainages with respect to observable properties (location of headwaters, presence of alluvial GW, etc.), assign percolation rates based on other modeling and data collection efforts
- Vadose zone flow and transport
  - Construct simple vertical pathway model locally at a large number of locations across the Plateau, compute vadose zone travel time to the water table at each location
- Regional aquifer flow and transport
  - Use regional aquifer model to track pathways from municipal water supply wells back to the water source, identifying locations where recharging fluids might contain Laboratory contaminants

Zones of Past Tritium Contamination in Alluvial Groundwater



Percolation Indices for Canyon Drainages



Legend

- Percolation Index 1
- Percolation Index 2
- Percolation Index 3
- Percolation Index 4
- Percolation Index 5
- Percolation outside AOI
- Lab Boundary

Digital Elevation Model

High: 9870 ft

Low: 5350 ft

N W E S

Preliminary results

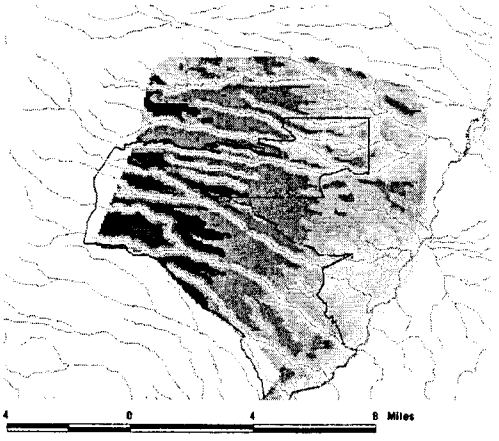
ENVIRONMENTAL RESTORATION PROJECT

Los Alamos NATIONAL LABORATORY

ER2001-

Slide 9

Vadose Zone Travel Times: Full Scale



Laboratory Boundary

Vadose Zone Travel Times (years)

- 0 - 1000
- 1000 - 2000
- 2000 - 5000
- 5000 - 10000
- 10000 - 15000
- 15000 - 20000
- 20000 - 25000
- 25000 - 30000
- >30000
- No Data

4 0 4 8 Miles

N W E S

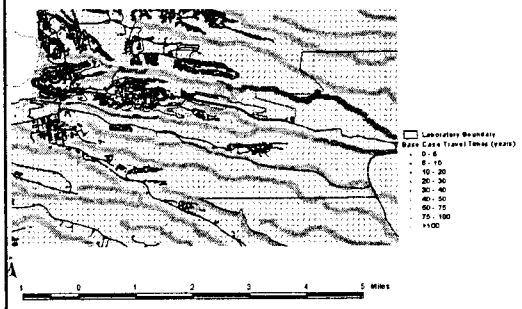
ENVIRONMENTAL RESTORATION PROJECT

Los Alamos NATIONAL LABORATORY

ER2001-

Slide 10

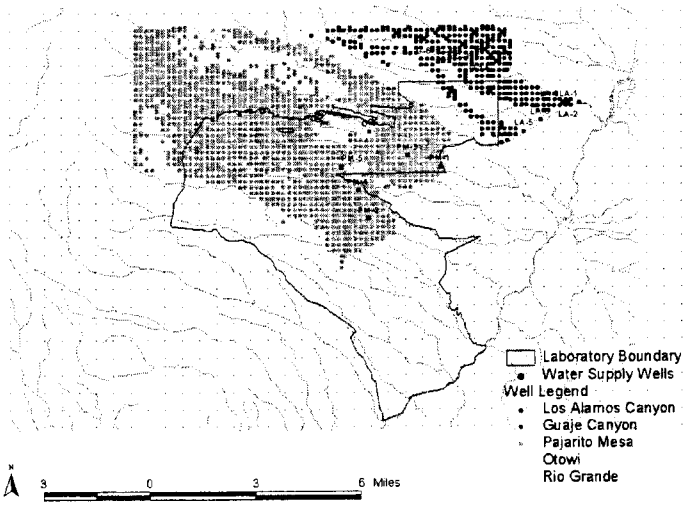
Vadose Zone Travel Times: Impact of Percolation Rate



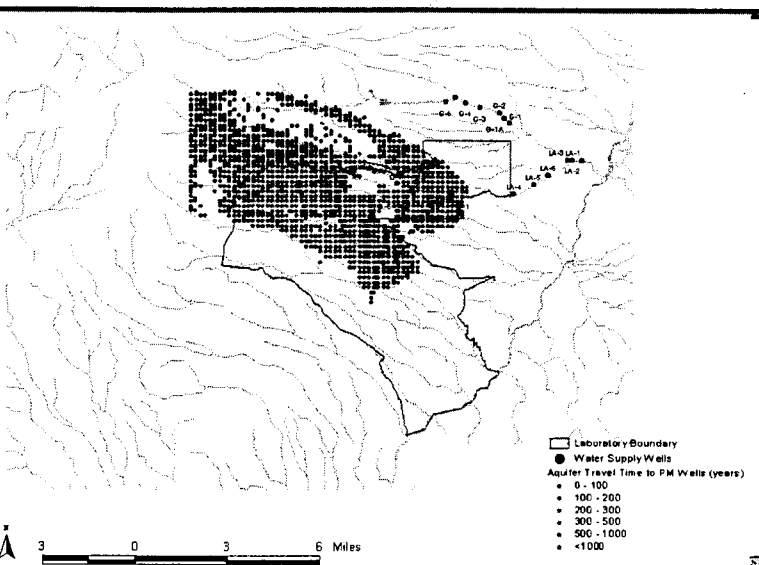
Base Case Percolation Scenario

High Flux Percolation Scenario

Regional Aquifer Source Locations for Water Reaching Water Supply Wells



Regional Aquifer Travel Times to PM Wells



ENVIRONMENTAL RESTORATION PROJECT ER2001- Los Alamos NATIONAL LABORATORY Slide 13

Goal of Groundwater Pathways Assessment Project

Produce a report of model predictions (with uncertainties) of the concentration-time histories and plume locations for key contaminants in the regional aquifer and estimates of the likelihood that these contaminants will be detected in the R-well network and/or existing water supply wells within a specified time frame. Our report will also identify the most important conceptual models and parameters requiring further study to reduce uncertainties.

ENVIRONMENTAL RESTORATION PROJECT ER2001- Los Alamos NATIONAL LABORATORY Slide 14

Groundwater Pathways Assessment – Major Steps

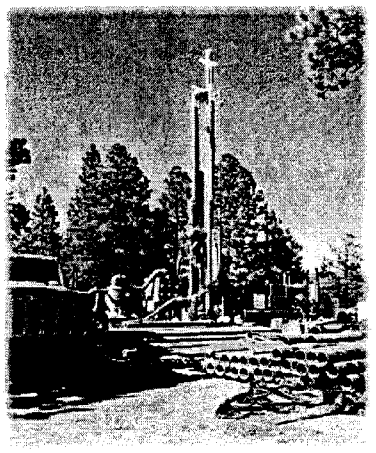
- Select contaminants of concern
- Document conceptual models
- Develop submodels used to predict the behavior (with uncertainties) of:
  - Contaminant source terms
  - Vadose zone contaminant transport
  - Regional aquifer contaminant transport
- Construct systems model linking the submodels
- Assign distributions for uncertain parameters
- Perform Monte Carlo simulations

FY03 Proposed Work

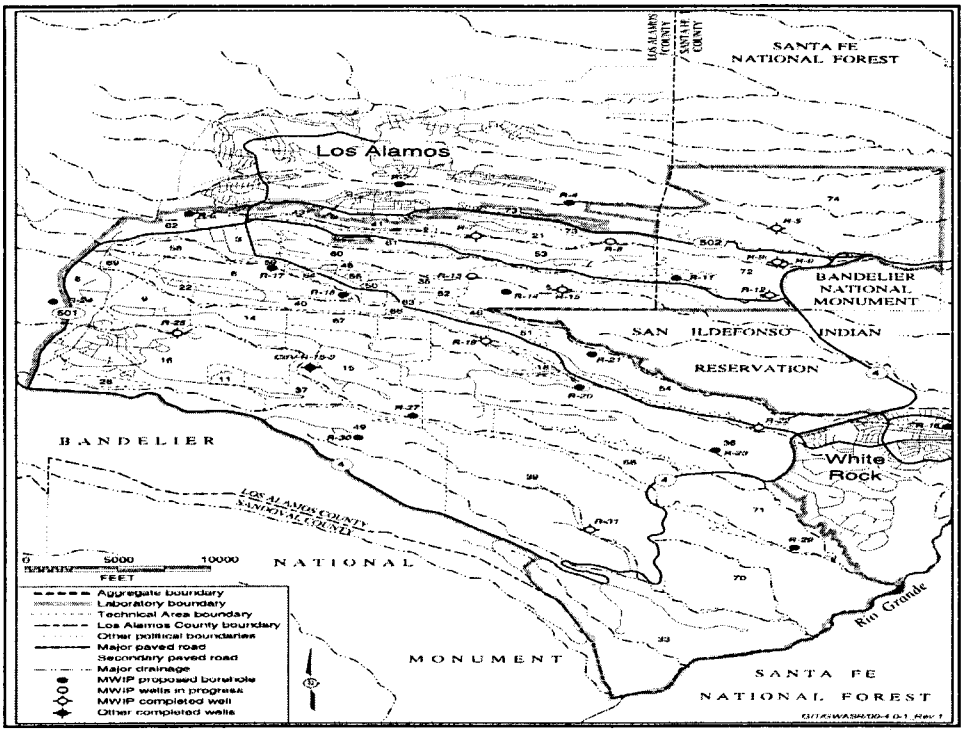
Charlie Nylander
Hydrogeologic Characterization
Program Manager

Los Alamos
NATIONAL LABORATORY

Proposed FY03 Field Activities



- Drill and complete:
  - **NWT: R-2, R-11, & R-24**
  - **ER: R-4, R-18, & R-27**
- Characterization sampling and analysis in completed wells



Pueblo Canyon: Wells R-2 & R-4

- R-2 is a replacement for TW-4
- Pueblo Canyon has contamination, it is wet, has short travel times due to the rocks at the surface, so it is important to investigate.
- Wells along the length of the canyon would be useful for demonstrating Monitored Natural Attenuation.
- Tb2 basalt is near the top of the water table, but is poorly constrained around R-2.
- TW-2A (perched zone completion) has had high tritium for a long time and a few indications of plutonium (not reproduced).

Sandia Canyon: Well R-11

- R-11 is proposed as a sentry water well for PM-3.
- Need one well to find pathway for contaminants found in R-12
- R-11 identified as anticipated monitoring well by ER Project
- R-11 could be located close enough to PM-3 to conduct cross- hole testing

Cañon de Valle: Well R-24

- R-24 located west of the fault system, useful to refine recharge and boundary flux estimates.
- The Pajarito Fault zone could divert water to the south; need geochemical data to determine flow paths.
- Hydrologic testing could determine if the fault was acting as a barrier to flow.
- R-24 is identified as anticipated monitoring well by ER Project.

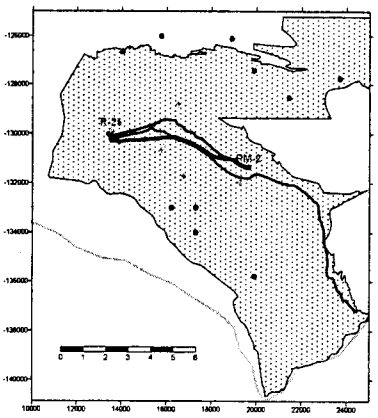
Pajarito Canyon: Well R-18

- R-18 was proposed to provide information on presence, occurrence and quality of perched zones and depth to regional aquifer in poorly understood part of the Lab.
- This well is necessary because there are no wells in Pajarito Canyon.
- In R-22 there was elevated Tc-99 and tritium.
- Due to access, R-18 can not be drilled where it was shown on the Hydrogeologic Workplan map; relocated to Pajarito and 2-Mile confluence

Water Canyon: Well 27

- Both LANL and NMED have agreed to combine R-27 and R-28
- Baseline characterization for poorly-known south-central part of the Lab
- Groundwater quality data upgradient of TA-49 and in the HE corridor

FY03 Non-Field Activities



- **Information Management**
- **Groundwater Pathways Assessment**
- **Regional aquifer modeling**
- **Geologic Model**
- **Quarterly and Annual Meetings**
- **Annual Report**

Status of Groundwater Protection Implementation

Charlie Nylander
Hydrogeologic Characterization
Program Manager

Los Alamos
NATIONAL LABORATORY

Relationship of Groundwater Documents

- Groundwater Protection Management Program Plan
  - Monitoring Plan in Appendix
- Hydrogeologic Workplan
- ER Installation Work Plan and RFI Workplans
- Field Implementation Plans (well-specific)

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Status of Groundwater Protection Implementation

- Proposed Groundwater Criteria developed for Core Team consideration
- Initiated elicitation of current state of knowledge
- Advocated Core Team formation in Manager's Meeting

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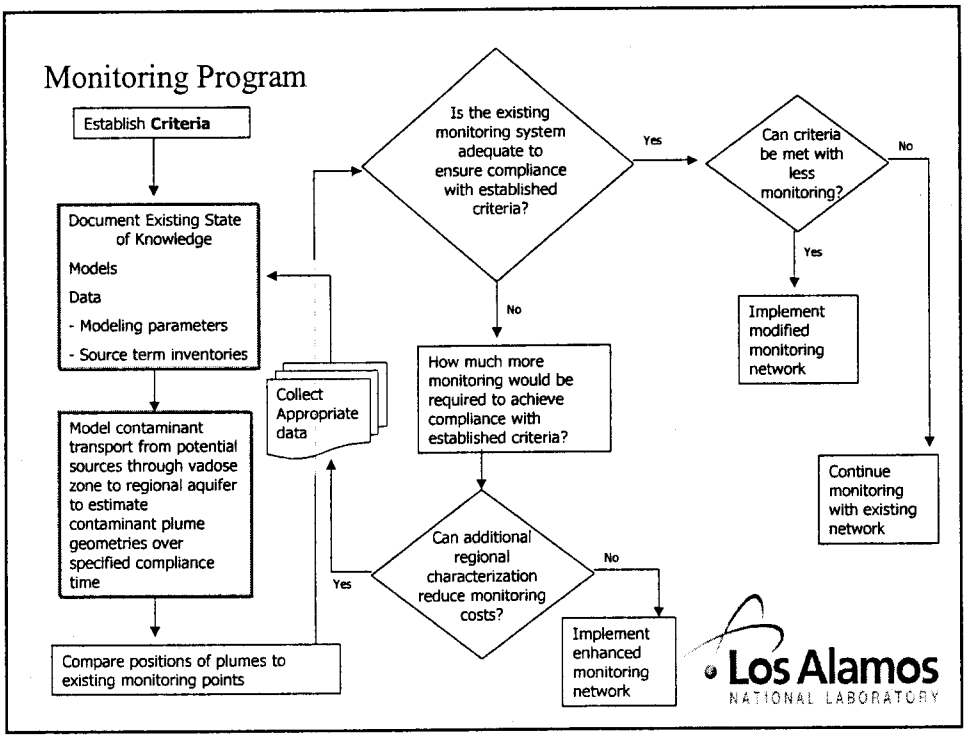

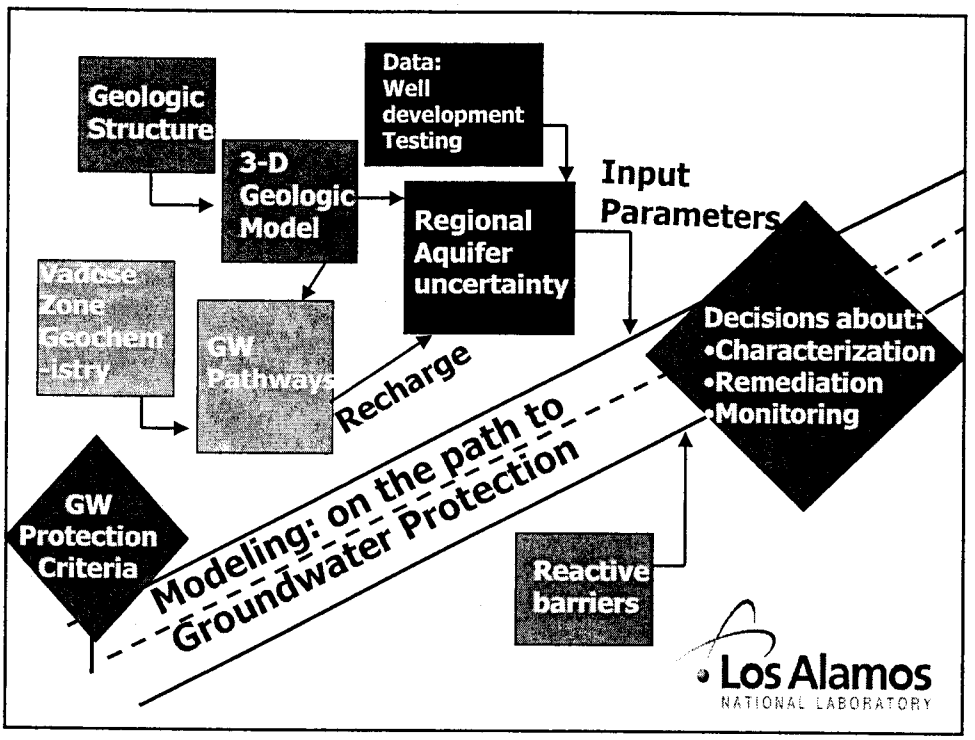
Geologic Structure
Data: Well development Testing
3-D Geologic Model
Input Parameters
Regional Aquifer uncertainty
Vadose Zone Geochem -istry
GW Pathways
Recharge
Decisions about:
•Characterization
•Remediation
•Monitoring
GW Protection Criteria
Modeling: on the path to Groundwater Protection
Reactive barriers
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SINGLE-WELL TESTING OF R WELLS AT LANL – FROM HYDROLOGIC CONSTRAINTS TO CONDUCTIVITY

William J. Stone (EES-6) and Stephen G. McLin (ESH-18)

ABSTRACT

LANL is drilling a series of wells to the regional aquifer ("R wells") to better characterize the hydrogeologic setting beneath the Pajarito Plateau. Testing to determine hydraulic properties of saturated media encountered in these wells is an important part of the characterization process. However, there are three major constraints on testing:1) in the case of wells completed in more than one interval, each screen must be isolated for testing, 2) the R wells are quite deep, most >1000 ft, and 3) the production casing is small: only 4.5" ID. Although straddle packers can isolate screened intervals, an accompanying testing apparatus which permits interchanging transducers and pumping from considerable depth at a rate sufficient to stress a water-bearing zone, especially in the small diameter of production casing used, is not readily available. Thus, testing of multi-screened wells has been by injection between straddle packers. Testing of wells in which there is a single screen, especially if the screen is below the water table, has been by traditional single-well pumping tests. Six wells have been successfully tested to date. R-9i, R-19, R-22, and R-31 were tested by the straddle-packer/injection method. R-13 and R-15 were tested by pumping.

OVERVIEW OF SINGLE-WELL TESTING

- Water level is allowed to recover after development
- Packer/Injection device or pump is installed
- Static water level is achieved
- Stress is applied (water injected or pumped)
- Flow rate is monitored by flowmeter/stopwatch
- Water level change is monitored by transducer/datalogger
- Water level change is viewed real-time on a laptop
- Test is halted when water is back to static/constant level
- Data are analyzed by appropriate method (software)
- Poster gives results for 6 wells: 4 injection, 2 pumping

Analysis of Capture Zones of the Buckman Wellfield and a Proposed Horizontal Collector Well North of the Otowi Bridge

Velimir V Vesselinov, Elizabeth Keating

The Buckman wellfield provides more than one third of Santa Fe water supply and its withdrawal rates are among the highest in the region. To increase the Santa Fe water supply, a new horizontal collector well is proposed. We have conducted a capture zone analysis of these water supply wells to determine the likelihood that either of these systems would draw water from the aquifer beneath LANL. Our analysis is based on results obtained by the ongoing regional hydrogeological study and modeling of the Espanola basin (Keating et al.,2000, 2001). According to our model, there will be some interference between the Buckman wellfield and the horizontal collector well. The simulated three-dimensional capture zone of Buckman includes areas both west and east of the Rio Grande and a portion of the Rio Grande itself; part of the zone is within the LANL boundaries. The simulated capture zone of collector well includes also areas of west Rio Grande, but entirely outside (north of) the LANL boundaries. We also simulated the advective-dispersive groundwater transport of hypothetical non-reactive, non-decaying, aqueous species from the water table at five locations beneath LANL. Our results suggest that groundwater originating from these locations will eventually be captured at Buckman, but the mixing factors at the wellhead are less than five orders of magnitude. Travel times in the regional aquifer are on the order of ten thousand years. Our results indicate there would be no groundwater transport in the direction of the horizontal collector well. Our predictions are sensitive to assumptions about (1) heterogeneity within the Santa Fe Group, Cerros del Rio basalts and Puye Formation, (2) hydraulic connectivity between surface and subsurface waters, (3) spatial distribution of infiltration recharge. These aspects of the model cannot be improved at the moment, due to lack of sufficient data, but may be improved in the future based on our ongoing hydrogeological characterization study of the region.

Pajarito Plateau Vadose Zone Characterization Using Pore Water Anions and Stable Isotopes

Brent Newman, Deborah Bergfeld, and Pat Longmire

Earth and Environmental Sciences Division/Environmental Restoration, Los Alamos National Laboratory

One of goal of the hydrogeologic workplan is to collect data to characterize and understand vadose processes on the Pajarito Plateau. The vadose zone includes the region between the ground surface and the top of the regional aquifer. In this presentation, we discuss examples from two aspects of the vadose zone work at Los Alamos, namely pore water anions (i.e., chloride, nitrate, sulfate, phosphate, and perchlorate) and stable isotopes (i.e., $\delta^{18}O$, δD, and $\delta^{15}N$). These results support differences in downward fluxes between mesas and canyons; are used to generate quantitative estimates of downward flux; help constrain the vertical extent of some contaminants and their vadose zone inventories; and are useful for pathway analysis. We will discuss new data from Ancho Canyon and Mortandad Canyon, as well as other locations on the Plateau.

Pajarito Plateau Vadose Zone Characterization Using Pore Water Anions and Stable Isotopes

Brent Newman, Deborah Bergfeld, and Pat Longmire

Earth and Environmental Sciences Division/Environmental Restoration, Los Alamos National Laboratory

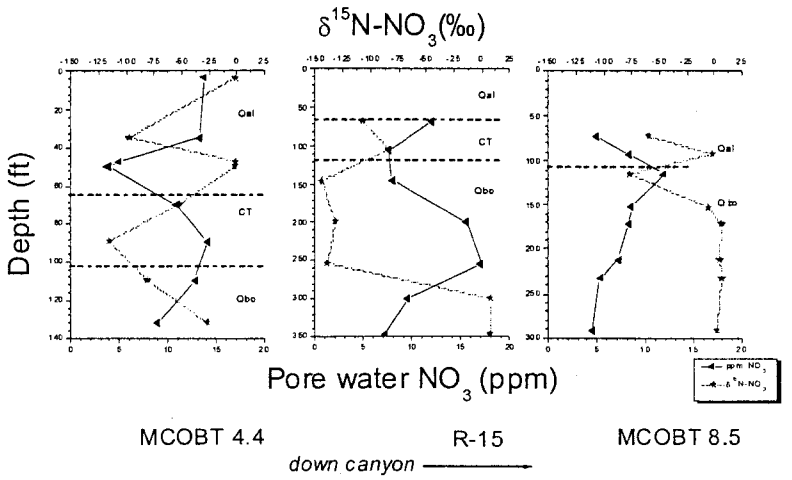
- One of goal of the hydrogeologic workplan is to collect data to characterize and understand vadose processes on the Pajarito Plateau
- Discuss examples from two aspects of the vadose zone work at Los Alamos, namely pore water anions and stable isotopes
- These results are used to:
  - quantify differences in downward fluxes between mesas and canyons
  - constrain the vertical extent and inventories of some contaminants
  - useful for pathway analysis

Chloride Mass Balance Method

- $R=P*Cl_p/Cl_{sw}$
  - –Where R is the flux (m/yr); P is the average annual precipitation rate (m/yr); Cl_p is average chloride concentration in precipitation (g/m^3); and Cl_{sw} is the pore water chloride concentration.
- Assumptions include 1-D downward flux, chloride input has been constant with time, plant uptake is negligible, and no additional sources of chloride.

Comparison of chloride based downward flux estimates for TA-21 area boreholes

Well DP4			Well LAOIA 1.1			Well DP3		
depth (ft)	units	flux (cm/yr)	depth (ft)	units	flux (cm/yr)	depth (ft)	units	flux (cm/yr)
9-171	2,1v,1g	0.04	18-158	Qbo	0.50	20-70	Qal, Qbo	0.18
171-537	1g, CT, Qbo	1.0	158-320	Qbo, Qbog, TPp	1.67	70-319	Qbo, Qbog, TPp	1.13
547-800	Qbo-g, TPp	0.1						

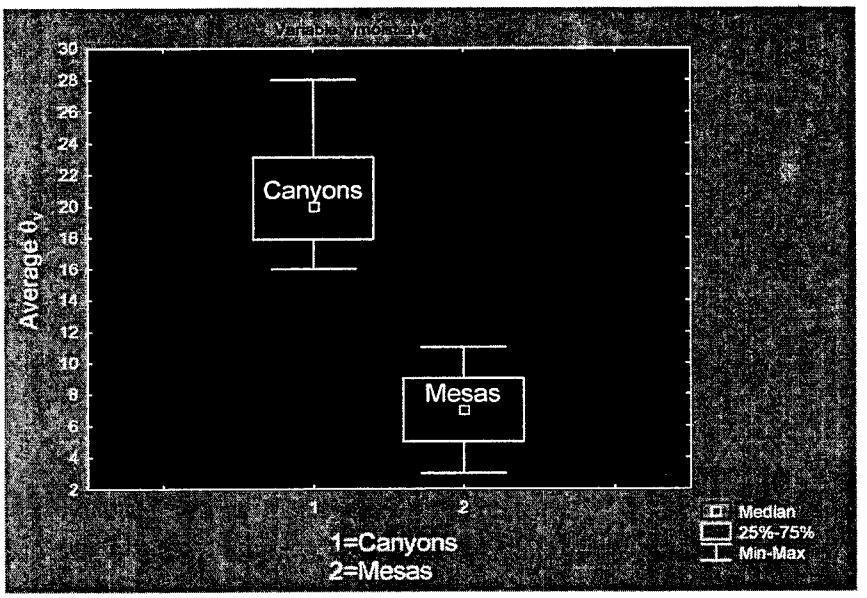


Mortandad Canyon pore water nitrate and $\delta^{15}N$ profiles

Canyon/Mesa Comparison

	Max Cl⁻	Ave Cl⁻	Max PO_4^{3-}	Ave PO_4^{3-}	Max SO_4^{2-}	Ave SO_4^{2-}	Max $\delta^{18}O$	Ave $\delta^{18}O$	Max θ_v	Ave θ_v
Canyons	172	30	54	10	641	78	-7	-10	52	20
Mesas	1761	398	99	19	8913	766	-1	-8	18	7
Delta	1589	368	45	9	8272	688	6	2	-33	-13

9 Canyon Boreholes
13 Mesa Boreholes



Canyons vs. Mesas (Continued)

Nonparametric Kolmogorov-Smirnov and Mann-Whitney U Tests, (p=0.05)

•K-G test, significant differences for θ_v Cl^-, SO_4^{2-} (maximum and average).

•M-W test, significant differences for θ_v, Cl^-, SO_4^{2-}, and $\delta^{18}O$ (maximum and average).

Canyons vs. Mesas Summary

- Are significant differences in vadose zone characteristics between mesas and canyons
  - Average and Maximum Moisture Content, Chloride, Sulfate and probably $\delta^{18}O$
- Mesas appear to have minimal downward fluxes/recharge
  - Chloride mass balance and other modeling suggest less than a few mm/yr
  - Are exceptions
    - ponded water
    - along the mountain front

REMEDIATION OF INORGANIC-CONTAMINATED GROUNDWATER BY A PERMEABLE REACTIVE BARRIER

Patrick Longmire, Tammy P. Taylor,
Dale A. Counce, Steve J. Chipera, John P. Kaszuba, James L. Conca
Los Alamos National Laboratory, Los Alamos, New Mexico

ABSTRACT

Permeable reactive treatment wall technology has been studied as a means to remediate inorganic-contaminated alluvial groundwater *in situ* in Mortandad Canyon, Los Alamos National Laboratory (LANL). The prevalence of multiple contaminants, including $^{238, 239, 240}Pu$, ^{241}Am, ^{90}Sr, $^{234, 235, 238}U$, nitrate (NO_3^-) and perchlorate (ClO_4^-), has prompted utilization of novel types of reactive media to immobilize the contaminants. The reactive media selected for study in the 2-D cell included polymer-coated volcanic basalt, Apatite®II, pecan shells and limestone. Laboratory-scale treatability studies were conducted with reactive media to effectively reduce contaminant levels below regulatory limits for groundwater for a minimum of 10 years. Reactive materials will be replaced at the end of each 10-year cycle. Previous 1-D column results indicated that a multiple layer treatment approach was necessary for optimal removal of the different contaminants. Porous media were contacted with contaminants using a kinetically limited two-dimensional (2-D) aquifer cell. Apatite II and pecan shells have shown significant propensity to remediate the contaminated groundwater used in column experiments and in a 2 dimensional aquifer cell. The microorganisms that proliferated on the surface of the pecan shells, sustained by organic matter leaching from the Apatite II, reduced NO_3^- and ClO_4^- to undetectable levels for approximately 310 pore volumes (285 days of injection) in the 2-D cell. Prior to detection of NO_3^- and ClO_4^- in effluent for the 2-D aquifer cell, greater than 90% of the NO_3^- reduction and 70% of the ClO_4^- reduction was accomplished in the Apatite II layer, while the remainder was degraded in the pecan shells. Geochemical Modeling was conducted using the computer program MINTEQA2 to evaluate aqueous speciation and mineral equilibria within the 2-D cell.

INTRODUCTION

Los Alamos National Laboratory has evaluated permeable reactive barrier (PRB) technology that can immobilize multiple contaminants *in situ* with low technological demand and cost. Reactive media were selectively identified for the removal of radionuclides, metals, NO_3^- and ClO_4^-. A shallow alluvial groundwater system at LANL has been identified for implementation of this technology. Radionuclides, including ^{90}Sr, $^{238, 239,240}Pu$, and ^{241}Am, have been detected in alluvial groundwater at this site since 1963 (LANL, 1997). With the impending EPA regulation of ClO_4^-, this contaminant has been identified as a significant concern.

The objective of laboratory-scale treatability studies was to identify reactive media that could effectively reduce contaminant levels below regulatory limits for a minimum of 10 years. Reactive materials will be replaced at the end of each 10-year cycle. The following materials were selected for investigation:

polymer (Catfloc®) coated volcanic basalt for agglomerating colloids ($^{238, 239, 250}Pu$ and ^{241}Am colloids),

Apatite II for precipitating heavy metals and radionuclides and supplying reactive organic carbon to enhance microbial degradation of NO_3^- and ClO_4^-,

pecan shells to adsorb metals and provide physical support for biofilm to further reduce NO_3^- and ClO_4^-, and

limestone to raise the pH of exiting pore waters and adsorb residual anionic complexes of ^{90}Sr, ^{241}Am, $^{238, 239, 250}Pu$ and $^{234, 235, 238}U$.

