JK

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

memorandum

TO: DISTRIBUTION

DATE: June 26, 2000

FROM: CHARLES NYLANDER, ESH-18

MAIL STOP/TELEPHONE: K497/5-4681

SYMBOL: ESH-18/WQ&H:00-0212

SUBJECT: **EAG SEMI-ANNUAL REPORT**

Enclosed is the final External Advisory Group (EAG) Semi-Annual Report dated June 26, 2000. This report is based on the EAG's semi-annual review of Los Alamos National Laboratory's implementation of the Hydrogeologic Workplan during the Annual Meeting held March 29-31, 2000. If you have any questions or comments, please contact Dr. Robert Charles by telephone at (307) 655-3128, by mail at 31 River Road, Box 904, Ranchester, Wyoming, 82839.

This report is being sent to you because you have received a copy of the Laboratory's Hydrogeologic Workplan and a binder for the Annual Reports and meeting minutes, or have requested to be on the distribution list. If you are not interested in continuing to receive these materials, please contact me at the address or telephone number listed above.

CN/tml

Enclosures: a/s

JUL 2000
RECEIVED

Distribution:
A. Armijo, NNMCAB, Nambe Pueblo, NM, w/enc.
J. Arends, CCNS, w/enc.
K. Agogino, EPD, DOE/AL, Albuquerque, NM 87116, w/enc.
R. Enz. DOE/LAAO, w/enc., MS A316
T. Taylor, LAAME, DOE/LAAO, w/enc., MS A316
J. Vozella, DOE/LAAO, w/enc., MS A316
M. Johansen, DOE/LAAO, w/enc., MS A316
G. Turner, DOE/LAAO, w/enc., MS A316
J. Ordaz, DOE/HQ/DP-13, Germantown, MD, w/enc.
T. Longo, DOE/HQ/EM-45, Germantown, MD, w/enc.
W. Holman, ERD/DOE, Oakland, CA, w/enc.
E. Anderson, EAG, Sciences International Inc., Alexandria, VA, w/enc.
R. Charles, EAG, Ranchester, WY, w/enc.
R. Powell, EAG, Powell & Associates, Las Vegas, NV, w/enc.
J. Powers, EAG, Murray, UT, w/enc.
D. Schafer, EAG, Stillwater, MN, w/enc.
C. McLane, EAG, McLane Environmental, Princeton, N.J., w/enc.
A. Chang, EPA, Dallas, TX, w/enc.
R. Mayer, EPA, Dallas, TX, w/enc.
D. Neleigh, EPA, Dallas, TX, w/enc.

13402

Distribution (continued):
P. Reneau, IT Corp., w/enc. MS M892
T. Glasco, Los Alamos County, Los Alamos, NM, w/enc.
M. Bates, Los Alamos Study Group, w/enc.
R. Hull, LATA, w/enc., MS M321
S. Johnson, LATA, w/enc., MS M321
M. Everett, MK/PMC, w/enc., MS M327
A. Crowder, MK/PMC, w/enc., MS M327
K. Bitner, Neptune & Co., Albuquerque, NM, w/enc.
K. Hull, Neptune & Co., Albuquerque, NM, w/enc.
P. Maggiore, NMED Secretary, Santa Fe, NM, w/enc.
J. Parker, NMED/DOE/OB, Santa Fe, NM, w/enc.
M. Dale, NMED/DOE/OB, w/enc., MS J993
S. Yanicak, NMED/DOE/OB, w/enc., MS J993
R. Montoya, NMED/DOE/OB, Santa Fe, NM, w/enc.
B. Wedgeworth, NMED/DOE/OB, Santa Fe, NM, w/enc.
J. Bearzi, NMED/HRMB, Santa Fe, NM, w/enc.
G. Lewis, NMED/HRMB, Santa Fe, NM w/enc.
J. Keiling, NMED/HRMB, Santa Fe, NM, w/enc.
J. Young, NMED/HRMB, Santa Fe, NM, w/enc.
M. Taylor, NMED/HRMB, Santa Fe, NM w/enc.
M. Leavitt, NMED/GWQB, Santa Fe, NM, w/enc.
P. Bustamante, NMED/GWQB, Santa Fe, NM, w/enc.
J. Mullany, NMED/GWQB, Santa Fe, NM w/enc.
J. Davis, NMED/SWQB, Santa Fe NM, w/enc.
B. Jacobs, NPS, Los Alamos w/enc.
J. Pecos, Cochiti Pueblo, Cochiti, NM, w/enc.
D. Duffy, Jemez Pueblo, Jemez, NM, w/enc.
J. Chavarria, Santa Clara Pueblo, Espanola, NM, w/enc.
R. Gutierrez, Santa Clara Pueblo, Espanola, NM, w/enc.
D. Saracino, San Ildefonso Pueblo, Santa Fe, NM, w/enc.
K. Nasser, Revision, Denver, CO, w/enc.
R. Koch, SAIC, w/enc., MS J521
R. Lewis, Schlumberger, Englewood, CO, w/enc.
B. Johnson, Westbay, N. Vancouver, w/enc.
F. Patton, Westbay, N. Vancouver, w/enc.
C. Abeyta, USGS, w/enc.
Congressman T. Udall, Santa Fe, NM, w/enc.
Assistant Attorney General J. Grubesic, Santa Fe, NM, w/enc.
K. Henning, CIC-15, w/enc., MS M311
G. Suazo, CRO-1, w/enc., MS A117
T. Gunderson, DLDOPS, w/enc., MS A100
J. Aldrich, EES-1, w/enc., MS D462
D. Broxton, EES-1, w/enc., MS J462
B. Carey, EES-1, w/enc., MS D462
G. Cole, EES-1, w/enc., MS D462
F. Goff, EES-1, w/enc., MS D462

Distribution (continued):
D. Hickmott, EES-1, w/enc., MS D462
P. Longmire, EES-1, w/enc., MS D469
D. Vaniman, EES-1, w/enc., MS D462
R. Warren, EES-1, w/enc., MS D462
K. Birdsell, EES-5, w/enc., MS F649
E. Keating, EES-5, w/enc., MS C306
B. Robinson, EES-5, w/enc., MS-F649
B. Stone, EES-5, w/enc., MS-F649
A. Pratt, EES-13, w/enc., MS M992
A. Dorries, EES-13, w/enc., MS M992
S. Bolivar, EES-13, w/enc., MS H865
D. Daymon, EES-15, w/enc., MS M992
E. Springer, EES-15, w/enc., MS J495
B. Newman, EES-15, w/enc., MS J495
A. Gallegos, EES-15, w/enc., MS J495
M. Baker, EM-DO, w/enc., MS J591
J. Canepa, EM/ER, w/enc., MS M992
R. Vocke, EM/ER, w/enc., MS J591
D. Hollis, EM/ER, w/enc., MS M992
M. Cummings, EM/ER, w/enc., MS M992 (2 copies)
T. Ball, E-ER, w/enc., MS M992
B. Martin, E-ER, w/enc., MS M992
D. Erickson, ESH-DO, w/enc., MS K491
B. Gallaher, ESH-18, w/enc., MS K497
S. Kinkead, ESH-18, w/enc., MS K497
S. McLin, ESH-18, w/enc., MS K497
K. Mullen, ESH-18, w/enc., MS K497
C. Nylander, ESH-18, w/enc., MS K497
S. Rae, ESH-18, w/enc., MS K497
D. Rogers, ESH-18, w/enc., MS K497
B. Turney, ESH-18, w/enc., MS K497
A. Barr, ESH-19, w/enc., MS K498
M. Cash, ESH-19, w/enc., MS P915
C. Bare, ESH-20, w/enc., MS M887 (3 copies)
P. Schumann, ESH-19, w/enc., MS M992
J. Sisneros, F-1, w/enc., MS P908
D. Woitte, LC-GL, w/enc., MS A187
P. Wardwell, LC-GL, w/enc., MS A187
J. Holt, NWT-PO, w/enc., MS F629
LANL Reading Room, MS A117

Cy: CIC-10, MS A150, w/enc.
WQ&H File, w/enc., MS K497

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

for meeting dates - 29-31 March 2000

June 26, 2000

External Advisory Group

Elizabeth L. Anderson, Sciences International, Inc.

Robert W. Charles, Consultant, Geochemistry and Management

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

Robert M. Powell, Powell & Associates Science Services

Jack D. Powers, Consulting Engineer

David C. Schafer, David Schafer and Associates

CONTENTS

1.0 INTRODUCTION 3

2.0 MANAGEMENT AND GLOBAL ISSUES 3

2.1 Program Management 3

2.2 Management of Stakeholder Issues 4

2.3 Action Plan for Recommendations of the EAG 6

2.4 Data Quality Objectives 7

2.5 Administrative 8

3.0 TECHNICAL ISSUES 9

3.1 Data Gathering 9

3.2 Database 12

3.3 Modeling 13

3.4 Drilling and Well Completion 20

3.5 Groundwater Monitoring 21

3.6 Risk Based Assessment 24

APPENDIX A Risk Assessment Toxicological Information for Perchlorate 26

1.0 INTRODUCTION

The External Advisory Group (EAG) for the Groundwater Integration Team (GIT) of Los Alamos National Laboratory (LANL) met 29-31 March, at Ghost Ranch and Los Alamos, New Mexico. This was the fourth semi-annual review of activities proposed under the Hydrogeologic Workplan (Workplan) developed at the Laboratory. The purpose of the EAG is to function as an independent peer review body, comprised of professionals with expertise and experience germane to the Hydrogeologic Workplan activities. The EAG provides an objective review and appraisal of the Laboratory's scientific, technical, and economic approach to, and implementation of, the Hydrogeologic Workplan.

The current document is the deliverable that is provided by the EAG after each semi-annual meeting. The EAG studied the Annual report, notes from the January Quarterly Meeting, and the Action Plan for EAG Recommendations; heard technical presentations; participated in subsequent discussions; and facilitated meetings with External Stakeholders and Senior Management of the Laboratory, Department of Energy (DOE) and New Mexico Environment Department (NMED). Reference documents include the Hydrogeologic Workplan, the Groundwater Protection Management Program Plan, the Monitoring Well Installation Project, Project Execution Plan, the Groundwater Integration Team Implementation Plan, previous annual reports, interim completion reports for various wells, and correspondence among the various stakeholders. The reviewing team consisted of Elizabeth L. Anderson, Robert W. Charles, Charles F. McLane, Robert M. Powell, Jack D. Powers, and David C. Schafer. All participated in the review and the preparation of this document. This report summarizes the discussions, impressions, and recommendations of the EAG as of the date of the meeting.

2.0 MANAGEMENT AND GLOBAL ISSUES

2.1 Program Management

A meeting of the senior management for the Workplan was held on the morning of 31 March to discuss goals and specific products of the Workplan. Attendees included LANL: ESH Division, ER Division; DOE: Los Alamos Area Office, Albuquerque Operations Office, Defense Programs; NMED: Oversight Bureau and Hazardous and Radioactive Materials Bureau; the Program Manager for the Workplan, and the EAG. A first meeting of this group was held during the 1999 fall review in which the principals agreed to discuss their perceptions of the ultimate goals of the program and possible products from the perspective of their organizations.

In preparation for the spring meeting each participant, exclusive of the EAG members, was asked to prepare a goal definition, some specific products expected, measurements that would lead to these products, and a possible schedule. These were tabulated for each organization at the beginning of the meeting. Recurrent themes punctuated the discussion that followed. All of the organizations agreed that major end state products are:

1. the wells themselves
2. plans for long term monitoring of the wells
3. robust, comprehensive models, and
4. a database sufficient to support the models.

