TA54

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TECHLAW INC.

April 29, 2002

Mr. David Cobrain
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Hazardous Waste Bureau
2905 Rodeo Park Drive East
Building One
Santa Fe, New Mexico 87505-6303

2002

Reference: Work Assignment No. Y513, 06082.500; State of New Mexico Environment Department, Santa Fe, New Mexico; General Permit Support Contracts; Los Alamos National Laboratories (LANL)-1B; Draft Mesa-Top Material Disposal Area; Summary of TechLaw Reviews and Comments on Technical Documents Related to TA-54 (Task 02 Deliverable); Task 05 Deliverable.

Dear Mr. Cobrain:

Prior to the departure of Ms. Eliza Frank from the NMED, Ms. Frank requested that TechLaw provide a general summary of the reviews conducted by TechLaw for NMED related to the Material Disposal Areas (MDAs) at LANL Technical Area 54 (TA-54). This summary is intended to provide you a general overview of TechLaw's involvement, as related to task 2 of the project. This summary recaps the issues identified by TechLaw during the reviews listed below:

1. Twenty-five reference documents related to TA-54 (formally submitted on June 13, 2001), Summary Document page 1;
2. The conceptual site model for MDAs G, H, and L presented in Section 6 of the RFI report for TA-54, Summary Document page 15;
3. *Advective-Dispersive Transport of Dense Organic Vapors in the Unsaturated Zone: 2,Sensitivity Analysis* by Carl A. Mendoza and Emil O. Frind of the Waterloo Centre for Groundwater Research, University of Waterloo, Ontario, Canada and *Monitoring of Pore Gas Pressures and Chemical constituents at Wells 54-1015 and 54-1016 During 1995 and 1996*, authored by Donald A. Neeper of Science and Engineering Associates, Inc., Santa Fe, New Mexico, Summary Document page 18;
4. Observations and comments on the minutes of the ITRD LANL MDA L TAG meeting of December 12, 2001, Summary Document page 20;
5. Reformatted comments on the *Subsurface Vapor-Phase Transport of TCA at MDA L: Model Predictions*. Stauffer, Birdsell, Witkowski, Cherry, and Hopkins of the Earth

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and Environmental Sciences Division, LANL, April 2000, Summary Document page 21; and

6. Additional material for inclusion in the draft ITRD MDA L Modeling Subgroup Report, Summary Document page 22.

The reviews identified numerous incidents where information was presented but not supported in the way needed for regulatory submittals. Many points brought out in the documents were left unsupported, possibly because they seemed obvious to the author(s). For example, many detected chemicals were eliminated without adequate justification from the conceptual site model described in Section 6 of the TA-54 RFI report. In formulating the conceptual and numerical models for transport in the subsurface below MDA L, LANL described their approach but did not always justify the actions taken, thus, giving the impression that the approach relied upon unjustified assumptions.

Specific technical issues were noted in the reviews as well and these are presented in the summary document. For example, the issue of fracture flow in the subsurface at TA-54 has not been adequately addressed in the documents reviewed to date. However, it is known through participation in the ITRD LANL MDA L TAG that the facility is continuing to characterize the influence of fracture flow on the subsurface transport of contaminants.

TechLaw recommends that NMED continue to push LANL to develop a complete understanding of the fate and transport of hazardous constituents in the subsurface of TA-54 and to incorporate that understanding in conceptual models and numerical simulations, as appropriate.

As stated in the summary, TechLaw supports the redesign of monitoring program at TA-54 MDA L. However, provisions for some short-term modeling (i.e., quarterly) should be retained as LANL's documents do not convey an ability to positively identify causes of elevated readings in a timely fashion.

At the request of NMED, Michael Smith (TechLaw) has participated in the ITRD LANL MDA L TAG for identifying a suitable remedial technology for TA-54 MDA L. Mr. Smith attended a meeting held in December 2001 and participated in two conference calls. Mr. Smith has provided:

- Comments on minutes of the December 12, 2001 TAG meeting;
- Reformatted comments on the conceptual model and numerical simulations of transport through the subsurface of MDA L;
- Support for NMED during two conference calls of the TAG Modeling Subgroup; and

- Explanatory text for incorporation into the ITRD TAG Modeling Subgroup Draft Report.