MATERIALS AND METHODS

Experimental. Concentrations of target contaminants in the groundwater after adding spikes were 2.0 mg/L ^{87}Sr (± 0.019), 140 mg/L NO_3^- and ~350 μg/L ClO_4^-. The cell packed with the reactive media was flushed at a constant flow rate of approximately 1.5 mL/min. This flow rate resulted in a resident contact time approximately equivalent to what will be observed within the PRB layers at a LANL field site. Aliquots of effluent were retrieved manually for analysis of ^{87}Sr, NO_3^- and ClO_4^- on a daily basis from the effluent well and sample ports located between each layer within the cell. On day 285 of the experiment, a comprehensive analysis of metals, organic and inorganic carbon and alkalinity was conducted. Solid samples of each reactive medium in the 2-D cell were collected for analysis by X-ray diffraction (XRD).

Sample Preparation and Analytical Methods. Daily analysis of influent, effluent and samples collected from between the layers of the media in the 2-D cell were conducted by inductively coupled plasma atomic emission spectroscopy (ICP-AES) for ^{87}Sr and by ion chromatography (IC) for NO_3^- and ClO_4^-. Influent and effluent water samples collected after 310 pore volume (285 days) for the 2-D aquifer cell were analyzed for inorganic and organic chemicals including anions, metals, and trace elements. An Orion meter with a Ross combination pH electrode was used to measure pH. Samples were filtered through 0.45-μm Gelman filters and acidified with analytical-grade HNO_3 to a pH of 2.0 or less for metal analyses.

Water samples were analyzed using techniques specified in EPA method SW-846 including IC for bromide, chloride, fluoride, oxalate, nitrate, nitrite, perchlorate, phosphate, and sulfate. Calcium, magnesium, silicon (silica), and sodium were analyzed by ICP-OES. Aluminum, antimony, arsenic, boron, beryllium, barium, cadmium, cobalt, chromium, copper, iron, mercury, potassium, manganese, molybdenum, nickel, selenium, strontium, thallium, thorium, uranium, vanadium, and zinc were analyzed by ICP-MS. Alkalinity was determined using standard titration techniques. Total organic carbon was determined by oxidation/combustion with infrared detection of carbon as carbon dioxide.

Geochemical Modeling. Calculations of solute speciation, PCO_2 gas, and solid phase saturation indices were made using the computer program MINTEQA2 (Allison et al., 1991), with single ion activity coefficients calculated using the Davies equation. A source of error with the computer program is the accuracy of the thermochemical data contained in the MINTEQA2 database. Errors are greater for trace solutes in which experimental data are inaccurate or incomplete. The uranium database contained in MINTEQA2 has been critically evaluated and summarized in Langmuir (1997). There are few errors associated with the major ions and solid phases consisting of carbonate, silicate, and sulfate minerals (Langmuir, 1997).

EXPERIMENTAL RESULTS

Figure 1 provides a description of the 2-D aquifer cell. Figure 2 summarizes the concentrations of ^{87}Sr, NO_3^- and ClO_4^- eluted from the cell as a function of pore volume. Because Apatite II contains significant amounts of naturally abundant ^{87}Sr, its capacity to adsorb injected ^{87}Sr was limited. Consequently, this material leached ^{87}Sr continuously during early times in the experiment at a concentration of approximately 0.85 mg/L under the flow conditions simulated in this study. After 220 pore volumes of groundwater were introduced to the cell, ^{87}Sr concentrations began to approach the influent level, 2 mg/L.

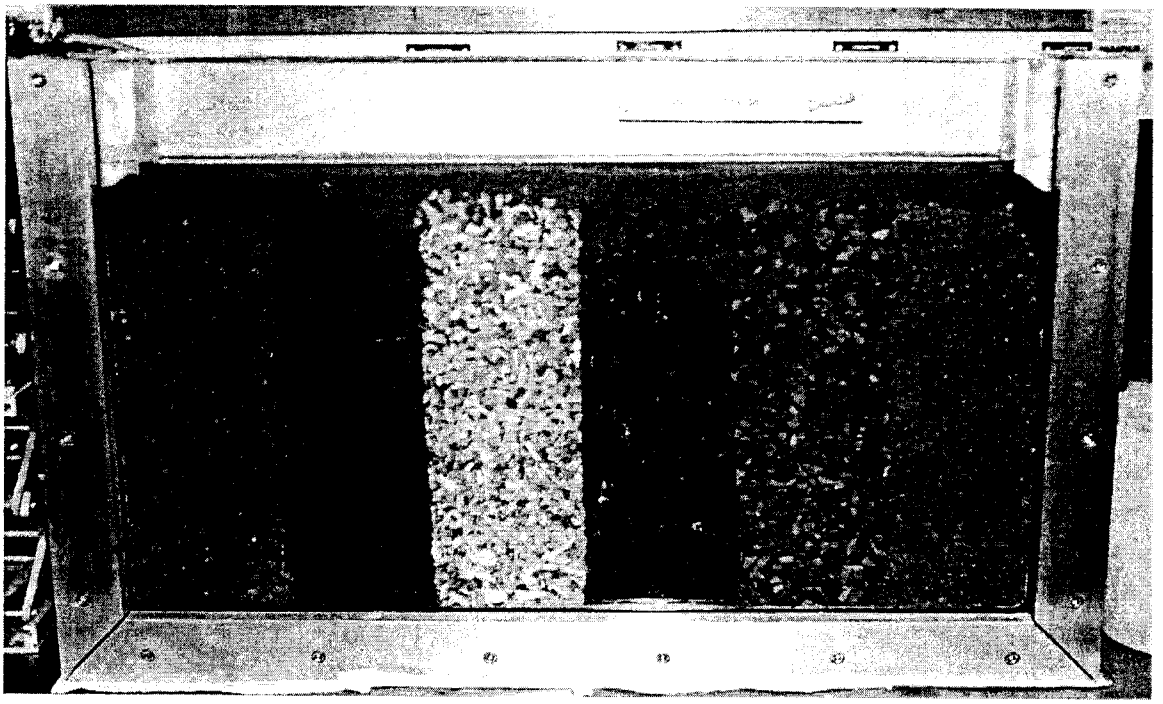


Figure 1. View of 2-D aquifer cell consisting of volcanic rock, Apatite II, pecan shells, and limestone (after Taylor et al., 2001)

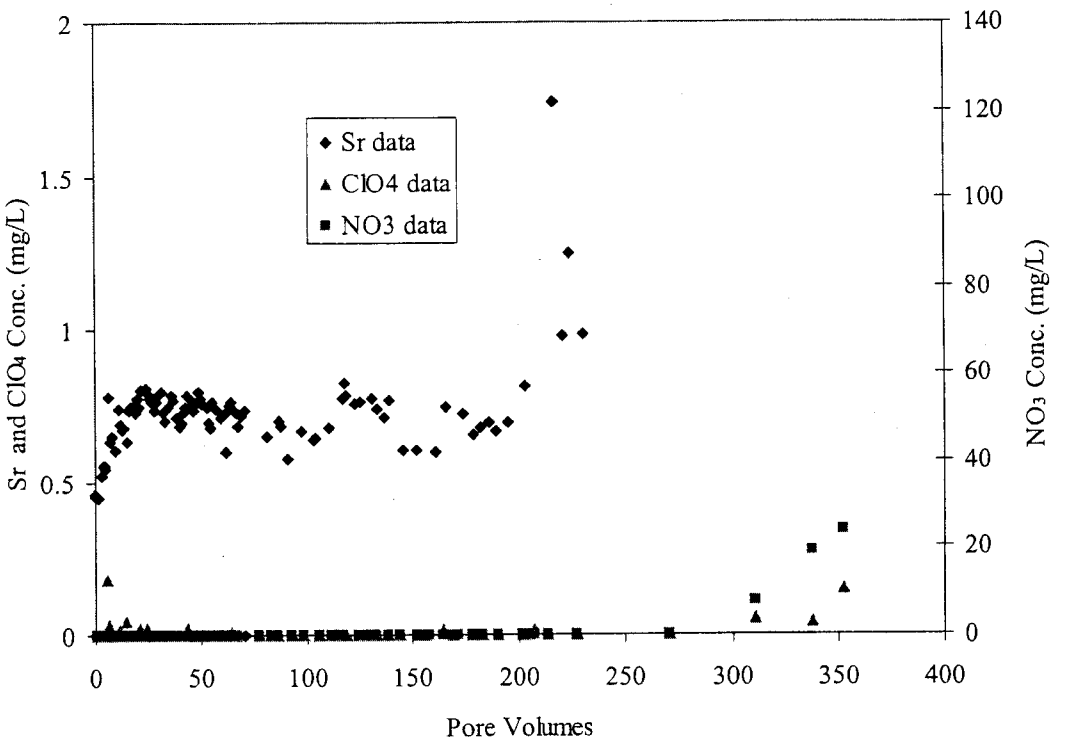


Figure 2. Pore volumes versus concentrations of nitrate, perchlorate, and strontium in the 2-D aquifer cell (after Taylor et al., 2001)

Results of a column experiment indicated that Apatite II provided a substrate for microorganisms that continuously reduced NO_3^- and ClO_4^-. These two analytes were undetected during the column experiment (Taylor et al., 2001). Pecan shells adsorbed some ^{87}Sr (42 mg ^{87}Sr/kg shells) and the microorganisms that proliferated on the surface of the pecan shells, sustained by organic matter leaching from the Apatite II, reduced NO_3^- and ClO_4^- to undetectable levels for approximately 305 pore volumes (282 days of injection). Prior to detection of NO_3^- and ClO_4^- in effluent samples of the 2-D aquifer cell (<310 pore volumes), greater than 90% of the NO_3^- reduction and 70% of the ClO_4^- reduction was accomplished in the Apatite II layer, while the remainder was degraded during residence within the pecan shells.

Results of analytes measured in influent and effluent water samples collected on day 285 (310 pore volumes) are provided in Table 1. Influent water was characterized by a mixed sodium-calcium-nitrate-bicarbonate ionic composition with calculated total dissolved solids of 623 mg/L. The effluent water was also characterized by a mixed sodium-calcium-nitrate-bicarbonate ionic composition with calculated total dissolved solids of 591 mg/L. Concentrations of dissolved sodium, barium, chromium, NO_3^-, ClO_4^-, fluoride, molybdenum, strontium, TOC, and uranium are higher in the influent water. Conversely, concentrations of alkalinity, calcium, sulfate, arsenic, manganese, and nickel were higher in the effluent water.

The total inorganic carbon (TIC) contents within fresh and 285 day-reacted Apatite II were 16.9% and 2.6% (wt.), respectively. Increasing concentrations of alkalinity within the pore water enhanced the precipitation of $CaCO_3$ and $SrCO_3$, which provided additional adsorption sites for barium, chromium, molybdenum, strontium and uranium. The TOC contents within the fresh and reacted Apatite II were 2.6% and 1.9% (wt.), respectively. Oxidation of organic carbon to CO_2 gas resulted in decreasing TOC within the Apatite II. This oxidation process was coupled with the reduction of both ClO_4^- to Cl^- and NO_3^- to N_2 gas based on the reductive capacity of reactive organic carbon in the presence of microbial populations. Total organic carbon in the water decreased by approximately 27% as the pore water reacted with surfaces of Apatite II particles. Perchlorate may have adsorbed onto mineral surfaces coated with reactive solid organic matter (SOM) under near-neutral pH conditions.

Reduction reactions of ClO_4^- to Cl^- and other aqueous species are provided in Table 2. Chlorate, a reduction intermediate of perchlorate, is observed in some groundwater at LANL in the part per billion range (Blake et al., 1995). Strong reducing agents, such as reactive organic matter and hydrogen sulfide, however, are thermodynamically capable of reducing ClO_4^- to Cl^- under anaerobic conditions (Langmuir, 1997).

Table 1. Aqueous Chemistry of Influent and Effluent Waters for the 2-D Aquifer Cell

Water Type	**Influent**	**Effluent**
Sample Treatment	**Filtered**	**Filtered**
Date Sampled (mo/dy/yr)	**08/15/01 (285 d)**	**08/15/01 (285 d)**
Temperature (°C)	25	25
pH	7.84	8.18
Alkalinity ($CaCO_3$ mg/L)	97.1	217
Ca (mg/L)	29.9	50.9
Mg (mg/L)	3.08	3.55
Na (mg/L)	85.0	75.5
K (mg/L)	14.8	15.0
Cl (mg/L)	26.8	27.0
SiO_2 (mg/L)	35.9	35.0
SO_4 (mg/L)	35.1	43.9
As (mg/L)	0.0009	0.0037
B (mg/L)	0.040	0.043
Ba (mg/L)	0.078	0.052
Cd (mg/L)	<0.001, U	<0.001, U
Cr (mg/L)	0.0027	0.0020
Co (mg/L)	<0.001, U	<0.001, U
ClO_4 (mg/L)	0.118	0.034
F (mg/L)	1.19	0.03
Fe (mg/L)	0.01	0.02

Water Type	Influent	Effluent
Sample Treatment	**Filtered**	**Filtered**
Date Sampled (mo/dy/yr)	**08/15/01 (285 d)**	**08/15/01 (285 d)**
Mn (mg/L)	0.0005	0.027
Mo (mg/L)	0.089	0.030
Ni (mg/L)	0.0046	0.0064
NO_3 (as N) (mg/L)	34.1	8.6
Sr (mg/L)	2.12	1.54
PO_4 (total) (mg/L)	<0.02, U	<0.64, U
TOC (mgC/L), NF[b]	5.2	<1, U
U (mg/L)	0.0008	0.0005
MEQ[c] cations	5.789E-03	6.540E-03
MEQ anions	5.800E-03	6.944E-03
Charge Balance (%)	-0.10	-3.00

[a] U = not detected.
[b] NF = non filtered.
[c] MEQ = milliequivalents.

Table 2. The Standard Potential[a], E^0, and Eh at pH = 7.0 and 25°C of ClO_4^- and Related Aqueous Species, Assuming Equilibrium

Reaction	E^0 (V)	Eh (V) at pH 7.0
$ClO_4^- + 8H^+ + 8e^- \rightarrow Cl^- + 4H_2O$	1.39	1.306
$ClO_4^- + 2H^+ + 2e^- \rightarrow ClO_3^- + H_2O$	1.23	0.816
$ClO_3^- + 2H^+ + e^- \rightarrow ClO_2^0 + H_2O$	1.13	0.301
$ClO_3^- + 2H^+ + 2e^- \rightarrow ClO_2^- + H_2O$	1.10	0.686
$ClO_2^0 + e^- \rightarrow ClO_2^-$	1.07	1.067
$ClO_2^- + 2H^+ + 2e^- \rightarrow ClO^- + H_2O$	1.51	1.096
$ClO^- + 2H^+ + 2e^- \rightarrow Cl^- + H_2O$	1.72	1.306

[a] Thermochemical data used in calculations are from: Wagman et al., 1982, The NBS tables of chemical thermodynamic properties: Selected values for inorganic and C_1 and C_2 organic substances in SI units: National Bureau of Standards, Washington DC.

GEOCHEMICAL MODELING

Speciation calculations using the computer program MINTEQA2 (Allison et al., 1991) were performed to evaluate stable forms of dissolved solutes, which influence mineral precipitation and adsorption reactions occurring in the 2-D aquifer cell. Results of the speciation calculations are provided in Table 3.

Nitrate and ClO_4^- are stable as soluble anions and concentrations of these two solutes are not significantly decreased by adsorption and precipitation processes. Nitrate and ClO_4^-, however, are reduced in the presence of reactive SOM and

microbial populations as shown by concentration decreases of these two solutes in the effluent water (Figure 2 and Table 1).

Solid-solution phase calculations were performed with MINTEQA2 (Allison et al., 1991) using analytical results obtained from filtered (less than 0.45 μm membrane) influent and effluent water samples. The purpose of the calculations was to assess the importance of precipitation reactions. Table 4 shows the values of the saturation index (SI) for several key phases in the 2-D aquifer cell. The SI is a measure of the degree of saturation, undersaturation, or oversaturation of a solid phase in water [SI = $\log_{10}$ {activity product/solubility product}]; at equilibrium SI = 0 (± 0.05) (Langmuir, 1997).

Influent water was calculated to be in equilibrium with $BaSO_4$ (barite), $CaCO_3$ (calcite), $Al(OH)_3$ (gibbsite), and $Ca(UO_2)_2(Si_2O_5)_3 \cdot 5H_2O$ (haiweeite) and undersaturated with respect to $CaCO_3$ (aragonite), $FeCO_3$ (siderite), silica (gel and precipitate), CaF_2 (fluorite), and $(UO_2)_2SiO_4 \cdot 2H_2O$ (soddyite). This solution, however, was calculated to be oversaturated with respect to $SrCO_3$ (strontianite) and $Ca_5(PO_4)_3OH$ (hydroxyapatite). Modeling results suggested that effluent water was oversaturated with respect to calcite, aragonite, strontianite, haiweeite, and hydroxyapatite and undersaturated with respect to barite, fluorite, gibbsite, silica phases, siderite, and soddyite.

Table 3. Results of Speciation Calculations Using MINTEQA2 for Influent and Effluent Waters of the Reactive 2-D Aquifer Cell

Solute	Influent Dominant Speciation and Percentage	Effluent Dominant Speciation and Percentage
Sr(II)	Sr^{2+}, 95.6	Sr^{2+}, 95.3
Sr(II)	$SrNO_3^-$, 1.0	not present
Sr(II)	$SrSO_4^0$, 3.1	$SrSO_4^0$, 3.7
Perchlorate	ClO_4^-, 100	ClO_4^-, 100
N(V)	NO_3^-, 100	NO_3^-, 100
U(VI)	$UO_2(CO_3)_2^{2-}$, 59.3	$UO_2(CO_3)_2^{2-}$, 37.4
U(VI)	$UO_2(CO_3)_3^{4-}$, 36.4	$UO_2(CO_3)_3^{4-}$, 60.5
U(VI)	$UO_2(OH)_2^0$, 3.1	$UO_2(OH)_2^0$, 1.4
Mo(VI)	MoO_4^{2-}, 100	MoO_4^{2-}, 100
As(V)	$H_2AsO_4^-$, 6.0	$H_2AsO_4^-$, 2.8
As(V)	$HAsO_4^{2-}$, 94.0	$HAsO_4^{2-}$, 97.1

Table 4. Results of Saturation Index Calculations Using MINTEQA2 for Influent and Effluent Waters of the 2-D Aquifer Cell

Solid or Gas Phase	Influent Water	Effluent water
Barite	-0.06	-0.16
Aragonite	-0.22	0.41
Calcite	-0.08	0.55
Hydroxyapatite	1.01	7.75
Fluorite	-0.85	-3.83
Gibbsite	-0.02	-0.44
Silica (ppt)	-0.52	-0.53
Silica (gel)	-0.21	-0.22
Strontianite	0.60	0.87
Siderite	-1.63	-0.93
Haiweeite	0.011	0.21
Soddyite	-3.07	-3.70
$Log_{10}\ PCO_2$	-2.78	-3.04

Calcite, quartz, kaolinite, smectite, aragonite, hydroxyapatite, and whewellite ($CaC_2O_2 \cdot H_2O$) have been identified by quantitative XRD in materials used in the 2-D aquifer cell. Calcite and aragonite occurred within the Apatite II structure along with organic matter and whewellite is a constituent identified within the pecan shells. Strontianite and haiweeite have not been observed at abundance greater than 1% (wt.) in the materials, and precipitation of these phases is limited by kinetics. Overall, results of the modeling simulations support the identification of solid phases within the 2-D aquifer cell.

ACKNOWLEDGMENTS

LANL's Environmental Division and a Director's Postdoctoral Fellowship provided funding for T. Taylor. This manuscript summarizes recent research and does not represent the views of the funding agencies.

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Regional Groundwater Flow and Transport Modeling:
Data Needs and Model Uncertainty

Elizabeth Keating, Velimir V Vesselinov

We provide a general overview of LANL's approach to modeling the regional aquifer, with a summary of the basic data requirements for a robust model. In particular, we summarize the latest water level dataset, which now defines the water table reasonably well. Information concerning vertical gradients, however, is still sparse in the northern portion of LANL. Permeability data continues to demonstrate considerable heterogeneity within defined hydrostratigraphic units; however, inverse model results show that large-scale, effective permeability of some units (Cerros del Rio basalts, Santa Fe Group rocks) is fairly well known. Improved understanding of the permeability within the Puye Formation continues to be a high priority. Borehole geophysics has provided some information about porosity of the Puye Formation; although this data represents porosity at a very small scale, it is does provide our first site-specific information. This dataset suggests that much of the Puye Formation appears to have very, very low porosity and permeability. While in past years our modeling studies have focused on uncertainty in flow directions due to uncertainty in permeability of aquifer rocks, this year we focus on the influence of local recharge patterns. We present an uncertainty analysis of transport from a site beneath Mortandad Canyon, which, according to our calibrated model is within the capture zone of PM-5. Our results suggest that flow directions downstream are fairly well known; however, changes in the magnitude of canyon-focused recharge can have a significant impact on the local geometry of the capture zone.

Regional Groundwater Flow and Transport Modeling

Data Needs and Model Uncertainty

Elizabeth Keating
Velimir V. Vesselinov

Earth and Environmental Sciences Division

Modeling objectives

Develop a simulation tool that can be used to predict
flow directions, travel times, and solute transport
in the regional aquifer

with quantitative analysis of uncertainty

Model applications

-Determine optimal location of characterization wells downgradient of a potential source of contamination

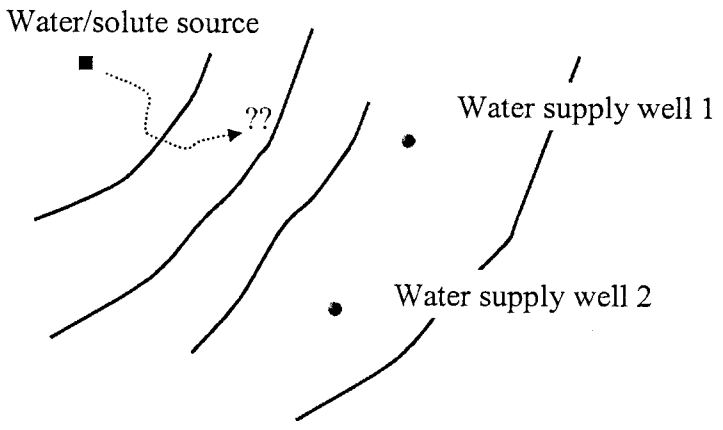
-Determine direction and rate of movement of HE downgradient of TA-16.

-Estimation of large-scale hydrologic properties of aquifer rocks and distribution of recharge rates

-Determination of "zones of capture" for water supply wells on the Pajarito Plateau and vicinity

-Supporting Groundwater Pathways Assessment Project, determining effectiveness of current monitoring well network

What path will water take??



To answer this question requires data

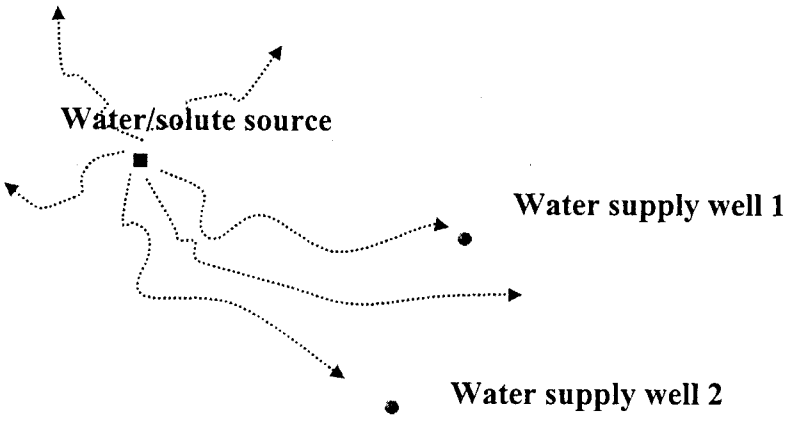
- Water levels (in 3-dimensions)
- Hydrostratigraphic relationships
- Hydrologeologic properties of the rocks
- Production information from water supply wells
- Recharge/discharge estimates

And

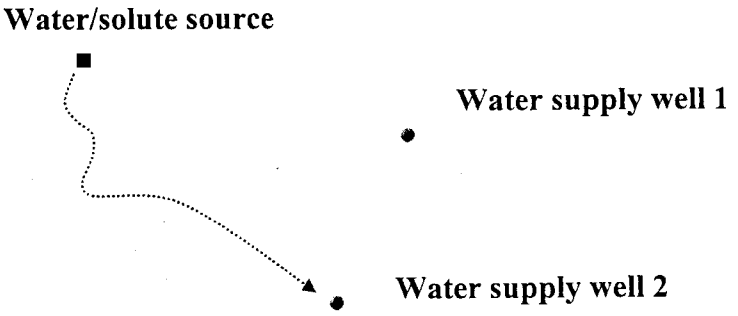
- A tool to integrate the data and incorporate basic fundamental hydrologic principles

Numerical model of groundwater flow and transport

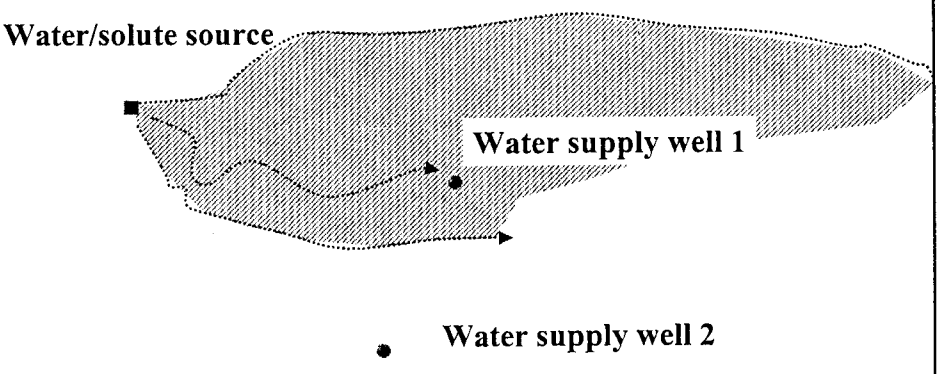
If there are no data...



If there are "perfect" data...



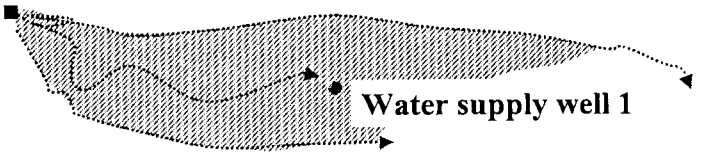
If there are *some* data...



This is not sensitivity analysis

If there are *more* data...

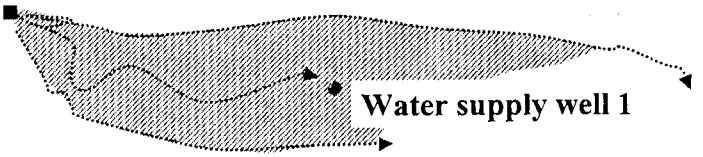
Water/solute source



Water supply well 2

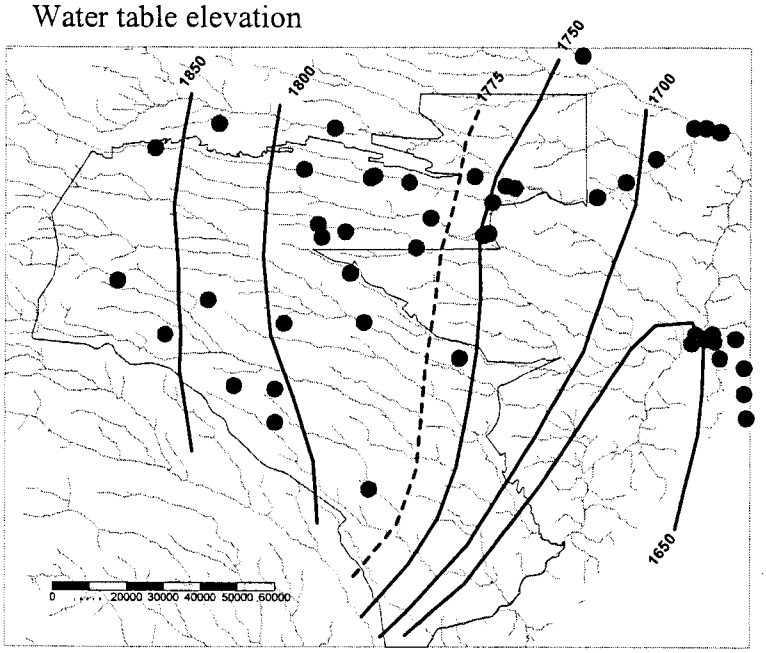
Do we have enough data?
Is the present level of uncertainty acceptable?
If "No" - then what kind of data is most valuable for further reducing uncertainty?