Discussion then addressed the mechanism to achieve these end states. A 'cartoon' depicting the sequence of data collection, database formation, modeling, prediction, and specific tangible products was put forward as a conceptual model for integrating the promulgation of the end state products. The mechanism for integration of the end state products was agreed to be the Annual Report issued by the GIT. The Program Manager agreed to prepare more detail for the modeling and database end states at the concurrent behest of NMED/Hazardous and Radioactive Materials Bureau (HRMB). Time frame for this response is about 45 days. The time frame for the drilling is in the process of being reworked although

there is some conflict over scheduling (see Stakeholder Section). The Program Manager stated that the requests and the directions were compatible with the Workplan. The Senior Managers agreed that the Workplan was well thought out and management was, in general, in tune with the major products. Stated in another way, the Senior Management has no desire to restart the Workplan but prefers to negotiate some specifics in its implementation and final products.

The EAG was impressed with the atmosphere of problem solving and empathy of the Senior Management for the goals and objectives of sister organizations. Much of the frustrating incomprehension of seemingly conflicting objectives expressed at the first meeting seems to have evolved into an indication of generally compatible end states. The EAG noted that, particularly, ESH Division management gave effective Los Alamos upper management support for the Workplan by clearly presenting its goals. That stated, it is clear that there will have to be continual discussions of end states and steps thereto because of conflicting time-goal orientation among the attendees. These range from the long term implications of the well field to produce data sufficient to support long term Laboratory objectives supporting environmental stewardship vs. schedule, budget, and specific product definition driven aspects of the external organizations which are of a shorter term. The EAG found continuing discussions to be a pathway for managing these conflicts and recommends these communications continue. EAG participation is not required at all of these meetings and such engagements could proceed in our absence to better refine Workplan products, with Senior Management delegating working-session tasks to other management and technical personnel as appropriate.

Positives:

- Full attendance *and* participation of the relevant management personnel
- General agreement on the goals of the Workplan
- Good problem solving approach by participants
- Effective Los Alamos Management support

Recommendation:

- Keep the communications going with or without EAG participation.

2.2 Management of Stakeholder Issues

The third installment of stakeholder meetings was held on 29 March at Ghost Ranch. These are intended to present stakeholder concerns directly to the EAG in the absence of the GIT. The GIT then responds to the enumerated concerns by convening with the EAG and stakeholders near the conclusion of the meeting. Attendees at this meeting included representatives of NMED/HRMB; Pueblos of Cochiti, San Ildefonso, and Nambe; University of California, Los Alamos County, NM Attorney General's Office, Concerned Citizens for Nuclear Safety (CCNS), Citizens Advisory Board (CAB), Los Alamos Technical Associates (LATA), DYNATEC, and Westbay Instruments.

The plan for the meeting was to present the issues of the last meeting and ask for any additions from new or old attendees. Two new issues were added, risk assessment and issues of standards/action levels, and two older drilling program issues (parked wells and drilling personnel changes) were ultimately dropped. A new subissue of watershed focus was added to the existing issue of well prioritization. Attendees then voted on issues of greatest concern. The issues were then addressed in this ranked order determined by the number of votes. All issues were covered in the allotted time.

I. *Well Prioritization* - Concerns included the prioritization of wells to characterize individual priority watersheds vs. the dispersed locations prioritization originally designed to fill data gaps, possible regional aquifer wells outside the LANL boundaries, falling behind schedule for drilling, and cross zone contamination of wells (possible transmittal of upper level contaminants to the regional aquifer due to drilling). The PM responded with a plan to drill two watershed wells per year yet still get some

of the wells more dispersed as per the original prioritization. He also indicated support for a Cochiti Pueblo well as providing a good boundary condition for the regional groundwater model in this area. The Lab will go on record supporting a Cochiti and San Ildefonso monitoring well. Although the drilling schedule is behind, it is rapidly catching up due to unencumbered (i.e., some mud) drilling methods advocated at the last meeting. The PM also stated that one cannot guarantee prevention of cross contamination, but the drilling methods are specifically designed to minimize this concern.

II. *Modeling vs Monitoring* - Questions involved the dollar breakdown between these two items and between the Environmental Restoration Project (or ER) and Defense Programs (DP). Concerns were expressed over using modeling as a substitute for monitoring and how the Hydrogeologic Workplan (HWP) leads to a monitoring program. The project manager (PM) gave approximate dollar values for the categories of concern, and stated that the data gathered from monitoring will be used to improve models. Wells are completed with an eye toward long term monitoring.

III. *Data Distribution* - There is continued frustration over data distribution. NMED noted some slight improvement in communications since last year. Pueblos noted that a 24-hour notice of data before decisions are made is too short. Perhaps additional agreements are necessary to improve the flow. A data release protocol was requested and some indicated that a two-tier data release might be needed. Stakeholders acknowledged that they should observe some restraint in the further distribution of LANL data and LANL may have to prioritize who gets what information and when. The PM stated that this is an issue that continues to be worked and a better trusting relationship seems to be emerging. Verbal discussions of preliminary data shall occur.

IV. *Planning Involvement* - The stakeholders were pleased with their participation, but felt the definition of planning vs. technical meetings remained somewhat obscure. Certain stakeholders indicated an interest in being more involved in the planning process. The PM restated that, while the annual meeting was more for policy related decisions and the quarterly meetings were more technical, there will be overlap. The agenda will attempt to clarify this dichotomy in the future.

V. *Drilling Methods* - This issue was a major concern at the previous meeting. Concerns currently are that the drilling methods be tied to the DQO's to assure that the data gathering needs are met by the drilling methods. The stakeholders noted positively the changes since fall 1999: The uses of unencumbered drilling methods, some mud drilling, and additional rigs have increased the rate at which wells can be installed. The PM will attempt to continue to balance the concerns of data over schedule. The new contract will have a contractor responsible for the driller and drilling schedule. The Lab will write the Field Implementation Plans (FIPs) but the contractor will have flexibility in carrying them out.

VI. *Risk Assessment* - There was concern that only Los Alamos County is being used to generate conceptual models for risk assessment. These generic scenarios need to be modified to take into account cultural issues and policies of additional stakeholders. These policies appear only partially defined at this time. There was concern expressed that biologists should be included in developing the risk assessments for evaluating issues related to ecological impacts. The result should be to recommend ultimate actions should contaminant detection occur. The PM recognizes these concerns and will work with stakeholders in an iterative fashion to modify the conceptual models. Existing models are taken from the ER Program.

VII. *Funding Flexibility and Adequacy* - This is a continuing concern about DP vs ER wells. Stakeholders indicated that who pays should be less important than whether or not it is appropriate to drill a certain well now, rather than having to wait. While funding levels are congressionally fixed, the programs will attempt to cooperate in this context. However, DP and ER have specific goals that sometimes cannot be compromised. The PM will explore swapping wells that, particularly, have mutually beneficial goals.

VIII. *Intermediate Wells* - Concern was stated that the issue of intermediate wells was partially addressed by the response to contaminant detection criteria, but that this still did not address contaminant pathways. The refinement or response criteria calling for intermediate wells remains obscure and should continue to be addressed.

IX. *Standards/Action Levels* - There is some concern with the jargon involved - ACLs, MCLs, etc. Once an observation of contamination is made, the ultimate impact/action should be expressed in layman's terms referring to established standards or action levels, as appropriate.

The EAG noted the generally less contentious nature of the stakeholder discussions relative to the previous two meetings. We feel this is due to the open, responsive nature of the PM and the GIT to reasonable requests from the stakeholders. We feel that the stakeholders, while they may not always get their way, do get their say and careful consideration is made of their recommendations in the context of the mission of the Workplan. Stakeholders continue to feel this meeting is worthwhile.

Effective management by the PM and GIT led to two issues dropping from the list at this meeting. This is the first time this has happened. The concern over personnel changes in the drilling operation has dissipated with the interim help of members of the EAG and the effective work of LATA and DYNATEC. The issue of parked wells has been resolved by eliminating them. One issue concerning a meeting of the EAG with the CAB is being worked and is tentatively being scheduled for the fall during concurrent meetings for the LANL review and a scheduled CAB meeting.

Positives:

- Forthright nature of the discussions with candor by all participants whether internal or external to Los Alamos
- Active participation by all parties
- Problem solving nature of the discussions
- Issues have been resolved and removed from the list of concerns.

Recommendations:

- While there are no new recommendations about the stakeholder meetings, as they seem to be serving a useful purpose, the EAG will continue to monitor concerns and how they are dispatched. Specific technical comments are treated in other sections of this report.

2.3 Action Plan for Recommendations of the EAG

The EAG notes the care, tracking, and resolution of the action items for the recommendations made by the EAG [See 'Los Alamos National Laboratory Groundwater Integration Team Action Plan for External Advisory Group December 1999 Recommendations' March, 2000]. Specific comments for a given recommendation, if appropriate, are handled in the current document in the appropriate section, particularly for recommendations numbered 12-99-1 through 25. The tabulation of all previous recommendations and their respective resolution is also appreciated. The addition of a column to depict possible cost and schedule impacts as well as other notes is a welcome addition.

Positives:

- Effective tracking mechanism for recommendations
- Responsiveness of the GIT
- Addition of possible schedule and budget impacts

Recommendations:

- No new recommendations

2.4 Data Quality Objectives

The EAG was very pleased to see the presentation of the ER Quality Program Overview during the GIT Annual Meeting at Ghost Ranch. The presentation clarified both the personnel and the processes involved in the quality assurance/quality control (QA/QC) implementation of the ER division at LANL. The QA/QC implementation in ER is obviously well thought out and clearly defined organizationally. We were also happy to see the addition of the Groundwater Investigations Focus Area to the hierarchy. As is often the case, given the time constraints of presentations at the meetings, the EAG members find themselves wishing that an additional level of detail had been available from the presentation. This detail would be to further clarify the Hydrogeologic Workplan within the framework and the tasks/processes/personnel that would be listed subordinate to the Workplan (ER Project Document Hierarchy) specifically, and the Groundwater Investigations Focus Area (ER Project Organization) perhaps more generally. It is still not entirely clear whether the QA/QC systems and processes previously developed for ER programs are directly applicable to the Workplan and its Data Quality Objectives (DQOs). It is our understanding, based on the presentation, that an evaluation of specifics, such as ER Standard Operating Procedure (SOP) applicability, is about to be implemented. We encourage this process to be expedited to the extent that is practicable, with the initial focus on SOPs that are relevant to the portions of the Workplan that are ongoing (e.g., well construction, coring, logging, completion, development, etc.), followed by evaluation of the SOPs that might be useful for later-stage processes (e.g., sampling of completed wells, sample preservation and storage, etc.). Some urgency should be associated with this process because the Workplan is well under way; some of the wells are currently being completed and will soon need to be sampled on a routine basis.

In previous reports the EAG has stated its concern that DQOs, or DQO-like processes be developed and applied to:

1. The well completion and development process
2. The sample collection and handling process
3. The data validation process
4. The database development process
5. The model development process

Presentations and discussions at the recent Annual Meeting seemed to indicate that such activities are ongoing in these important areas. Increased understanding of the DQO needs of these processes will allow better understanding of the applicability of the ER SOPs and drive updates and modifications to increase their relevance to attaining the overall goals of the Workplan. The EAG is comfortable with the progress that has been made in this regard and encourages it to continue. We hope to see additional details in future QA/QC presentations.

The EAG has also previously recommended the development of a GIT Quality Assurance Project Plan (QAPP) for the Workplan. The GIT has responded with an excellent approach to evaluating this need by incorporating the Workplan activities into the ER Project QA system, beginning with a QA self-assessment. The EAG strongly supports this approach, which should yield a baseline determination of QA/QC adequacy and provide a starting point for strengthening specific aspects, if necessary.