If you have any questions, please feel free to contact me at (303) 763-7188 or Ms. Paige Walton at (801) 451-2978.

Sincerely,

June K Dreith

June K. Dreith
Project Manager

Enclosure
cc: Mr. John Kieling, NMED
Mr. James Bearzi, NMED
Ms. Paige Walton, TechLaw
Mr. B. Jordan, TechLaw Central Files
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TASK 05 DELIVERABLE

GENERAL SUMMARY OF THE REVIEWS CONDUCTED BY TECHLAW FOR NMED RELATED TO THE MATERIAL DISPOSAL AREAS (MDAS) AT LANL TECHNICAL AREA 54 (TA-54)

Los Alamos National Laboratories (LANL)-1B
Draft Mesa-Top Material Disposal Area

Submitted by:

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Submitted to:

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Mr. James Bearzi
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In response to:

Work Assignment No. Y513, 06082.500

April 2002

GENERAL SUMMARY OF THE REVIEWS CONDUCTED BY TECHLAW FOR NMED RELATED TO THE MATERIAL DISPOSAL AREAS (MDAS) AT LANL TECHNICAL AREA 54 (TA-54)

1. Review of Reference Documents for TA-54

The first deliverable consisted of individual summaries of references selected by NMED and used by LANL in developing the site conceptual model for the LANL Material Disposal Areas (MDAs) as described in Section 6 of the TA-54 RFI report. Each article was summarized and reviewer comments were drafted as appropriate. The deliverable was e-mailed to eliza_frank@nmenv.state.nm.us on Wednesday, June 13, 2001. The following documents were reviewed:

References

Reference 5: Interaction Matrix No. 2.2, Mesa Top Soil: Davenport, D.W. 1993. *Micromorphology, Mineralogy, and Genesis of Soils and Fracture Fills on the Pajarito Plateau, New Mexico*, Texas Tech University PhD dissertation, Lubbock, Texas, 108 pages

Reference 11: 3.1-3.2, 3.4, 3.6-3.7 Gas Exchange - Diffusion of Volatile Contaminants is Significant Under Normal Saturation Conditions

Reference 12: 3.1-3.2, 3.4, 3.6-3.7 Gas Exchange (vapor advection): *Conceptual Model for Vapor Movement at MDAs: Organic Vapor Plume Movement at MDA L.* D.B. Rogers, Water Quality and Hydrology Group, ESH-18. LANL Report LA-UR-00-950. July 19, 1999

Reference 13: 3.4 Unsaturated Flow: Vadose Zone Characterization of Technical Area 54, Waste Disposal Areas G and L, LANL, New Mexico, Report 3: Preliminary Assessment of the Hydrogeologic System. Kearl, Dexter, and Kantsky; Bendix Field Engineering Corporation. March 1986

Reference 14: Interaction Matrix No. 3.3, Shallow Vadose Zone

Reference 15: Interaction Matrix No. 3.4, Unsaturated Flow, Interaction Matrix No. 3.6, Erosion (cliff retreat), Interaction Matrix No. 11.7, Intermediate Groundwater Discharge, Interaction Matrix No. 11.11, Intermediate Groundwater: Broxton, D.E. and P.G. Eller, Editors, May 1995. *Earth Science Investigations for Environmental Restoration—Los Alamos National Laboratory Technical Area 21*, Report LA-12934-MS, Los Alamos, New Mexico

Reference 16: Interaction Matrix No. 3.3, Shallow (Mesa Top) Vadose Zone: Reneau, S.L. and D.T. Vaniman, 1998. *Fracture Characteristics in a Disposal Pit on Mesita Del Buey, Los Alamos National Laboratory*, Los Alamos National Laboratory Report LA-13539-MS, Los Alamos, New Mexico, 21 pages (Reneau and Vaniman 1998, ER ID 63135)

Reference 17: Interaction Matrix No. 3.4, Shallow Vadose Zone Transport, Interaction Matrix No. 6.2-6.8, 6.10, and 6.12, Stormwater Interactions, Interaction Matrix No. 7.2, 7.5-7.10, and 7.12, Surface Water Interactions, Interaction Matrix No. 9.8-9.10, 9.12, Alluvial Groundwater Interactions, Interaction Matrix No. 10.11, Intermediate Vadose Zone Transport, Interaction Matrix No. 11.10-11.12, Intermediate Groundwater Interactions: Rogers, D.B. and B.M. Gallaher, 1995. *The Unsaturated Hydraulic Characteristics of the Bandelier Tuff*, Los Alamos National Laboratory Report LA-12968-MS, Los Alamos, New Mexico (Rogers and Gallaher 1995, ER ID 55334)