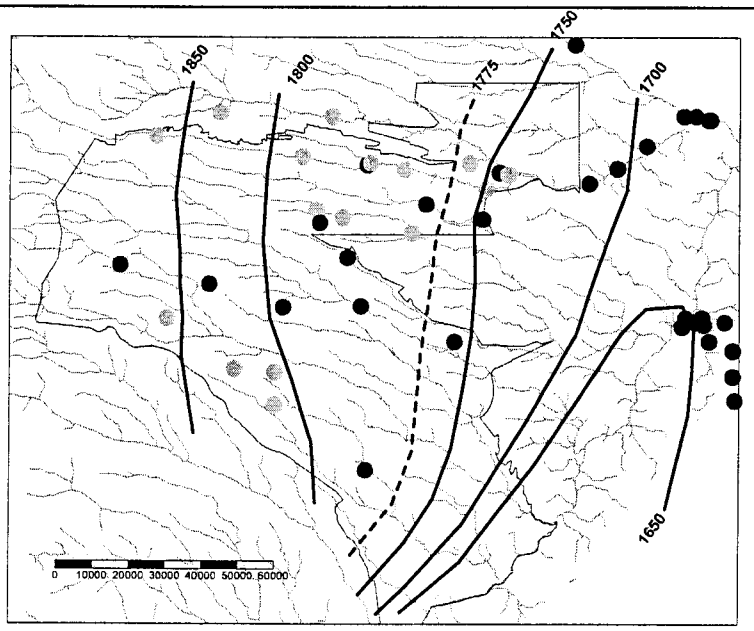
Water/solute source



Water supply well 2

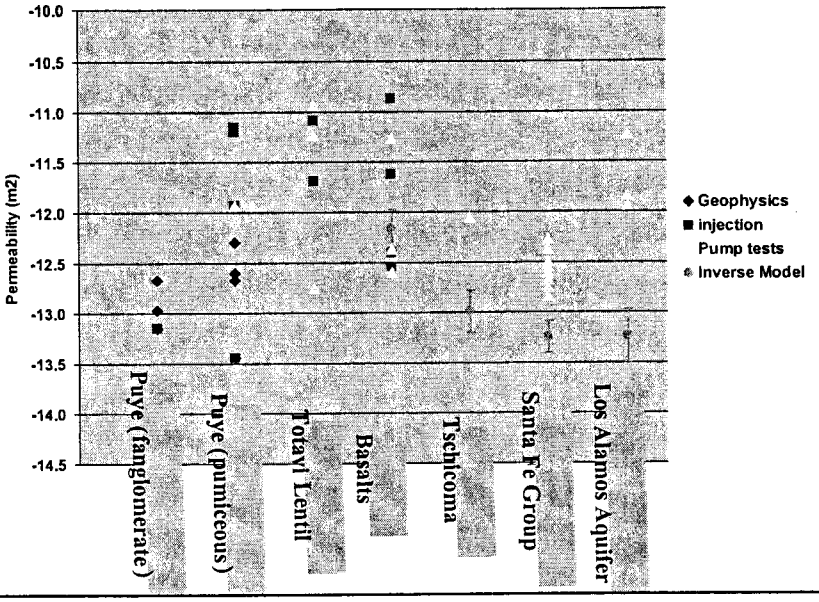
Water table elevation

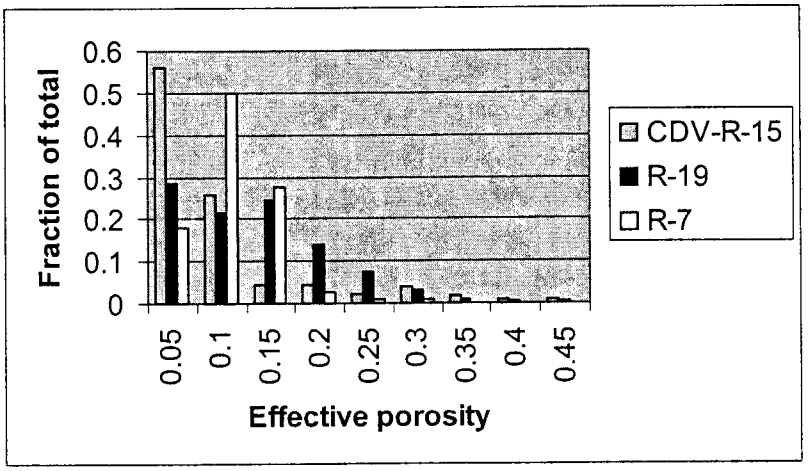




Vertical gradient data – red dots

Permeability of aquifer rocks





2001 Annual meeting

Uncertainty analysis focused on

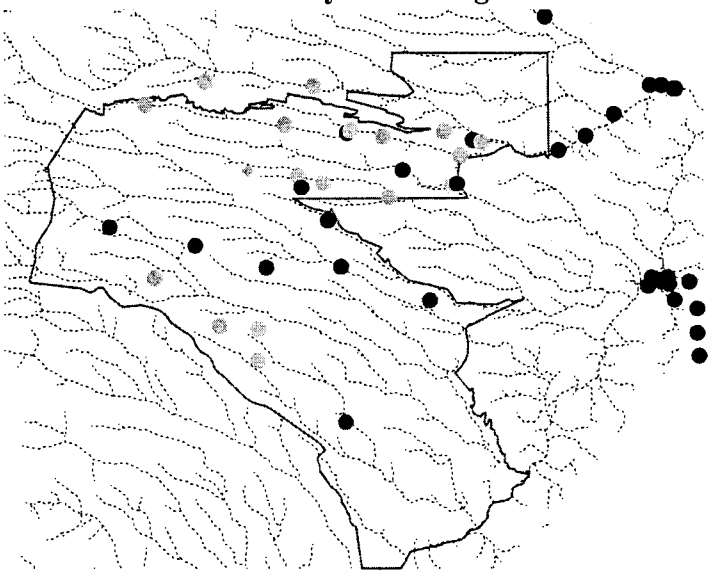
- Hydraulic properties of rocks
- Water level data
- Facies relationships within the Puye

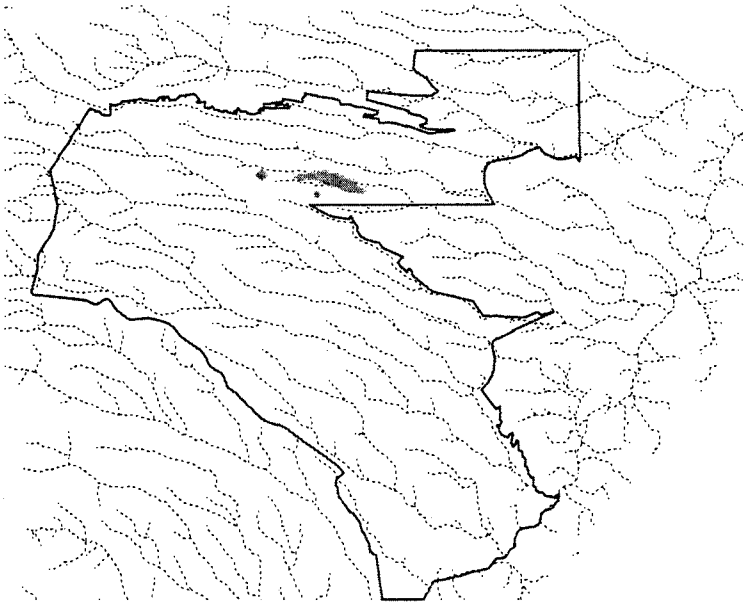
2002 Annual meeting

Uncertainty analysis focusing on

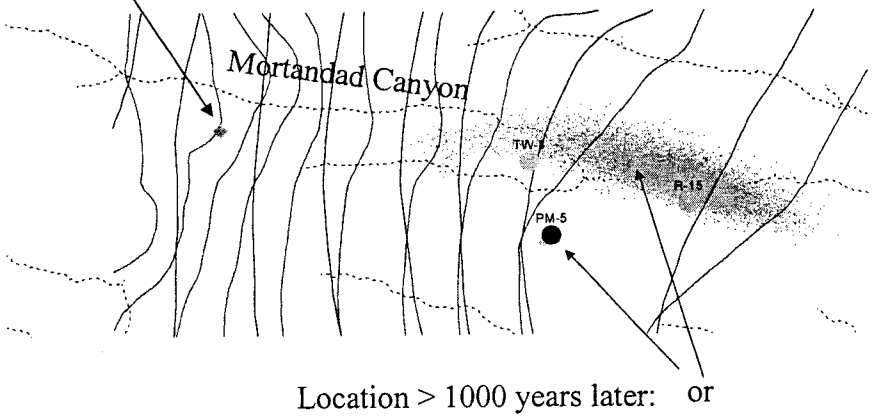
- Hydrostratigraphic relationships
- Rates of diffuse recharge and recharge along canyons
- Fluxes into/out of the aquifer from the north, west, and south

Influence of uncertainty in recharge rates





Location at water table where particles are assumed to enter the regional aquifer



Location > 1000 years later: or

Results depend on recharge rates

Groundwater Pathways Assessment Project

Bruce Robinson
Earth and Environmental Sciences Division

Need

This project is designed to focus the ER and Hydrogeologic Workplan site characterization and modeling activities by assessing the adequacy of our current state of knowledge of the hydrogeology of the site for designing a monitoring well network. It will also put in place a modeling methodology and suite of simulation tools that could be used in the future for probabilistic groundwater risk calculations, or for assessing the potential benefits of remediation and long term stewardship decisions.

Goal

Produce a report of model predictions (with uncertainties) of the concentration-time histories and plume locations for key contaminants in the regional aquifer that could be used to guide the design of a monitoring well network, identifying the most important conceptual models and parameters requiring further study to reduce uncertainties.

Technical Approach

To achieve the goals of this project, we are building a system model through the use of Monte Carlo simulations that span the ranges of uncertainty of the multi-dimensional parameter space, and presenting results using various hypothetical monitoring well performance metrics regarding the concentration, time period of interest, and plume location. Results will consist of probabilities of detection of contaminants, and identification of parameters and models contributing the most to the uncertainty. As preliminary steps toward building the system model, the following modeling activities are being carried out:

- Select contaminants of concern, document the reasons for selecting these and not others, and develop time histories and source locations (with uncertainties)
- Document the selection of conceptual models and discuss the rationale for either including alternatives or dismissing them
- Develop the vadose zone subsystem model to compute the concentration versus time in the vadose zone and at the water table (with uncertainties)
- Develop the regional aquifer subsystem model to compute plume concentration and location (with uncertainties) for a given source term from the vadose zone model
- Document the selection of constant and uncertain parameters, elicit expert opinions from the LANL staff and stakeholders regarding the uncertain parameters, and construct the parameter distributions to be used in the Monte Carlo analyses

Groundwater Pathways Assessment Project

Bruce Robinson

2002 Annual Meeting
April 10-12, 2002

Preliminary First Order Groundwater Assessment

- Examine potential contaminants that might pose a risk to groundwater receptors on a site-wide basis
- Approach: Use GIS tools to synthesize information from contaminant sources and hydrogeologic data to assess transport times and pathways. Components of the analysis include:
  - Contaminant sources
  - Percolation rates
  - Vadose Zone flow and transport
  - Regional Aquifer flow and transport

Goal of Groundwater Pathways Assessment Project

Produce a report of model predictions (with uncertainties) of the concentration-time histories and plume locations for key contaminants in the regional aquifer and estimates of the likelihood that these contaminants will be detected in the R-well network and/or existing water supply wells within a specified time frame. Our report will also identify the most important conceptual models and parameters requiring further study to reduce uncertainties.

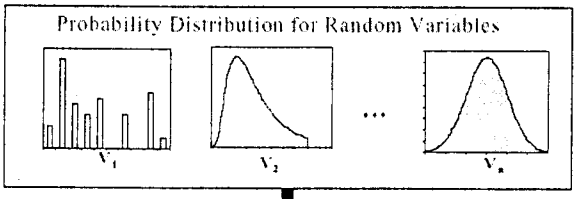
Groundwater Pathways Assessment – Major Steps

- Select contaminants of concern
- Document conceptual models
- Develop submodels used to predict the behavior (with uncertainties) of:
  - Contaminant source terms
  - Vadose zone contaminant transport
  - Regional aquifer contaminant transport
- Construct systems model linking the submodels
- Assign distributions for uncertain parameters
- Perform Monte Carlo simulations

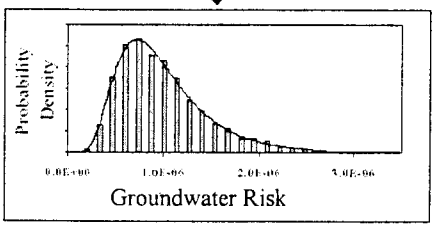
First Order Groundwater Pathway Assessment: Technical Approach for the Submodels

- Contaminant sources
  - Outline source term areas for key contaminants based on Water Quality Database entries for the alluvial, intermediate, and regional aquifer wells
  - Create uncertainty distribution for contaminant quantities entering the vadose zone
- Percolation Rates
  - Categorize canyon drainages with respect to observable properties (location of headwaters, presence of alluvial GW, etc.), assign percolation rates based on other modeling and data collection efforts
  - Establish maps of infiltration that are consistent with vadose zone data and water budget information from regional aquifer studies
- Vadose zone flow and transport
  - Construct a series of simple vertical pathway models at locations of interest, compute vadose zone contaminant flux to the water table at each location
- Regional aquifer flow and transport
  - Use regional aquifer model to simulate plume concentrations within the aquifer and at water supply wells

System Model: The Monte Carlo Approach



Groundwater Risk = $f(V_1, V_2, \ldots V_n)$



First Order Groundwater Pathway Assessment: Overall System Model

- Link models together to enable calculation from source to potential receptor
- Establish range of parameter values for all uncertain parameters
- Use Monte Carlo approach to find the range of possible outcomes (e.g. "concentration at supply wells within 100 years", "maximum concentration in regional aquifer at the Laboratory boundary", etc.)
- Determine which uncertainties control the uncertainty in the outcome (e.g. "uncertainty mostly due to uncertainty in the source term", "uncertainty controlled by the Kd of the contaminant", etc.)

Current Status

- A series of meetings have been held to establish the scope of the Project and to discuss the conceptual models to be included
- Numerical modeling approaches for the vadose zone and the regional aquifer transport submodels have been developed
- Core Team must decide upon criteria in order for simulations to become more focused
- Until then, staff will structure the calculations based on scientific judgment and will try to build flexible modeling approaches

Collaborative Database Design, Development, And Data Exchange

K. Henning, S. Kinkead, A. Lee, R. Adams, A. Dorries,
G. Erpenbeck, P. Gomez, C. LaDelfe, N. McCranie,
C. Smith, R. Watts

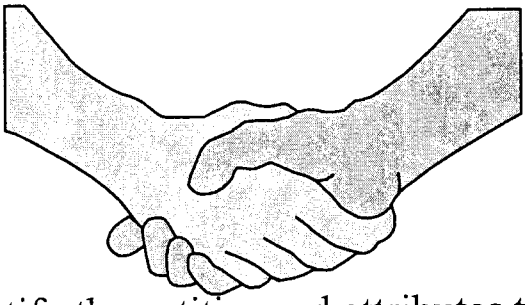
Vision

Develop an integrated repository for data generated during implementation of the Hydrogeologic Workplan

Requirements

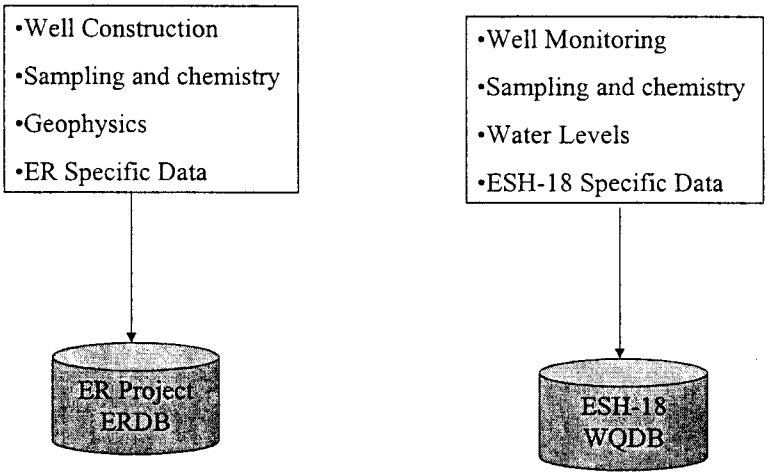
- Streamline access to all water data from two organizations
- Reduce duplication of effort
- Create consistent data reports
- Preserve ability to retrieve data for compliance and other reporting

Data Sharing Agreement

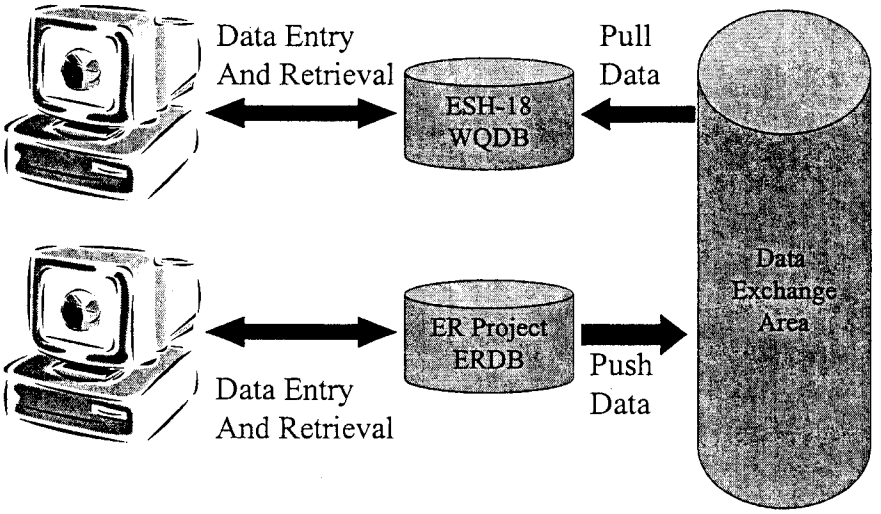


- Identify the entities and attributes to be shared
- Assign responsibility for shared lists of values

Data Sources



Current Process



Criteria for Data Exchange

- Data ready for exchange (proper QA/QC complete)
- Data is new since last push/pull
- Data has changed since last push/pull

Web Interface to ER Project & ESH-18 Data

- http://wqdbworld.lanl.gov
- Report Generation
- Data Download Capabilities
- Basic Chart/Graph Capabilities

Enhancements

- Implement "push" and "pull" in both directions
- Automate the push and pull
- Use more advanced technology for exchange to allow for differences in design
- Incorporate data from additional sources such as NMED

Revision of the 3D Geologic Model for Los Alamos National Laboratory

G. Cole, J. W. Carey, D. Broxton, and D. Vaniman

The present 3D Geologic Model of Los Alamos National Laboratory is based on data available in mid-1999. These data provided reasonable control for the surface geology at the laboratory, and provide some 3D control for the subsurface geology to the depths of the canyons dissecting the Pajarito Plateau. However, at that time, only a limited number of wells penetrated to depths sufficient for characterization of deeper (pre-Bandelier) units, and documentation of the geology for these holes was sparse. As a result, the geology of the saturated zone was poorly constrained, both conceptually and spatially.

A new 3D Geologic Model is currently being developed which will incorporate a re-evaluation of many of the older drill logs, as well as new drilling and surface mapping data. New and revised data include:

- new R-, CdV-, and MCOBT-series characterization well data;
- new and updated drilling and surface data for Areas G, H and L; and
- new 1:24,000-scale surface mapping of the Frijoles and Puye Quadrangles, and detailed mapping in western portions of the Laboratory.

The new model will be enhanced by:

- application of a structural (block) model based on new data from the Seismic Hazards Program and other legacy data;
- extension of the model to the boundaries of the 4 quad area (Frijoles, White Rock, Puye and Guaje Mountain), extending the 50-foot, 3D grid from 1281 rows x 1201 columns to 1823 rows x 1487 columns;
- incorporation of legacy data for the northern portion of the Guaje Mountain quadrangle;
- characterization of the Puye/Santa Fe as hydrostratigraphic units;
- creation of 2-D (XY) distributed attributes for pre-Bandelier units to better represent hydrologic variability within these units;
- new age dates, and
- utilization of LIDAR and airborne magnetic data to assist in redefining the distribution of geologic units and structure.

Changes and improvements will affect the entire 3D Geologic Model. Most noticeable will be (1) more accurate representation of pre-Bandelier units, (2) subdivision of portions of the Puye Formation previously described as fanglomerate into an upper fanglomerate and lower pumiceous unit, (3) changes in thickness and extent of the Cerros del Rio lavas, and (4) changes in thickness and extent of Totavi (and Totavi-like) river gravels. In addition to these changes, a reassessment of older and deeper drill-hole data has revealed major limitations in our ability to accurately represent sediments that are >5 Ma in age. Much of the sedimentary series previously described as Chaquehui (or Santa Fe Group undivided deposits with volcanic detritus, Tsfuv) have proved to be deeper

(older) Puye-like material or Santa Fe Group sediments of mixed plutonic, metamorphic, and volcanic origin. With the limited data available, formal stratigraphic designations cannot be assigned to these deeper deposits. However, a distinction between upper fanglomerates/conglomerates and lower sands/silts/clays can be defined and will be incorporated into the 3D Geologic Model as a transition of possible hydrogeologic significance.

Creation of spatially-distributed physical attributes for the pre-Bandelier units will assist in modeling hydrologic variability within individual stratigraphic units. Properties being quantified include:

(1) relative proportions of flow interior, open breccia, and clay-filled breccia for the Cerros del Rio lavas,
(2) percentage abundances of clay and glass in all subunits of the Puye Formation (fanglomerate, pumiceous, and river gravel subunits),
(3) percentages of Precambrian river detritus in the Puye river gravels, and
(4) relative proportions of volcanic and sedimentary materials within Cerros del Rio and older basaltic units, where sediments and lavas are interlayered on a scale that can not be separately mapped in the Model.

All of these property variations have potential hydrogeologic significance. Additional properties that may be significant include the amount and distribution of clay, carbonate, zeolite and other mineralization in the >5 Ma deposits, but there are as yet insufficient data to map these distributed properties in the deeper units.

GEOLOGY OF THE PAJARITO FAULT SYSTEM AT LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS, NEW MEXICO

LAVINE, Alexis, GARDNER, Jamie N., LEWIS, Claudia J., RENEAU, Steve L., WOLDEGABRIEL, Giday, KRIER, Don J., VANIMAN, Dave T.
Earth and Environmental Sciences Division, Los Alamos National Laboratory, Los Alamos, New Mexico, alavine@lanl.gov

The Los Alamos National Laboratory (LANL) Seismic Hazards Program has done detailed geologic mapping of the Pajarito fault system for several years to better understand the location and nature of faulting, which is essential to assessing ground motion and seismic surface rupture hazards at the Laboratory. We have developed a mapping technique using a total station for precise mapping of flow and cooling unit contacts in the 1.2 m.y. old Tshirege Member of the Bandelier Tuff. The technique enables us to locate faults that would be overlooked by conventional mapping techniques, and have as little as 15 cm of vertical displacement. Total station mapping has allowed us to define broad zones of small faults and varying styles of deformation along strike of individual faults in the Pajarito fault system. Total station bedrock mapping has been accompanied by conventional geologic and geomorphic mapping, shallow drilling on urbanized mesa tops, and paleoseismic trenching. Within LANL, deformation in the fault system is distributed across a 1.8 to >3.5 km-wide, dominantly north- to northeast-trending, complex zone to the east of the main Pajarito fault escarpment. Along strike the Pajarito fault zone can be expressed at the surface as a monocline, a large normal fault, or a distributed zone of deformation with >135 m of down-east vertical offset in the Bandelier Tuff. The associated zone of deformation to the east includes normal and strike-slip faulting and monoclinal folding, with 0 to >30 m of distributed down-west vertical offset in the Bandelier Tuff.

GEOLOGY OF THE PAJARITO FAULT SYSTEM AT LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS, NEW MEXICO

Alexis Lavine
Jamie N. Gardner
Claudia J. Lewis
Steven L. Reneau
Giday WoldeGabriel
Don J. Krier
David T. Vaniman

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Presented 4/11/02 at the LANL Hydrogeologic Characterization Program Annual Meeting

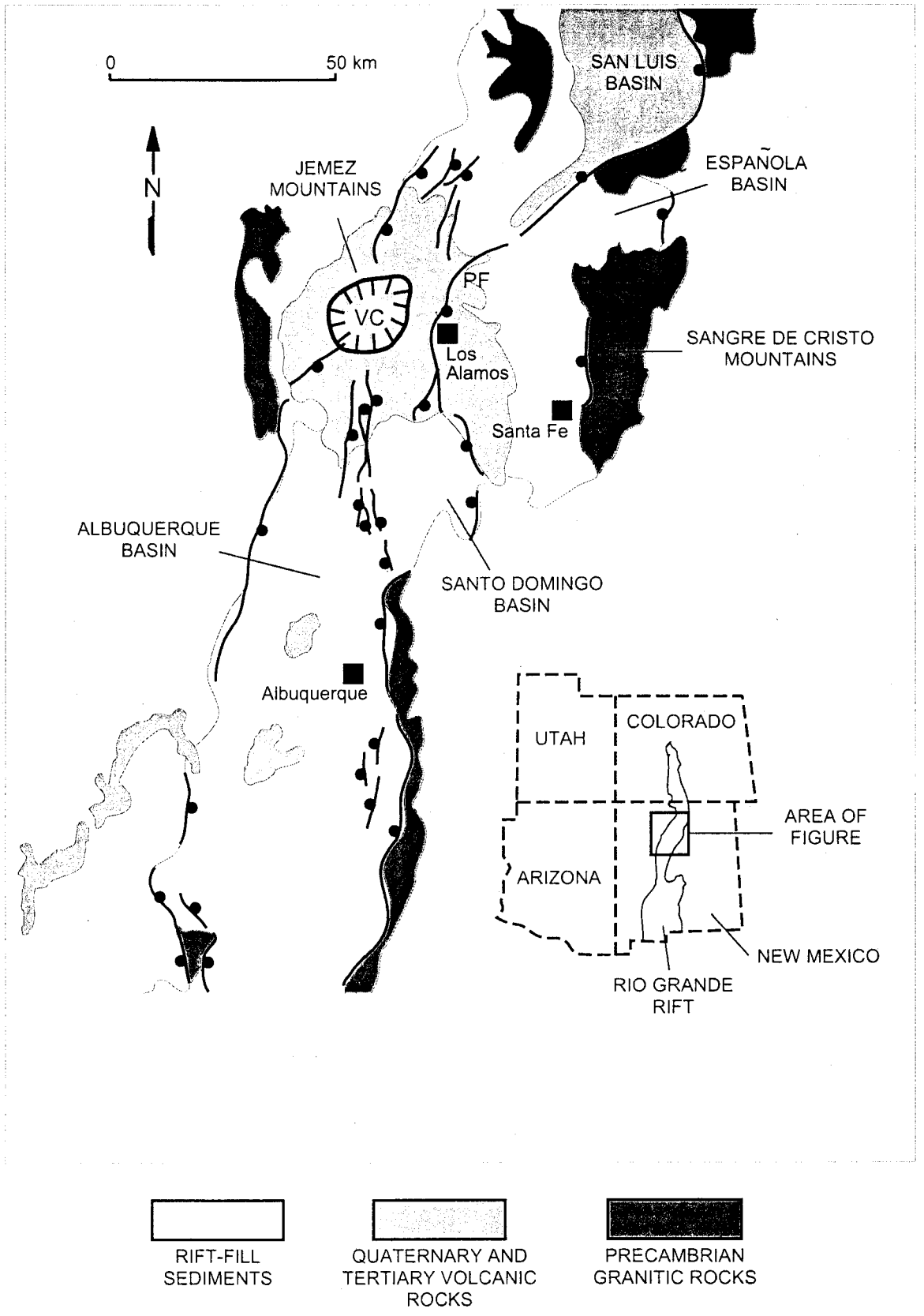

Figure 1. Map of the Rio Grande rift in northern New Mexico, showing the Valles caldera (VC), Pajarito fault (PF), other major fault systems, and the location of Los Alamos. (Modified from Gardner and Goff, 1984).

Lavine, A., Gardner, J.N., Lewis, C.J., Reneau, S.L., WoldeGabriel, G., Krier, D., Vaniman, D., EES Division, LANL

Presented 4/11/02 at the LANL Hydrogeologic Characterization Program Annual Meeting

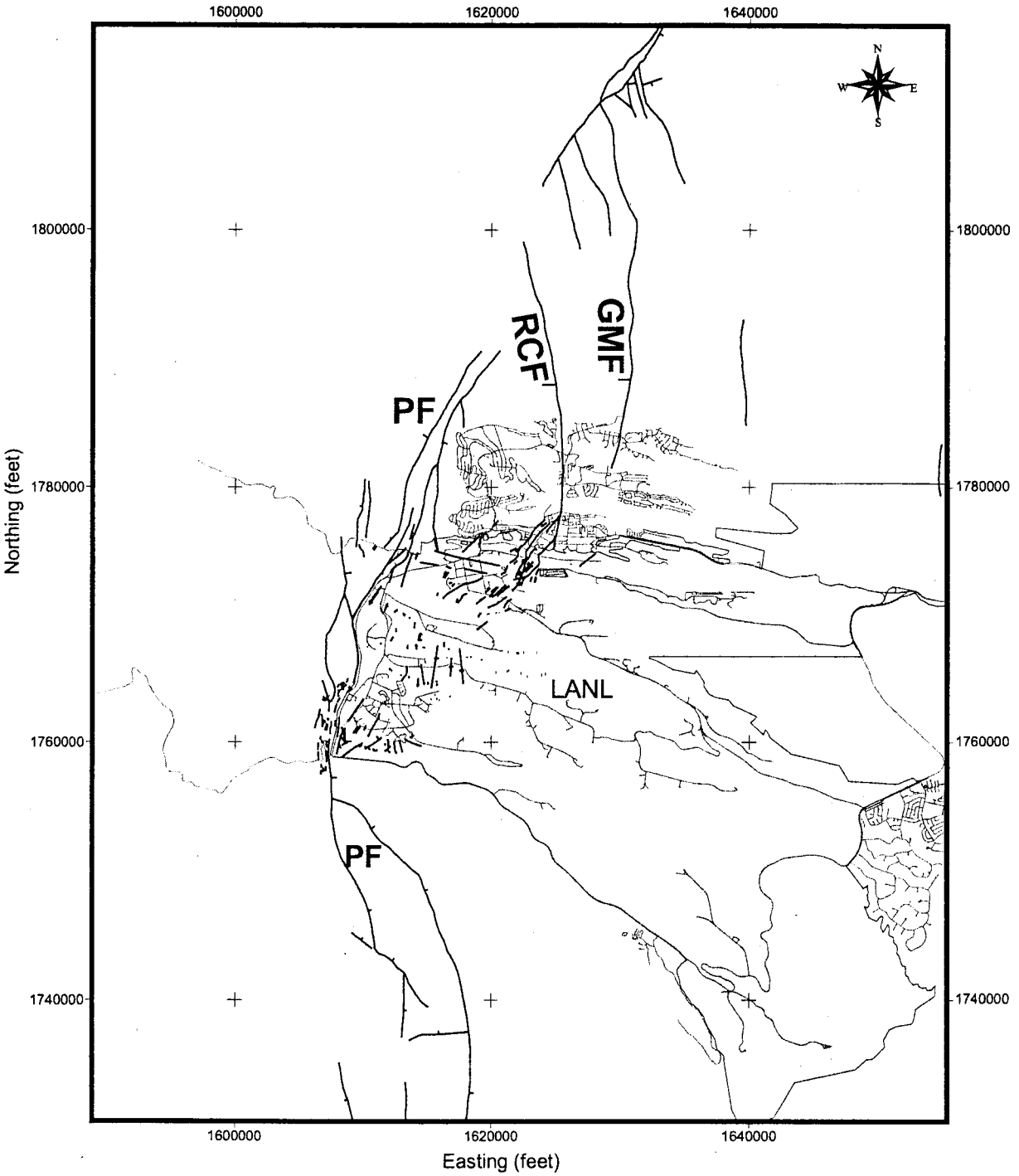

Figure 2. Map showing the Pajarito fault system in the vicinity of Los Alamos National Laboratory (shaded gray). Faults are from Gardner and House (1987), Gardner and Reneau (unpublished mapping), Reneau et al. (1995), Gardner et al. (1999 and 2001), and Lewis et al. (in prep.). PF= Pajarito fault, RCF= Rendija Canyon fault, GMF= Guaje Mountain fault. Roads are shown in light grey. Many areas where no faults are shown have not yet been mapped. Grid is in the State Plane Coordinate System (in feet), New Mexico Central Zone, 1983 North American Datum.