Unfortunately, certain results were presented at the Annual Meeting which indicate that there is already a serious QA/QC inadequacy that has apparently gone uncorrected for several years. The problem was manifested by ^{90}Sr data that are obviously inaccurate and have, at a minimum, seriously delayed the LANL Annual Environmental Surveillance Report for 1999. Regrettably, these data are from an internal LANL analytical laboratory (CST-9) and indications are that the poor results likely extend to other analytes as well, notably Americium. In essence, this internal laboratory is routinely finding ^{90}Sr in water samples where there is none, even in blanks. Sample splits with other laboratories, including the Oversight Bureau and the United States Geological Survey, show that these other laboratories are correctly analyzing the samples whereas the internal LANL laboratory is not. Typically the other laboratories are showing non-

detects while the LANL laboratory is showing elevated ^{90}Sr concentrations. It is the opinion of the EAG that this situation makes all data coming from this LANL laboratory suspect and open to question. This, in turn, will cause concerns about the quality of certain data that will be generated for the Workplan and be incorporated into the Water Quality Database, modeling efforts, and risk assessments. Overall, this will create credibility problems with the NMED, other LANL stakeholders, and the public in general. This is a problem that needs to be immediately corrected before the Workplan begins generating large amounts of data from routine monitoring processes. The EAG concurs with the GIT and the Workplan's Program Manager that ESH Division should use a different vendor for analytical services until it can be proven that the internal LANL laboratory can generate data of adequate performance and quality standards.

Positives:

- The EAG was very pleased to see the presentation of the ER Quality Program Overview
- The ER QA/QC implementation is well thought out and clearly defined organizationally.
- The EAG was happy to see the addition of the Groundwater Investigations Focus Area to the ER QA hierarchy
- The EAG is pleased that progress has been made in addressing critical topic areas with DQO or DQO-like processes
- The EAG strongly supports the approach of incorporating the Workplan activities into the ER Project QA system, beginning with a QA self-assessment.

Recommendations:

- The EAG requests a presentation at the next meeting that further clarifies details of the Hydrogeologic Workplan within the ER QA framework
- The EAG promotes continuing assessment of the DQO needs of the listed Workplan processes to allow better understanding of the applicability of ERs QA systems and SOPs.
- The EAG encourages rapid evaluation of ER SOPs relevant to the Workplan processes that are ongoing, to be quickly followed by evaluation of the SOPs useful for upcoming Workplan processes.
- An internal LANL laboratory is generating data of dubious quality for ^{90}Sr and possibly other analytes. Therefore the EAG concurs with the GIT and the Workplan's Program Manager that ESH Division should use a different vendor for analytical services until it can be proven that the internal LANL laboratory can generate data of adequate performance and quality standards.

2.5 Administrative

The EAG gratefully acknowledges the work of Johnson and Bitner with the general meeting arrangements, notes, name tags, and trouble shooting during the meeting. Their work is indispensable to a successful meeting. Due to the ever-increasing meeting content, comments, and questions, we advise the use of some laptop tabulation of notes so that they can be more rapidly disseminated.

Another administrative change we would like to implement, suggested by the ESH Division Director, is a close-out session for the managers during their regularly scheduled meeting. Managers could then depart if they so desire, because the close out with the GIT might involve more technical discussions than the senior managers would want. They, of course, are welcome to stay.

Positives:

- Hand out preparation
- Logistics
- Note taking

Recommendations:

- Facilitate note taking with immediate laptop storage.
- Add a management close-out session to the management portion of the meeting.

3.0 TECHNICAL ISSUES

3.1 Data Gathering

Data gathering continues to be a topic requiring ongoing adjustments and evaluation. Much of this is due to the transitioning of well drilling techniques from dry (air rotary, casing advance) to fluid-based approaches that increase the speed and reduce the expense of drilling. Changes in the drilling technique can affect the data that are collected during the drilling process and potentially affect the quality of the monitoring data that can be collected from the completed well for a period of time. For example, the fluid-based drilling techniques can tend to reduce the ability to characterize perched zones and collect uncompromised core samples. Changes in well locations and drilling prioritization might also affect data gathering processes with regard to DQOs.

The GIT has taken the important step of asking its subcommittees to assess their data needs and data quality requirements (i.e., DQOs) for each planned well prior to drilling. This should support well-informed decisions to be made regarding monitoring well prioritizations and locations, drilling technique and, if the technique is fluid-based, the type of drilling fluids to be used. The EAG has not participated in the GIT subcommittee meetings wherein these discussions/decisions have been occurring and is not very familiar with processes occurring therein. It is our understanding that the result is a verbal subcommittee consensus that is then acted upon by the drillers via a Field Implementation Plan (FIP). The EAG would suggest that increased formalization of this process via documentation could be valuable, especially later in the Workplan project. Documentation could ameliorate potential future concerns of regulators and stakeholders should questions arise about the drilling decisions that were made. A rationale and one approach to this type of documentation are addressed in the following paragraphs.

The EAG believes that to arrive at a well-informed drilling decision and implement the decision it is necessary for several factors to come into play. These include:

1. An understanding by each subcommittee of how the various drilling techniques, location changes, and well prioritizations affect their goals/data needs for the Workplan to achieve its DQOs
2. An analytical means by which each subcommittee can rank the wells with regard to their importance to the Workplan DQOs and subcommittee data needs
3. A means for resolution of potential conflicts between the subcommittees, i.e., a process for compromise on locations, prioritizations and drilling methods
4. An understanding by each subcommittee of the impact of such a drilling compromise or the chosen method on their data gathering needs
5. A method for formalizing the drilling decisions and transmitting them to those responsible for carrying out the drilling (e.g., the FIP)
6. A feedback mechanism from the drill team back to the GIT
7. GIT authority to have the well(s) drilled according to the overall GIT subcommittee consensus

The EAG believes there is sufficient expertise on each of the GIT subcommittees so that an understanding of changes in the approach to drilling a well can be competently evaluated in terms of the subcommittee data needs relative to the Workplan DQOs. We recommend that this understanding be documented in a manner that states the anticipated effects on the DQOs. The ranking of the relative importance of the individual wells to a subcommittee's Workplan goals will also depend on professional judgment. A scoring

system could be used to augment the process and provide a formal record of the well ranking determinations.

The EAG was somewhat surprised to hear that significant conflicts had not arisen among the subcommittees with regard to changes in the well drilling protocols. This probably indicates a high degree of discourse, resulting in a comprehensive understanding of the changes and a willingness to accept these changes. This shows commendable leadership skills by the GIT Program Manager in concert with the subcommittee team leaders. It is still possible that increased conflict could arise should one or more of the subcommittees determine that suggested changes to a well could critically impact its attainment of Workplan data needs. In this circumstance it will be important to consider where this well resides on the concerned subcommittee's priority list along with the rationale for its concern. If the well is indeed high on its priority list and the rationale for drilling/locating the well by the concerned subcommittee's recommendation is sound, then the remaining GIT subcommittees and Program Manager might want to defer to the concerned subcommittee's suggestions. This will, of course, have to be evaluated on a case-by-case basis. Although the EAG concurs that getting the wells drilled in a rapid and economical manner is of great concern to progress on the Workplan, we also realize that circumstances may dictate that certain wells should potentially be drilled in a different manner, e.g., without fluids or with different fluids, in particular critical instances necessary to achieve Workplan DQOs.

Inevitably in such a process, compromises must occur with respect to some of the wells. We encourage each of the subcommittees to document both the advantages and disadvantages to their Workplan goals they know or believe will occur due to the well drilling choices. This documentation could include data gathering activities that are assumed to be improved by the compromise decisions as well as data gathering activities that are anticipated to suffer as a result of the decisions. Information should be provided as to the presumed reasons for the impacts on the data gathering.

Finally, there should be a formal process for communicating the drilling decisions and specifications from the GIT to the drilling supervisor and drillers and real time feedback from the drillers to the GIT, when necessary, prior to and during the drilling. Ultimately the GIT should have the authority to determine the drilling protocols for the Workplan wells, based on both the Workplan DQOs, funding availability, and the GIT subcommittee decisions, and should not be countermanded by others in authority without sufficient rationale, justification, and warning.

A recurrent theme in this discussion of data gathering is documentation of the decision processes to support the types and quality of the data that are eventually collected. Although the EAG typically hesitates to formulate recommendations that create additional paperwork, it might become important as the Workplan progresses, and is finally completed, to have paperwork for each well that describes and justifies the approach used for the final drilling and installation decisions and why they evolved in the manner that they did. This documentation would provide regulators and other stakeholders with a complete picture of the decision procedures and the positive and negative effects on data gathering processes that were weighed during these procedures. Ideally these decisions and the supporting rationale could be conveyed for a brief comment period to the regulators and stakeholders prior to drilling decision implementation via the resultant FIP. Ultimately the decision documentation could be incorporated into the final Workplan product(s).

The needed documentation for well decisions that influence the data gathering processes could be very simple, including:

- Forms from the GIT Program Manager (or others) suggesting drilling and completion procedures and any location/prioritization changes for each well
- A ranking/rationale form to be completed for each well by each subcommittee would
    - indicate relative well importance to the subcommittee (i.e., rankings; either absolute, 1 to 32, or relative, e.g., a scale of 1 to 10)

    - explain the reasons for the ranking
    - indicate concerns/objections/acceptance of the Program Manager's suggestions in the context of the data gathering needs for attaining Workplan DQOs
- Meeting notes documenting discussions between the subcommittee team leaders and the Program Manager (or possibly all subcommittee members should such a circumstance arise)
- A form that is signed or initialed by each of the GIT subcommittee team leaders acknowledging the final well protocol decisions and, perhaps, indicating perceived influences of the decision on the data gathering processes. This decision form could also, at the discretion of LANL, be signed or initialed by a representative of the NMED and other stakeholders
- The FIP for each well.

Although developing this documentation may be somewhat more cumbersome than a group discussion and verbal consensus, it will probably require a more comprehensive thought process, potentially resulting in better decisions. At the very least it provides a defensible accounting of important decisions and an understanding of the consequences of said decisions to attainment of the Workplan DQOs and final products.

One specific concern about data gathering has arisen within the EAG. One of the stated goals of the monitoring well installation program is to gather hydraulic data (hydraulic conductivity and transmissivity) to support modeling activities. To achieve this objective, screened zones in the completed wells are hydraulically tested by pumping, injection, slug testing or other suitable procedures.

Thus far, only sparse, anecdotal data have been obtained because of the limited screened areas in the monitoring wells. In R-25, R-31 and R-19, for example, only about ten percent of the saturated thickness has been screened (and therefore hydraulically tested). With such limited testing, it may be difficult to know if the obtained hydraulic parameters are appropriately representative of average conditions within the formations tested. Looking forward, the EAG questions whether this approach will address the needs of the modelers with regard to identifying aquifer properties. The EAG is not suggesting that required data will not be collected, but only that this topic be addressed by the GIT.

Currently, a typical well completion might incorporate a long screen at the water table and several 10-foot screens below, with just one ten-foot screen for each 100 to 150 feet of saturated formation, on average. The quantity of hydraulic data obtained could be increased substantially by screening a greater percentage of the saturated thickness. For example, installing 50-foot long screens instead of 10-foot long screens would potentially offer a five-fold increase in the volume of formation that would be hydraulically tested.

The classical argument against long screens is concern over dilution of the pumped sample that occurs if the screen intersects a plume having limited vertical extent. The flip side of this argument, however, is that using only a 10-foot screen will miss the plume altogether 80 percent of the time in cases where a 50-foot screen would have facilitated detection.