Reference 18: Excerpt from the RFI Report for MDAs G, H, and L at Technical Area 54: Section 1.0, Introduction

Reference 19: Interaction Matrix No. 3.4, Percolation/Unsaturated Flow and Gas Exchange: Reneau, S.L., D.E. Broxton, J.S. Carney, C. LaDelfe, 1998. *Structure of the Tshirege Member of the Bandelier Tuff at Mesita del Buey, Technical Area 54, Los Alamos National Laboratory*, Los Alamos National Laboratory Report LA-13538-MS, Los Alamos, New Mexico (Reneau *et al* 1998, ER ID 63497)

Reference 20: Interaction Matrix No. 3.4, Percolation/Unsaturated Flow: Purtymun, W.D., E.A. Enyart, and S.G. McLin, 1989. Hydrologic Characteristics of the Bandelier as Determined through an Injection Well System, Los Alamos National Laboratory Report LA-11411-MS, Los Alamos, New Mexico (Purtymun et al 1989, ER ID 6889)

Reference 21: Interaction Matrix No. 3.4, Percolation/Unsaturated Flow, Interaction Matrix No. 4.10, Unsaturated Flow/Saturated Flow, Interaction Matrix No. 10.11, Percolation/Unsaturated Flow, Interaction Matrix No. 11.12, Unsaturated Flow/Saturated Flow, Interaction Matrix No. 12.13, Percolation/Unsaturated Flow: Birdsell, K.H., K.M. Bower, A.V. Wolfsberg, W.E. Soll, T.A. Cherry, T.W. Orr, 1999. *Simulations of Groundwater Flow and Radionuclide Transport in the Vadose and Saturated Zones beneath Area G, Los Alamos National Laboratory*, Los Alamos National Laboratory Report LA-13299-MS, Los Alamos, New Mexico

Reference 22: Interaction Matrix No. 3.4, Percolation/Unsaturated Flow: Vold, E.L., 1997. Analysis of Liquid Phase Transport in the Unsaturated Zone at a Mesa Top Disposal Facility, Los Alamos National Laboratory Report LA-UR-96-320, Los Alamos, New Mexico

Reference 23: 3.14 Root Uptake (Flora) and 3.15 Bioturbation, Ingestion, External Contact (Fauna): *A Model for the Biotic Translocation of Buried Low-Level Radioactive Waste to the Ground Surface in the Presence of Surface Erosion*, Vold (LANL) and Shuman (RAE), LA-UR-97-84

Reference 24: Interaction Matrix No. 10.10, Intermediate Vadose Zone, Interaction Matrix No. 10.11, Intermediate Vadose Zone percolation/unsaturated flow Interaction Matrix No. 11.11, Intermediate Water in Cañada del Buey: Los Alamos National Laboratory (LANL), September 1999. *Work Plan for Sandia Canyon and Cañada del Buey*, Los Alamos National Laboratory Report LA-UR-99-3610, Los Alamos, New Mexico (LANL 1999, ER ID Number 64617)

Reference 25: Interaction Matrix No. 11.11, Intermediate Groundwater—Potential for Presence near Technical Areas 21 and 54: Los Alamos National Laboratory (LANL), September 1998. *Work Plan for Pajarito Canyon*, Los Alamos National Laboratory Report LA-UR-98-2550, Los Alamos, New Mexico, pages 3-16 (LANL 1998, ER ID Number 59577)

Reference 26: Interaction Matrix No. 11.11, Intermediate Groundwater—Observation of Perched Groundwater in Cañada del Buey: Los Alamos National Laboratory (LANL), September 1999. *Work Plan for Sandia Canyon and Cañada del Buey*, Los Alamos National Laboratory Report LA-UR-99-3610, Los Alamos, New Mexico (LANL 1999, ER ID Number 64617)