Lavine, A., Gardner, J.N., Lewis, C.J., Reneau, S.L., WoldeGabriel, G., Krier, D., Vaniman, D., EES Division, LANL

Presented 4/11/02 at the LANL Hydrogeologic Characterization Program Annual Meeting

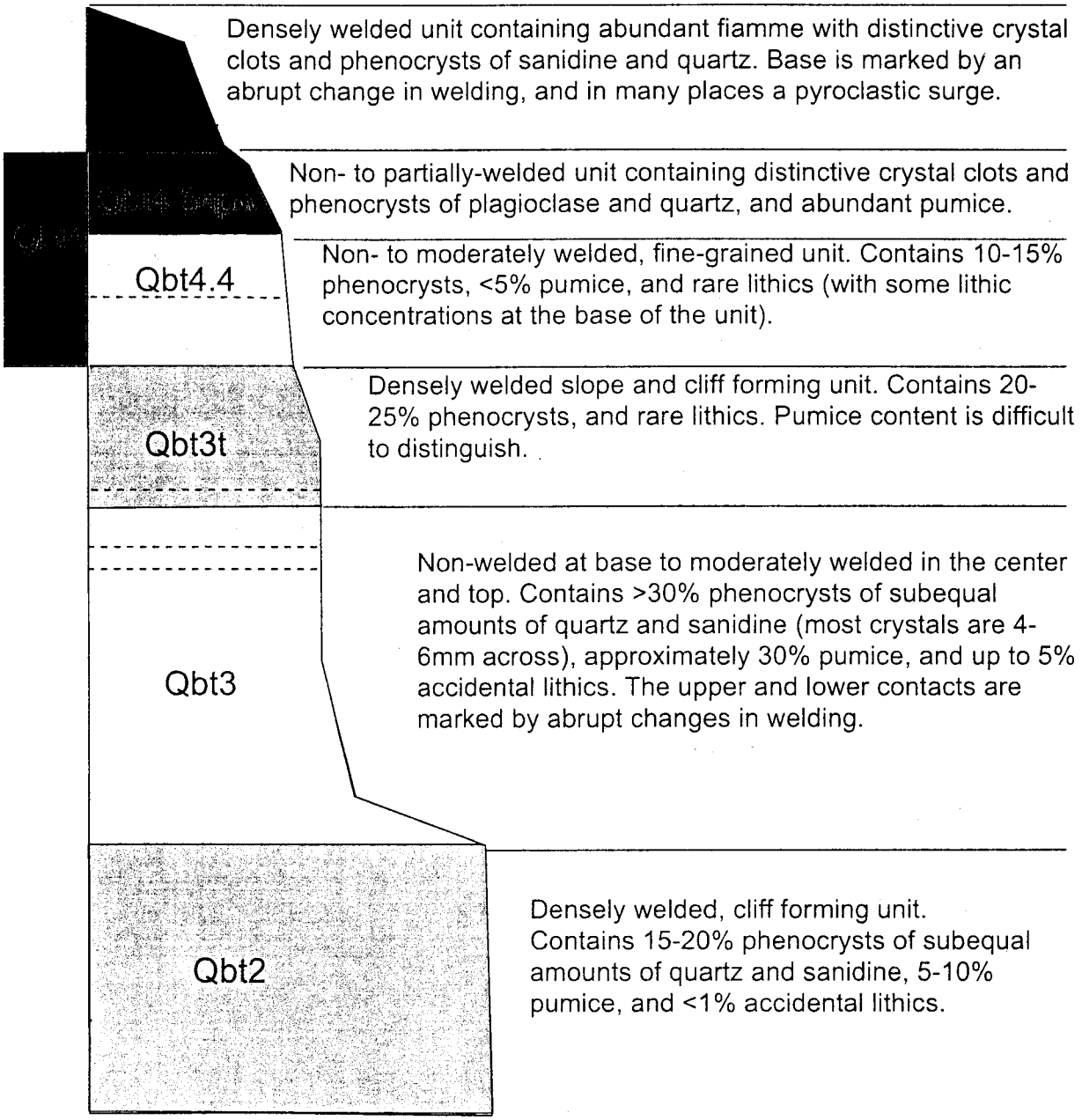

Figure 3. Generalized stratigraphy of mapped units of the Tshirege Member of the Bandelier Tuff shown in Figure 4 (modified from Broxton and Reneau, 1995). Thickness of units is shown schematically and varies over the Pajarito Plateau. Pyroclastic surges are shown by dashed lines. Unit 4 subdivisions from Lewis et al. (in prep.).

Lavine, A., Gardner, J.N., Lewis, C.J., Reneau, S.L., WoldeGabriel, G., Krier, D., Vaniman, D., EES Division, LANL

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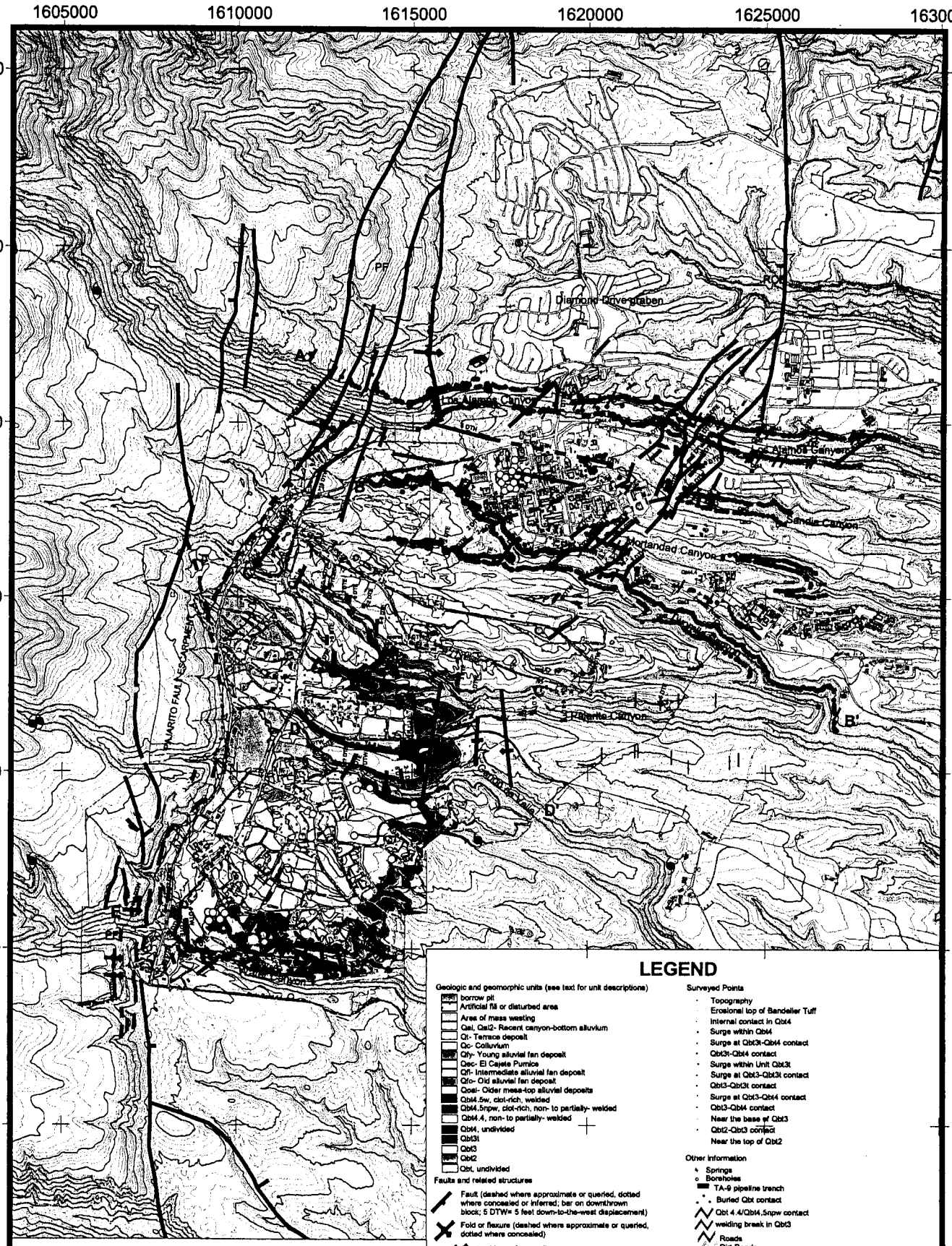

Figure 4. Geologic map of the western portion of LANL

The northern portion of the map (between Los Alamos and Twomile Canyons) shows only surveyed contacts (shown by dots) within the Bandelier Tuff; mapping has not been completed in this area. North of Los Alamos Canyon, the Pajarito fault system is defined by the Pajarito fault (PF) and the Rendija Canyon fault (RCF), which bound the Diamond Drive graben. South of Los Alamos Canyon, the zone of deformation associated with the PF is approximately 12,000 ft (3.7 km) wide. Between Twomile Canyon and Cañon de Valle, the zone of deformation is approximately 10,000 ft (3 km) wide. In Water Canyon, the zone of deformation is approximately 7000 ft (2 km) wide.

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Photograph looking north of total station mapping in Water Canyon, showing monocline.

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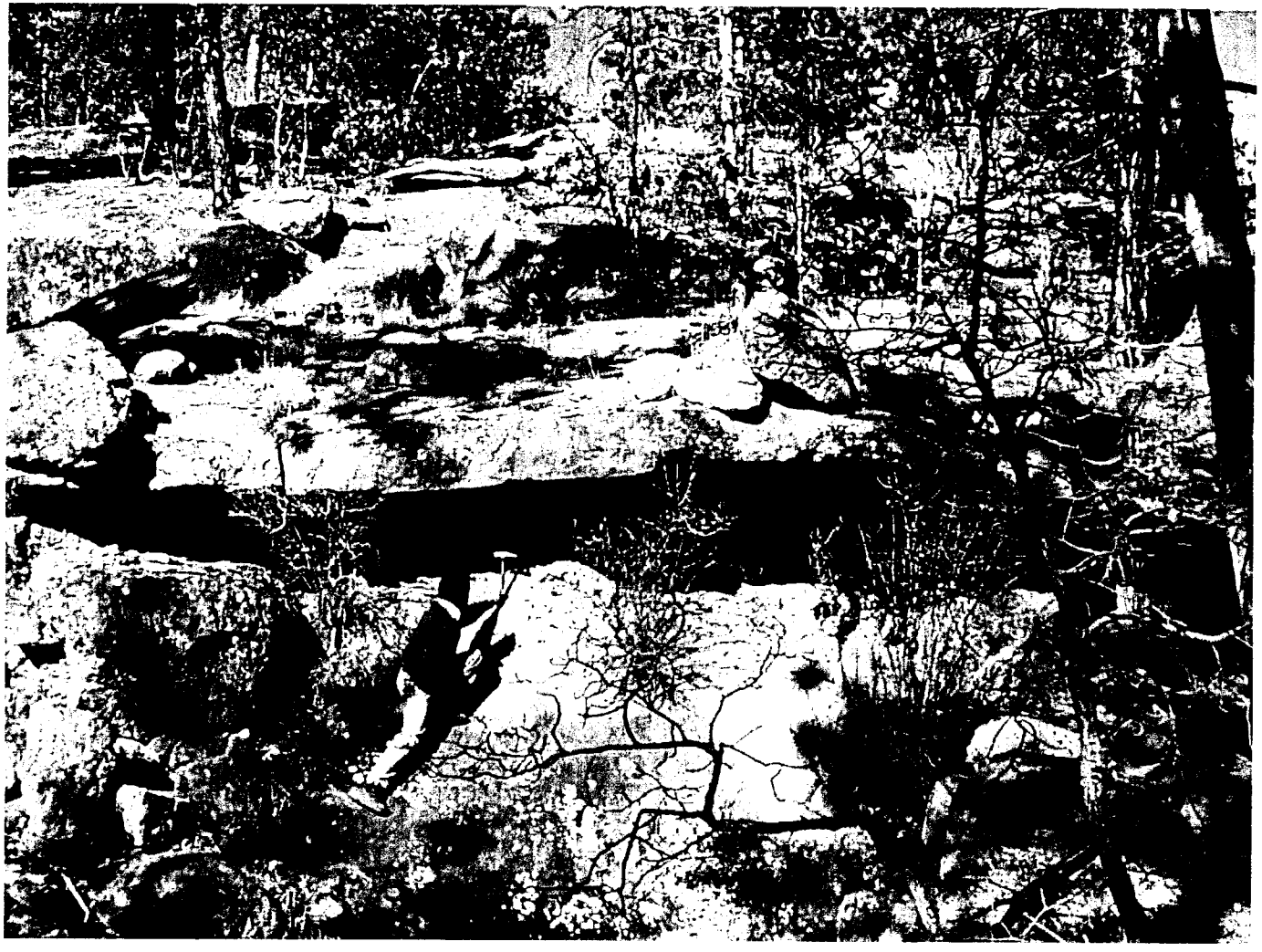

Photograph of Unit Qbt3/Qbt3t contact in Twomile Canyon

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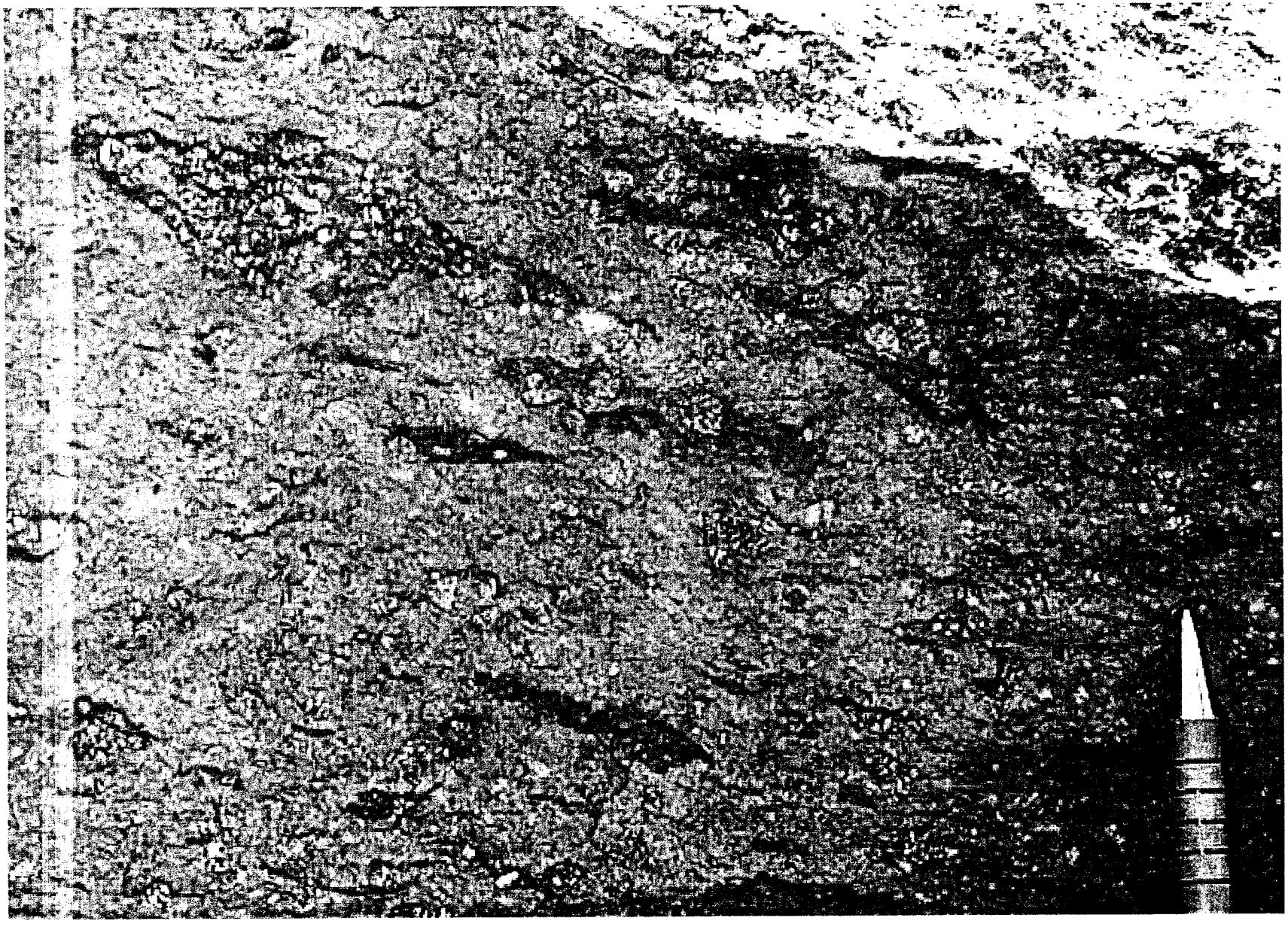

Photograph of unit 4.5w

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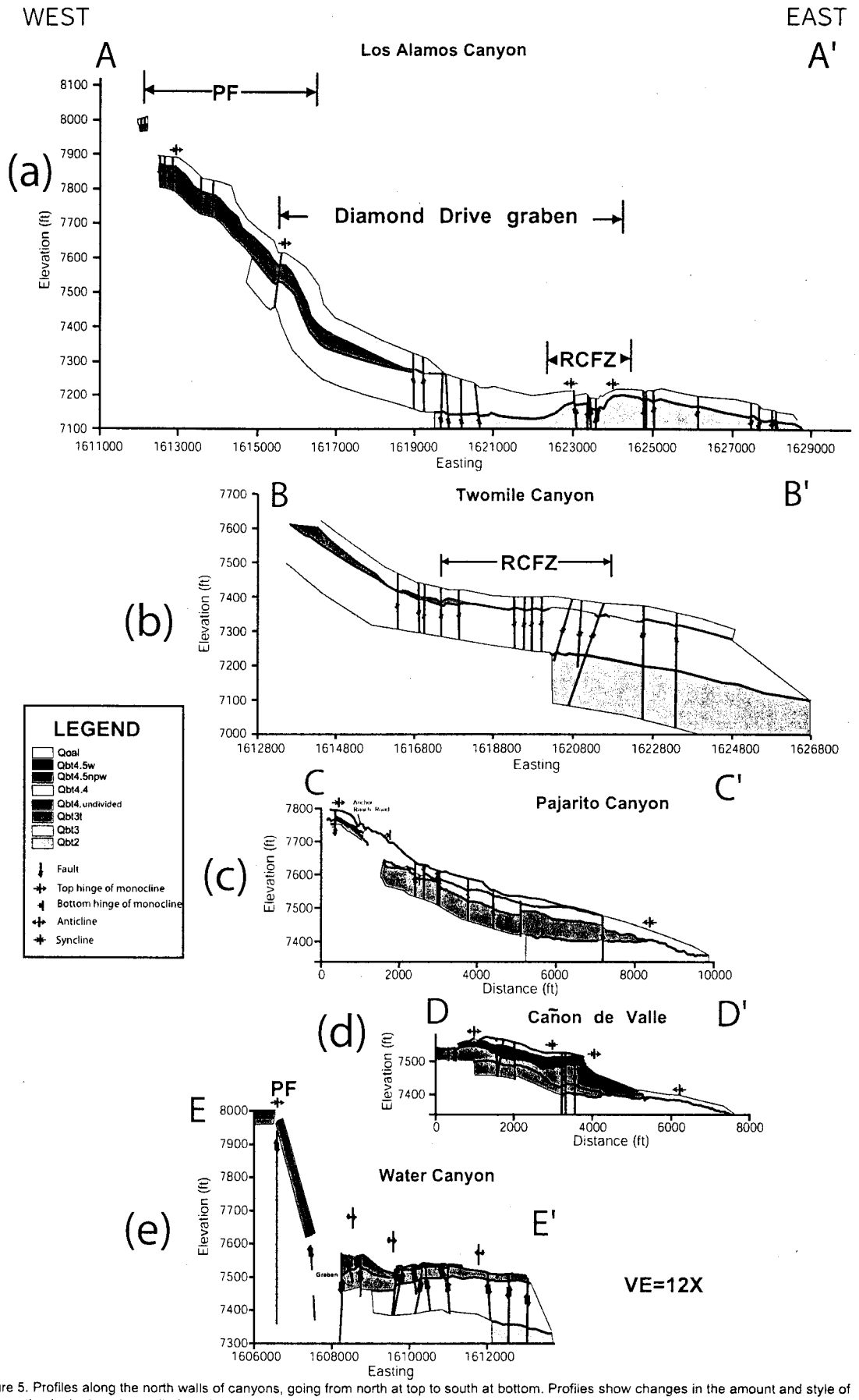

Figure 5. Profiles along the north walls of canyons, going from north at top to south at bottom. Profiles show changes in the amount and style of deformation in the hanging wall of the Pajarito fault (PF). Profiles are aligned relative to location of the PF. The zone of deformation in the hanging wall of the Pajarito fault includes the Rendija Canyon fault zone (RCFZ) in the northern part of the area. Profiles a, b, and e are derived from total station mapping of geologic contacts, and are projected into an east-west line. Total station mapping allowed for recognition of the broad zone of faulting in the southern part of the RCFZ (profile b), with most faults having less than 5 ft (1.5 m) vertical displacement. Note the decrease in net vertical displacement and widening of the RCFZ between profiles a and b. Profiles c and d are derived from conventional geologic mapping and are projected into the trend of the canyon walls (Lewis et al., in prep). Profiles a, b, and e are modified from Gardner et al. (1999 and 2001). The ends of profiles (A-A' through E-E') are shown in Figure 4.

CONCLUSIONS

* Within the western part of LANL, deformation in the Pajarito fault system is distributed across a dominantly north- to northeast- trending, complex zone. Along strike the Pajarito fault can be expressed at the surface as a monocline, a large normal fault, or a distributed zone of deformation with >400 ft (>120 m) of down-east vertical displacement in the Bandelier Tuff. The associated zone of deformation to the east includes normal faulting, monoclinal folding, and associated strike slip faulting, with 0 to >100 ft (30 m) of distributed down-west vertical displacement in the Bandelier Tuff.

* North of LANL and Los Alamos Canyon the Pajarito fault system is >15,000 feet (4.5 km) wide and trends generally north. Near the northwest end of LANL the Pajarito fault system trends generally northeast, is approximately 12,000 ft (3.7 km) wide, and deformation within the area encompassing the Pajarito and Rendija Canyon faults is distributed across zones of monoclinal flexures and faults. In the west-central portion of LANL, the fault system trends generally north, is approximately 10,000 ft (3 km) wide, and displacement on the Pajarito fault is greater and more localized than to the north. In the southwestern part of LANL, the fault system trends north to northeast, is approximately 7,000 ft (2 km) wide, and faults with large vertical displacement (>15 ft (4.5 m)) are confined to a narrow zone near the main Pajarito fault escarpment.

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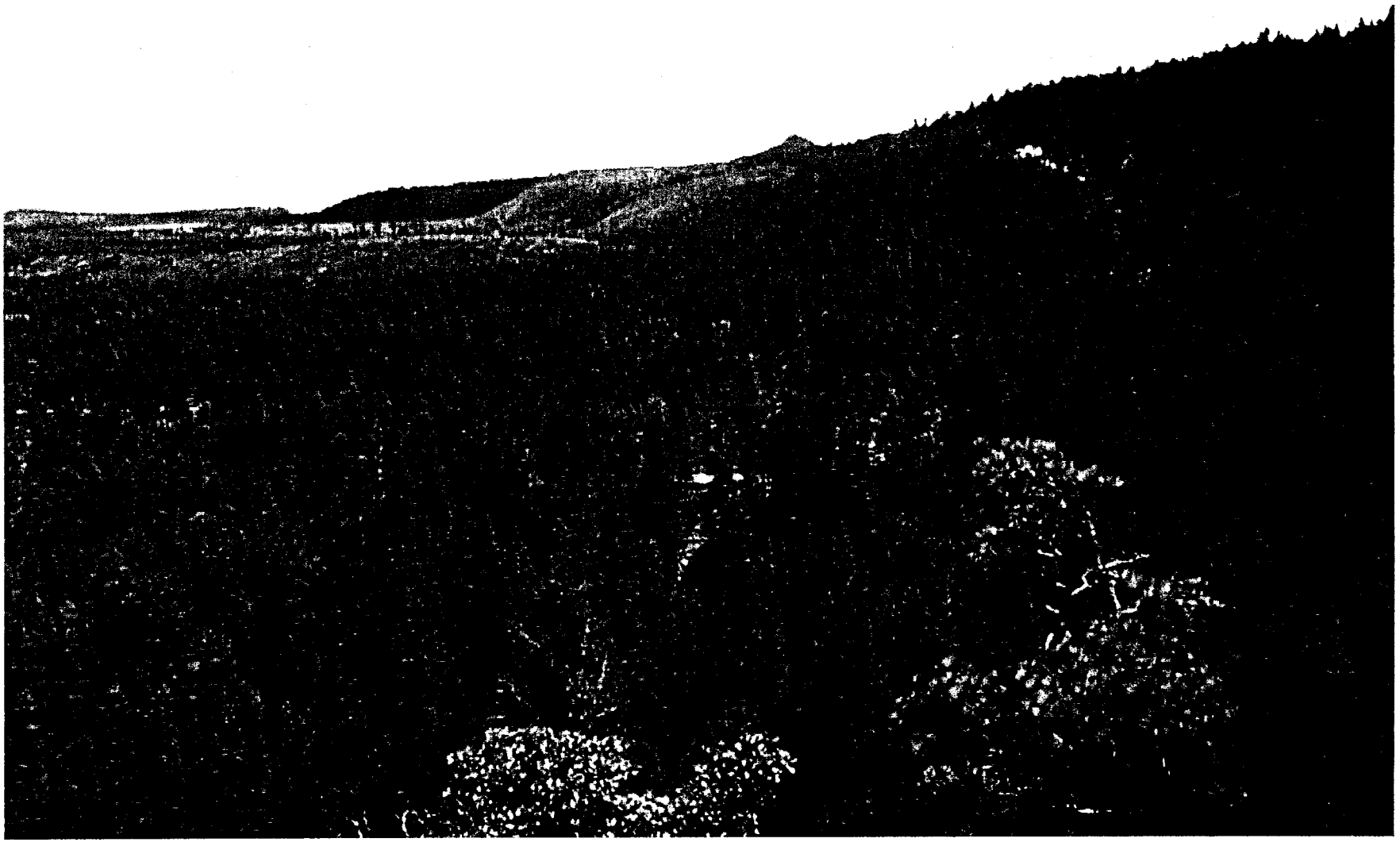

Photograph, looking south from Wather Canyon, of the Pajarito fault escarpment.

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ALLUVIAL AQUIFER TO WATER TABLE: TRACING GROUND WATER INFILTRATION AT TA-16 USING ELECTRICAL METHODS

W. Scott Baldridge (EES-11), Brent D. Newman (EES-10), and Donald D. Hickmott (EES-6)

Introduction. The alluvial system at Cañon de Valle is contaminated with high explosives (HE) and barium, resulting from processing of explosives at TA-16 over the past 50 years. HE contamination was also detected in the R-25 well at depths of greater than 700 feet (213 m). A goal of clean-up activities at TA-16 is identification of pathways from surface-contaminated sites near Cañon de Valle to deep groundwater. This information is required to determine the optimum locations for monitoring and/or treatment.

Techniques. Because the electrical resistivity of the subsurface is controlled, in part, by the presence and quality of ground water, we conducted electrical surveys in Cañon de Valle to characterize pathways along which water from the alluvial aquifer may reach the regional water table. In this first phase of work, we measured apparent electrical resistivity along three lines perpendicular to Cañon de Valle, and one line parallel to and within the canyon . The perpendicular lines ranged from 190 to 280 ft (58 to 85 m) in length, in all cases occupying the full width of the canyon. For control purposes, two were located near shallow [~10 ft (3 m)] alluvial wells adjacent to the stream. The longitudinal line, conducted as a "roll-along" survey, extended from Burning Ground Spring downstream past MDA-P a total distance of 1660 ft (506 m).

Results and interpretations. Apparent electrical resistivities ranged from approximately 100 to 850 ohm-meters. We interpret the low apparent resistivities to indicate saturated alluvium and/or bedrock; these resistivities are similar to measured resistivities of stream water (~50 ohm-meters). We interpret the high apparent resistivities to indicate unsaturated conditions in the bedrock Bandelier Tuff. Interpretation of the *perpendicular* lines indicates that the alluvial aquifer (1) extends into the bedrock below the alluvium [to a depth of about 15 ft (4.6 m) below the surface] and (2) does not occupy the full width of the canyon. These data were used to calculate cross sectional areas for the alluvial aquifer (Robinson et al., 2002). One line measured first in 1999 was repeated in 2001, yielding slightly higher apparent resistivities. We infer that the system was slightly drier in 2001. The *longitudinal* line unexpectedly yielded a *west*-dipping low apparent-resistivity zone, originating in a marshy area of Cañon de Valle near MDA-P. The zone, located in unit 3 of the Bandelier Tuff, extends approximately 300 ft (91 m) westward before disappearing from view below the survey depth [~60 ft (18 m)]. We are uncertain as to the degree of saturation of rocks within the zone, but it seems certain that they are saturated at least near the stream bottom. The westward dip may be controlled by the stratigraphy of the Bandelier Tuff, by structures associated with the Pajarito fault, or both. No perched water is observed in boreholes at MDA-P, near the TA-16-260 outfall, or in R-25 at equivalent depths.

Significance and future. We are encouraged that preliminary results of electrical measurements at TA-16 suggest that the these methods may be useful for tracing zones of saturation in the subsurface. Thus, they may provide a direct observational tool for evaluating and refining

hydrologic models of subsurface flow. Along the perpendicular lines we completed shallow core sampling to determine moisture contents of alluvium and shallow bedrock; moisture analyses are in progress. We plan a future phase of electrical or electromagnetic (EM) *soundings* (vertical profiles) to trace the west-dipping, low-apparent-resistivity zone to greater depths, and to determine the resistivity structure of the TA-16 area to depths of ~1000 ft (305 m). We also plan future drilling and sampling to better evaluate the geological and hydrological controls on the electrical profiles. Electrical and EM techniques may constitute an extremely cost-effective alternative to drilling for characterizing the presence, and lateral and vertical extent, of subsurface water.

[†] Surveys conducted by hydroGEOPHYSICS, Inc., Tucson, Arizona.

Reference:

Robinson, B., Keating, E., Newman, B., Birdsell, K., Carey, B., Witkowski, M., Lu, Z., Idar, A., Haagenstad, M., Zyvoloski, G., and Vesselinov, V., 2002, Process-Level and Systems Models of Groundwater Flow and Transport Beneath the Pajarito Plateau: Migration of High Explosives at TA-16. Los Alamos National Laboratory Report, in preparation.

The Effect of Welding and Porosity on Fault-Zone Structures in Ignimbrite Deposits: Examples from the Bandelier Tuff, Los Alamos, New Mexico

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Characteristics of faults in ignimbrite sequences are of interest for a variety of reasons, including their potential impact on fluid flow and contaminant transport. Small-displacement faults in the Bandelier Tuff of Los Alamos, New Mexico, display a range of deformation characteristics that are linked to petrophysical characteristics, such as porosity and degree of welding. The two basic structural features found among the ignimbrite units are shear fractures and deformation bands. The primary control on which of these features forms in response to deformation is degree of welding (cohesion of volcanic ash). Low porosity welded units deform by transgranular fracture, resulting in shear fractures that are similar to well studied faults in low porosity crystalline rock. In contrast, high porosity, non-welded units deform by cataclastic grain crushing and pore collapse within deformation bands. Deformation bands have been described previously only in high porosity sandstones and poorly lithified sediments. Our investigation of the impact of variations in welding and protolith porosity on deformation characteristics strengthens the established link between porosity and mode of deformation in sedimentary rocks, and identifies welding as a critical component in this link. Through this research, we hope to develop criteria by which we can predict whether fractures or deformation bands will form in a given ignimbrite. Such criteria are necessary to develop accurate hydrologic models in ignimbrites since fractures and deformation bands affect porosity and permeability in very different ways. This has been illustrated in sedimentary rocks, where the presence of fractures increases fault-zone porosity and permeability, and deformation bands reduce porosity and saturated permeability.