The 50-foot length mentioned here is arbitrary and has no particular significance. However, some combination of more and/or longer screens would be required to increase the quantity of hydraulic data obtained from the monitoring wells. Any such modifications of the well designs would have to conform with other project requirements, including sampling, chemistry interpretation, regulatory requirements, etc. It would be appropriate for the GIT to examine this option in light of the data needs of the modeling program as well as other program requirements. Determining whether or not to use longer screened intervals for better evaluating hydrologic properties could be incorporated into the decision process previously discussed in this section of the report. That is, ranking of the wells by the subcommittees relative to their data needs and DQOs could be used for the determination of screen lengths. Certain wells might be more valuable for assessing hydrologic properties and less important for accurate geochemical quantification, hence would be amenable to longer well screens. Other wells might be essential for geochemical

quantification, especially in certain zones of concern, and have to continue being built with the shorter screened intervals.

The existing municipal wells on the Pajarito Plato could serve as additional sources of hydraulic information. The EAG has seen examples of pumping test data and at least one spinner test log from these wells, but we do not know to what extent this source of information has been exploited. Means of increasing the hydraulic database include reviewing old pumping test records on these wells, and conducting new pumping tests and running spinner logs on all available wells.

Hydraulic data obtained from pumping tests require interpretation before usable information can be transferred to groundwater models. The data interpretation step is one of the most critical steps in the data processing effort for aquifer hydraulic property data. Interpreting pumping test data requires experience, and is often an area in which errors are introduced during site investigation. The EAG would like the opportunity to evaluate this critical step by reviewing analyses of hydraulic performance tests. This QA step seems vital in assuring that the best possible information is obtained.

Positives:

- The GIT is promoting competent decisions and being proactive by asking its subcommittees to assess their data needs and data quality requirements (i.e., DQOs) for each planned well prior to the issuing of FIPs and drilling.
- There is a high degree of expertise on the GIT subcommittees that should allow appropriate review and discussion or relevant factors leading to well-informed drilling decisions.
- The lack of acrimony between subcommittees during the discussions of drilling decisions attests to the leadership of the GIT Program Manager and the subcommittee team leaders.

Recommendations:

- The EAG recommends that the decision process carried out among the GIT subcommittees and resulting in FIPs for the Workplan wells be formalized via increased documentation (rationale and approach provided in the foregoing text).
- The EAG recommends external review of the analysis and interpretation of aquifer test data to enhance the accuracy and reliability of aquifer property estimates that will be important to the success of the modeling program.
- The GIT should consider pros and cons of screening a greater percentage of the aquifer thicknesses in some wells to provide more or better data to the modelers where feasible, as well as thorough testing and analysis of existing municipal production wells in the area.

3.2 Database

The Water Quality Database Project (WQDB) is now making good headway. The EAG was pleased to hear the recent presentation at the Annual Meeting and see that the WQDB design had been considered sufficiently that the number of database tables anticipated has been enumerated. Significant progress is also shown by the fact that 45 of these 110 tables have been fully analyzed and designed.

The EAG was encouraged that additional funding (hence additional personnel) was made available at the beginning of FY00 for the Information Management Subcommittee (IMS) to speed development of the WQDB. We consider the WQDB to be an important product of the Workplan that will integrate Workplan data with existing and future data from ground water monitoring activities. Also serving as the data repository for the modeling efforts, the database will probably be the primary interface to the Workplan results for stakeholders and the general public. Because of this, the EAG feels it is important for the WQDB development tasks to remain on, and if possible, exceed the currently published schedule.

The EAG has a few concerns, which may already be in the process of being addressed by the IMS and GIT, with regard to specifics of the database:

1. Due to the changes that are occurring in the drilling methods among the R wells (e.g., dry vs. various drilling fluids, etc.), it is important that the Well Construction Module capture all this information. Construction information should also include changes that are made during the drilling of a single well and, if possible, the depths and stratigraphy at which those changes were implemented.
2. LANL and the GIT are striving to standardize the methods, via standardizing SOPs, by which Workplan data are collected. Because of this it is important that any new external data added to the WQDB be collected by the same methods. This would preclude any new State or other water data being incorporated unless conformance to WQDB collection standards can be verified.
3. All older data, that are not assured to meet the more recent data quality standards, should be flagged as such in the WQDB if they are used at all.
4. Although it is scheduled for Phase II of the WQDB development, we feel it is important that staffing and funding be identified for the development of the GIS/map interface for the WQDB. This functionality will increase Internet usability and stakeholder comprehension of the data contained therein.
5. The IMS has requested suggestions for external entities to beta test the WQDB in addition to Michael Dale of NMED. The EAG would also recommend at least one beta tester from each of the following: Pueblos, CAB, and EAG.

Positives:

- Significant progress has been made on development of the WQDB during the past year
- The EAG was very pleased by the additional funding and personnel provided to the IMS for speeding development of the WQDB

Recommendations:

- The development of the WQDB should remain on or exceed the planned schedule for development
- The Well Construction module should capture all aspects of the drilling of a well, including such things as changes in fluids while drilling a well through various depths
- External data should probably not be added to the WQDB unless the data conform to the same collection SOPs/methodologies as the new LANL data
- Older data, that do not conform to the more recent data quality standards, should be flagged as such in the WQDB, it they are used at all
- The GIS/map interface for the WQDB is important to the usability of the database; funding and staffing should be planned and identified
- The EAG would recommend at least one WQDB beta tester from each of the following in addition to the NMED: Pueblos, CAB, and EAG

3.3 Modeling

General Comments

From the modeling information presented at the March 2000 Annual Meeting, the EAG noted continuing progress in the GIT hydrologic modeling program. It also appears that efforts are underway to further integrate hydrologic modeling analyses with three-dimensional geologic modeling, geochemical modeling and risk assessment. The EAG notes as a particular positive, the links to modeling established in the presentation of the ER Project's approach for risk assessment of contaminants found in ground water. The

presentation highlighted EPA's acceptance under RCRA of the use of fate and transport models to establish risk levels. It was also stated that the ER Project will propose monitored natural attenuation (MNA), and that the ER Project anticipates having sufficient site-specific data to support models to demonstrate the long-term effectiveness of an MNA remedy.

The link between hydrologic modeling and the water quality data base (WQDB) development effort appear to be less well established (or simply may not have been emphasized in the data base presentation). The EAG recommends that efforts continue to more clearly define and strengthen the link between hydrologic modeling and the program areas of geologic modeling, geochemical modeling, risk assessment and data base development. The EAG also recommends that the intended use of modeling in the siting and prioritization of deep monitoring wells (as discussed in the HWP), be more clearly defined and discussed in future modeling and well drilling presentations.

As in previous reports, the EAG notes that it is difficult to evaluate the appropriateness, effectiveness, adequacy, and efficiency of the modeling studies and results from the brief summaries presented at the March 2000 meeting and in the Groundwater Annual Status Report for Fiscal Year 1999 (released March 2000). The meeting forum, with the necessary time limit for each presentation and the variety of backgrounds of the participants, is not conducive to in-depth technical information exchange. It would be beneficial for the EAG to be provided with additional information prior to each meeting, and to spend additional time with the GIT modeling team to discuss technical modeling issues. This might be accomplished most efficiently by scheduling a technical working session in conjunction with one or more of the already scheduled meetings at which the EAG will be in attendance.

In addition, we would suggest that EAG input and recommendations might be more effectively directed toward planned activities, rather than in evaluating results that have already been produced through the expenditure of considerable time and effort. To be able to provide this up-front input, the EAG would require a schedule of planned modeling (and possibly other) activities and a brief description of the purpose, scope, methodology and outputs of each task as it will be used to guide site characterization, risk assessment, and remediation decisions. This might be accomplished by providing the EAG a copy of the Modeling Work Plan that is currently being prepared in draft form. The EAG, if so requested, could provide input to the document in its current draft form, and then rely on the document (along with other planning documents) as the roadmap for reviewing and commenting on planned modeling activities.

As a final general comment, the EAG recommends that the GIT continue to follow and build upon the DQO process for hydrologic modeling that was established in Appendix 4 of the HWP. Appendix 4 is a good initial template for applying the DQO process to hydrologic modeling in the HWP program, but it will require refinement and redefinition as the modeling progresses. The "decisions" listed in the table should evolve from the technical questions posed in some instances to ultimate decisions that will be based on modeling results, e.g. well placement locations or remedial response actions to be taken. The appendix should also be revised to clarify, to the extent possible, where modeling results will be relied on in reaching decisions (the current wording of "estimate", "calculate", "compute", "determine", or "predict" implies, but does not specifically call out, modeling as the source of data for decision making).

The EAG recommends that DQOs should be revisited at the beginning of each new modeling project or task. The EAG recommended this approach for modeling activities in its 12/23/99 Semi-Annual Report (page 7), but the recommendation was not directly addressed in the GIT March 2000 Action Plan. The GIT (page 6) noted that the adoption of the HWP activities into the ER Project QA system will begin with a Quality Assurance self-assessment to be conducted by a member of the ER Project QA staff and QA Specialist from ESH-14. This self-assessment, as presented at the March 2000 Annual Meeting, is to be completed in the May timeframe. It may be beneficial for the EAG to receive a summary of the self-assessment findings as they relate to the DQO/SOQ/QAPP process, specifically for hydrologic modeling.

Specific Comments

The status and results of several modeling studies were presented at the March 2000 meeting. EAG comments and recommendations regarding these studies are provided below.

Area L Vapor Plume Modeling

Vapor transport simulations were conducted for volatile organic carbons (VOCs) in the vadose zone of Area L in the vicinity of TA-54 to assist in the assessment of risks, and to contribute to the understanding of vapor-phase transport in the vadose zone. Simulations were performed assuming diffusion-dominated transport. Simulation results matched well with VOC vapor phase concentrations measured in the field (an example of a TCA plume comparison at an elevation of 6740 ft msl was presented at the March 2000 meeting). In addition, the model results suggest that plume growth can be adequately captured with yearly monitoring, as opposed to the quarterly monitoring currently employed.

From the limited information provided, the EAG views this as a successful application of modeling to test the conceptual model of vapor phase transport beneath Area L. These findings will support a simpler approach to vapor phase modeling. The EAG also sees as a positive the use of the model to support a petition for reduced monitoring frequency. The EAG does not have sufficient information to comment on the appropriateness of such an interpretation of the model results.

Area G Risk Assessment Model Development

GoldSim, a commercially available, graphical, object-oriented computer program for probabilistic simulation, is being used to perform probabilistic groundwater transport calculations to evaluate potential contaminant migration impacts to groundwater at Area G. In FY2000 a report will be prepared describing the results of a comparison of GoldSim and FEHM process-level models and a demonstration of GoldSim to MDA G.

The EAG feels that this appears to be a promising approach. It apparently trades off more accurate simulation of physical transport processes for the benefit of being able to quantitatively examine uncertainty in model predictions (using the Monte Carlo simulation method). The EAG was not provided with sufficient information regarding the features and capabilities of GoldSim, or the analyses that are currently being performed with GoldSim, to support any comments regarding the appropriateness and likely success of this approach. It would be beneficial for the EAG to be provided with more information regarding the current and planned GoldSim analyses, and to review the results of the comparison with FEHM process models, to evaluate the acceptability of the tradeoff for the purposes for which GoldSim will be applied.

Los Alamos Canyon Flow and Transport Model Development

3-D model simulations were performed to examine processes that govern the transport of tritium through the vadose zone. Tritium travel times of 40 years or less through the vadose zone are explained by the model. Vadose zone concentrations will naturally decline over the next 50 to 100 years due to dilution by clean fluid, radioactive decay, and mass arrival at the regional aquifer. Tritium concentrations in the intermediate perched zones are predicted reasonably well by the model. Values are considerably lower than the measured alluvial groundwater concentrations. Long-term monitoring of intermediate groundwater concentrations is predicted to reveal slowly changing concentrations, suggesting that relatively infrequent samples are required.