Reference 27: Interaction Matrix No. 11.11, Intermediate Groundwater

Reference 28: Interaction Matrix No. 11.11, Intermediate Groundwater: Purtymun, W.D., January 1995. *Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area*, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos, New Mexico (Purtymun 1995, ER ID 45344)

Reference 30: *Quarterly Pore Gas Sampling at TA-54 MDA L and MDA G, First Quarter FY2000.* MDA Focus Area, Environmental Restoration Project. Los Alamos National Laboratory. February 2000

Reference 31: *Subsurface Vapor-Phase Transport of TCA at MDA L: Model Predictions.* Stauffer, Birdsell, Witkowski, Cherry, and Hopkins. Earth and Environmental Sciences Division, LANL, April 2000

Reference 32: *Pore Gas Sampling at Technical Areas 50 and 54 Material Disposal*

Areas C, G, and L, Annual Report for Fiscal Year 2000. MDA Focus Area, Environmental Restoration Project. Los Alamos National Laboratory. November 2000

Reference 33: *Measurement of Surface Emission Flux Rates for Volatile Organic Compounds at Technical Area 54.* Trujillo, Gilkeson, Morgenstern, and Krier. Los Alamos National Laboratory. Los Alamos, New Mexico. June, 1998

Reference 34: *EMFLUX Soil-Gas Survey of Technical Area 54, Los Alamos National Laboratory*; Los Alamos, New Mexico; Quadrel Services, Inc.; September 30, 1993

Reference 35: *EMFLUX Soil-Gas Survey of Technical Area 54, Los Alamos National Laboratory.* Los Alamos, New Mexico. Quadrel Services, Inc.; September 9, 1994

Reference Summaries

Reference 5: Interaction Matrix No. 2.2, Mesa Top Soil

TechLaw noted that statements made in the Davenport document implied that the fractures act as transport pathways within the Bandelier Tuff. Clearly, these fractures could serve as conduits for releases from the various waste management units at TA-54, including Material Disposal Areas (MDAs) G, H, and L.

Reference 11: 3.1-3.2, 3.4, 3.6-3.7 Gas Exchange - Diffusion of volatile contaminants is significant under normal saturation conditions

TechLaw recommended that the "existing studies" referred to in the text be obtained and reviewed. The references included:

LANL. May 1991. TA-21 Operable Unit RFI Work Plan for Environmental Restoration, Volume II, Los Alamos National Laboratory Report LAUR-91-962. Los Alamos, NM. (LANL 1991, 7529)

Nyham, Dreenon, Abeele, Trujillo, Herrera, Wheeler, Booth, and Purtymun. 1984. Distribution of Radionuclides and Water in Bandelier Tuff Beneath a Former Los Alamos Liquid Waste Disposal Site After 33 Years. Los Alamos National Laboratory Report LA-10159-LLWM. Los Alamos, NM. (Nyhan et. al. 1984, 6529)

Purtymun. 1973. Underground Movement of Tritium from Solid-Waste Storage Shafts. Los Alamos Scientific Laboratory Report LA-5286-MS. Los Alamos, NM. (Purtymun

1973, 4975)

Purtymun, Wheeler, Rogers. May 1978. Geologic Description of Cores from Holes P-3 MH-1 Through P-3 MH-5, Area G, Technical Area 54. Los Alamos Scientific Laboratory report LA-7308-MS. Los Alamos, NM. (Purtymun et. al. 1978, 5728)

Puglisi, Vold. November 27, 1995. Low-Impact Sampling Under an Active Solid Low-Level Radioactive Waste Disposal Unit Using Horizontal Drilling Technology. Los Alamos Nation Laboratory Report LA-UR-95-3691. Los Alamos, NM. (Puglisi and Vold 1995, 63894)

Reference 12: 3.1-3.2, 3.4, 3.6-3.7 Gas exchange (vapor advection)

It was not clear from the document text whether vapor retardation was addressed in FEHM, RIP, or other fate and transport modeling or not. Vapor retardation was addressed in subsequent documents (see Reference 31) and it was not included in the formulation of the conceptual model and the numerical model for MDA L.