Permeability of Fault Zones in the Bandelier Tuff

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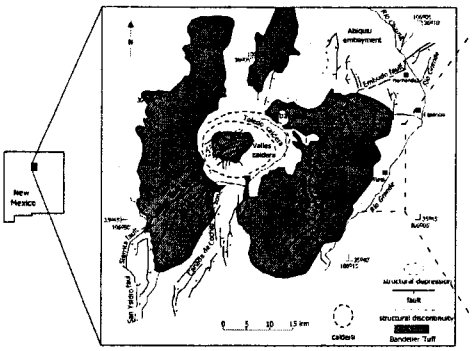
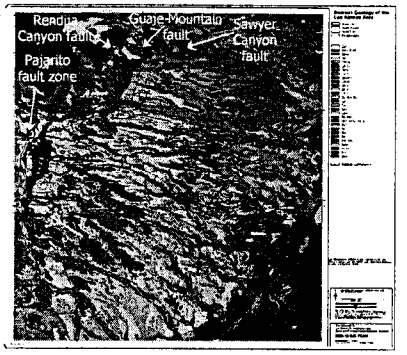
Outline

- Overview of the Bandelier Tuff
- Review of Welding and Fault-Zone Structures
- Hypotheses for Fault-Zone Processes
- Controls on Fault-Zone Structures
- Controls on Fault-Zone Permeability
- Implications for Fluid Flow
- Future Research



Bandelier Tuff: Pyroclastic flow and fall deposits from 1.6 and 1.2 Ma (Izett and Obradovich, 1994)

Map modified from Aldrich (1986), Heiken et al. (1990), and Purtymun (1995)

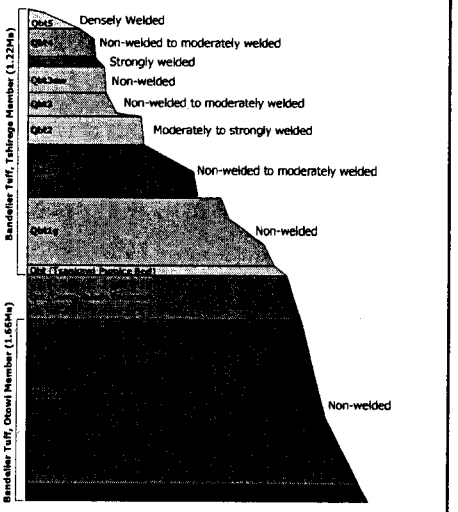


Units of the Bandelier Tuff and major faults in the vicinity of LANL

Welding in the Bandelier Tuff

Compaction and cohesion of matrix glass shards

- Decreases porosity (e.g., Ross and Smith, 1961)
- Decreases permeability (Istok et al., 1994)
- Increases mechanical strength of the rock (Schultz & Li, 1995; Moon, 1993)



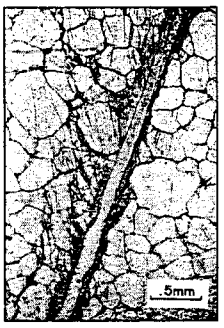
Modified from Broxton and Reneau (1995), with Qbt5 defined by Warren et al. (1997). Note that the upper Tshirege Member stratigraphy is under revision by Lewis et al. (in press).

Fault-Zone Structures

Structural features that result from fault-zone deformation

- Fractures: discrete surfaces across which cohesion has been lost
- Deformation bands: mm-wide zones of grain- and pore-size reduction

Fault-Zone Structures in Sandstones

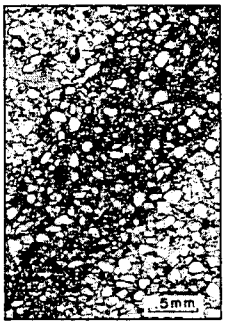


Fracture

Develop in low porosity (~0-5%) rocks

•Increased porosity

•Increased saturated permeability



Deformation Band

Develop in high porosity (~5-50%) rocks

•Decreased porosity

•Decreased saturated permeability

Photomicrographs from Dunn et al. (1973)

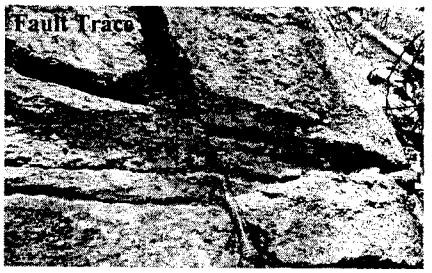
Hypotheses for the Controls on Fault-Zone Structures & Permeability in the Bandelier Tuff

- Porosity and degree of welding control the type of fault-zone structure found in ignimbrites
  - Tested by field and petrographic characterization
- Permeability structure of a fault zone is controlled by the type of fault-zone structures present (i.e., fractures versus deformation bands)
  - Will be tested by hydrologic studies

Controls on Fault-Zone Structures

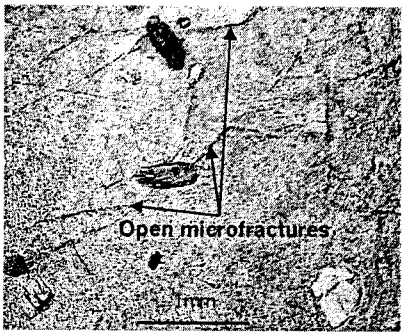
- Porosity and degree of welding control the type of fault-zone structure found in ignimbrites (Wilson et al., 2002)
  - Non-welded units deform by cataclasis, forming deformation bands
  - Welded units deform by fracture, forming shear fractures

Fractures in Welded Units



Field photo of a shear fracture in unit 3t (densely welded)

Wilson et al. (2001, 2002)



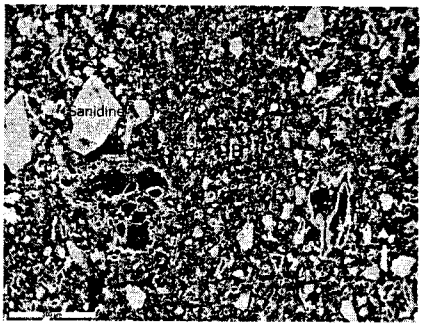
Photomicrograph of open, transgranular microfractures found adjacent to an open shear fracture

Wilson et al. (2002)

Deformation Bands in Non-Welded Units

Field photo of a deformation band in unit 3 (non-welded)

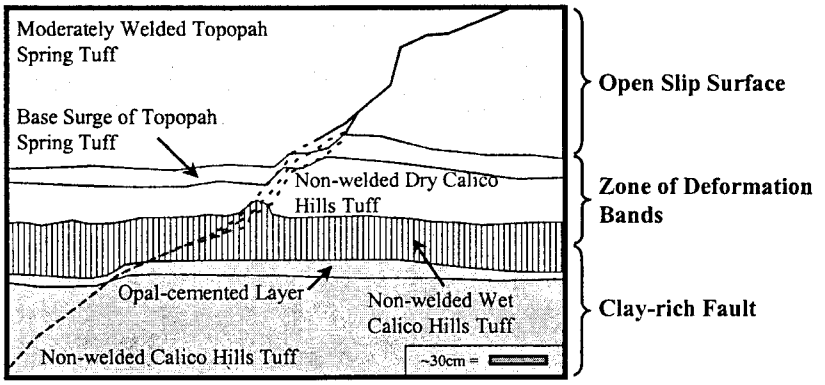
Wilson et al. (2002)



Back-scattered electron microprobe image of the deformation band seen in the field photo

Wilson et al. (2001, 2002)

Welding Controls the Variability of Fault-Zone Structures at Busted Butte, NV



Wilson et al. (2001)

Controls on Fault-Zone Permeability

- Permeability structure of a fault zone in ignimbrite is controlled by the type of fault-zone structure present (Wilson et al., 2002)
  - Based on the similarities in structures found in sandstones and poorly lithified sediments (e.g., Rawling et al., 2001; Sigda et al., 1999; Antonellini and Aydin, 1994)
    - Fracture-dominated faults (in welded units) have increased porosity and potentially enhanced saturated permeability
    - Deformation-band faults (in non-welded units) have decreased porosity and potentially decreased saturated permeability

Implications for Fluid Flow

- Permeability structure of faults in welded tuffs may be very different from that in non-welded tuffs
  - In high porosity sandstones and poorly lithified sediments, deformation bands decrease fault-zone permeability by three orders of magnitude (e.g., Sigda et al., 1999). The similarity in microstructures found in these materials and in ignimbrites suggests that a similar effect on permeability may exist in the Bandelier Tuff
  - Crushing of volcanic glass in deformation bands increases fluid-fault interactions, producing clay-rich or carbonate cemented fault zones, potentially further decreasing the permeability of these faults (Wilson et al., 2001; 2002)

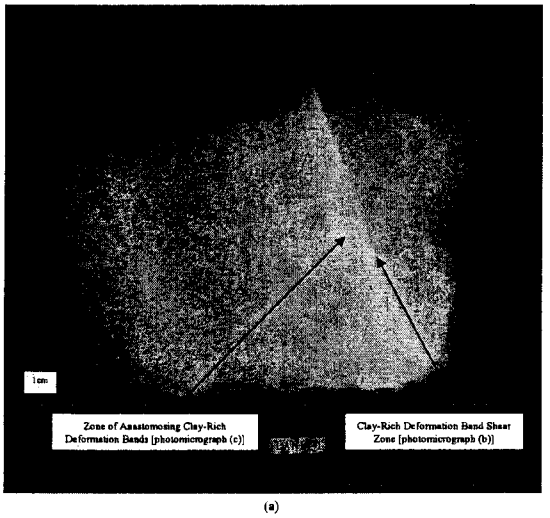
Implications for Fluid Flow

- Alternatively:
  - Crushing of pumice and glass shards may increase connectivity of previously isolated pore space, potentially enhancing fault-parallel permeability (Wilson et al., 2001; 2002)
  - In the vadose zone, capillary pressure effects may cause a deformation-band fault zone to be a fast path for fluid flow (Sigda et al., 1999; Antonellini and Aydin, 1994)
- **Although fractures and deformation bands may have dramatically different hydrologic properties, only fractures have been incorporated into flow models for the Pajarito Plateau**

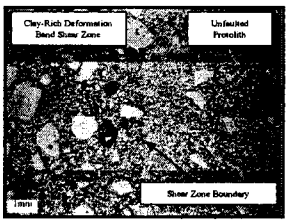
Future Research

- Hydrologic Studies
  - Test the hypothesis that fault-zone structures control and significantly impact fault-zone permeability
    - In situ fault-zone permeability measurements with an air minipermeameter
    - Dynamic experiments using neutron tomography to image fluid flow through deformation-band faults and fractures

Neutron Tomography: Initial (dry) Scan of a Clay-Rich Deformation Band Fault Zone



(a)



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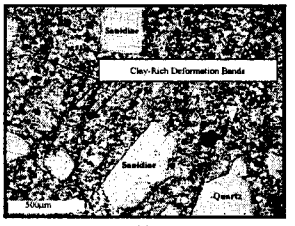

(c)

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Fracture Characterization of the Bandelier Tuff in Cañon de Valle, Los Alamos, NM for Seismic Hazards and Flow and Transport Analysis

Authors: Channell, R.A.[1], Lewis, C.[1], Criswell, C.W.[2], Lavine, A.[1], and Bostick, K.V.[1]

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[2] Roy F. Weston Inc., Albuquerque, NM

A seismic hazards investigation and the need to understand hydrologic transport through fractured bedrock motivated fracture characterization in the Tshirege Member of the Bandelier Tuff (welded and non-welded units 3, 3T, and 4) at material disposal area P (MDA-P) at Los Alamos National Laboratory. We measured 454 fractures along eight traverses to characterize fracture distribution, orientation, and aperture in three dimensions. Removal of over 50,000 cu yd of waste from MDA-P exposed 87% of the bedrock along traverses. Fractures show a preferred orientation of N15W with some scatter due to cooling joints. Background fracture density in the non-welded tuff is 20 fractures/100 ft, representing a tectonic signature. Apertures in all units are bimodal (0-4 mm and 10-14 mm); 79% of large apertures (20-110 mm) are in welded units 3 and 3T. Higher fracture densities (to 40 fractures/100 ft) and larger apertures in the welded tuffs demonstrate the influence of cooling joints. Only a few fractures are open; 89% are filled with clay and roots. The fractures dissecting MDA-P have a mean trace length of only 9.5 ft, and therefore are not large structural features. Geologic mapping adjacent to the study area indicates that fracturing may be related to monoclinal folding associated with deformation in the hanging wall of the Pajarito fault. Characterizing fractures at MDA-P also establishes a foundation for modeling flow and transport in fractured Bandelier Tuff.

Los Alamos National Laboratory
Hydrogeologic Characterization Program
Master Publication List

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Primary Author	Co-Authors	Date	Title	Report Number	Publishing Information
Ball, T.T.		2001	Use of Modern Project Management Techniques for the Hydrological Characterization Project at Los Alamos National Laboratory	ER2001-0930 and LA-UR-01-6171	Department of Energy Technical Information Exchange Workshop, November 13, 2001 Albuquerque, New Mexico
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Broxton, D.E.	R. Warren, D. Vaniman, B. Newman, A. Crowder, M. Everett, R. Gilkeson, P. Longmire, J. Marin, W.J. Stone, S. McLin, D. B. Rogers	2001	Characterization Well R-12 Completion Report	ER2000-0290 and LA-UR-00-3785	Los Alamos National Laboratory, Los Alamos, New Mexico
Broxton, D.E.	D. Vaniman, W. Stone, S. McLin, M. Everett, A. Crowder	2001	Characterization Well R-9i Completion Report	ER2000-0446 and LA-UR-00-4255	Los Alamos National Laboratory, Los Alamos, New Mexico
Broxton, D.E.	D. Vaniman, W. Stone, S. McLin, J. Marin, R. Koch, R. Warren, P. Longmire, D. Rogers, N. Tapia	2001	Characterization Well R-19 Completion Report	ER2000-0398 and LA-UR-00-4085	Los Alamos National Laboratory, Los Alamos, New Mexico
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Los Alamos National Laboratory
Groundwater Integration Team

Action Plan

for

External Advisory Group
December 2001 Recommendations

March 31, 2002

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INTRODUCTION

This Action Plan addresses the recommendations in the External Advisory Group's (EAG) fifth semi-annual report, "Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory by the External Advisory Group", dated December 2001. The EAG was established in October 1998 to provide a periodic external assessment of Los Alamos National Laboratory's (LANL or Laboratory) Hydrogeologic Characterization Program and the implementation of proposed characterization activities.

This is the fifth Action Plan written to address EAG recommendations. This Action Plan addresses the recommendations from the EAG October 2001 report. Recommendations from the previous EAG semi-annual reports dated November 1998, July 1999, December 1999, March 2000, December 2000, and June 2001 are included in Appendix A.

EAG DECEMBER 2001 RECOMMENDATIONS AND GIT PROPOSED ACTIONS

The following section provides a description of each EAG recommendation paraphrased from the October 2001 Semi-Annual Report, and the LANL Groundwater Integration Team (GIT) proposed action for addressing the recommendation. Each recommendation is provided a "tracking" number that includes the month and year of the EAG report from which it was taken. A summary table of each of the recommendations and proposed actions is provided (Table 1). The summary table also provides a crosswalk to previous EAG recommendations (November 1998, July 1999, December 1999, March 2000, December 2000, and June 2001 Semi-Annual Reports) that are similar.

MANAGEMENT AND GLOBAL ISSUES – Program Management

Recommendation 12-01-1: The EAG recommends revisions of the new scope to emphasize the broader nature of the mission of the Workplan.

The EAG recognizes the GIT efforts to refine the HWP scope, define needs to complete the Workplan, and monitor progress. Goal conflicts between participating organizations (GIT, ER, DP, and regulators) continue to be evident. The scope of the Workplan should be broader than understanding hydrogeologic settings for the purpose of establishing a monitoring network and should focus on long-term protection goals.

Proposed Action 12-01-1:

The ultimate scope of the hydrologic workplan is to support the scope of the Groundwater Protection Management Program Plan (GWPMPP), which was developed to evaluate the adequacy of the existing groundwater monitoring network in response to DOE Order 5400.1. One purpose of the GWPMPP is to present a Groundwater Monitoring Plan (GMP) to demonstrate compliance with applicable regulations, allow early detection of contamination, identify existing and potential groundwater contamination sources, and provide data upon which decisions can be made concerning land disposal practices and the protection of groundwater resources. The scope of the GWPMPP includes hydrogeologic characterization, contamination identification and control, and groundwater monitoring. The HWP was designed to provide a technical basis for evaluating the adequacy of the existing monitoring network and broadly identify groundwater contaminants.

The GIT has initiated a risk-based approach to assessing the adequacy of the existing regional groundwater-monitoring network including assessments of the need for new monitoring wells and/or additional characterization in support of monitoring.

The GIT agrees that the scope of LANL groundwater activities is larger than groundwater monitoring. The larger scope is the protection of groundwater resources for all current and future use. Such a scope includes the protection of groundwater from existing and potential contaminant sources. Therefore, we are developing a risk-based approach to groundwater protection considering all sources over "all time." The results of an all-pathways baseline risk-assessment will objectively identify the need for additional actions to meet the ultimate goal of the GWPMPP, actions which may include source control, additional characterization and monitoring. This mission will be incorporated into future documents, discussions, and presentations.

Recommendation 12-01-2: The EAG (as well as others present at the fall meeting) recommends the preparation of a draft final document, initially in outline and abstract form, showing the deliverables for the Workplan and balancing long and short term goals.

End products and the prioritization and risk drivers to define the path to these end products are still not well defined. It is recommended that the GIT prepare a draft outline and abstract detailing the deliverables and short- and long-term goals of the Workplan.

Proposed Action 12-01-2

The GIT concurs with the importance of concretely visualizing the final document for the Hydrogeologic Workplan. Note that, in part, the risk-based approach to determining monitoring and associated characterization needs (and other actions) will be addressing this recommendation. That is, an early step in this process is to document the current state of knowledge with respect to: a) potential sources; b) the vadose zone and; c) the regional aquifer. The GIT will continue to formalize the outline of the final document.

MANAGEMENT AND GLOBAL ISSUES – Management and Stakeholder Issues

Recommendation 12-01-3: The EAG should become more of a participant in the dialogue to clarify and crystallize stakeholder concerns rather than a passive gatherer of observations at the Stakeholders' meeting.

Proposed Action 12-01-3

The EAG is intended to be an independent peer review group. Meeting individually with stakeholders was originally suggested by the EAG and the conduct of those stakeholder meetings is within the purview of the EAG to define. While the GIT believes it is important for the EAG to retain the role of honest brokers of information between groups and not to become an advocate for any particular group, it is incumbent on the EAG to understand the concerns of any group well enough to thoroughly convey them.

Additionally, a new level of stakeholder involvement is proposed for the risk-based approach to groundwater monitoring. In this effort, we intend to bring stakeholders into the process of defining models and model input including coming to agreement on the type, extent, and adequacy of model-calibration data. In this forum we propose to come to agreement between LANL and the stakeholders about what is known about the geohydrology of the LANL area and to develop an objective, transparent approach to determine the adequacy of existing knowledge

for ensuring protection, and (if needed) to determine what additional actions are indicated to improve the state of knowledge to do so.

MANAGEMENT AND GLOBAL ISSUES – Data Quality Objectives

Recommendation 12-01-4: Decisions are needed as to what the goals and outputs of the Workplan will be, in a very specific sense. These should result from the "Core Team" meetings discussed during the presentations. These decisions will allow iteration of the relevant DQOs.

A DQO process is typically used to define/redefine the processes used to obtain program objectives, not change objectives. The EAG states that the DQO iteration process undertaken in 2001 redefined the scope of the Workplan to a limited objective of a monitoring well program. It is recommended that the DQO process be reviewed by the Core Team to verify the Workplan objectives and communicate these objectives to the GIT and stakeholders.

Proposed Action 12-01-4

The GIT envisions the role of the Core Team to be to establish a consensus on the groundwater protection criteria and the objectives and scope of the hydrogeologic characterization required to demonstrate the criteria are being met.

Recommendation 12-01-5: When the DQO iteration process is invoked, appropriate procedures should be followed to ascertain that all relevant aspects are addressed and that adequate documentation of changes results.

Several references were cited indicating DOE's acceptance and use of the DQO process. The EAG stated that the DQO iteration undertaken in 2001 was not a true DQO process, but a discussion between technical staff and without employing risk assessment or risk management decision-making. The EAG would like a more true and well-documented DQO process to be used in decision making.

Proposed Action 12-01-5:

The GIT does not agree that the definition of a "true" DQO process involves risk assessment or risk management decision-making. The EPA describes the DQO process as:

> "The DQO process is a strategic planning approach based on the Scientific Method that is used to prepare for a data collection activity. It provides a systematic procedure for defining the criteria that a data collection design should satisfy, including when to collect samples, the tolerable level of decision errors for the study, and how many samples to collect.
>
> By using the DQO Process, the Agency will assure that the type, quantity, and quality of environmental data used in decision-making will be appropriate for the intended application. In addition, the Agency will guard against committing resources to data collection efforts that do not support a defensible decision." (EPA, 1994. Guidance for the Data Quality Objectives Process, EPA QA/G-4, p. 1)

Thus, the DQO process is used to ensure that data collected is appropriate for the intended application, whether it be risk assessment or compliance with an NPDES permit. However, the GIT does agree with the importance of planning data collection activities using a well-documented DQO process.

MANAGEMENT AND GLOBAL ISSUES – Administrative

Recommendation 12-01-6: Designated time for report outlining and scheduling by the EAG at the end of the meeting with all EAG members participating.

Proposed Action 12-01-6:

The EAG is intended to be an independent peer review group and scheduling of EAG working time is within the purview of the EAG to implement. Although such EAG working time has always been included on the agenda on the final day of every review meeting, if additional time is required, the EAG should request a specific time on the agenda.

TECHNICAL ISSUES – Data Gathering and Database

Recommendation 12-01-7: Data transfer between ER and the WQDB needs to be accomplished in a smoother manner.

The EAG praised the development of the WQDB, to include collaboration of ER and ESH-18. However, data transfer delays between systems need to be addressed.

Proposed Action 12-01-7:

The GIT agrees that the data transfer between the Environmental Restoration Database (ERDB) and the Water Quality Database (WQDB) has been neither smooth nor timely. However, there has been significant progress since the October EAG review meeting and there will be a presentation and hands-on demonstration at the Annual Meeting in April 2002.

Recommendation 12-01-8: Resources should be managed such that data requests do not interfere with the development of the database.

The EAG recognizes that entities external to the program have requested data, which resulted in delays in database development and data transfer. Once the database is fully developed, these data requests can be easily managed. Until such time, it is requested that this issue be addressed by employing additional personnel to respond to these data requests or to minimize the external data requests until the system is complete.

Proposed Action 12-01-8:

The data requests referred to in the EAG report were directed at the Environmental Restoration Project. Management of the Environmental Restoration Project is not within the purview of the GIT.

Recommendation 12-01-9: Sufficient resources should be provided to maintain the expertise necessary for constructing and maintaining the database.

Delays in WQDB development resulted from a transfer from Oracle to SQL Server, which occurred because of the inability to keep Oracle-trained personnel. To avoid delays in the future, staff with data systems expertise need to be employed and maintained.

Proposed Action 12-01-9:

The Environmental Restoration Project's decision to transfer the ERDB from an Oracle platform to the SQL server was not within the purview of the GIT. The WQDB remains on the Oracle platform.

Recommendation 12-01-10: Some means of identifying and communicating which well installations and activities are most relevant to accomplishing Workplan goals should be devised.

Although the recent DQO iteration proposed Workplan revisions; i.e., modification of the number and placement of wells and the execution of field based activities, the EAG would like to see data to support these proposed changes. Without risk-based decision-making and defined end-states, it is unclear whether revisions are adequate for data needs. The Core Team should be tasked to define Workplan end-states and conduct sensitivity analyses to evaluate which parameters are required to sufficiently address data needs.

Proposed Action 12-01-10:

The GIT envisions the role of the Core Team to be to establish a consensus on the groundwater protection criteria and the objectives and scope of the hydrogeologic characterization required to demonstrate the criteria are being met. Detailed sensitivity analysis is beyond the scope of the Core Team task.

TECHNICAL ISSUES – Modeling

Recommendation 12-01-11: Reexamine modeling "data needs" identified in Appendix A of Revised Hydrogeologic Workplan Scope in light of ultimate end uses of data in risk assessment (i.e. protecting beneficial uses of groundwater), remedial decision making, and higher Laboratory risk management functions.

Reference Recommendation 12-01-5. The EAG recommends defining data end-uses employing risk assessment and then revisit the DQO iteration decisions in light of defined end uses.

Proposed Action 12-01-11:

The GIT concurs with the need to understand the end-state in order to tailor the modeling and other activities to accomplish the mission. The role of the Core Team is critical to this because the Core Team will develop a consensus on the groundwater protection criteria and the objectives and scope of the hydrogeologic characterization required to demonstrate that the criteria are being met. This process is expected to provide the data end-uses and risk assessment goals that are necessary for defining modeling data needs.

Recommendation Requiring Additional Action:

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

The GIT believes that the code selected for the groundwater process modeling is appropriate as a tool for decision-makers at LANL. The groundwater process models for the vadose zone and regional aquifer are implemented with the Finite Element Heat and Mass (FEHM) flow and transport code, which was developed at the Laboratory in support of the Yucca Mountain Project. FEHM is a two- or three-dimensional finite-element/finite-volume code suitable for simulating systems with complex geometries that arise when modeling subsurface flow and transport. In the unsaturated zone, the governing equations for flow are based on the principles of conservation of water and air, whereas in the regional aquifer, a one-phase system is assumed. Darcy's law is assumed to be valid for the movement of the air and water phases in the unsaturated zone and for the water phase in the saturated zone. Contaminant transport and particle tracking modules are also available to perform simulations of the movement of natural chemicals present in the groundwater as well as contaminants. It should also be pointed out that the relative simplicity or complexity of a model has very little to do with the computer code used. We are currently using FEHM in rather simple ways to handle the vadose zone (a series of one-dimensional pathways) and in more complex modeling of the regional aquifer. The choice depends on the needs of the project, the complexity of the site, and data availability. The GIT believes that the complexity of our models is already tailored to the specific need, and that the models are as simple as necessary to address the relevant issues.

TECHNICAL ISSUES – Geochemistry and Geochemical Modeling

Recommendation 12-01-12: Carry out the adsorption studies requested for the Cerros del Rio basalt and Puye formation, as discussed during the presentations, provided some level of risk analysis improvement can be demonstrated and that the work is completed within three years, i.e., by the end of the program.

Although no risk sensitivity analyses have been applied to mineralogical phases, the EAG understands that mineralogic factors of subsurface characterization will most likely affect contaminant transport and fate, particularly for metals and radionuclides. It is recommended that adsorption studies be conducted and in conjunction with the canyon percolation rates study for purposes of cost effectiveness.

Proposed Action 12-01-12:

The GIT envisions the role of the Core Team to be to establish a consensus on the groundwater protection criteria and the objectives and scope of the hydrogeologic characterization required to demonstrate the criteria are being met. Sorption studies will be within the scope that is considered by the Core Team.

TECHNICAL ISSUES – Drilling and Well Completion

Recommendation 12-01-13: Track the drilling environment as well as the cost consequences of open hole drilling versus casing advance methods so that optimum decisions regarding drilling method can be made on subsequent R wells on a case by case basis.

Drilling plans for R wells calls for open hole drilling with casing advance as a last resort option. The EAG understands that open hole drilling is less expensive than casing advance; however, open hole drilling has a greater risk of collapse resulting in unplanned costs for redrilling and, potentially, retrieving lost tools. The EAG recommends tracking open hole drilling outcomes and costs and comparing these to casing advance. This results of this effort should then be used on a case be case basis in determining the most cost effective drilling method for each well.

Proposed Action 12-01-13:

The GIT is expanding the currently utilized drilling methodologies to include fluid drilling technologies and the use of permanent conductor casing in the vadose zone. Beginning with well R-14, which will start mid-May, 2002 the borehole will be drilled using open-hole drilling techniques to a depth within approximately 100 feet of the top of the regional aquifer (approximately 700 feet). If borehole stability becomes an issue during drilling, a thin-walled steel casing will be installed to keep the borehole open. In either case, once the borehole reaches the 100 foot depth above the top of the regional aquifer, a thin-walled steel casing will be run from the surface to that depth, and will be pressure-sealed with cement from the bottom to the surface. At that point, a sealed conductor pipe will then exist throughout the vadose zone, and the drilling technique will be changed to flooded-reverse drilling with mud. The borehole will reach its total depth using this drilling method; a stainless steel well string will be installed and backfilled; and the well will be rigorously developed to meet the Laboratory's well development specifications. Similar approaches will be used on subsequent wells according to the dictates of specific DQOs for those wells. From the outset of the drilling program, the GIT has operated with a commitment to flexibility and mid-course improvement. As we continue to experiment with a number of variables, we are attempting the strike the right balance between cost-effectiveness and timeliness on the one hand, versus collection of complete information on the other. We agree that the ultimate goal is to achieve the DQOs for each well, and we will welcome the EAG's continuing assistance in negotiating both the DQOs and a set of drilling methodologies that will achieve the goals of the Hydrogeologic Workplan.

Recommendation 12-01-14: Document costs, both direct and indirect, and other deleterious consequences associated with funding-related shutdown and restarting of the R well drilling program.

Lack of funding can result in drilling shutdown, demobilization, remobilization, and retraining, adding to the cost of well drilling. The EAG would like program management to find ways to lessen the effect of drilling inefficiencies related to funding issues.

Proposed Action 12-01-14:

The GIT concurs with the EAG that starting and stopping the drilling program has adverse effects. The start-and-stop nature of the drilling program has not been exclusively the result of funding, but also in uncertainty in wells, quality-related (drilling stand-down), safety-related (flooding), and Threatened and Endangered Species-related. However, if there was a more certain funding profile, then planning and contracting for wells would improve. Despite

recognizing the problem exists, the GIT does not agree that the effort spent to document those costs would be successful in changing any of the factors that cause starting-and-stopping.

Recommendation 12-01-15: Apprise NMED representatives of the rationale for the current well screen/casing design, so they understand the properties of the materials and their suitability for use in the R wells.

NMED has the impression that R well screens are hydraulically inferior and that rod base screens should be used. LANL should make an effort to provide design, rationale, and facts to NMED regarding the appropriateness and efficiency of the screens currently used.

Proposed Action 12-01-15:

The NMED expressed their concern over the well screen and casing design in a letter dated March 1, 2002. The response to the NMED March 1 letter on this subject was:

> "The switch to pipe-based screens was a result of failure of standard wire screens to withstand the forces encountered during installation and construction of the deep regional wells. The pipe-based well screens were designed to provide maximum strength while maintaining reasonable open area for hydraulic performance. Johnson Well Screen fabricates the Laboratory pipe-based screens presently in use as per specifications recommended by the EAG. The base pipe in use is the blank casing used in the well completion. The perforated section of the base pipe is manufactured by drilling 84 half inch holes per linear foot. This design provides an open area of 8.75% of the pipe surface area. The screen jacket is a continuous-slot V-shaped, non-clogging, wire wound design and conforms to industry standards. The slot size of the screen jacket is .010-inch and provides an open area of 14.29%.
>
> The total area of holes (% open area) in the pipe is less than the area of the slot openings of the outer screen jacket. Therefore hydraulic performance of the screen is dependent on the % open area of the pipe base. The advantage of the screen lies in its increased strength allowing for safer installation and for more vigorous and sustained well development, thereby allowing for removal of EZ Mud and fines present in and adjacent to the filter pack. Review of well development and quarterly sampling data indicates turbidity values of less than 5 NTUs, which would indicate that the fines are not being trapped in the screen, but are being developed and removed from the well
>
> The deep and intermediate well screens installed as part of the Hydrogeologic Workplan and ER groundwater investigations are generally less than 20 ft in length. A tabulation of screen lengths for each well is listed in the table below. Except in one case (MCOBT-4.4, see table below), only those screens straddling the top of the regional aquifer exceed 20 feet. The lengths of screens straddling the top of regional aquifer are based on an expected well life of 30 to 40 years and on historic drawdown patterns recorded for nearby water-supply and test wells (e.g. Rogers et al., 1996). The EPA TEGD guidance on the selection of appropriate well screen and casing materials implicitly recognizes the long expected life of these wells through their statement that "Long term structural integrity, i.e., 30 or more years, is essential to the collection of unbiased groundwater samples over the lifetime of the facility and post-closure period" (EPA, 1986, p.81)."