The EAG views these results as encouraging, and as a demonstration of the use of modeling by the GIT to design an efficient monitoring program. It may be beneficial for the EAG to review this modeling study in greater detail to provide more in-depth comments regarding the approach and results. In particular, the EAG notes the statement in the FY 1999 Annual Report that, "Despite these results, sensitivity analyses

indicate that uncertainties in recharge and hydrologic parameter values remain, and that these uncertainties influence the model results." This is a meaningless truism. Uncertainties will always remain, and they will always influence the model results. The key questions that must be answered at the conclusion of any modeling study are:

1) Has the modeling study produced the answer it was designed to answer, or produced the information it was designed to produce, to support a decision?
2) Is the model reliable? (e.g., is the model validated by observed values?), and
3) Are the remaining uncertainties acceptable to the decision maker?

Whether or not the modeling study is adequate to answer these questions in the affirmative should be based on decision points that were identified earlier in the project using DQOs, and by defining the HWP work products (see discussion of DQOs under General Comments above). The acceptable level of uncertainty in the modeling results, for the specific decision to be addressed, should have been defined (to the extent possible) at the onset of the modeling project or task.

The EAG does not have sufficient information in this instance (and in several other instances) to be able to assess the modeling analysis and results relative to the intended purpose of the study and relative to these important questions regarding adequacy of, and uncertainty in, results. In future technical information transmittals, it would be beneficial for the GIT to provide the EAG sufficient context for making this determination.

TA-50 Water Injection Test Simulation

A water injection test and subsequent moisture monitoring in the vadose zone was performed at TA-50 in the 1960s. In a recent modeling study reported at the March 2000 meeting, the water injection test and subsequent moisture distribution was simulated using FEHM. The simulation was performed using an effective continuum model without fractures. Results indicate that this simpler conceptual and numerical model is adequate to explain the test data. The two major implications for risk assessment are that (1) percolation through the matrix rock suggests long travel times and more effective sorption; and (2) characterization of fracture networks may not be necessary for the Bandelier Tuff.

It was reported that the GIT modeling team has questioned whether discrete fracture and dual permeability models might also fit the data. Work is ongoing to attempt to match the water injection test data with other conceptual models (discrete fracture; dual permeability).

The EAG views the results of this modeling as positive, and questions the need for additional modeling. The results of the simulation test yield significant benefits from at least two perspectives; less calculated risk and less costly characterization and modeling. These results should be put forward to support an effective continuum conceptual model approach.

TA-49 Flow and Transport Modeling

This modeling effort was not presented at the March 2000 meeting, but summaries in the January 27, 2000 Quarterly Meeting Notes and FY 1999 Annual Report document that modeling was performed for area TA-49 in which non-nuclear explosive testing was conducted in subsurface shafts between 1950 and 1960. After the experiments were finished, the area was covered with an asphalt pad. The pad not only inhibited evaporation, but also dammed surface water along its edges and potentially channeled water through the pad into the underlying shafts.

Modeling results indicated that, while background water infiltration flux rate is approximately 0.1 – 1.0 mm/yr, water infiltration flux rates beneath the asphalt pad where evapotranspiration losses are eliminated, are estimated to range from 60 – 388 mm/yr. The TA-49 model was also used to evaluate radionuclide transport away from test shafts. The mechanism of transport was assumed to be nuclides in

colloidal form moving from the shaft bottoms, because colloids have the potential to move the farthest. Transport simulation results indicate that very little contamination has left the source region. The model also indicates that the recent removal of the asphalt pad, along with other site improvements will reduce recharge resulting in slower contaminant migration rates.

The EAG views this as a successful application of modeling to guide remedial action decision making, and concurs with the GIT recommendation, as stated in the FY 1999 Annual Report that model results should be verified with carefully planned field testing and long-term moisture monitoring.

Regional Aquifer Modeling of HE Transport and Travel Times

One of the applications of the regional model was its use in analyzing transport in the regional aquifer of HE originating at TA-16 and travel times to the nearest water supply wells. The modeling approach was based on advective particle tracking and did not include dispersion or degradation. Two sources were examined; single source (assumes R-25), and a distributed source (assumes HE infiltration from the stream in Canon de Valle as a line source). The model indicates that HE would travel to wells PM-3 and PM-4.

Hydraulic conductivity was based on the current regional model configuration, and aquifer porosity was varied. Travel times are controlled by assumed porosity. As porosity is decreased, travel time is shortened. The tentative conclusion of these preliminary analyses is that the HE contamination poses little or no short-term threat to water supply wells in the area. Plans to examine a new statistically based approach for representing the regional aquifer hydraulic conductivity field were presented at the March 2000 meeting.

The EAG views this as a successful application, even if in a preliminary form, of the regional aquifer model to examine issues relating to migration of site-related chemicals to potential receptors. While much of the current modeling appears to be focused on conceptual model testing and model development, eventually one of the key uses of modeling will be to examine potential risk scenarios similar to the one posed by the presence of HE in the regional aquifer. The EAG concurs with the GIT recommendation (as stated in the FY 1999 Annual Report, and as mentioned at the March 2000 meeting) that the hydrologic properties of the aquifer model be refined to better support such analyses.

Geochemical Modeling

There has been significant progress made during the past year with regard to both the acquisition of geochemical data, development of the geochemical conceptual model and the application of speciation programs to specific geochemical modeling scenarios. The proliferation of data and information from these efforts is apparent during the presentations at the quarterly meetings, wherein there is insufficient time for the speaker to address the numerous ongoing efforts with explanation of their relationship to other Workplan components. These data products will clearly be valuable for developing linkage with, and serving as input to, the transport and fate components of the hydrogeologic modeling efforts. Further elucidation is needed to begin to better develop an understanding for all stakeholders of the information that is currently available: what information is needed, what the information means, how it is to be used, and how it is tied to the eventual Workplan products. The EAG is aware that a good deal of this information is available in current printed materials, but a major effort of time and energy is required for individuals to locate and assimilate the information into a useable concept of the progress that is being made. We would request therefore, that the Geochemistry Subcommittee of the GIT develop a brief report that brings this information together into a single, easy to update document. This document could, until the geochemical conceptual model is finalized, be relatively informal but might contain information such as the following:

- A summary, in lay terms (to the extent possible), of the status and future direction of the geochemical studies and conceptual model
- A section about what is currently known (including, for example, the Geochemistry Elements as per the FY99 Annual Report, Section 3.2.5) and what aspects need to be clarified or further investigated
- An analysis/description of how the geochemical conceptual model, and the data needs to fully develop the model, need to be scaled in order to provide adequate inputs to contaminant transport and fate determinations over the potentially long flowpaths at LANL. For example, is a plateau wide conceptual model, with averaged data (Rf, precipitation potential, etc.) adequate? Should the geochemical conceptual model be subdivided into Mesas and Canyons; or perhaps mesas, canyons, alluvia, vadose zone, perched zone, and regional aquifer; or is an even finer scale, such as a grid system conceptual model, needed?
- A discussion of how the resultant determinations of the Kd estimations (literature or experimental), complexation modeling, surface and phase precipitation calculations, etc., relate to one another with regard to aqueous contaminant concentrations, how it will be determined which values to use if they are in disagreement with one another or measured field data, and how eventually these values will tie into the transport and fate modeling and risk assessment
- Appendices, with tables and figures as needed (since much of this has already been generated), to contain supplemental information that supports the body of the document.

The foregoing list is not intended to be all inclusive of topics that the Geochemistry Subcommittee might wish to include in such a document. We provide this list merely to indicate certain areas about which we would like to see additional clarification. An ideal format for a document such as this would be an online hypertext format. The EAG will be happy to provide additional input into the concept of this document and its development if such is requested by the GIT.

Positives:

- Continued progress in the modeling program overall.
- Better established integration of hydrologic modeling with geologic modeling, geochemical modeling, and risk assessment.
- Demonstrated use of modeling to support a number of overall program objectives, including:
    - Site characterization
    - Conceptual model development
    - Modeling tool/approach development
    - Remedial action evaluation
    - Groundwater monitoring strategy
    - Receptor pathway and risk analysis; and
    - Uncertainty analysis
- Significant progress has been made on the acquisition and interpretation of geochemical data
- The geochemical conceptual model is being developed and updated as new data become available
- Speciation programs are being used and compared to evaluate specific geochemical scenarios
- The information being developed will be critical for understanding and modeling contaminant transport and fate for risk assessment determinations

Recommendations:

- Provide EAG information regarding planned modeling activities so that appropriate input can be provided at an early stage. Such information could include:
    - An overall schedule of modeling activities showing logical progression to completion

- For each planned modeling study, specific information describing:
    - Purpose, driver, and scope
    - Methodology and tools
    - Outputs
    - Use of outputs in decision making for site characterization, risk assessment and remediation
- Afford EAG time to meet with modeling staff outside of open forum/brief presentation setting to discuss technical issues relating to planned and ongoing modeling activities (possibly in conjunction with regularly scheduled meetings).
- The GIT should continue to more clearly define, document and strengthen the links between hydrologic modeling and:
    - Geologic modeling, geochemical modeling and data base development to meet on-going modeling program goals;
    - Well installation and other site characterization activities to meet short-term overall program goals,
    - the siting and prioritization of deep monitoring well, as proposed in the HWP, and
    - Risk assessment to meet overall program end goals.
- Continue to follow and build upon the DQO process for hydrologic modeling that was established in Appendix 4 of the HWP to (a) allow the stated decisions to evolve from technical questions to ultimate well placement or remedial response decisions, (b) clarify where and how modeling will be used to support decisions and, (c) to the extent possible, define the acceptable level of uncertainty in modeling results that, from the perspective of the decision maker, would still support a valid decision.
- Provide EAG with a copy of the Draft Hydrologic Modeling Work Plan so that EAG could (1) provide comments if so requested; and (2) gain a more complete understanding of the overall hydrologic modeling program to provide a better basis for developing recommendations on individual modeling program elements.
- Provide the EAG with additional information regarding the methodology and results of modeling studies, if the GIT would benefit from EAG comments and conclusions regarding the adequacy of the study to support the GIT interpretations and proposed actions.
- Provide EAG with additional information regarding the planned use of GoldSim and the FEHM/GoldSim comparison modeling.
- The GIT should reconsider the planned studies to simulate the TA-50 water injection test with discrete fracture and dual permeability models. The current results support a finding that the simpler and less costly effective continuum conceptual model is adequate to reproduce test results.
- The GIT should proceed, as planned, with field testing and long-term monitoring to support the modeling findings that surface cover modifications at TA-49 have significantly reduced water infiltration flux rates.
- The GIT should continue its efforts to refine the regional aquifer model (including examining new approaches to representing the hydraulic conductivity field) so that the model can evolve into a reliable tool for performing receptor and risk analyses.
- A report should be prepared that consolidates the geochemical activities into a single concise document, with a summary accessible to lay persons but also containing project status, future directions, what information is needed, what the information means, how it is to be used, and how it ties to the eventual Workplan products (see discussion for additional details).

3.4 Drilling and Well Completion

Great improvements have been made recently in the drilling and well completion procedures. The "unencumbered" casing-advance approach, with the option of drilling open hole where the formations are sufficiently stable, has resulted in fast drilling and economically completed wells. While these improvements are welcome, the lab must remain vigilant in addressing the data acquisition to ensure that data quality objectives continue to be achieved.

The design change to five-inch OD stainless steel casing and pipe base well screens offers several benefits. The combination of maximum ID and minimum OD has been optimized to allow installation of West Bay equipment and the use of adequate tremie pipes regardless of the size of advance casing used. The API threaded casing and screen assure straight and strong pipe connections. The only recommendation (likely already planned) is that the current pipe lengths of 9 and 19 feet should be changed to 10 and 20 feet on future purchase orders.