TECHNICAL ISSUES – Hydrology

Recommendation 12-01-16: Avoid the expense of devoting the cost of R wells or new piezometers for the sole purpose of acquiring hydraulic data from the regional aquifer.

While recognizing the need for large scale hydraulic information and the process required to obtain this information, the EAG recommends not installing an R well for the sole purpose of gathering hydraulic information because of the high cost of well installation. Multiple well pumping could be achieved with the use of existing observation wells. However, if well installation is being considered for the purpose of supporting pumping tests, the well installation cost should be carefully weighed against the information that could be acquired from such tests.

Proposed Action 12-01-16:

The GIT concurs with the EAG and are not advocating the drilling of any R well to be used exclusively for monitoring during a pump test. All R-wells are used to collect geochemical, geologic, and hydrologic data. The location of an R-well very close to a water supply well does not mean it is not useful in the site-wide characterization effort. In addition to getting geologic and geochemical data, the well would provide hydrologic data based on a multiple-well pumping test and data to improve our understanding of the hydrostratigraphic setting of a water supply well, which would be very beneficial for capture zone delineation & wellhead protection. Finally, such a well could be used as a sentry well.

Recommendation 12-01-17: Caution is warranted if the GIT decides to perform a forced gradient tracer test and personnel experienced in these types of tests should be used.

Because forced gradient tracer tests are difficult and expensive, the EAG would like to see LANL employ an organization experienced in performing these tests.

Proposed Action 12-01-17:

The GIT concurs with the EAG that if a forced gradient tracer test were undertaken, an experienced organization should be employed to conduct the testing. Such experience exists at LANL, having carried out tests like this for the Yucca Mountain Project and the Nevada Test Site Environmental Restoration Project, but LANL is also open to suggestions from the EAG if such a test were conducted.

Recommendation 12-01-18: Demonstrate that data obtained from colloidal borescope flow measurements will provide useful information to the Workplan project, regardless of the inherent limitations of this method.

Measurements of horizontal groundwater velocities within boreholes and water supply wells might be made using a colloidal borescope and possibly a flowmeter. The EAG warns that misleading results can be obtained for these tests. Two influences may affect the readings: 1) in wells with long or multiple screens, vertical gradients will induce vertical flow and turbulence within well casing and screen; and 2) horizontal velocity within a screen is affected by well efficiency because it is difficult for water to enter and exit a borehole that is plugged than one that is open. Therefore, horizontal velocities inside the well may be biased downward by an order of magnitude by well efficiency.

The EAG also warns that thermal gradients and other colloidal borescope effects might be significant across the diameter of a large borehole. There is potential of random movement of colloids within a large diameter well, rather than a predominantly unidirectional movement. The

EAG requests information regarding planned use of the data acquired from these tests and projected costs of these tests.

Proposed Action 12-01-18:

The GIT agrees with the EAG that the use of a colloidal boroscope would have to be fully investigated before employing such a methodology.

TECHNICAL ISSUES – Groundwater Monitoring

Recommendation 12-01-19: Sampling of the single completion wells should be accomplished using low-flow rate purging and sampling techniques, not by purging 3 well volumes.

The EAG states that the approach of purging three well volumes prior to sampling single completion wells is inappropriate, and recognizes that this approach may be being used because of the lack of formalized low-flow purging and guidance from NMED. It is recommended that the GIT obtain concurrence from NMED to use low-flow techniques.

Proposed Action 12-01-19:

The GIT does not agree that the single completion wells should be sampled using low-flow methods. The major obstacle is that the pumps that are installed in the single completion wells are not suitable for low-flow sampling. However, the current single completion sampling procedures appear to be adequate because the resulting samples are consistent and representative of the aquifer. The multiple completion wells outfitted with Westbay equipment are sampled using low flow methods.

Recommendation 12-01-20: Sampling SOPs should be completed.

It is recognized that SOPs provide guidance and assurances that procedures are being implemented correctly and consistently. The EAG did not see evidence that the new or modified sampling SOPs are available and would like completion of the documents as soon as possible.

Proposed Action 12-01-20:

The revised SOPs are complete and are available through the Environmental Restoration Project.

TECHNICAL ISSUES – Risk Based Assessment

Recommendation 12-01-21: The goals of the Workplan should reflect the broader risk perspectives of LANL and not just support of a monitoring objective or a more limited role of supporting only the ER mission.

Reference 12-01-1.

Proposed Action 12-01-21:

The GIT agrees that the mission of the Hydrogeologic Workplan is not solely the design of a monitoring network or support of the ER Project. The broadest goal for the GWPMPP is the protection of groundwater for all current and future uses. We are developing a risk-based approach to integrate source removal and control, pollution prevention, characterization, and monitoring to support this broader goal.

Recommendation 12-01-22: The term "characterization" needs to be defined as a practical matter to meet the risk- based objectives of the Workplan and to give the Workplan a clear set of parameters for defining when the Workplan goals have been met, i.e., define characterization in terms of scientific adequacy to meet the Workplan goal of protecting beneficial groundwater uses.

The Workplan's goals and objectives, protecting beneficial uses of groundwater, are risk-related. The EAG recommends a risk-based management strategy in defining "characterization" for the purpose of meeting Workplan goals and objectives. This approach will facilitate the answers to the risk questions of how likely it is that an event will occur, and if an event does occur, what will be the quantitative impact.

Proposed Action 12-01-22:

The GIT agrees, but believes the term in need of definition is 'adequate characterization' because the scientific use the term characterization does not and could not have a defined endpoint – we can always learn more. On the other hand, we intend to define 'adequate characterization' as the amount of characterization that will support a conclusion that a combination of activities (monitoring, source control and removal, and characterization) will provide for protection of the regional aquifer.

Recommendation 12-01-23: A hierarchy of risk-based decision criteria taken from the recommendation above, can productively yield the remaining steps of modeling which drives data collection which drives well siting and drilling, defining endpoints and a ranking of the most important data required to meet the "characterization" objectives.

Proposed Action 12-01-23:

The GIT concurs with this recommendation. For clarification we point out that the criteria set by the Core Team will drive the risk-based decision analysis and identify activities (combinations of new monitoring wells various characterization activities) that if funded provide an acceptable likelihood of successfully meeting the Core Team goals/criteria.

Recommendation 12-01-24: Risk-based decision drivers should be used to set priorities amongst the various data needs (presented in the management meeting,), i.e., the use of a sensitivity analysis to determine which data gaps will likely have the greatest impact on the "characterization" program as defined in risk-based terms recommended above. The EAG recommends a more structured approach is needed for setting data need priorities than a "gut feel" approach.

Proposed Action 12-01-24:

The GIT agrees that a structured approach to defining data needs is required. For clarification, the current approach uses formal decision analysis instead of mathematical sensitivity analysis. The difference being: Our approach will focus on prioritizing activities that, if funded, have an acceptable likelihood of changing a decision. Take one example: the measurement of effective porosity. There is little doubt that sensitivity analysis will yield effective porosity as an important parameter with respect to groundwater travel times. However that alone does not address the key issues: 1) can we live with the current uncertainty in groundwater travel times with respect to a given goal/criteria and; 2) even with large amounts of time and money are we likely to significantly reduce the uncertainty in effective porosities across the laboratory and by enough to change a real decision (add or subtract monitoring wells, clean up or not clean up a site, etc.).

On the other hand, the risk-based decision analysis will be structured to quantitatively address these questions.

Recommendation 12-01-25: To the extent that the EAG understands the risk-based approach presented at the quarterly meeting, there is some implication that the current state of subsurface characterization is sufficient to satisfy a risk-based decision framework with no more characterization required. If this understanding is correct, the EAG is concerned that this might not be an accurate assessment and recommends that this hypothesis be tested to ascertain if this conclusion is correct.

Proposed Action 12-01-25:

The GIT did not intend to imply that there is known to be sufficient characterization information. The approach makes no a priori judgment as to the adequacy of the current state of characterization. Instead we ask the GIT to quantify the current state of knowledge specifically including any and all uncertainties associated with this knowledge. As the end of the risk-based analysis we ask the following questions; a) is the goal met, in which case the current level of uncertainty is acceptable and; b) if not, which combination of additional monitoring wells and/or characterization would, if funded, have the highest likelihood of reducing uncertainties to the point of meeting the goal.

Recommendation 12-01-26: The Workplan repeatedly invokes the term "risk." In this regard, the EAG recommends that an effort needs to be commenced to set risk limits for contaminants of greatest concern.

To take further the risk-based program, the EAG feels that the next step is to establish risk limits for contaminants of greatest concern.

Proposed Action 12-01-26:

The GIT anticipates that the Core Team will set an overall risk goal to be achieved. Once the goal is established, a quantitative (i.e., probabilistic) all sources risk assessment will be conducted, the results of which will be used to evaluate the adequacy of the existing monitoring network to meet the risk goal. If the risk goal is not met, then potential contaminants of concern will be identified from the results of the risk assessment. The goal then of the monitoring network will be to protect any receptor from an undue risk from any single contaminant or any combination of contaminants. In turn, the monitoring well network will evaluate detection data in light of the total risk to a receptor.

Recommendation 12-01-27: Risk drivers are identified in Appendix A of the revised Workplan scope: "Perchlorate, RDX, and TNT are the present day risk drivers for groundwater at the laboratory because their action and/or health advisory levels are less than 20µg/l." This statement should be re-assessed to relate the term "risk driver" not just to a health advisory level, but to potential off-site receptor exposure levels. It is the combination of the two factors, toxicity and potential exposure (levels associated with transport and fate), that will ultimately determine the drivers. Conversely, levels of other agents could also be risk drivers even if their health-based levels are higher but corresponding potential exposures are also higher. The EAG recommends revisiting the current approach as it is outlined in Appendix A.

Proposed Action 12-01-27:

The approach outlined in Appendix A is being replaced by the risk-based decision analysis being carried out in cooperation with the LANL ER Project. In this new approach, the actual drivers to risk cannot be identified a priori. The new process to identifying 'risk drivers' is as follows: 1) all potential contaminants are identified; 2) a quantitative, consistent, and documented approach to screening contaminants is applied; 3) the remaining contaminants are included in vadose zone and aquifer flow and transport modeling; 4) risk to actual receptors is calculated using the results of the transport modeling and; 5) if the Core Team risk criteria are exceeded, then activities are defined that lead to successful management and reduction of risk (including additional monitoring, additional characterization, and potential source removal). It is at this last stage that any specific 'risk-drivers' will be identified. Thus, the GIT agrees that the term "risk driver" was inappropriately used in Appendix A of the DQO reiteration document that was distributed at the Quarterly Meeting in October 2001 and Appendix A will be revised accordingly.

Recommendation Requiring Additional Action:

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

EAG INFORMATION REQUESTS

The information requested in this section will be provided to the EAG during the Annual Meeting on April 10-12.

- **Additional information on the top-down modeling approach**: The EAG would like information regarding what form the top-down modeling program will take, what models might be used, and how models will be integrated.
- **NMED Modeling Information Request**: The EAG requests information on any clarification provided by NMED in response to a GIT letter requesting clarification of NMED requested modeling-related data and information.
- **Integration of Hydrogeologic Characterization and ER Modeling**: Referencing Recommendation 12-00-33, the EAG would like to renew the request for information regarding the integration of the characterization and ER modeling projects; in particular, information regarding which modeling activities and analysis results will be integrated into the program to meet DQOs and to support risk management decisions.
- **Hydrology**: The EAG requests colloidal boroscope testing plans (target wells/zones, test objectives, proposed data interpretation approach, projected costs).
- **ER Risk Activities**: Regarding the October 2001 Quarterly Meeting presentation titled, "Integration of Aquifer Characterization and ER Needs", the EAG requests:
  - information supporting the assumption (?) that the Workplan falls in the category presented in the visual display as "Can additional regional characterization reduce monitoring costs?"
  - the definition of monitoring in the context of the presentation
  - criteria for determining the cost tradeoffs between more characterization and monitoring
  - clarification of approach to monitoring well placement
  - information on why the goal of the monitoring network is set as minimizing risk of an undetected, offsite release
  - definition of risk in the presentation
  - definition of long-term mortgage
  - information on why the term 10^{-6} per years was used instead of 10^{-6} per lifetime
  - information on why the certainty goals is set at 95%
- The EAG would like clarification as to whether the monitoring network proposal includes continued interaction with the Workplan or does the Workplan end when ER monitoring network commences. It the monitoring network will not utilize the Workplan, how will the ER program determine if it has sufficient characterization data to fill its needs and by what measures is this being determined.

TABLE 1.
EAG CURRENT RECOMMENDATIONS AND PROPOSED ACTIONS

Number	Recommendation	Action	Estimate of Schedule and Funding Impacts from Recommendation
12-01-1	Recommends revisions of the new scope to emphasize the broader nature of the mission of the Workplan.	The mission is to understand the hydrogeologic system below the Laboratory as a technical basis for decisions related to protecting and preserving groundwater as a resource for future generations while the Lab continues to operate. This mission will be incorporated into future documents.	No funding or schedule impacts are anticipated.
12-01-2	Recommends the preparation of a draft final document, initially in outline and abstract form, showing the deliverables for the Workplan and balancing long and short term goals.	The GIT concurs with the importance of concretely visualizing the final document for the Hydrogeologic Workplan. The GIT will continue to formalize the outline of the final document.	No funding or schedule impacts are anticipated.
12-01-3	The EAG should become more of a participant in the dialogue to clarify and crystallize stakeholder concerns rather than a passive gatherer of observations at the Stakeholder's meeting.	The conduct of those stakeholder meetings is within the purview of the EAG to define. The GIT believes it is incumbent on the EAG to understand the concerns of any group well enough to thoroughly convey them.	No funding or schedule impacts are anticipated
12-01-4	Decisions are needed as to what the goals and outputs of the Workplan will be, in a very specific sense. These should result from the "Core Team" meetings discussed during the presentations. These decisions will allow iteration of the relevant DQOs.	The GIT envisions the role of the Core Team to be to establish a consensus on the groundwater protection criteria and the objectives and scope of the hydrogeologic characterization required to demonstrate the criteria are being met.	It is anticipated that there could be significant effects on the scope and schedule from Core Team decisions, but it is unknown what those effects might be.
12-01-5	When the DQO iteration process is invoked, appropriate procedures should be followed to ascertain that all relevant aspects are addressed and that adequate documentation of changes results.	The DQO process is used to ensure that data collected is appropriate for the intended application and the GIT does agree with the importance of planning data collection activities using a well-documented DQO process.	No funding or schedule impacts are anticipated

TABLE 1.
EAG CURRENT RECOMMENDATIONS AND PROPOSED ACTIONS

Number	Recommendation	Action	Estimate of Schedule and Funding Impacts from Recommendation
12-01-6	Designated time for report outlining and scheduling by the EAG at the end of the meeting with all EAG members participating.	The EAG is intended to be an independent peer review group and scheduling of EAG working time within the purview of the EAG to implement.	No funding or schedule impacts are anticipated
12-01-7	Data transfer between ER and the WQDB needs to be accomplished in a smoother manner.	There has been significant progress since the October EAG review meeting and there will be a presentation and hands-on demonstration at the Annual Meeting in April 2002.	No funding or schedule impacts are anticipated
12-01-8	Resources should be managed such that data requests do not interfere with the development of the database.	The data requests referred to in the EAG report were directed at the Environmental Restoration Project. Management of the Environmental Restoration Project is not within the purview of the GIT.	No funding or schedule impacts are anticipated
12-01-9	Sufficient resources should be provided to maintain the expertise necessary for constructing and maintaining the database.	The Environmental Restoration Project's decision to transfer the ERDB from an Oracle platform to the SQL server was not within the purview of the GIT. The WQDB remains on the Oracle platform.	No funding or schedule impacts are anticipated
12-01-10	Some means of identifying and communicating which well installations and activities are most relevant to accomplishing Workplan goals should be devised.	The GIT envisions the role of the Core Team to be to establish a consensus on the groundwater protection criteria and the objectives and scope of the hydrogeologic characterization required to demonstrate the criteria are being met.	It is anticipated that there could be significant effects on the scope and schedule from Core Team decisions, but it is unknown what those effects might be.

TABLE 1.
EAG CURRENT RECOMMENDATIONS AND PROPOSED ACTIONS

Number	Recommendation	Action	Estimate of Schedule and Funding Impacts from Recommendation
12-01-11	Reexamine modeling "data needs" identified in Appendix A of Revised Hydrogeologic Workplan Scope in light of ultimate end uses of data in risk assessment (i.e. protecting beneficial uses of groundwater), remedial decision making, and higher Laboratory risk management functions.	The GIT concurs with the need to understand the end-state in order to tailor the modeling and other activities to accomplish the mission. The Core Team process is expected to provide the data end-uses and risk assessment goals that are necessary for defining modeling data needs.	It is anticipated that there could be significant effects on the scope and schedule from Core Team decisions, but it is unknown what those effects might be.
12-01-12	Carry out the adsorption studies requested for the Cerros del Rio basalt and Puye formation, as discussed during the presentations, provided some level of risk analysis improvement can be demonstrated and that the work is completed within three years, i.e., by the end of the program.	The GIT envisions the role of the Core Team to be to establish a consensus on the groundwater protection criteria and the objectives and scope of the hydrogeologic characterization required to demonstrate the criteria are being met. Sorption studies will be within the scope that is considered by the Core Team.	It is anticipated that there could be significant effects on the scope and schedule from Core Team decisions, but it is unknown what those effects might be.
12-01-13	Track the drilling environment as well as the cost consequences of open hole drilling versus casing advance methods so that optimum decisions regarding drilling method can be made on subsequent R wells on a case by case basis.	The GIT is expanding the currently utilized drilling methodologies to include fluid drilling technologies and the use of permanent conductor casing in the vadose zone.	There is anticipated to be a positive impact on schedule and funding from expanding the drilling options.
12-01-14	Document costs, both direct and indirect, and other deleterious consequences associated with funding-related shutdown and restarting of the R well drilling program.	Despite recognizing the problem exists, the GIT does not agree that the effort spent to document those costs would be successful in changing any of the factors that cause starting-and-stopping.	No impact is expected because the GIT declines to implement the recommendation.

TABLE 1.
EAG CURRENT RECOMMENDATIONS AND PROPOSED ACTIONS

Number	Recommendation	Action	Estimate of Schedule and Funding Impacts from Recommendation
12-01-15	Apprise NMED representatives of the rationale for the current well screen/casing design, so they understand the properties of the materials and their suitability for use in the R wells.	A letter responding to NMED concerns about well screen and casing design in was sent on March 29, 2002.	No funding or schedule impacts are anticipated
12-01-16	Avoid the expense of devoting the cost of R wells or new piezometers for the sole purpose of acquiring hydraulic data from the regional aquifer.	The GIT concurs with the EAG and are not advocating the drilling of any R well to be used exclusively for monitoring during a pump test.	No funding or schedule impacts are anticipated
12-01-17	Caution is warranted if the GIT decides to perform a forced gradient tracer test and personnel experienced in these types of tests should be used.	The GIT concurs with the EAG that if a forced gradient tracer test were undertaken, an experienced organization should be employed to conduct the testing.	No funding or schedule impacts are anticipated
12-01-18	Demonstrate that data obtained from colloidal borescope flow measurements will provide useful information to the Workplan project, regardless of the inherent limitations of this method.	The GIT agrees with the EAG that the use of a colloidal boroscope would have to be fully investigated before employing such a methodology.	No funding or schedule impacts are anticipated
12-01-19	Sampling of the single completion wells should be accomplished using low-flow rate purging and sampling techniques, not by purging 3 well volumes.	The GIT does not agree that the single completion wells should be sampled using low-flow methods. The multiple completion wells outfitted with Westbay equipment are sampled using low flow methods.	No funding or schedule impacts are anticipated
12-01-20	Sampling SOPs should be completed.	The revised SOPs are complete and are available through the Environmental Restoration Project.	No funding or schedule impacts are anticipated

TABLE 1.
EAG CURRENT RECOMMENDATIONS AND PROPOSED ACTIONS

Number	Recommendation	Action	Estimate of Schedule and Funding Impacts from Recommendation
12-01-21	The goals of the Workplan should reflect the broader risk perspectives of LANL and not just support of a monitoring objective or a more limited role of supporting only the ER mission.	The GIT agrees that the mission of the Hydrogeologic Workplan is not solely the design of a monitoring network or support of the ER Project. The broadest goal for the GWPMPP is the protection of groundwater for all current and future uses. We are developing a risk-based approach to integrate source removal and control, pollution prevention, characterization, and monitoring to support this broader goal.	No funding or schedule impacts are anticipated
12-01-22	The term "characterization" needs to be defined as a practical matter to meet the risk- based objectives of the Workplan and to give the Workplan a clear set of parameters for defining when the Workplan goals have been met, i.e., define characterization in terms of scientific adequacy to meet the Workplan goal of protecting beneficial groundwater uses.	The GIT agrees, but believes the term in need of definition is 'adequate characterization' because the scientific use the term characterization does not and could not have a defined endpoint – we can always learn more. On the other hand, we intend to define 'adequate characterization' as the amount of characterization that will support a conclusion that a combination of activities (monitoring, source control and removal, and characterization) will provide for protection of the regional aquifer.	It is anticipated that there could be significant effects on the scope and schedule from Core Team decisions, but it is unknown what those effects might be.
12-01-23	A hierarchy of risk-based decision criteria taken from the recommendation above, can productively yield the remaining steps of modeling which drives data collection which drives well siting and drilling, defining endpoints and a ranking of the most important data required to meet the "characterization" objectives.	The criteria set by the Core Team will drive the risk-based decision analysis and identify activities (combinations of new monitoring wells various characterization activities) that if funded provide an acceptable likelihood of successfully meeting the Core Team goals/criteria.	It is anticipated that there could be significant effects on the scope and schedule from Core Team decisions, but it is unknown what those effects might be

TABLE 1.
EAG CURRENT RECOMMENDATIONS AND PROPOSED ACTIONS

Number	Recommendation	Action	Estimate of Schedule and Funding Impacts from Recommendation
12-01-24	Risk-based decision drivers should be used to set priorities amongst the various data needs (presented in the management meeting,), i.e., the use of a sensitivity analysis to determine which data gaps will likely have the greatest impact on the "characterization" program as defined in risk-based terms recommended above. The EAG recommends a more structured approach is needed for setting data need priorities than a "gut feel" approach.	The GIT agrees that a structured approach to defining data needs is required. For clarification, the current approach uses formal decision analysis instead of mathematical sensitivity analysis.	It is anticipated that there could be significant effects on the scope and schedule from Core Team decisions, but it is unknown what those effects might be
12-01-25	To the extent that the EAG understands the risk-based approach presented at the quarterly meeting, there is some implication that the current state of subsurface characterization is sufficient to satisfy a risk-based decision framework with no more characterization required. If this understanding is correct, the EAG is concerned that this might not be an accurate assessment and recommends that this hypothesis be tested to ascertain if this conclusion is correct.	The GIT did not intend to imply that there is known to be sufficient characterization information. The approach makes no a priori judgment as to the adequacy of the current state of characterization. Instead we ask the GIT to quantify the current state of knowledge specifically including any and all uncertainties associated with this knowledge. As the end of the risk-based analysis we ask the following questions; a) is the goal met, in which case the current level of uncertainty is acceptable and; b) if not, which combination of additional monitoring wells and/or characterization would, if funded, have the highest likelihood of reducing uncertainties to the point of meeting the goal.	It is anticipated that there could be significant effects on the scope and schedule from Core Team decisions, but it is unknown what those effects might be

TABLE 1.
EAG CURRENT RECOMMENDATIONS AND PROPOSED ACTIONS

Number	Recommendation	Action	Estimate of Schedule and Funding Impacts from Recommendation
12-01-26	The Workplan repeatedly invokes the term "risk." In this regard, the EAG recommends that an effort needs to be commenced to set risk limits for contaminants of greatest concern.	The GIT anticipates that the Core Team will set an overall risk goal to be achieved. Once the goal is established, a quantitative (i.e., probabilistic) all sources risk assessment will be conducted, the results of which will be used to evaluate the adequacy of the existing monitoring network to meet the risk goal. If the risk goal is not met, then potential contaminants of concern will be identified from the results of the risk assessment. The goal then of the monitoring network will be to protect any receptor from an undue risk from any single contaminant or any combination of contaminants. In turn, the monitoring well network will evaluate detection data in light of the total risk to a receptor.	It is anticipated that there could be significant effects on the scope and schedule from Core Team decisions, but it is unknown what those effects might be

TABLE 1.
EAG CURRENT RECOMMENDATIONS AND PROPOSED ACTIONS

Number	Recommendation	Action	Estimate of Schedule and Funding Impacts from Recommendation
12-01-27	Risk drivers are identified in Appendix A of the revised Workplan scope: "Perchlorate, RDX, and TNT are the present day risk drivers for groundwater at the laboratory because their action and/or health advisory levels are less than 20µg/l." This statement should be re-assessed to relate the term "risk driver" not just to a health advisory level, but to potential off-site receptor exposure levels. It is the combination of the two factors, toxicity and potential exposure (levels associated with transport and fate), that will ultimately determine the drivers. Conversely, levels of other agents could also be risk drivers even if their health-based levels are higher but corresponding potential exposures are also higher. The EAG recommends revisiting the current approach as it is outlined in Appendix A.	The approach outlined in Appendix A is being replaced by the risk-based decision analysis being carried out in cooperation with the LANL ER Project. In this new approach, the actual drivers to risk cannot be identified a priori.	No funding or schedule impacts are anticipated

APPENDIX A: COMPREHENSIVE LIST OF RECOMMENDATIONS AND STATUS OF PROPOSED ACTIONS

The EAG will produce two reports, e.g., "External Advisory Group Semi-Annual Report", for each fiscal year of implementation of the Hydrogeologic Characterization Program. Each report will contain the EAG's comments and recommendations. The Laboratory will address the comments and recommendations in an action plan for each of the EAG's reports.

Table A-1 provides a matrix matching EAG reports with the Laboratory's action plan addressing each report.

Table A-1: EAG Reports and Corresponding LANL GIT Action Plans

EAG Report	Date	LANL GIT Action Plan	Date
"Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory by the External Evaluation Group"	11-98	"Los Alamos National Laboratory Groundwater Integration Team Action Plan for External Evaluation Group November 1998 Recommendations"	2-99
"Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory by the External Advisory Group"	7-99	"Los Alamos National Laboratory Groundwater Integration Team Action Plan for External Evaluation Group July 1999 Recommendations"	11-99
"Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory by the External Evaluation Group"	12-99	"Los Alamos National Laboratory Groundwater Integration Team Action Plan for External Evaluation Group October 1999 Recommendations"	02-00
"Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory by the External Evaluation Group"	6-00	"Los Alamos National Laboratory Groundwater Integration Team Action Plan for External Evaluation Group March 2000 Recommendations"	9-00
"Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory by the External Evaluation Group"	12-00	"Los Alamos National Laboratory Groundwater Integration Team Action Plan for External Evaluation Group December 2000 Recommendations"	3-01
"Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory by the External Evaluation Group"	6-01	"Los Alamos National Laboratory Groundwater Integration Team Action Plan for External Evaluation Group March 2001 Recommendations"	7-01
"Semi-Annual Report to the Groundwater Integration Team of the Los Alamos National Laboratory by the External Evaluation Group"	12-01	This document	4-02

Table A-2 provides a mechanism for tracking past recommendations and the status of implementation of proposed actions. Each action has been given a "tracking" number, which includes the EAG report publication month and year. Notation is provided where recommendations are substantially the same in previous EAG reports.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
6-01-1		Suggest development of a more formal hierarchy using risk-based decision-making.	The GIT agrees with the need to more clearly define the Hydrogeologic Workplan scope of activities so that it is possible to distinguish "in scope" from "out of scope" and to predetermine the "end". The GIT is taking positive steps to accomplish this through DQO iteration. The DQO iteration will take place in two phases. The first phase (May through October) is intended to compile information needed for the decision-makers to complete the iteration. Using the decisions in the Hydrogeologic Workplan as a basis, the GIT is examining the existing data and analyses to understand "what we know" and suggesting "what we still need to know". In the second phase, the decision-makers from LANL, DOE, and NMED will review the compiled information and develop a consensus on the remaining scope of Hydrogeologic Workplan activities. The revised scope will be documented in the Annual Report. Presentations of the compiled information will be made at the Quarterly Meeting/Semi-Annual EAG Review in October 2001 to obtain input from the EAG and stakeholders.	A Core Team will be formed to establish groundwater protection criteria and the scope of work necessary to demonstrate criteria are met.
6-01-2		Suggest limiting the attendance at the meeting to perhaps four or eight, one or two from each primary organization if the meetings are to be decision-making meetings.	The Project Manager agrees that decision-making is more efficient with fewer people and will try to limit attendance at decision-making meetings.	The invitation to the managers meeting associated with the April 2002 Annual Meeting requested the attendance be limited to 12 people.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
6-01-3		Suggest that the funding shortfall be addressed sooner rather than later due to the possible critical importance to Laboratory operations.	The Project Manager has addressed the funding shortfall to the extent possible. Additional funding has been requested and is under consideration by the DOE. Combined with Recommendation **7-00-1, 12-99-1**.	Additional funding for FY02 has been provided to the program
6-01-4		Suggest that NW IF&C participate more fully in the discussions.	The Project Manager agrees with the importance of NW IF&C participation and will continue to request their attendance at all GIT meetings.	NW IF&C has been invited to attend the April 2002 Annual Meeting.
6-01-5		Suggest simplifying the "bagel chart" by eliminating either the filled bagels/segments or the hollow bagels/segments, at least for a summary version of the chart.	The bagel chart will be simplified for presentation purposes.	The bagel chart in the FY01 Groundwater Annual Status Report has been simplified.
6-01-6		It would be useful to document how and when it is determined that a bagel segment should be filled, indicating that it is completed, i.e., the decision is resolved.	The GIT concurs on the importance of having consistent criteria for determining when a decision is adequately resolved. One product of the DQO iteration process, described in response to recommendation 6-01-1, will be the criteria for determining decision resolution.	There are more explanation of the bagels in the DQO reiteration document.
6-01-7		The decisions on the bagel chart appear to the EAG to be risk-based decisions, yet the issue of how the Workplan fits into an overall risk strategy is not yet clear to the EAG. We encourage the GIT to resolve these relationships as quickly as possible.	The GIT agrees with the need to reconcile the role of the Hydrogeologic Workplan in providing characterization data to the risk assessment(s) that are the purview of the Environmental Restoration Project. A product of the DQO iteration process, described in response to recommendation 6-01-1, will be an understanding of how risk assessment needs affect the scope of Hydrogeologic Workplan activities.	The role of risk assessment in Hydrogeologic Workplan activities is an evolving one. Significant discussion of this is planned for the Annual Meeting in April 2002.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
6-01-8		Using simple terminology, in the appropriate sections of the Annual Report, clarify how the accomplishments being discussed help to achieve the goals of the Workplan, especially with regard to answering DQO questions.	The Groundwater Annual Status Report will be expanded to include a discussion of how each activity described applies to the Hydrogeologic Workplan DQOs.	The FY01 Groundwater Annual Status Report attempted to incorporate this comment.
6-01-9		Suggest revising the breakout sessions to be more one-on-one between the GIT and the EAG or eliminate the sessions.	The Project Manager agrees that the breakout sessions that were held in March did not accomplish what was intended. The Project Manager will discuss future breakout sessions with the EAG Chairperson to determine the action. Combined with Recommendation **7-99-7, 12-99-12.**	This recommendation has been suitably addressed and is considered closed.
6-01-10		Simplify. Focus data gathering activities and resources on those processes that can be clearly shown to be important for achieving Workplan objectives.	It is anticipated that as a product of the DQO iteration process, described in response to recommendation 6-01-1, the scope of Hydrogeologic Workplan activities will be focused on just those that are necessary to complete the Workplan.	The Core Team process employed in FY02 will address this comment.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
6-01-11		Keep the modeling simple, where possible, and communicate this approach.	The GIT recognizes the need to more effectively communicate the modeling activities to regulators and other stakeholders. Communication with the regulators regarding modeling has increased to bi-weekly meetings and has been successful in increasing the understanding of the modeling process in general and the specifics of the modeling for the Pajarito Plateau. Communicating with other stakeholders regarding the modeling continues to be a challenge that has to be addressed by the GIT.	A "transparent" description of the regional aquifer modeling, targeted for a public audience is being developed and will be released by July, 2002.
6-01-12		Employ a top down modeling approach with clearly articulated decision points and DQOs.	The GIT concurs with the need for a top-down look at the hydrogeologic system. A first-order pathway assessment for groundwater will be complete by the end of FY01. It is anticipated that this assessment will indicate areas where groundwater investigations should be focused.	The groundwater pathway assessment is continuing and will be focused by the decisions of the Core Team
6-01-13		Clarify and strengthen the use of models to guide data collection and drilling program activities.	It is anticipated that as a product of the DQO iteration process, described in response to recommendation 6-01-1, modeling will be the primary driver in determining the remaining scope of Hydrogeologic Workplan activities.	The models are being used to guide and focus data collection activities.
6-01-14		Test the methodology for the statistical assessment of sentry well placement but place high value on site-specific knowledge and expert judgment.	A study is underway to conduct a statistical analysis to assess the number and location of monitoring wells that may be required in a monitoring network. As recommended, this study is being conducted as a pilot to test the methodology.	The statistical assessment has been overtaken by the groundwater pathway assessment and this recommendation is considered closed.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
6-01-15		More clearly communicate the preliminary nature of certain of the modeling analyses.	The GIT will indicate the maturity of modeling approaches and results in future presentations.	The presentations at the Annual Meeting in April 2002 will explicitly recognize the relative maturity of the modeling.
6-01-16		Clearly communicate the LANL position on documenting modeling analyses and releasing that documentation.	The Project Manager committed to providing a list of publications for this program at Quarterly Meetings. The Project Manager will describe the document release policies and process at the next Quarterly Meeting.	The list of publications associated with the Hydrogeologic Workplan is handed out at every quarterly meeting
6-01-17		Request clarification from NMED regarding the recent request for modeling-related data and information.	In response to the letter from NMED regarding modeling-related data and information, a letter was sent requesting a meeting to clarify the NMED request.	Explanation of the modeling continues to be an issue, as evidenced by the comments on modeling in the NMED March 1, 2002 letter. The efforts to communicate the modeling information continue.
6-01-18		Prioritize geochemical studies in the context of Workplan goals.	The GIT agrees with the need to prioritize geochemical studies in the context of the Hydrogeologic Workplan. A product of the DQO iteration process, described in response to recommendation 6-01-1, will be a prioritized list of geochemical studies necessary to complete the scope of Hydrogeologic Workplan.	Refinement of the data needs continues with the Core Team and groundwater pathway assessment. Geochemical data needs will be established in light of the results of these efforts.
6-01-19		Avoid the expense of devoting the cost of an entire R well for the sole purpose of acquiring hydraulic data.	At present, no wells are planned with the singular purpose of obtaining hydrologic information.	At present, no wells are planned with the singular purpose of obtaining hydrologic information.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
6-01-20		Temporarily discontinue use of the measurement port and MOSDAX probe in the Westbay wells. Instead, collect samples with the pump and the Westbay pumping ports via low-flow sampling techniques with equilibration of indicator parameters using a flow-through cell.	The Geochemistry Subcommittee is not aware of available equipment, primarily pumps, which could be used to collect samples. Further information from the EAG on this equipment would be useful.	Further information from the EAG on this equipment would be useful.
6-01-21		Suggest that the GIT evaluate and consider limiting the sampling suites and frequency of sampling needed for the regional aquifer wells.	The Geochemistry Subcommittee has developed a proposal for characterization sampling. The proposal includes an equilibration period of six months for multiple completion wells and elimination of non-detected analytical suites after the first full-suite analysis. This proposal was presented at the Quarterly Meeting in June and will be the subject of discussions with NMED prior to the September sampling.	The proposed characterization sampling has been submitted to NMED. This recommendation is considered closed.
6-01-22		Enhance risk-based management to focus and guide the Hydrogeologic Workplan components.	When the Workplan is fully implemented, it is anticipated that there will be sufficient data to complete the design of a monitoring network and for the ER Program to have identified all areas where further groundwater investigations are necessary. One objective of the Workplan is to identify areas of groundwater contamination. However, determining the extent of contamination and the risk posed by that contamination is the responsibility of the ER Program and is not within the scope of the Workplan. The Workplan was intended to be the integrated characterization phase necessary for two different programs to carry out their related missions -- institutional environmental monitoring and environmental restoration -- in a coordinated and cost-effective fashion.	The Core Team and groundwater pathway assessment will lead to the risk-based management focus.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
6-01-23		Clearly articulate the risk-based goals of the Hydrogeologic Workplan and the models, data collection, and other risk assessment information that will be necessary to meet these goals.	A product of the DQO iteration process, described in response to recommendation 6-01-1, is expected to be an articulation of the yet-to-be-met goals of the Hydrogeologic Workplan, the data necessary to meet those goals, and how those data will be collected. This will be described at the Quarterly Meeting/Semi-Annual EAG review in October and documented in the annual report.	The Core Team and groundwater pathway assessment will lead to the risk-based management focus
6-01-24		Identify and use risk assessment information being generated from the ER Program to inform the Hydrogeologic Workplan.	The GIT agrees with the need to reconcile the role of the Hydrogeologic Workplan in providing characterization data to the risk assessments that are the purview of the E R Program. A product of the DQO iteration process, described in response to recommendation 6-01-1, will be an understanding of how risk assessment needs affect the scope of Hydrogeologic Workplan activities.	The groundwater pathway assessment relies on probabilistic risk assessment.
6-01-25		Increase the focus on probabilistic risk assessment as appropriate for key facets of the Hydrogeologic Workplan.	As described in the response to recommendation 6-01-23, the extent of contamination and the risk posed by contamination are the purview of the ER Program. The Hydrogeologic Workplan is intended to provide information to support those ER functions.	The groundwater pathway assessment relies on probabilistic risk assessment.
12-00-1	Complete	Continue prompt, open, and regular communications.	Program Manager and GIT intend to continue communication efforts established in the Hydrogeologic Characterization Program. The Program Manager will request that EAG solicit feedback from stakeholders on how to improve communications during the stakeholder session at the March 2001 Annual Meeting.	Communication efforts will continue

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-2	Complete	Sample R-25 quarterly and determine disposition in about one year.	GIT concurs with recommendation and has included it in the letter responding to NMED's letter regarding R-25.	
12-00-3	Complete	Address the contracting schedule slippage.	In FY00, delays in drilling were largely related to budget impacts from the Cerro Grande fire. At the October 2000 Quarterly Meeting, the Program Manager reported that delays in contracting had impacted FY01 planning, but this in itself has not resulted in a delay of the drilling schedule. A drilling "time out" was instituted in FY01 to address deficiencies identified in the Management Assessment Report for Groundwater Investigations Focus Area and to optimize the drilling schedule with respect to the funding profile for FY01 and FY02.	
12-00-4	Complete	Include a working meeting for managers at the next meeting.	A working meeting for managers has been scheduled for Monday, March 19, associated with the annual meeting. The focus of the senior manager meeting is the revised groundwater protection strategy and issues for senior management attention.	
12-00-5	Complete	Develop skills in matrix management.	GIT agrees that matrix management at LANL, DOE, and NMED affects implementation of the Hydrogeologic Characterization Program. This is an issue for senior management attention to be discussed at the March 19 senior manager meeting.	Combined with Recommendation 12-99-2.

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-6	In process	Definitions of modeling uncertainty are desirable.	Uncertainties in modeling have been evaluated in FY01 for modeling activities and will continue to be evaluated in FY02. It is the goal of the Laboratory to develop probability distributions for model input parameters, confirmed by site-specific numbers, in order to address the effects of uncertainty in the modeling outputs.	
12-00-7	Complete	Institution of the Risk Assessment Committee is necessary.	Risk assessment has been combined with the Hydrology Subcommittee.	
12-00-8	Complete	Displacement of post fire sampling/analyses/activities is necessary.	The Project Manager conducted a meeting to coordinate sampling efforts in alluvial wells in response to the concerns expressed by the NMED at the October 2000 Quarterly Meeting. Ken Mullen has been named the Program Manager for surface water and will be the single point of contact for surface water. Charlie Nylander has been named the Groundwater Program Manager and will serve as the single point of contact for groundwater.	
12-00-9	In process	Long term stewardship of the Workplan activities is unclear.	The Los Alamos National Laboratory Groundwater Protection Strategy has been revised to reflect comprehensive groundwater protection so that the Laboratory can fulfill the responsibility of stewards of natural resources. This revised strategy will be discussed with a goal of attaining consensus among the senior managers at the March 19 senior manager meeting.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-10	In process	EAG continues to promote the use of a QAPP-type process for the Workplan that requires personnel to critically examine their portions of the Workplan to assure that DQOs are achieved efficiently and within budget.	The GIT agrees with the need to have a quality program for the Hydrogeologic Workplan (HWP) Activities. The drilling portion of the program will continue to use the ER QAPP. The ER Project performed a QA audit of the ER groundwater focus area team (presented at the October 2000 Quarterly Meeting), and the focus area team is correcting deficiencies. The ER Project has initiated an activity to "projectize" the HWP to identify discrete projects, responsible parties, scope, schedules, and deliverables. The result of this effort will be a list of projects that must be brought under the QAPP umbrella. In the meantime, the GIT has taken steps to formalize communication of DQOs for individual wells.	Combined with Recommendation 7-00-2, 7-00-3, 12-99-7, 12-99-9, 7-99-16, 7-99-17.
12-00-11	In process	EAG involvement in peer-review of the new, or modified, SOPs prior to their full adoption by the GIT for use in the Workplan. Conduct a presentation on SOP implementation within the Workplan during the March 2001 Annual Meeting.	The EAG will be requested to peer review selected SOPs, particularly those pertaining to sampling. However, resources are not available to fund EAG review of every SOP to be employed in implementing the Hydrogeologic Workplan activities.	Combined with Recommendation 12-00-12 SOP implementation presentation did not occur as SOPs were not complete.
12-00-12	See 12-00-11	Conduct a presentation on SOP implementation within the Workplan during the March 2001 Annual Meeting.	A presentation on the QA program will be made on Tuesday, March 20 at the Annual Meeting.	Combined with Recommendation 12-00-11.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-13	Complete	If data quality problems are occurring with Americium analyses, as they did for 90Sr analyses, quickly address the issues or turn them over to an external laboratory.	This recommendation refers to analyses done for the Environmental Surveillance Program rather than for the ER Project. The latter group is responsible for analysis of samples from Hydrogeologic Workplan wells. The Environmental Surveillance Program moved its analyses for surface water, runoff, groundwater, and sediment samples to analytical laboratories outside of the Laboratory during calendar year 2000.	
12-00-14	Complete	Caucus for no more than ½ hour before the first meeting and at the end of each day and would like the schedule to be more closely followed.	The Project Manager will endeavor to respect the schedule so that the EAG can have time to meet at the end of the general meeting. There are no constraints on the EAG meeting in the morning before the general meeting begins.	
12-00-15	Complete	Provide comments to the EAG on recommendations about a week before the next meeting.	The GIT regrets that this action plan will not be completed a week before the annual meeting. However, we will try to distribute the action plans at least a week prior to EAG reviews.	
12-00-16	In process	The EAG remains concerned that the ER documentation requirements might be too general to fully address the specific data gathering needs of the relatively complex Workplan.	The GIT concurs with the need to reiterate on the DQOs in the Hydrogeologic Workplan, particularly with a site-wide emphasis, rather than well by well. This effort is planned to follow the March 2001 Annual Meeting. The team to conduct the reiteration will include NMED. The results will be documented. Based on this effort, individual DQOs will be derived and put in the FIPs.	

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-17	In process	Familiarize EAG with specifics of the ER Project QA Program requirements relative to Workplan data gathering activities. This can be done via documentation to be provided to us, a detailed presentation at the March 2001 Annual Meeting, or a combination of the two.	A presentation on the QA program will be provided at the annual meeting on March 20. The EAG may request a longer breakout session with the ER Project QA staff on Thursday, March 22.	
12-00-18	In process	ER QA personnel review EAG concerns and suggested approach from the data gathering section of the June 26, 2000 EAG report and make a determination as to the sufficiency of current ER QA documentation requirements in the context of those concerns.	The March 20 Annual Meeting presentation on the QA program will address EAG recommendations. The EAG may request a longer breakout session with the ER Project QA staff on Thursday, March 22.	
12-00-19	Complete	The hydraulic testing approach and expectations for O-1/R-5 need to be articulated and reviewed by the EAG to verify that this significant expenditure of funds will yield valuable information.	The concerns expressed by the EAG are moot because R-5 is no longer being drilled close enough to O-1 to be used as a hydrologic testing well.	Retired by the EAG June 2001.
12-00-20	In process	Conduct spinner tests on as many municipal wells as possible.	The GIT Hydrology Subcommittee agrees with the recommendation but has not identified resources necessary to accomplish this task. The Hydrology and Modeling subcommittees request further discussion of this item at the breakout session on Thursday, March 22.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-21	In process	Explore the use of properly designed recovery tests, as opposed to constant-rate pumping tests, as a more pragmatic way of obtaining municipal well hydraulic data.	The GIT Hydrology Subcommittee agrees with the recommendation but has not identified resources necessary to accomplish this task. The Hydrology and Modeling subcommittees request further discussion of this item at the breakout session on Thursday, March 22.	
12-00-22	In process	Review limiting factors to see if actions could be taken to obtain hydraulic data from municipal wells sooner, rather than later, to support model development.	The GIT Hydrology Subcommittee agrees with the recommendation, but has not identified resources necessary to accomplish this task. The Hydrology and Modeling subcommittees request further discussion of this item at the breakout session on Thursday, March 22.	
12-00-23	In process	Encourage the GIS/map interface for the WQDB to be extremely important to the usability and overall quality of the database and encourage the GIT to locate resources allowing its implementation.	The GIT Information Management Subcommittee agrees with the recommendation, but has not identified technical and funding resources necessary to accomplish this task. Further discussion of this item is requested at the March 2001 Annual Meeting.	
12-00-24	Complete	Provide additional information to the EAG about certain aspects of the WQDB.	Two presentations on information management are scheduled at the March 2001 Annual Meeting: the Information Subcommittee Status Report and an information management poster.	
12-00-25	Complete	Enabling the WQDB to output results to a tab or comma delimited text file following a database query.	The WQDB does download to delimited files that can be used in spreadsheets.	
12-00-26	Complete	Inform the EAG of the URL for the WQDB as soon as it is available online.	http://wqdbworld.lanl.gov.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-27	Complete	Develop a modeling education and communication program as part of Workplan activities and work with NMED to develop a mutual understanding of the role that modeling and analysis results are to play in risk and remedial response decision making for the LANL site.	The GIT concurs with this recommendation and will be starting a new feature at the quarterly meetings: a separate session on modeling will be provided for NMED and stakeholders to focus on the modeling activities. The goal of these sessions is to familiarize interested parties in the modeling and allow the opportunity for input and feedback.	
12-00-28	Complete	Modify draft Revised Section 3.0 of Workplan to include less technical detail, and more information on description, scheduling, and integration of planned modeling tasks.	It is our understanding that the NMED will approve Section 3.0 as submitted, so no further modifications are anticipated. However, the communication suggested in this recommendation is expected to occur at the modeling sessions that are to be added features of each quarterly meeting.	Retired by the EAG June 2001
12-00-29	In process	Revise modeling-related DQOs to correspond to the revised modeling work plan.	The GIT concurs with the need to reiterate on the DQOs in the Hydrogeologic Workplan, particularly with a site-wide emphasis, rather than well by well. This effort is planned to follow the March 2001 Annual Meeting. The team to conduct the reiteration will include the NMED. The results will be documented. Based on this effort, the DQOs for modeling will be revised to reflect the progress that has been made in the characterization program.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-30	In process	Take steps to include in modeling reports information on any manipulations made to geologic layer data to form model hydrostatigraphic units to ensure reproducibility of results; and include date stamps on any graphic output generated during modeling analyses as a QA documentation measure.	QA documentation, such as date stamping, will be added to graphic outputs.	
12-00-31	Complete	Provide EAG with more information on the ongoing and planned modeling program to provide a context and basis for meaningful technical review and comment.	The March 22 breakout sessions planned for the annual meeting are in response to this recommendation. The EAG will have the opportunity to discuss the modeling with the staff involved in that effort. In addition, the new feature of the quarterly meetings (a separate session on modeling) is expected to provide a forum for communicating this information to the EAG.	
12-00-32	Closed	Evaluate the impacts that modeling the effects of Cerro Grande fire have had, and will have, on the planned modeling program, and adjust schedule as necessary.	The GIT appreciates this recommendation, but believes it is beyond the scope of the EAG review.	Retired by the EAG June 2001
12-00-33	Complete	Arrange a meeting between EAG and GIT and ER Project management (and staff as appropriate) to discuss scope and integration of modeling activities in the HC and ER programs (preferably prior to the March 2001 Annual Meeting).	Members of the EAG met with ER Management on January 30, 2001, and a similar meeting has been set for March 22, 2001 with DP management. The Project Manager will arrange meetings for EAG modeling specialists with GIT and ER managers during the EAG semi-annual review in October 2001.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-34	In process	Provide to the EAG, as committed to in the September 2000 Action Plan, copies of reports documenting completed modeling studies when they have been cleared for release. Move forward with plans to form a Risk-Based Decision Support Subcommittee to ensure integration of hydrogeologic characterization (HC) activities, and HC and ER modeling efforts, to meet DQOs and provide necessary information for risk-based corrective action decisions.	EAG members will be requested to review reports on a case-by-case basis. The GIT reserves the discretion to forward documents as appropriate for EAG charter, scope, and funding. The risk assessment responsibilities have been combined with the Modeling Subcommittee.	
12-00-35	Complete	Continue investigations of drilling additive effects on groundwater samples and progress with removal during development.	The GIT intends to continue investigations to understand and quantify the impact of drilling additives on the quality of groundwater samples.	Combined with Recommendations 12-00-36, 7-00-31.
12-00-36	Complete	Continue measuring and tracking parameters related to additive contamination when quarterly samples are collected.	The GIT intends to continue investigations to understand and quantify the impact of drilling additives, including measuring and tracking parameters related to drilling additives in quarterly samples.	Combined with Recommendation 12-00-35.
12-00-37	In process	Carefully consider the ER SOPs being modified/developed for the Workplan in the context of Workplan DQOs.	The Geochemistry Subcommittee will be involved in developing and reviewing the ER SOPs.	Combined with Recommendation 7-00-26.
12-00-38	In process	Attempt to create a first draft of the summary report requested in the last EAG report (June 26, 2000) by the March 2001 Annual Meeting. (7-00-26)	Completion of the summary geochemical report has been delayed, but it is in progress and completion is expected in FY01.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-39	In process	Use longer filter pack overlaps.	The GIT agrees on the importance of developing a consensus on filter pack length with the NMED. The process of negotiating permit language addressing this is ongoing.	
12-00-40	Complete	Use cement grout in the blank pipe sections between well screens.	The well installation procedures have been modified to include placing cement grout at the midpoint of blank pipe areas in multicompletion wells.	
12-00-41	Complete	While striving to maximize well diameters, continue to be cognizant of the corresponding costs so that design changes are economically justified.	The GIT is not considering increasing the well diameters at this time.	
12-00-42	Complete	Continue to use casing and screen designs that optimize well performance and are trouble free to install.	The GIT intends to continue to use casing and screen designs that optimize well performance.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-43	Complete	Develop (or articulate) criteria for selecting screen zones in the R-wells.	Regarding selection of zones to be screened, a committee (including experts in geology, hydrology, and geochemistry) currently decides the number and location of screen zones in R wells after drilling and logging are completed. The criteria can be generalized as follows: Larger perched zones are screened (this may include direct detection of perched conditions while drilling or the interpreted presence of perched conditions via borehole geophysics). The top of the regional aquifer is screened. Deeper portions of the regional aquifer are screened at intervals of every 100 or 150 ft depending on anticipated presence of contaminants and need for vertical hydraulic gradient information. Particular depths for screening is determined based on a combination of geologic strata encountered, presence of water during drilling, and use of information from logs on likely permeable intervals. Individuals involved in the well design represent a cross section of GIT technical disciplines including geochemistry, hydrology, geology, and drilling. Data considered during well design include borehole geophysics, borehole videos, driller's observations, interpretation of drill cuttings, water-levels collected during drilling, and available groundwater screening results.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-44	Complete	Meet with a subset of the EAG following the next semi-annual meeting to review and explain drilling cost categories and other available data.	The breakout session with the Well Construction Subcommittee has been scheduled for March 22 to allow the EAG the opportunity to discuss well construction concerns.	
12-00-45	In process	Consider examining drilling costs at INEL for benchmarking purposes.	The GIT recognizes the importance of benchmarking drilling costs as expressed by the EAG in this recommendation and those in previous reports (11-98-18, 7-99-2, and 7-99-26). It remains the intention of the Program Manager to conduct a benchmarking study that will include INEEL.	
12-00-46	Closed	Do not suspend drilling operations.	The drilling operations were suspended due to quality concerns and to schedule drilling resources more efficiently.	
12-00-47	Complete	Conduct a presentation to the EAG dedicated solely to current and planned groundwater sampling methodologies at the next meeting.	A presentation of the quarterly sampling methodology and analytical results will be provided on March 21.	Combined with Recommendation 7-00-29.
12-00-48	Complete	Iinvestigators and stakeholders should make a significant effort to understand the relationships among the factors that influence sample quality and how these will impact their interpretations.	The GIT concurs with the need to understand the relationships that influence sampling and data quality. The Geochemistry Subcommittee looks forward to discussing these factors at the breakout session on March 22.	
12-00-49	In process	Avoid over-interpretation, and over reliance on, sampling results from the early quarterly monitoring events.	The GIT recognizes the limitations of sampling results from early quarterly monitoring events. A working group from the Laboratory and NMED will be formed to discuss the quarterly sampling analytical requirements.	Combined with Recommendation 7-00-31.

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-50	Complete	Develop logical and consistent approach for determining where to screen the wells and the methods for calculating the depths of the screens, seals, and sand packs. The EAG recommends that the GIT develop this approach and have a single individual, highly trained in geology and/or hydrology, make these onsite decisions for all the remaining R wells.	Refer to 12-00-43	
12-00-51	In process	Follow ASTM guidelines for well development, and encourage the last step of the process to be pumping of each of the screened intervals with a pump using packers to isolate the individual intervals.	The GIT is familiar with ASTM development guidelines and believes that the current development procedures conform to them. However, we do not yet have a dual packer development system.	
12-00-52	Complete	Provide information regarding sampling the single completion wells, such as R-9.	The sampling procedures will be described at a presentation at the March 2001 Annual Meeting. If more information is required, the breakout session on March 22 is an appropriate forum for discussion.	Combined with Recommendation 12-99-20.
12-00-53	In process	The EAG cautions that field analytical parameters that are sensitive to the atmosphere (e.g., DO, Eh, possibly pH) might not be accurate unless analyzed within a flow-through cell. The EAG recommends that the GIT consider eliminating filtration of samples from the Westbay systems to reduce analytical costs and conserve collected samples.	The GIT Geochemistry Subcommittee agrees that atmosphere-sensitive field parameters can only be accurately measured with the flow-through cells. Discussions with Westbay about modifying equipment to allow a flow-through cell are ongoing.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-00-54	In process	Empower the Risk-Based Decision Subcommittee to develop a risk assessment plan for use in the Hydrogeologic Workplan.	A breakout session has been planned for March 22 for risk assessment. The GIT expects that the breakout session discussion will further the development of a plan.	
12-00-55	In process	Provide information to the EAG on risk assessment approaches that go beyond the ER program, to address the special issues that must be addressed, should contaminants be found during well drilling.	A breakout session has been planned for March 22 for risk assessment. The GIT expects that the breakout session discussion will further the development of a plan.	
12-00-56	Complete	EAG staff to meet with the risk assessment staff at EAG meetings to review risk assessment approaches and methods.	A breakout session has been planned for March 22 for risk assessment. The GIT expects that the breakout session discussion will further the development of a plan.	
12-00-57	In process	Use the Risk-Based Decision Subcommittee as a central focus for the development of a program to inform all the involved parties of potential risk that may be associated with the risk significance of finding contaminants in groundwater.	The Hydrology and Risk Subcommittee will be a central focus for communication of hydrologic and risk information.	
7-00-1	See 6-01-3	Continue ongoing communications to refine Workplan end product(s) with representatives from LANL, DOE, and NMED with EAG participation not mandatory.	The GIT will continue to schedule manager meetings with the EAG during the EAG semi-annual reviews. The GIT encourages the EAG to reiterate the importance of the management consensus at these sessions.	Combined with Recommendation 6-01-3.
7-00-2	See 12-00-10	A presentation at the next EAG meeting to clarify details of the Hydrogeologic Workplan as it relates to the Environmental Restoration (ER) QA framework.	A presentation on the adoption of the ER Quality Assurance framework by the hydrogeologic characterization program has been scheduled for the October 2000 Quarterly/EAG Semi-Annual meeting.	Combined with Recommendation 12-00-10.

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-00-3	See 12-00-10	Continue assessment of DQO needs of the Workplan and applicability to ER QA and SOP processes.	The ER Project Groundwater Investigation Focus Area has committed to reviewing existing SOPs by October 2000 and updating and/or preparing necessary SOPs by January 2001.	Combined with Recommendation 12-00-10.
7-00-5	Complete	Analytical services to be provided by a vendor external to LANL until LANL laboratory services can prove quality data generation.	LANL environmental surveillance program is now using outside analytical laboratories.	
7-00-6	Complete	Facilitate note taking with immediate laptop storage.	Meeting minutes will be limited to summaries of conclusions, significant discussions, and action items. It is hoped that limiting the scope of the minutes will facilitate turn around time and distribution.	
7-00-7	Complete	Addition of a management closeout session to the regularly scheduled GIT management meeting.	A debriefing for managers by the EAG has been scheduled for the October 2000 Quarterly/Semi-Annual EAG meeting.	
7-00-8	Complete	Formalize the GIT Subcommittees' decision process resulting in Workplan wells Field Implementation Plans (FIP) to include increased documentation of rationale and approach.	The hydrogeologic characterization program will adopt the documentation requirements of the ER Project QA program.	
7-00-9	In process	External review of aquifer test data analysis and interpretation for the modeling program.	Separate reports on hydrologic testing are being prepared. EAG will be asked to provide comments on the draft reports.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-00-10	In process	Consider enhanced aquifer screening in some wells for modeling purposes and consider thorough testing and analysis of existing municipal production wells.	Municipal supply wells were tested when constructed. Further work on the production wells is a matter of opportunity as they are used for water supply. Some of the new R wells will be located near municipal supply wells in order to provide further information on hydrologic properties. It will be hard to achieve a static water level near some of the wells for hydrologic testing.	
7-00-11	In process	Continue the Water Quality Database (WQDB) per schedule or exceed scheduled development.	The WQDB has made significant progress toward making all data accessible. Accelerated the process of making runoff data available on the web. The schedule for the WQDB will be presented at the October Quarterly/EAG Semi-Annual meeting.	
7-00-12	In process	The Well Construction module of the WQDB should contain all drilling aspects of the wells.	Ability to capture drilling techniques, fluids in the hole, drilling depths, and much more are included in the database design. D. Broxton and B. Stone participated in the design process in order to ensure completeness. Each module is extensively reviewed prior to finalization to ensure items are not left out.	
7-00-13	In process	Include external data to the WQDB only if the data conforms to specific collection SOPs and methodologies, and either flag or do not include older data that do not conform.	Data from external sources to be incorporated in the database through the use of identifiers related to the data's source and to the SOPs/collection methods that were used. Ultimately, it is the decision of data stewards whether to incorporate external data into the WQDB at all; but these identifiers should make the decision to do so less risky.	
7-00-14	In process	Include the GIS/map interface in the WQDB.	Actively working to identify and obtain additional resources necessary to support the development of GIS/map interface in WQDB.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-00-15	In process	Utilize WQDB beta testers external to the Laboratory.	Difficulties arranging for system beta testing because of the LANL firewall. Modules of the system are becoming available for access to the public in late September 2000, which will allow ease of beta testing by NMED, the Pueblos, CAB, and EAG. In addition, the WQDB team is willing to organize periodic on-site testing sessions for representatives of these organizations.	
7-00-16	Complete	Provide EAG with information regarding planned modeling activities to include activity schedules and descriptions.	A revision to the Hydrogeologic Workplan has been drafted that provides a schedule for the planned modeling activities and describes how modeling is used in decision-making. To be presented at the October meeting.	
7-00-17	Complete	Afford EAG additional time with modeling staff to discuss technical modeling issues.	To provide more detail, written reports will be distributed to some or all members of the EAG when the documents are approved for distribution. Additionally, an evening session to discuss modeling has been added to the agenda for the October Quarterly/EAG Semi-Annual Meeting.	
7-00-18	Complete	Provide the EAG with a copy of the draft Hydrologic Workplan.	The modeling workplan is a revision to Section 4 of Hydrogeologic Workplan and will be presented at the October Quarterly/EAG Semi-Annual meeting.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-00-19	Complete	Continue to enhance the hydrologic modeling in respect to geologic and geochemical modeling, well installations and site characterization, deep well monitoring, and risk assessment.	A "hands-on" session to demonstrate and clarify the links between the modeling and the databases will be conducted at the October Quarterly/EAG Semi-Annual meeting. Demonstrated will be the integration of R-Well data collection, spatial data analysis, geologic modeling and hydrologic and geochemical modeling. The GIT Risk-Based Decisions Subcommittee will handle the definition and description of the relationship of DQOs for data and models in the context of a risk end-point.	
7-00-20	In process	Continue to build on the DQO process for hydrologic modeling that was established in the Hydrologic Workplan.	The GIT Risk-Based Decisions Subcommittee will address much of this recommendation. The ER Project has initiated a dialog with NMED regarding confidence intervals and the use of probabilistic contaminant fate and transport models to support risk-based corrective-action decisions.	
7-00-21	In process	Provide EAG with additional technical information regarding modeling methodologies and results.	The ER Project sees great value in peer review by the EAG and will pursue funding avenues to support the EAG in this activity.	
7-00-22	Complete	Provide GoldSim/FEHM comparison modeling information to EAG.	The ER Project will be pleased to provide EAG with FEHM/GoldSim comparisons to date. In FY 2001, the ER Project will be developing GoldSim applications for particular corrective-action remedies for the MDAs.	
7-00-23	Complete	Reconsider the feasibility of planned studies to simulate TA-50 water injection test with discrete fracture and dual permeability models.	Additional calculations have not been included in Work Packages with EES-5 for Fiscal Year 2001. Any new modeling concerning the TA-50 tracer test will be limited in scope and designed to bolster the conclusions already obtained.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-00-24	Complete	Continue with planned testing and monitoring activities at TA-49.	The ER Project will continue to report to the GIT (and the EAG, if requested) on the effectiveness of the VCM at reducing in situ moisture at that site, to the extent that such information provides insight into the hydrology of specific (disturbed) portions of the Pajarito Plateau.	
7-00-25	In process	Continue to refine regional aquifer model for receptor and risk analysis performance capabilities.	The GIT and the ER Project will evaluate the applicability of commercial probabilistic groundwater pathway analysis tools (e.g., GoldSim and GroundwaterFX) to aide in the development of a useful risk-based decision-support tool for the regional aquifer.	
7-00-26	See 12-00-38	Develop a concise summary geochemical report in lay terms.	The GIT Risk-Based Decisions Subcommittee will consider this recommendation. The subcommittee chairperson assesses this recommendation as the need for DQOs for geochemical analysis and modeling activities.	Combined with Recommendation 12-00-38.
7-00-27	Complete	Require longer pipe lengths for well drilling and completion and require an 8.75 percent open area in the base pipe.	The recommendation will be incorporated as purchase orders for pipes are issued.	
7-00-28	In process	Obtain NMED approval for installation of longer filter pack intervals in R wells.	The October Quarterly/EAG Semi-Annual meeting will include a presentation and discussion of the status of the RCRA/HSWA permit and well construction issues, including screen length, filter pack, and well annulus.	
7-00-29	See 12-00-47	Present current and planned groundwater sampling methodologies at the next EAG.	The October Quarterly/Semi-Annual GIT meeting will include a presentation on the progress thus far in developing SOPs. At the March 2001Annual Meeting, there will be a complete presentation of completed SOPs.	Combined with Recommendation 12-00-47.