The EAG has observed that the initial order of pipe base well screens was manufactured with only 2.5 percent open area in the base pipe because of a unilateral decision by the manufacturer. Steps now have been taken to require 8.75 percent open area in the base pipe on future orders. Keep in mind that the "effective" open area is substantially greater than this because the solids (filter pack and formation) are in contact only with the wire wound sleeve, which is installed over the base pipe.

Filter Pack Design

There is concern that the configuration of filter pack installed in the deep monitoring wells could lead to some well failures. Currently, design criteria call for installing a limited filter pack length (two to three feet) above and below the well screen with a limited length of fine sand above and below the filter pack to serve as a transition between the filter pack and the bentonite grout seal. Because of using such a limited reservoir of filter pack material, minor settling of the filter pack could allow the fine sand layer to move down to the well screen. This has forced the use of a very small screen slot size (0.010-inch) to make sure that the screen can retain the fine sand should the two come in contact. This conservative slot size could hinder well development somewhat compared to what could be achieved with a larger slot size.

Furthermore, significant settling of the filter pack could allow the top of the fine sand layer to fall below the top of the well screen, allowing either formation material or the bentonite grout seal to enter the well. Compounding this problem is the difficulty of placing backfill materials hundreds or thousands of feet deep with great precision in the first place.

Steps should be taken to obtain approval to modify the design to permit the use of a longer filter packed interval. A prudent design would incorporate five to ten feet of filter pack below the screen and ten to 15 feet above the screen. In some circumstances, shorter filter packed intervals might be required to avoid breaching aquitards but, in most instances, the use of longer filter packed zones would be acceptable.

Positives:

- Drilling costs have come down nicely.
- Drilling speed has increased and the drilling program appears to be back on schedule.
- Well materials (pipe and screen) have been optimized to simultaneously permit installation of West Bay equipment and allow the use of adequate tremie pipes for placing backfill materials.
- The new casing and screen design will assure trouble free make-up in the field, straight joints, a smooth well interior and adequate structural strength for the application depth of the R wells.

Recommendations:

- Specify longer section lengths on future pipe orders, preferably 10-foot and 20-foot lengths.
- Require a minimum of 8.75 percent open area in the base pipe on future well screen orders.
- Work with NMED to obtain approval to install longer filter pack intervals in future R wells to provide adequate screen cover to guard against filter pack settlement induced failures.

3.5 Groundwater Monitoring

The GIT and the Geochemistry Subcommittee have done an admirable job of obtaining groundwater, core and cuttings data from the R wells during drilling. These data have been incorporated into an impressive suite of geochemical investigations including contaminant discoveries, water age calculations, vadose zone tracing, geochemical modeling using MinteqA2 and Phreeqc, transport and fate estimations, and a geochemical conceptual model. This is a formidable body of information that has been assembled primarily from screening data.

Although large quantities of geochemical data and information were displayed at the recent Annual Meeting, very little new information was presented regarding the GIT's philosophical and pragmatic approaches to groundwater monitoring for completed wells. The EAG notes that the LANL document "Action Plan for the External Advisory Group Semi-Annual Report Dated December 1999" repeatedly invokes the statement that "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" for every EAG recommendation involving groundwater monitoring that was presented in our December 23 report. However, these issues were not addressed for groundwater monitoring at the Annual Meeting. A single slide was presented that did not really speak to these issues relative to the consideration given them in the Groundwater Monitoring section and Appendix B of the EAG December report. Because of this, the concerns of the EAG are very similar to those presented in our last report, dated 12/23/99. We are still concerned that there is an insufficient appreciation and understanding of how a multitude of factors including well drilling, well construction, well completion, sample collection device, sampling flow rate, sample filtration, etc., can impact sample quality and, therefore, every other aspect of the Workplan. Errors in obtaining representative groundwater samples and properly analyzing them will propagate through the WQDB, the modeling efforts, and, ultimately the risk assessment, should contaminants be present. The EAG would like to see a presentation dedicated solely to current and planned groundwater sampling methodologies at the next meeting we attend in October, 2000.

The EAG realizes that most of the current R wells are in some phase of construction and are not yet ready for routine monitoring. We are also aware that groundwater samples have been collected for years by certain ingrained protocols and there may be some institutional resistance to methodological changes. It is important for LANL to realize, however, that there have been vast improvements in sample collection techniques during the last decade that should be incorporated into LANL's collection protocols. In fact, the installation of the Westbay systems in many of the R wells will necessitate the development of new sampling protocols and SOPs. The newer sampling approaches almost universally implement low-flow, semi-passive, or passive approaches to collecting groundwater samples. The advantages of such approaches have been extensively discussed and documented previously, and will not be reiterated here, but have been found to be an improvement over traditional sampling approaches. This is found to be true when used in wells that were previously sampled by traditional high-flow rate pumping or bailing methods as well as in modern wells designed for newer sampling techniques. We strongly encourage LANL and the GIT to examine the recent enhancements in methods of groundwater sampling and initiate the development of sampling SOPs for both the Westbay systems and the single-screen installation R wells. Currently the NMED is developing a low-flow sampling protocol that might be valuable for the finalization of LANL sampling SOPs should it be completed in a timely manner.

The most significant change that will affect monitoring since the previous quarterly meeting in October is the decision to avoid the use of bentonite-based drilling mud when drilling the wells. The elimination of

bentonite drilling was due to concerns of both the EAG and the Geochemistry Subcommittee regarding the potential impacts of aquifer-entrained bentonite residue in the pore spaces on adsorption of metals and metalloids from the sampled waters. Unfortunately, the elimination of bentonite resulted in a perceived need to substitute other drilling fluids because of the increased difficulty of drilling without such lubricants and borehole stabilizers.

Currently there is much that is unknown about the effects of these new fluids, such as EZ-MUD, on sample quality. However, EAG understanding is that the screening samples collected during construction of well R-31 were heavily contaminated with organic compounds due to the synthetic drilling fluid and were essentially unusable. This may not be the case for water samples obtained following well completion and development after following manufacturer's instructions for removing the EZ-MUD, although certain aspects of breaking the EZ-MUD in the screened interval are themselves somewhat troubling. The EZ-MUD is evidently broken by injection of a solution containing sodium hypochlorite (household bleach), which is a very strong oxidant. If a strong oxidant such as this penetrates the aquifer matrix in the vicinity of the well screen, oxidation of the mineral surfaces could occur. This would alter the surface properties of the minerals and potentially cause the oxidation and precipitation of dissolved metal species in solution, such as iron, upon contact with the oxidized surfaces. The period required for such an effect to return to background conditions is difficult to estimate at this time. The solution concentration of sodium hypochlorite required is, fortunately, fairly low. A five percent solution seems to be diluted by a factor of 100 based on the manufacturer's guidelines. This would result in a final concentration of 0.05 percent as sodium hypochlorite that could potentially impact the aquifer surrounding the well screen and could still impart significant oxidizing capacity to the aquifer materials. The radius of influx into the aquifer and the residence time of the hypochlorite are two additional factors, in addition to concentration, that would influence the overall effect on collected samples. These factors may be difficult to estimate.

The EAG believes that wells drilled with these synthetic drilling materials, when completed, will probably be better for collecting groundwater samples, particularly for metals, than bentonite-drilled wells. It is important to understand, however, that drilling itself is an intrusive process that destabilizes the extant subsurface conditions and causes some geochemical disequilibrium under the best of circumstances. These disturbances will require some recovery time before representative samples can be obtained from the aquifer, even when drilled dry. To our knowledge, little is known about the synthetic drilling fluids and the impacts they might exert upon sample quality following well completion and development. It has been anecdotally discussed, however, that certain sites drilled with bentonite (typically monitoring for organic compounds rather than metals and inorganics) require several quarterly sampling intervals before asymptotically approaching the expected background geochemical conditions and contaminant concentrations. Therefore the EAG would caution the GIT, NMED, and the other stakeholders that gradual changes such as these might be observed in the R wells for some number of sampling events after well completion. The duration of this readjustment period is difficult to estimate, and may vary from well to well depending on the drilling fluids used, the type of mineral matrix in which the screen has been set and the groundwater flux through this matrix.

In keeping with our recommendations in the Data Gathering section, regarding subcommittee well prioritization and data needs, the EAG recommends a return to air rotary casing advance drilling methods, without fluids other than water, to the extent practical, for the geochemically important wells in Los Alamos and Mortandad Canyons. These are also the locations having the highest probability of anthropogenic contamination. To our understanding this is less than one-third of the planned R wells. It seems, based on the speed with which the other wells are currently being completed using fluid-based drilling, that this should not exert an overly negative impact on completing the planned wells in a timely, cost-effective and on-schedule manner. If drilling only with water proves to be impractical, the extent of the use of fluid additives should be minimized. Having said this, we also realize that drilling through certain stratigraphic zones might simply not be possible without the use of drilling fluids under some circumstances. It is important that the drillers communicate this information back to the GIT, should the use of drilling fluids other than air and water become unavoidable.

The EAG is somewhat concerned that the potential importance of colloidal transport of contaminants may be overlooked in both the GIT's approach to sample collection and modeling. This mode of transport has been neglected at other DOE sites only to become possibly the most significant aspect of long-distance transport of radionuclides. Based on reading page 9 of the minutes of the January 27, 2000, Quarterly Meeting, it appears that the current LANL conceptual model assumes that colloids are large, move slowly, and tend to get trapped in the pore throats. The conceptual model further assumes that forms that move more rapidly must be aqueous species (that would adsorb to rock) and that a fractured rock matrix is necessary for the colloids to move very significant distances, *a la* the Nevada Test Site. This conceptual model may be in error. Whether or not colloidal particles are small, large, move rapidly, get trapped in pore spaces, etc., are almost solely functions of the specific hydrogeochemistry of the system. Colloids have been shown to travel remarkably well through porous media (i.e., fractures are convenient but not necessary) under certain conditions, e.g., particle size smaller than the pore diameters (size exclusion from pore-trapping), the colloids are stable in suspension (non-agglomerating), and the colloid surface charge is of the same polarity as the media through which it is moving (charge exclusion from pore-trapping).

One member of the EAG has done research on colloidal transport in porous media. Column experiments showed breakthrough of radiolabeled hematite particles with adsorbed phosphate or arsenate before tritiated water. This clearly shows that the average flowpath of the colloidal particles was shorter than that of bulk water, due to the exclusion of colloidal materials from some of the pore spaces. Arsenate breakthrough occurred 21 times faster in association with the colloids than dissolved arsenic. In fact, 93% to 99% breakthrough concentrations were achieved when the particles were in the 100-125 nm size range. Even when the particles were as large as 900 nm, breakthrough concentrations of 30% and 33% were realized. Based on results like these, as well as those from other research groups, field investigations, and unexpected contaminant finds at other DOE sites, the EAG recommends caution with regard to deciding *a priori* that colloidal transport will not be significant. Since the determination of naturally-mobile colloidal materials in groundwater can be affected both by disruptive sampling procedures and sample handling (e.g., sample filtration), the EAG recommends that some thought be given to this during the development of sampling protocols.

Positives:

- The GIT and the Geochemistry Subcommittee have done an exemplary amount of investigative work while having primarily only screening data collected during well drilling with which to work
- The informational approach being assembled by the GIT and the Geochemistry Subcommittee about contaminant discoveries, water age calculations, vadose zone tracing, geochemical modeling using MinteqA2 and Phreeqc, and transport and fate estimations, will be of inestimable value for better comprehending the site and further developing the geochemical conceptual model
- The EAG commends the GIT for eliminating the use of bentonite-based drilling fluids during well drilling

Recommendations:

- The concerns of the EAG regarding LANL's groundwater monitoring plans are very similar to those presented in our last report, dated 12/23/99. We would like to see a presentation dedicated solely to current and planned groundwater sampling methodologies at the next meeting we attend in October, 2000.
- We recommend that LANL and the GIT better familiarize themselves with newer methods of groundwater sampling and initiate the development of sampling SOPs for both the Westbay systems and the single-screen installation R wells.
- The low-flow sampling protocol under development by NMED should be used as a development resource for LANL sampling SOPs if completed in time
- The effects of the newly-utilized synthetic drilling fluids on sample quality following well completion are largely unknown at this time. Therefore the EAG would caution the GIT, NMED, and the 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

- The EAG recommends a return to air rotary casing advance drilling methods, without fluids other than water, if possible, for the wells in Los Alamos and Mortandad Canyons
- The EAG recommends caution with regard to deciding *a priori* that colloidal transport will not be significant at LANL. Since the determination of naturally-mobile colloidal materials in groundwater can be affected both by disruptive sampling procedures and sample handling (e.g., sample filtration), the EAG recommends that some thought be given to this during the development of sampling protocols.

3.6 Risk Based Assessment

The EAG is pleased to see elements of risk assessment being incorporated into the Hydrogeologic Workplan. The use of probabilistic and deterministic approaches to groundwater modeling will be critical to the risk assessment process. In addition, advances in the understanding of contaminant geochemistry that address source, chemical transformation, and transport processes are also critical to determining the potential risk associated with contaminant species that may be found during the drilling and sampling program.

The EAG is also pleased to see progress in the development of the database management system. Efficient management, integration, and distribution of data to all participants in the process will help ensure the overall success of the entire program. Specific to the risk assessment program, an organized database is crucial to the potential need to assess risk associated with an identified contaminant. For example, immediate accessibility to contaminant trends, background data, and co-location of contaminant species in perched zones relative to the regional aquifer will be necessary.

The conceptual framework for the use of risk assessment, presented to the EAG, was helpful. The current risk assessment program, as generally described, seems appropriate to the ER program but undoubtedly has staff focused on risk assessment issues that are not the focus of that program. It is our understanding that this conceptual framework is being used to address legacy issues and Resource Conservation and Recovery Act (RCRA) permit issues at LANL. While the basic concepts are applicable to the identification of contaminants in the course of developing the Hydrogeologic Workplan, a focused approach is needed to address the potential risk due to contaminant species should they be identified in groundwater. Identification of contaminants during the implementation of the Hydrogeologic Workplan requires a different approach to the risk assessment already being conducted in the ER. For example, if data identifying a toxic contaminant at levels of potential concern were released to the public and stakeholders, there would be an immediate need to answer questions concerning public health and drinking water safety. To answer these questions, consideration of travel time to supply wells and other attendant risk issues must be considered. It is essential for the GIT to be prepared with a response in the event of finding such contaminant species in test wells. The identification of responsible staff and a process for response should be decided upon prior to the need for action.

The EAG encourages development of a plan that will address how risk issues, identified during implementation of the Hydrogeologic Workplan, differ from those of ER, which staff members will be responsible for guiding the risk assessment work, and how risk assessment will be used in making decisions and communicating with regulators and stakeholders. For example, the plan should clearly recognize that simple exceedance of a Maximum Contaminant Level (MCL) in the regional aquifer does not necessarily mean that a public health risk exists.

In addition to a risk assessment process, the EAG recognizes the need to develop target levels of contamination that could be used in determining whether contaminants pose a significant risk. For most of the chemicals of principal concern at LANL these target levels are known. For some of these chemicals, existing MCLs can be quickly identified. For contaminants lacking an MCL, a technical process needs to

be undertaken to review the currently available literature to establish guidance levels that can be used for purposes of estimating risk associated with contaminants detected in test wells. Such a process is currently needed for perchlorate. Because perchlorate does not have an MCL, but has been observed at approximately 600 feet in the shallow groundwater of Mortandad Canyon, the appropriate toxicological information needs to be assembled for input to the risk assessment process should this information be needed. The EAG is providing the current toxicological data for perchlorate in Appendix A.

Finally, the process of risk assessment for any subpopulation group needs to be flexible and iterative. The EAG recognizes that the program is moving in that direction; however, the perception from the stakeholders is that such is not the case. The EAG recommends that the ER project team consider the definition of the parameters and scenarios used in the risk assessment and evaluate local practices for refinement. For example, the exposure of children should be based upon the characteristics of the actual locations where local children play; the exposure of domestic animals should be based upon the characteristics of local grazing and drinking water sources with due consideration to the potential for ingestion of agents that might either adversely affect the cattle or bioaccumulate in edible foods.

Positives:

- The EAG commends the use of risk-based assessments as important to the progress of the hydrogeologic workplan and of the presentation of the conceptual risk model.
- The EAG also commends the planned use of probabilistic and deterministic approaches in groundwater modeling as these approaches will be critical to the risk assessment process.
- The EAG is pleased to hear presentations that emphasize the importance of contaminant geochemistry as essential to the risk assessment process.

Recommendations:

- Develop a risk assessment plan for use in the hydrogeologic workplan including risk assessment approaches that may differ from those required by the ER, including designation of responsible staff
- Provide more information to the EAG on risk assessment approaches that might be employed should contaminants be found during well drilling so that the EAG may have input at an early stage.
- Possibly provide time during EAG meetings for EAG staff to meet with the risk assessment staff to review risk assessment approaches and methods.
- Develop a risk-based response plan that can be readily available if data are released to the public and stakeholders, which show exceedances of MCLs or other health based standards and provide this plan for review to the EAG.
- Assemble a list of the potential chemicals of concern and the associated MCLs or other available health based guidelines. Where information is unavailable, formulate plans to identify appropriate health based guidance levels.
- Ensure that the risk assessment process addressing any subpopulation group is flexible and recognizes local and site-specific practices.

APPENDIX A

Risk Assessment Toxicological Information for Perchlorate

Qualitative Margin of Safety

Until relatively recently, perchlorate was thought not to be associated with adverse human health effects at low doses; perchlorate is used as a therapeutic agent to treat patients with Graves' disease, an auto-immune disease resulting in hypothyroidism. No current MCL exists for perchlorate. However, a provisional level of 18 ppb was established by the EPA in 1995 and was adopted by the California Department of Health Services (CADHS) as an Action Level in 1997 based on an acknowledged threshold mechanism for inducing thyroid hyperplasia which, though reversible with the cessation of exposure, could lead to thyroid cancer after long-term exposures. This health guidance level is derived from a human study in which Graves' disease patients were given a single dose of potassium perchlorate, which inhibits iodide uptake by the thyroid. A no adverse effect limit (NOAEL) was established based on 100% iodide released from the thyroid and incomplete inhibition of thyroid uptake. The advantage of the study is that it is a human study, however, large uncertainties in using the study to derive a health guidance level have been noted.

The qualitative margin of safety for this endpoint is derived from the following: even though perchlorate is known to cause damage to the thyroid only after a particular dose level has been reached, lower levels of exposure to humans with a composite uncertainty factor of 300-fold has been assigned to account for the possibility that some humans may be more sensitive (x10); the fact that the study is a single dose, acute study and not a chronic study, and therefore the NOAEL established might be too high (x10); and there are deficiencies in the database (x3). While the composite safety factor of 300 is quantitative in nature, it has a qualitative aspect in that it assumes that a threshold event can occur in some humans after exposure to a level that is 300 times less than that used to establish a NOAEL in Graves' disease patients treated with perchlorate.

Two other guidance levels have been proposed by EPA in a 1998 draft document, "Perchlorate Environmental Contamination: Toxicological review and risk characterization based on emerging information", (EPA 1998), which is currently under agency peer review. Revisions depend upon important on-going studies that are scheduled for completion in 2000. The guidance levels are based on a neurodevelopmental study in rats which showed results including thyroid changes and potential neurotoxic effects (high dose only) in offspring 4-day-old pups. From this study, backed up by additional information reported by EPA, a lowest adverse effect limit (LOAEL) has been established. This LOAEL is based on noncancerous, histological changes in the thyroid which are the subject of a new histopathology slide review being conducted by the National Toxicology Program (NTP). From this study, two additional proposed guidance levels that have been identified are 32 ppb for adults (thyroid lesions, principle concern, precursor to thyroid cancer) and 5 ppb for infants (thyroid lesions, precursor to possible neurotoxic effects). The qualitative margin of safety lies in a number of factors, several of which may be described as follows. The rat model is considered conservative for human risk and note has been made in the EPA draft 1998 document that rats appear to be more sensitive to thyroid-pituitary disruption leading to thyroid cancer or neurological effects than are humans. While the pharmacodynamics (the actions of perchlorate on the thyroid that lead to histological changes and endpoints of thyroid cancer or potential neurological deficits in laboratory animal studies) are reasonably well defined, the pharmacokinetics that describe the distribution of perchlorate to the target tissue are less well-defined for both humans and rats. Currently, an uncertainty factor of 3 has been assigned to the LOAEL derived from the laboratory animal studies, which assumes that humans may be more sensitive than rats. An additional uncertainty factor of 3 has been assigned because of uncertainties about the differences in sensitivities among humans, and a final uncertainty factor of 3 has been assigned because the thyroid changes in the pups define a LOAEL rather than a NOAEL. The total composite uncertainty factor of 100 takes into account these three uncertainties coupled with other uncertainties in the database. Since initial thyroid changes are reversible, the safety factor of 3 assigned for the LOAEL has been particularly controversial; the EPA 1998 draft

document notes that peer reviewers have questioned the need for this safety factor. The observed histopathological changes of the thyroid are reportedly reversible, an observation that adds greater uncertainty to the interpretation of the data and further detracts from the need for the uncertainty factor. The severity of these lesions is currently the subject of a re-review of the pathology by an NTP working group; the pathologic changes will be reclassified according to a new scoring system developed by the NTP. The results of this working group should contribute to narrowing the uncertainty and the assignment of this particular uncertainty factor. Finally, there are some differences between the laboratory (Argus lab, the laboratory that conducted the study) analysis of the neurotoxic results and the EPA re-analysis of the study results.

The qualitative margin of safety inherent in assigning the proposed levels of 32 and 5 ppb has been set assuming that the same pathologic changes noted in the thyroid studies in laboratory animals (4-day-old pups) will occur in humans and at doses 100-fold lower than those associated with the LOAEL in the laboratory studies. Since perchlorate is thought to act only through a threshold mechanism, ongoing work should clarify the level at which the critical biological event would occur. It is unlikely that EPA's assignment of these proposed values from everything that is known to date is an underestimate of risk; on the other hand, the appropriateness of these uncertainty factors should be clarified when the current work is completed.

Perchlorate-induced thyroid changes, which after chronic exposures at high enough levels, can lead to thyroid cancer in humans or, in laboratory studies, can lead to possible neurological effects at high doses in 4-day-old pups, result from a mechanism which, unlike the mechanisms of most agents, is relatively well defined. Perchlorate inhibits active iodide uptake by the symporter in most mammals, including human and laboratory test species (EPA 1998). This decrease in intra-thyroidal iodide results in a decreased production of T-3 and T-4 thyroid hormones. This decrease can potentially perturb the hypothalamic-pituitary-thyroid axis to increase TSH from the thyroid to stimulate production of thyroid hormones. Prolonged stimulation may result in thyroid neoplasia, particularly in rodents known to be sensitive. Tumors have been observed in rats dosed with high levels of perchlorate for long periods.

Changes in the thyroid hormone homeostasis are regarded as initial signals for the subsequent initial histopathological changes of hyperplasia and hypertrophy (EPA 1998). However, the exact degree of change necessary to induce thyroid histopathology is unknown. If perchlorate exposure is stopped, the thyroid effects have been shown to be reversible after exposures as long as 90 days in rats. There are also some case studies in humans treated therapeutically with perchlorate which indicate reversibility of thyroid hormone changes after years of exposure.