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-00-31	See 12-00-35 12-00-49	The effects of newly utilized synthetic drilling fluids on sample quality following well completion are largely unknown. Therefore, the EAG would caution the GIT, NMED, and other stakeholders that gradual changes in monitored parameters, including potential contaminants, might be observed in the R wells for some number of sampling events after well completion.	Chemistry studies have been done to quantify potential effects of interference of drilling fluids. Documenting the affect of the various types of drilling fluid effects is one step toward interpreting the sampling results that will be obtained from the quarterly sampling.	Combined with Recommendation 12-00-35, 12-00-49.
7-00-32	Complete	Use air rotary casing advance drilling methods, without fluids other than water, for Los Alamos and Mortandad Canyon wells.	The possibility of drilling without drilling fluids will be evaluated for each well, weighing the benefits of water chemistry against the cost and schedule risks of "dry" drilling.	
7-00-33	In process	Review the significance of colloidal transport of contaminants in sample collection and modeling.	The subcommittee will continue to review information regarding colloidal transport of contaminants and to closely evaluate water quality data to assess the occurrence of colloidal transport within the hydrogeologic system of the Pajarito Plateau.	
7-00-34	In process	Develop risk assessments plan specific to the Hydrological Workplan and identify risk assessment staff.	The GIT Risk-Based Decisions Subcommittee will identify risk-based decision analysis methods applicable to the objectives of the Hydrogeologic Workplan, communicate the utility of these methods to develop DQOs for tasks and activities pursuant to the objectives of the Hydrogeologic Workplan, and assist the GIT in implementing these methods consistently and appropriately.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-00-35	Complete	Provide risk assessment approaches to be employed if contaminants noted during well drilling for EAG review, and provide time during EAG meetings for EAG and risk assessment staff discussion.	The GIT Risk-Based Decision Subcommittee will provide the GIT and EAG with periodic updates of progress made by the subcommittee, which will focus on discussions, decisions and possible roadblocks and/or resistance regarding the application of risk-based decision analysis methods to GIT activities and tasks.	
7-00-36	Complete	Develop a risk-based response plan to be implemented if data in exceedance of established standards is released to the public and stakeholders.	The Risk-Based Decision Subcommittee will review and revise, as necessary, the draft response-to-contamination decisions framework proposed by the GIT to the NMED. The decision framework will identify decision criteria such as exceedances of MCLs at accessible locations. Once the draft decision framework is determined to be complete by the subcommittee, it will be provided to the EAG for review and comment.	
7-00-37	In process	Develop list of MCLs, or other guideline, for potential chemicals of concern.	The risk assessor of the Risk-Based Decisions Subcommittee will ensure that such a list is available, either as a stand-alone document or as a list of readily accessible references.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-00-38	In process	Risk assessment process for subpopulation groups is to be flexible and iterative.	The Risk-Based Decisions Subcommittee will be aware of current and emergent discussions regarding risk assessment scenarios through member involvement in the ER Project's integrated risk assessment team. Non-standard receptors and/or exposure scenarios that are determined to be reasonable and appropriate for contamination identified in groundwater will be included in risk assessments for the groundwater pathway, when such risk assessments are deemed necessary to support a decision. Those situations will be identified in the decision framework discussed in Response Action 4.	
12-99-1	See 6-01-03	Formation of a Senior Management Team to help define end product(s) with representatives from LANL, DOE, and NMED.	The Program Manager commits to identifying a manager willing to organize and chair this group. The assistance of EAG member Dr. Robert Charles may be requested to facilitate the initiation of the group.	The EAG/Managers meeting in March found general concurrence on the end state of the hydrogeologic characterization program. Continued semi-annual meetings with the managers will confirm the expected products. Combined with Recommendation 6-01-3
12-99-2	See 12-00-5	Continued examination of add-on requests and divesting the GIT of items not specifically enumerated by the Workplan.	The Response to Contamination process is expected to keep a focus on the Hydrogeologic Workplan objectives. The definition of the end state by the management team will also help in maintaining a focus on the long-term objectives.	Combined with Recommendation 12-00-5.

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-99-3	Complete	Establishment of a policy for data distribution.	Data will be available on the Water Quality Database via the internet. The distribution of preliminary (unvalidated) data does require a process that has Laboratory management and legal counsel approval. The Program Manager will request the assistance of Laboratory Legal in developing a preliminary data distribution policy.	Data collected from runoff after the Cerro Grande fire has focused responsibility for development of a policy for data release on the Watershed Integration Team.
12-99-4	Complete	Re-enumeration of the criteria for well prioritization.	The GIT and NMED/HRMB have had initial discussions on the prioritization scheme and have agreed to reach a consensus prioritization at the Annual Meeting scheduled for March 2000.	
12-99-5	Complete	The EAG will meet with the CAB at a mutually agreeable time and place.	The GIT encourages the EAG to participate in a CAB meeting. If the timing of CAB meetings is not coincident with EAG meetings, then the Chair of the EAG should attend a CAB meeting.	
12-99-6	In process	Development of a risk-based conceptual approach.	The Response to Contamination process incorporates a qualitative assessment of risk. The ER Project has developed a risk assessment approach that will be used in defining the scope of the response. A presentation of the risk assessment approach will be provided at the Annual Meeting in March.	The GIT has formed a subcommittee for risk decisions to provide more focus on risk assessment.

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-99-7	See 12-00-10	The Selection of an individual on the GIT to lead development of subordinate DQO's, manage QAPP for the Workplan, and elucidate its relationship to the existing documents in the Environmental Restoration (ER) and Environmental Safety and Health (ESH) as well as the Workplan final products.	The adoption of Hydrogeologic Workplan activities into the ER Project QA system will begin with a Quality Assurance self-assessment. The assessment will provide the information necessary to bring a coherent and consistent QA system to the Hydrogeologic Workplan activities.	Combined with Recommendation 12-00-10.
12-99-8	In process	Development and regular updating of the web site for routine communication of data, issues, etc.	The ESH-18 web site will be expanded to include the GIT activities. The map and contents of the web site is under development now. The schedule and contents of the web site will be discussed at the Annual Meeting in March.	A draft web page has been developed and is in review.
12-99-9	See 12-00-10	Data gathering activities should be guided by the development of the DQO processes for these activities and supports the efforts in this direction.	The GIT continues to promote the use of DQOs (or equivalent approaches) to planning data collection within the GIT Subcommittees.	The GIT has formed a subcommittee for risk decisions to provide more focus on risk assessment. Combined with Recommendation 12-00-10.
12-99-12	See 6-01-9	Technical sessions be held for the purpose of examining data gathering at later semi-annual meetings.	The suggestions for technical sessions will be incorporated into the Annual Meeting agenda to the extent possible given time constraints.	Combined with Recommendation 6-01-9.

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-99-13	Complete	The plan for a comprehensive Water Quality Database and input from users in both the preliminary and latter stages of a database module's development should be continued.	The Water Quality Database (WQDB) development team has adopted the EAG recommendation to implement the system's water level module prior to the chemistry module. The WQDB development team completes a software design process prior to any programming. This process helps ensure that the system will meet the needs of users, thereby reducing the potential for system rewrites due to inadequate implementation. The modular design process includes a cooperative effort between development team members, GIT subject matter experts, and additional representatives of the end-user community.	
12-99-14	In process	Continue with efforts to better understand the spatial distribution of infiltration, porosity, and hydraulic conductivity.	The modeling approach that will be taken is to use statistically based distributions as input for hydrologic parameters that are based on (and constrained by) the data collected from the R-wells. This statistical approach to developing input parameters in the hydrologic models will be discussed at the Annual Meeting in March.	
12-99-15	Complete	The EAG promotes the geochemical modeling as it relates to fate and transport of contaminates or where it can yield better understanding of ground water flow directions and rates.	Geochemical modeling continues to be an interpretative task for the GIT Geochemistry Subcommittee.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-99-16	Complete	The EAG recommends better evaluation of the advantages and disadvantages of using parameters developed from surface complexation modeling versus the incorporation of simple linear isotherm Kd values in the models and the use of non site specific Kd.	The GIT concurs with the need to include surface complexation modeling in the "toolbox" for interpreting data collected for the hydrogeologic characterization program. The Geochemistry Subcommittee has begun modeling simulations to determine Kds from surface complexation.	
12-99-17	Complete	Properly designed profile wire screens in the monitoring wells should be used.	Wire screens are currently planned for all of the wells. If alternative types of well screens are considered in the future, the EAG will be asked to provide technical review.	
12-99-18	Complete	All processes involved in creating and sampling the monitoring wells should be considered within the context of capturing the information needed to accomplish the monitoring objectives.	The GIT Geochemistry Subcommittee has been assigned the task of evaluating the considerations brought forward by the EAG and providing recommendations to the GIT regarding those considerations. A presentation on groundwater sampling at the Annual Meeting in March will address these recommendations.	The GIT has formed a subcommittee for risk decisions to provide more focus on risk assessment
12-99-19	Complete	Unencumbered casing advance drilling should be used as a substitute for mud rotary drilling if extensive data needs are not needed.	At present, casing advance is the only well drilling method planned. However, the GIT will continue to evaluate alternative drilling methods suggested by stakeholders. The EAG will be essential to evaluation of alternative drilling methods.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-99-20	See 12-00-52	For long screen wells that are already installed, characterize flow rates across the screened interval with depth and/or characterize the well for contaminants along the screen length to determine where to place the pump.	The GIT Geochemistry Subcommittee is evaluating the concerns regarding well drilling, well design, and sampling methods and will report on their recommendations at the Annual Meeting in March.	Combined with Recommendation 12-00-52.
12-99-21	Complete	Different construction techniques should be considered for long-screen completions that are not yet installed.	The GIT Geochemistry Subcommittee is evaluating the concerns regarding well drilling, well design, and sampling methods and will report on their recommendations at the Annual Meeting in March.	
12-99-22	Complete	The monitoring wells at LANL should not be screened above the water table.	The Technical Enforcement Guidance Document has been used for technical construction specifications for screen placement. However, the GIT Geochemistry Subcommittee is evaluating the concerns regarding well drilling, well design, and sampling methods and will report on their recommendations at the Annual Meeting in March.	
12-99-23	Complete	Different construction techniques (i.e., not single long screen) should be considered for wells that will be subjected to screen aeration as the water table drops during the well's lifetime.	The GIT Geochemistry Subcommittee is evaluating the concerns regarding well drilling, well design, and sampling methods and will report on their recommendations at the Annual Meeting in March.	

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
12-99-24	Complete	Low-flow sampling should be used for routine monitoring in all the monitoring wells at LANL due to the potentially detrimental impacts of high-flow sampling on sample quality.	The GIT Geochemistry Subcommittee is evaluating the concerns regarding well drilling, well design, and sampling methods and will report on their recommendations at the Annual Meeting in March.	Combined with Recommendation 11-98-8.
12-99-25	Complete	The proper collection of core sequences should be continued for the deep monitoring wells installed in areas having high expected contaminant probability. Consideration must be given to reducing the amount of coring in locations where contaminants are considered to be unlikely, thus speeding well installation.	The amount of coring planned for each borehole is determined based on a number of factors including hydrologic uncertainties, stratigraphic uncertainties, and expectations regarding contaminants. The GIT feels that the uncertainties in the hydrologic and geologic setting should be weighed equally with presence of contaminants.	Coring needs are determined on a well-by-well basis.
7-99-1	Complete	Develop an understanding of the relationships of upper management among the stakeholders.	The upper management of LANL, DOE, and NMED will be invited to the quarterly meetings, annual meeting, and the next EAG meeting.	Combined with Recommendation 11-98-4. The GIT chairperson has provided briefings as requested and will continue to be available on an on-call basis for briefing upper management.
7-99-2	In process	Pursue some aspects of benchmarking.	Potential contractors have been contacted to determine their capabilities in this area and initial ideas for a scope of work have been discussed.	Combined with Recommendation 11-98-18, 7-99-7. The benchmarking study is important to the GIT and some progress has been made toward implementing this study. Due to budget constraints, the study can not be started until October 1999.
7-99-3	Complete	Continue meetings between external stakeholders and the EAG.	The GIT intends to continue this forum of expression and feedback at EAG meetings.	The feedback from the stakeholders has been positive.

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-99-4	Complete	Continue extensive communication efforts, including the expansion of Internet utilization.	In addition to formal and informal meetings with the stakeholders, the GIT plans to make information accessible via the Internet.	Combined with Recommendation 11-98-1. The Water Quality Database will be accessible through the Internet. A GIT web page with links to searchable GIT minutes, the Hydrogeologic Workplan, field implementation plans, well completion reports, daily drilling reports, and other documents have been under consideration.
7-99-5	Complete	Continue preparation and implementation of action plans responding to the EAG's recommendations.	An action plan will be prepared in response to each EAG report.	The recommendations have been numbered to facilitate tracking. Each successive action plan will provide a status of cumulative set of recommendations to ensure that each is fully addressed.
7-99-6	Complete	Continue providing meeting locations that enhance focus.	The meeting locations will be off-LANL whenever possible to enhance focus.	Positive feedback was received on the choice of Ghost Ranch for the location for the annual meeting. Similar settings will be considered for future meetings.
7-99-7	See 6-01-9	Prepare hard copies of presenter's more technical transparencies.	The overheads will be compiled into a meeting booklet to facilitate the EAG program reviews.	Combined with Recommendation 6-01-9.
7-99-8	Complete	Add some technical sessions.	There will be increased time allotted to technical presentations. Concurrent sessions may be appropriate if the participants at meetings have clearly defined and distinct interests that can be addressed in separate sessions.	The GIT would like to try this approach on a pilot basis. There is a concern that some stakeholders may feel left out of discussions that are held concurrently.

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-99-9	Complete	Add EAG members for geoscience and economics expertise and, possibly temporary members in other areas.	The GIT requests that the EAG identify potential new members and invite their commitment to serve on the EAG.	The GIT concurs in the need to expand the fields of expertise within the EAG.
7-99-10	In process	Develop a risk-based conceptual plan in three categories: Chemicals of Concern, Source, Transport and Fate, and Exposure to Receptors.	A plan to address contamination found while implementing Hydrogeologic Workplan activities will be presented to NMED and EAG during the October meeting.	Development of this plan requires coordination of different groups and programs within LANL so that it can be incorporated into the re-issued RCRA permit.
7-99-11	Pending	Have EAG review LANL's risk assessment team results and future plans.	The EAG will be asked to review the planned response to detecting contamination at the October meeting	
7-99-12	Pending	Develop a risk-based approach for interpreting the significance of finding on-site well contamination; as the site-specific, alternate contaminant level (ACL) approach has proven most useful for complex sites such as LANL.	Initial inputs to this plan were discussed at the Annual Meeting and work on it is continuing. The development of this plan requires coordination of different groups and programs within LANL so that it can be incorporated into re-issued RCRA permit.	Combined with Recommendation 11-98-7. The ACL criteria have been incorporated into the response for detecting contamination.
7-99-13	Pending	Compare such plans to those used by other regulatory agencies (e.g. EPA) and other states.	The GIT will obtain the available resources and use them in the development of the response plan.	The GIT understands that this program is not an unfamiliar task.
7-99-14	Pending	Establish acceptance of site specific ACLs.	The ACL criteria have been incorporated into the response to detecting contamination as a first step to establishing the response to contamination.	Combined with Recommendation 11-98-2. The GIT agrees that the process for establishing ACLs should be part of the response plan. However, the GIT feels that it is inappropriate to propose actual numbers for ACLs until more is known about the hydrogeologic characteristics of the specific locations for which they might be proposed.

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Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-99-15	Complete	Reconsider the Hydrogeologic Workplan DQO scenarios when updating the hydrogeologic conceptual models.	The conceptual models will be refined based on new data collected in this program. The DQO scenarios, which are based on the conceptual models, will likewise be refined as appropriate.	The GIT is in agreement with this recommendation. Each GIT subcommittee has been asked to begin the DQO process with the data collected thus far.
7-99-16	See 12-00-10	Develop DQOs for processes subordinate, but essential to, the hydrogeologic characterization such as well completion, sample collection, data validation, database development, and model development.	The GIT subcommittees have been encouraged to use the DQO process (or a DQO-like process) in the areas mentioned in the recommendation and in all of their planning activities.	Combined with Recommendation 12-00-10.
7-99-17	See 12-00-10	Data gathering efforts should utilize DQO processes and a special session discussing these efforts should be held.	The GIT subcommittees have been encouraged to use the DQO process (or a DQO-like process) to develop comprehensive Standard Operating Procedures for data collection. At the next EAG meeting, the GIT will provide a report on the status of this activity.	Combined with Recommendation 12-00-10.
7-99-18	Complete	Database issues should be clarified, and funding issues for database development should be given a high priority	The Information Management Subcommittee has brought on a project management specialist to develop a resource-loaded schedule in order to develop a request for funding adequate to support the information management system development and maintenance.	Combined with Recommendation 11-98-14. The GIT recognized information management as the keystone of this program. Development of the system is lagging in the information collection in the program. This is primarily due to funding priorities and constraints.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-99-19	Complete	The geologic model should be used for preliminary predictions of stratigraphic boundaries.	The predictions on the stratigraphic contacts will continue to be used in the Field Implementation Plan. As more data are added to the geologic model, these predictions will become more certain.	Predicted stratigraphic contacts are included in the Field Implementation Plan. The predictions come from the stratigraphic model. In areas of LANL where there are more nearby wells, the predictions are closer to reality than in areas of LANL where less is known. The basalts are a "wild card" because the geologic controls on the distribution are not well known.
7-99-20	Complete	An overall geochemical model should be developed.	A budget will be requested for this task. Each subcommittee member is engaged in the process so that the FY00 budget request will include adequate funding.	One goal of the GIT Geochemistry Subcommittee is to develop an overall geochemical model.
7-99-21	Complete	Present more geochemical calculations and carry out sorption isotherm experiments.	These are interpretive tasks that will have a funding request for FY00. Sorption studies are planned for areas where contamination is encountered so that remedial options can be developed.	
7-99-22	Complete	Additional hydrogeologic modeling results should be presented.	The modeling presentations for the next EAG meeting will focus on the technical details of the modeling accomplished thus far.	Combined with Recommendation 11-98-23. The budget constraints for the modeling effort are a result of the difficulties at well R-25. The response to the constraints is to focus on documenting what has been done rather than further development. This focus will have the additional benefit of having materials prepared for the next EAG meeting.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
7-99-23	Complete	The segmented approach to site modeling should be continued.	The segmented approach to site modeling will be continued.	Approaching the modeling at three different scales seems to be effectively providing modeling results to many users at the same time.
7-99-24	Complete	Review of hydrologic modeling reports is requested by the EAG.	The EAG will be requested to review the hydrologic modeling reports.	
7-99-25	In process	The locations and rates of recharge should continue to be defined.	The results of the plateau-scale modeling will be presented at the October meeting.	In addition to the preliminary recharge discussion presented at the Annual Meeting, the plateau-scale modeling has indicated that recharge is a sensitive parameter in the model.
7-99-26	In process	Improvement of drilling cost analyses, as part of benchmarking should continue.	Some potential contractors have been contacted to determine their capabilities in this area, and initial ideas for scope of work have been discussed.	The benchmarking study is important to the GIT.
7-99-27	Complete	Review of the design of stainless steel screens installed in the deep monitoring wells is requested by the EAG.	The EAG will be requested to review the well design for each well.	The specifications for well construction are included in the Field Implementation Plan for each well.
7-99-28	Complete	Evaluate drilling method after five or six wells have been drilled using the current method.	The procurement for continued drilling services will take place this fall. More discussions will occur before the drilling method(s) will be specified.	The new drilling procurement will allow the flexibility to try different drilling methods if the drilling costs remain high after five or six holes.
11-98-1	See 7-99-4	Continue the frequent, detailed and exhaustive communication efforts to keep relationships on the upswing with the regulators and the community as well as the funding organizations.	Maintain communication with stakeholders at the level that it has been for the past 2 years. Formal meetings will occur five times a year – four quarterly meetings and one annual meeting. Informal meetings and communication (e-mail, phone calls) will also continue as new information warrants. Make data accessible through the Internet.	Web interface will be operational in approximately one year. This recommendation is combined with 7-99-4 for further action.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
11-98-2	See 7-99-14	Reach agreement with NMED on MCL's (and ACL's).	Initial discussions about MCLs and ACLs occurred at January 1999 Quarterly Meeting. Proposed approach in Annual Report. The proposed approach was discussed the Annual Meeting in March.	Requires coordination and consensus within the Laboratory (ESH-18, ER Project) to develop groundwater cleanup levels that can be proposed to NMED. This recommendation has been combined with recommendation 7-99-14 for action.
11-98-3	Complete	Have NMED representatives present during some portion of the next EAG meeting.	Arrangements will be made with NMED to attend appropriate portions of the meeting.	Inviting stakeholders to EAG meetings will continue.
11-98-4	See 7-99-1	Have a better description of the relationship and support within LANL for the activity, including how the management of ESH, ER, NWT, etc. regards the activity with respect to their other priorities.	A description of how the Hydrogeologic Workplan activities fit within the LANL structure will be prepared for the next meeting of the EAG.	This recommendation is combined with 7-99-1 for action.
11-98-5	Complete	Have a more detailed stakeholders identification map defining relationships other than the three to five major stakeholders.	A stakeholder identification map will be prepared for the next meeting of the EAG.	The complete implementation of this recommendation is now scheduled for the October 1999 meeting of the EAG.
11-98-6	Complete	The proper sequence of priorities should be consistent in Tables 4.1 and 4.2.	Tables 4-1 and 4-2 in the Hydrogeologic Workplan (May 22, 1998) will be revised as the program evolves and new data is collected. The priority sequence will be adjusted during quarterly meetings and will be reflected in the Annual Report. Information in Tables 4-1 and 4-2 will be updated on an annual basis and included in the Annual Report.	The tables will be updated in every annual report.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
11-98-7	See 7-99-12	Develop contingency for examination of intermediate zones, particularly working with stakeholders to evaluate tradeoff between deep wells and shallower wells.	A proposed approach will be discussed with NMED at the Annual Meeting. The approach, when finalized, will be formalized by inclusion in the RCRA permit when it is reauthorized.	Requires coordination and consensus within the Laboratory (ESH-18, ER Project) to develop an approach that can be proposed to NMED. This recommendation has been combined with recommendation 7-99-12 for action.
11-98-8	See 12-99-24	Use low-flow purging and sampling techniques for water-yielding wells and passive sampling for poorly-yielding wells.	The options and technical basis for each option should be an agenda item for the next meeting of the EEG.	This issue will have increased importance when a well is completed and quarterly sampling begins. Consensus with stakeholders on the use of these sampling techniques must be reached before sampling begins. This recommendation has been combined with 12-99-24 for action.
11-98-9	Complete	Core should be logged and evaluated as soon as possible after retrieval. Core that will be used for parameter testing or sorptive potential should be stored in an intact state and tested as soon as possible.	The procedures for handling core include logging the retrieved core as soon as possible after extraction. Immediately after logging, sections of the core that are of possible hydrologic, geologic, or geochemical interest are preserved. After the core from the entire borehole has been collected, portions of core are selected for testing.	Adherence to the Standard Operating Procedures for handling core and other samples will continue to preserve the integrity of the samples.
11-98-10	Complete	Consider using cement seals if the bentonite grout seals fail under certain circumstances.	Should the situation arise that bentonite seals are not effective, then other sealing options (including cement seals) will be considered, evaluated, and tested in order to continue the drilling.	In the event that other seals are necessary, the EAG will be asked to provide input on the sealing options. NMED will have to concur with any decision to change the well completion specifications.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
11-98-11	Complete	Review data needs on a continual basis and review the scope of the characterization program on an annual basis in light of what the regulators require.	The Hydrogeologic Workplan was developed on the premise that data needs would be reviewed with each addition of new data and the scope of the program adjusted based on that review. The regulators are regularly involved in this review via the Annual Meeting, Quarterly Meetings, and informal meetings as required.	Continual re-evaluation of the data needs will continue in conjunction with stakeholder and EAG input.
11-98-12	See 12-99-19	Avoid mud-rotary drilling in order to preserve the pristine nature of subsequent samples.	There are no plans to use mud rotary-type drilling for the regional wells. Mud rotary-type drilling may be used in other circumstances, such as installation of wells targeted for the intermediate zone(s) where the exact depth and configuration is known prior to the start of drilling.	When mud rotary and other drilling methods are under consideration, the EAG will be asked to provide input on the options. Input from NMED will be requested with any decision to change the well drilling methods. This recommendation has been combined with 12-99-19 for action.
11-98-13	Complete	WESTBAY systems should be demonstrated and well understood before it is used.	LANL personnel have taken a number of steps to investigate WESTBAY system including visiting sites with WESTBAY systems installed for demonstration of sampling, and studying literature from sites that are using WESTBAY systems. The next demonstration of the WESTBAY system will be as installed in the R-25 well. Completion decisions for each well will be made after the drilling and initial sampling have been completed and will be based on the conditions encountered in each well. WESTBAY systems will only be installed in wells for which it is suitable.	The use of WESTBAY systems will be evaluated on a well-by-well basis and will incorporate stakeholder and EAG input.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
11-98-14	See 11-99-18	FIMAD should more rapidly incorporate legacy data and the system be available for timely use by stakeholders	Environmental surveillance data and data collected under this program to be available through the Internet. Groundwater data will be linked to Environmental Restoration data, but the exact relationship of the Water Quality Database to FIMAD has not been determined.	The Groundwater Database is in development. This recommendation has been combined with 11-99-18 for action.
11-98-15	Complete	The three-person drilling crew should have backups in case of fatigue, illness, or other reasons.	Evaluate the possibility of training another three-person crew.	The staffing provided by the driller under their contract is under close scrutiny. The procurement for continued drilling services to be released this fall might specify staffing levels.
11-98-16	Complete	Complete the wells with metal fittings rather than PVC.	Currently all deep wells are planned for metal fittings. There may be conditions under which PVC fittings would be considered, but that decision would be made on a case-by-case basis considering the factors in the situation and weighing the pros and cons of PVC. This decision would not be made without seeking input from the stakeholders and technical experts.	In the event that other fittings are evaluated for use, the EAG will be asked to provide input on the options. NMED will have to concur with any decision to change the well completion specifications.
11-98-17	Complete	Place filter packs greater than 2 feet (10 to 20 feet) above the top of the screens to account for settling of the filter material in wells that may be used for monitoring.	Filter pack will be placed 2 feet above the perforations; additionally 3 feet of fine sand will be placed above the filter pack.	Adherence to the Standard Operating Procedures for well construction will continue to preserve the integrity of the well.
11-98-18	In process	Benchmark the costs-to-date against similar activities.	A benchmarking study will be initiated in early 1999 with the goal of having preliminary results for the next EAG meeting.	The GIT concurs with this recommendation. This recommendation is combined with recommendation 7-99-2 for action.

Table A-2: Comprehensive List of Recommendations and Status of Proposed Actions

Tracking Number	Action Status	EAG Recommendation	LANL GIT Action	Notes
11-98-19	Complete	Develop more detailed GANTT chart with scheduled deliverables that indicates how the results of the hydrologic investigations will be incorporated into the RFIs and CMSs.	How hydrologic results will be incorporated into ER Project documents will be determined and described. A GANTT chart may not be the best presentation of this information.	The complete implementation of this recommendation is now scheduled for the October 1999 meeting of the EAG.
11-98-20	Complete	Revise budget and update budget projections on a continual basis to reflect the iterative nature to the program.	There is quarterly reporting on the budget, an annual post mortem, and a projection for the next fiscal year. Budget revisions will be discussed at the annual project review.	This recommendation will be fully implemented at the annual project review scheduled for October 1999.
11-98-21	Complete	Have an annual project review to identify mid-course corrections and ensure cost-effective management and execution. The review should include performance reviews, costs to date, next year's tasks, and proposed budget.	An annual project review will be initiated for FY99. The review will include technical and management performance review, previous year costs, and next year tasks, and proposed budget. Participants will include LANL organizations (ESH-18, ER, EES, NWT) and DOE.	An annual project review is scheduled for October 1999.
11-98-22	Complete	Consider periodic rebid of drilling work on a combination of per-foot basis for drilling and coring and per-hour basis for other activities.	Rebid of the drilling contract will consider definition of per-foot charges for certain activities and per-hour charges for other activities.	The initial meetings to develop the drilling procurement documents have focused on how to structure the compensation framework.
11-98-23	See 7-99-20	Use modeling as a tool to evaluate the need for and location of future wells and as a communication tool with stakeholders.	Planned modeling activities for FY99 should produce a working model that can be used for this purpose. The model will also be used to communicate the program with stakeholders.	This recommendation has been combined with 7-99-20 for action.