The available information concerning perchlorate and thyroid function (e.g., inhibition of iodide uptake, perturbation on the thyroid-pituitary homeostasis precursor lesions that progress to neoplasia, lack of genotoxicity activity) clearly support a threshold mechanism. There are species differences with regard to the mechanism of action of perchlorate as it relates to thyroid function. A number of factors caused rats to be more sensitive than humans in certain aspects of thyroid function and its sensitivity to agents such as perchlorate. A summary of species differences taken from the latest EPA draft document (EPA 1998) is found in Table 1 of this Appendix. The significance of these interspecies differences is not clear, but may indicate differences with regard to species sensitivity.

The qualitative margin of safety associated with 18 ppb, or draft guidance of 32 ppb for adults and 5 ppb for infants, is therefore considerable primarily because the mode of action is a clearly-defined, threshold event that results from actions on the thyroid that are clearly understood (pharmacodynamics). Any assignment of guidance levels such as these that are considerably lower than the threshold events recorded in the human studies, or in the laboratory animal studies, must be regarded as amply protective. The ongoing studies should enable scientists to set a more accurate guidance level for protection of human health from perchlorate exposure.

Quantitative Margins of Safety

Since there is no MCL assigned for perchlorate, guidance levels for comparison to excursion data include 18 ppb, the current EPA provisional level and the current CADHS Action Level. Also, for completeness, the draft proposed levels of 32 ppb for adults and 5 ppb for infants should be considered as well. An uncertainty factor of 300 is associated with the 18 ppb and one of 100 is associated with the 32 ppb (adult) and 5 ppb (infant). The same mechanism of action is thought to underlie the occurrence of both endpoints of thyroid cancer and neurological deficit.

An approach to addressing potential risk associated with the identification of perchlorate in the regional aquifer is to perform a sensitivity analysis designed to determine whether any excursion levels might reach supply wells and, if so, for what duration of well operation. For purposes of addressing the significance of a public health risk, the results of this analysis could be compared with the various guidance levels and a determination made as to whether the estimated levels at supply wells might exceed the ample margins of safety. If public health protective approaches are used in the sensitivity analysis, and no risk is identified, then the analyses need go no further. If any potential risk is identified, then a more refined, reevaluation must be conducted which would include refined exposure values for delivered drinking water among other factors.

Also recognizing that there is no current MCL for perchlorate, future re-analysis might be necessary if an established MCL differs substantially from the current health guidance levels used in the sensitivity analysis.

Technical Profile

No MCL has been promulgated yet for perchlorate because toxicological information on this chemical is still being gathered. A provisional Action Level of 18 ppb has been used by California since 1997, and is derived from EPA's provisional Action Level, based on its provisional RfD.

In 1985, U.S. EPA Region 9 discovered perchlorate contamination in 14 wells in the range of 0.11 to 2.6 ppm, using a colorimetric method. In the early 1990s, perchlorate was found at >1 ppm in monitoring wells at a California Superfund site. The first provisional RfD was issued in 1992 in response to these developments. In March 1997, development of a low-level ion chromatographic detection method (down to 4 ppb) led to the discovery of wider spread perchlorate contamination in water supplies in the western United States.

First Provisional RfD (1992)

A provisional RfD of 3.5 ppb was issued in 1992 by the EPA Superfund Technical Support Center. This number was derived from a human study (Stanbury and Wyngaarden 1952), in which patients with Graves' disease (an autoimmune disease resulting in hyperthyroidism) were given single doses of potassium perchlorate, which inhibits iodide uptake by the thyroid. The release of iodide from the thyroid was measured, and a perchlorate NOAEL of 0.14 mg/kg-day was established based on 100% iodide release and incomplete inhibition of iodide uptake.

Uncertainty factors were applied to the NOAEL as follows: 10 for intrahuman variability, 10 for less than chronic data, and 10 for database deficiencies, to produce an RfD of 0.00014 mg/kg-day. Application of standard assumptions for ingestion rate and body weight were applied to this number to derive a groundwater cleanup guidance level of 4 ppb.

Second Provisional RfD (1995)

A second, revised provisional RfD was issued in 1995 by the EPA Superfund Technical Support Center. The RfD was based on the same study, but included an uncertainty factor of 300. The 10-fold uncertainty

factor for data deficiencies was reduced to 3, based on data improvements that reduced the uncertainty in perchlorate's mode of action. The CADHS adopted a provisional Action Level of 18 ppb in 1997.

Placement on Contaminant Candidate List (March 1998)

The U.S. EPA Contaminant Candidate List (CCL) contains 50 chemicals and 10 microbiological agents, and is divided into two categories: contaminants for which regulatory determinations will be made by 2001, and contaminants for which more information is necessary before regulatory determinations can be made. Perchlorate is in the second category.

Revised RfD (1998)

A revised RfD of 0.0009 mg/kg-day was proposed by EPA (1998) based on thyroid histopathology observed in rat pups at 0.1 mg/kg-day in a neurodevelopmental study. Ammonium perchlorate was used as the test article, so an adjustment factor of 0.85 was used to present the RfD for perchlorate anion only. Uncertainty factors (Ufs) were applied as follows: 3-fold for intrahuman variability, 3-fold for interspecies extrapolation, 3-fold for the use of a LOAEL, and taking into account database deficiencies; the UF's result in a composite safety factor of 100.

The mechanism of action for perchlorate is reasonably well characterized (pharmacodynamics) in humans and in laboratory animals. The pharmacokinetics are not as well described by the data. The critical question pertinent to establishing a MCL is the relative sensitivity of animals and humans. The current uncertainty factor of 3 for interspecies differences used in the EPA draft document is assigned because note is made of the extremely limited data to describe the toxicokinetics of perchlorate. This safety factor will likely be replaced when ongoing studies establish whether or not the rat is more or less sensitive than the human to thyroid function (e.g., inhibition of iodide uptake by perchlorate). Also, the current studies are attempting to address the necessity of the second uncertainty factor of 3 to account for intra-human sensitivities by more clearly defining the pharmacokinetics of perchlorate in humans. Finally, the uncertainty factor of 3 that is assigned because the study is reported as a LOAEL rather than a NOAEL is reportedly controversial (EPA 1998); some reviewers of the document felt that this safety factor was unnecessary. The central issue was the severity of the thyroid lesions noted in the study. These lesions are the current subject of an NTP pathology working group review; the result will be a new assignment of the histopathology using a consistent scoring system for thyroid lesions developed by the NTP.

Finally, we can expect the composite uncertainty factor of 100 to be replaced by information gleaned from ongoing studies that are scheduled to be completed in June 2000. If these studies are successful, uncertainty factors for establishing a MCL for perchlorate should become obsolete in favor of the use of mode of action data to establish a more accurate dose-response curve to describe the threshold actions of perchlorate. Finally, there is one remaining issue that must be clarified: dose rate. For most chronic effects, the total dose accumulated during an exposure event is spread out over a lifetime to describe the lifetime average daily dose (LADD) pertinent to calculating an individuals' risk of disease to that chronic health endpoint. At the opposite end of the spectrum, for acute events, subacute and some subchronic effects, an average daily dose (ADD) is thought to be a more accurate portrayal of the effective exposure because the single event can occur as a consequence of a single exposure or short durations of exposure. In the case of perchlorate, the noncancerous thyroid lesions which are reflective of the mechanism of action are reversible following cessation of exposure. It is generally thought that long-term doses above the threshold would be necessary for exposure to induce cancer of the thyroid. The same mechanism underlies the occurrence of neurological deficits noted in the pups in the laboratory rat study. While a 1 day exposure is unlikely to induce these effects, a lifetime daily dose may be inappropriate particularly for interpreting the neurological effects in 4 day old pups in the laboratory study. It is most likely that the effective dose rate capable of producing effects lies somewhere between the LADD and the ADD and needs to be more clearly defined for purposes of interpreting short-term elevated exposures to perchlorate.

Physicochemical Properties

Perchlorate acts primarily as an oxidant, the activation energy for reduction being very high. It is very soluble in water, and not likely to sorb to particulate surfaces. This means that it is highly mobile in aqueous systems. It is also kinetically nonlabile, meaning that chemical degradation to chloride occurs slowly, making it very persistent. Exposure is primarily through the oral route; perchlorate is not readily absorbed through the skin. Once ingested, it is readily absorbed through the gastrointestinal tract. Inhalation exposure is not substantial because perchlorate has a very low vapor pressure.

Toxicologic Properties

Perchlorate inhibits iodide uptake in the thyroid, leading to a reduction in the hormones thyroxine (T3) and triiodothyronine (T4). The target tissue for systemic effects of perchlorate is the thyroid. The results of animal studies have shown alterations in T3, T4, and TSH levels, and histologic effects including thyroid hypertrophy and hyperplasia. Benign tumors have been reported in the thyroids of rats and mice treated with repeated, high-dose exposures of potassium perchlorate in drinking water. Benign tumors in the thyroid are considered to be the result of a series of progressive changes that occur in the thyroid in response to interference with thyroid-pituitary homeostasis (i.e., perturbation of the normal stable state of the hormones and functions shared between these two related glands). The proposed draft EPA (1998) RfD, which is currently under review, was based on thyroid follicular cell hypertrophy in rat pups on post-natal day 5 of a neurodevelopmental toxicity study that exposed the mothers during gestation.

Mode of Action

Perchlorate is a competitive inhibitor of active iodide uptake by the symporter in most mammals, including humans and laboratory test species (EPA 1998). This decrease in intrathyroidal iodide results in a decreased production of T3 and T4 thyroid hormones. This decrease can potentially perturb the hypothalamic-pituitary-thyroid axis to increase TSH from the pituitary to stimulate production of thyroid hormone. Prolonged stimulation may result in thyroid neoplasia, particularly in rodents known to be sensitive. Tumors have been observed in rats dosed with high levels of perchlorate for long periods.

Changes in the thyroid hormone homeostasis are regarded as harbingers for subsequent histopathological changes, including follicular hypertrophy and decrease in follicular lumen size (EPA 1998). However, the exact degree of change necessary to induce thyroid histopathology is unknown. If perchlorate exposure is stopped, the thyroid effects have been shown to be reversible after exposures as long as 90-days in rats. There are also some case studies in humans treated therapeutically with perchlorate indicating reversibility of thyroid hormone changes after years of exposure.

The available information concerning perchlorate and thyroid function(e.g., inhibition of iodide uptake, perturbation on the thyroid-pituitary homeostasis, precursor lesions that progress to neoplasia, lack of genotoxic activity) suggests a threshold mechanism. There are species differences with regard to the mechanism of action of perchlorate as it relates to thyroid function. For instance, a notable difference is that rats, in contrast to humans, do not utilize thyroglobulin to transport thyroid hormone out into the bloodstream. Other species differences are summarized in Table 1. The significance of these interspecies differences is not clear, but may indicate differences with regard to species sensitivity.

Table 1. Interspecies and Intraspecies Differences in Thyroid Structure and T_3, T_4, and TSH Hormones.

Parameter	Human	Rat
Thyroxine-binding globulin	Present	Essentially absent
T_4 Half-life	5–6 days	0.5–1 day
T_3 Half-life	1 day	0.25 day
T_4 Production rate/kg body weight	1x	10x that in humans
TSH	1x	6– 60x that in humans
Follicular cell morphology	Low cuboidal	Cuboidal
Sex differences		
Serum TSH	M = F	2 x F ≥ M
Cancer sensitivity	F = 2.5 x M	F< M

M = Male, F = Female
Source: EPA 1998