Another statement in the text was supported by a reference to Mendoza and Frind. However, a discussion that tied the Mendoza and Frind work to TA-54 was not provided. TechLaw recommended that the following studies cited in Reference 12 should be obtained and reviewed:

Neeper. 1997a. Monitoring Pore Gas Pressures and Chemical Constituents at Wells 54-1015 and 54-1016 during 1995 and 1996. SEA-SF-TR-97-170. October 1997.

Neeper. 1999. Review of Pore Gas Monitoring, TA-54, MDA L and MDA G, Draft Report. Science & Engineering Associates, Inc. June 1999.

Mendoza and Frind. (1990). Advective-dispersive transport of dense organic vapors in the unsaturated zone, 2. Sensitivity Analysis. Water Resources Research. 26. pp. 388-398, 1990.

LANL. 1992. RFI Work Plan for Operable Unit 11484. LANL Report LA-UR-92-855. May 1992.

The Neeper 1997a and Mendoza and Frind references were subsequently reviewed.

Reference 13: 3.4 Unsaturated flow: 3.1-3.2, 3.4, 3.6-3.7 Percolation/Unsaturated Flow - Aqueous-phase transport of contaminants is minimal under normal unsaturated conditions

This report summarized investigations into the hydrogeologic characteristics of the vadose zone at MDAs G and L. Findings pertinent to understanding fate and transport at MDAs G and L are

listed below.

> Vapor phase transport is the predominant mechanism controlling the potential subsurface movement of contaminants in the study area.
>
> The intrinsic permeability of the Bandelier Tuff fell in the range of 10^{-8} to 10^{-9} cm^2.
>
> Low moisture conditions in the Tuff were characterized by psychrometer data.
>
> High porosity showed that the Tuff acted like a sponge.
>
> Porosity and pumice content were highly correlated. Permeability was inversely proportional to porosity due to the significant amount of dead-end pore space in the pumice.
>
> A high degree of welding appeared to reduce the average radii of pores, thus increasing capillary forces and the residual moisture content.

Results were inconclusive with respect to the role of fractures on transport in the Bandelier Tuff. However, the permeability of fractured zones was not significantly greater than that of the surrounding rock, even though some fractured zones exhibited higher moisture content. However, the documented noted that detection of the differences in permeability might have been beyond the sensitivity of the testing methods used.

The text indicated that due to length of the study, the assessment of the vadose zone (beneath Mesita del Buey) was for the short-term only.

The geologic framework for transport was characterized as a complex network of pumice and lithic clasts surrounded by a glass-shard/crystal matrix exhibiting occasional fractures dissecting the porous media. Thus, porosity, degree of welding, and pumice content were expected to have a direct effect on unsaturated hydraulic characteristics.

The document pointed out that moisture characteristic curves for crushed tuff differed significantly from those for core samples and interpretation of in-situ hydrogeologic transport could not be reliably based on the hydraulic data for crushed tuff.

Reference 14: Interaction Matrix No. 3.3, Shallow Vadose Zone

Although the relative occurrence of fractures within the various units of the Tshirege Member was listed in a table, the discussion of primary and secondary pathways contained in the document did not identify the actual mechanism(s) for contaminant transport or state whether transport was expected to occur via the fracture system.

Reference 15: Interaction Matrix No. 3.4, Unsaturated Flow, Interaction Matrix No. 3.6, Erosion (cliff retreat), Interaction Matrix No. 11.7, Intermediate Groundwater Discharge, Interaction Matrix No. 11.11, Intermediate Groundwater,

The report described the geology at LANL TA-21. Although the investigations specifically addressed geologic conditions at TA-21, the report noted that the conclusions had substantial relevance to other Laboratory operable units.

Three investigations cited in the Reference 15 were applicable to interaction matrix numbers 3.4, 3.6, 11.7, and 11.11.

Interaction Matrix No.	**Investigation Presented in Report LA-12934-MS**
3.4	Wohletz, K.H., 1995. *Measurement and Analysis of Rock Fractures in the Tshirege Member of the Bandelier Tuff Along Los Alamos Canyon Adjacent to Technical Area-21*, pages 19-31 (Wohletz 1995, ER ID 54404)
3.6, 11.7	Reneau, S.L., June 1995. *Geomorphic Studies at DP Mesa and Vicinity*, pages 65-92 (Reneau 1995, ER ID 50134)
11.11	Broxton, D.E., P.A. Longmire, P.G. Eller, and D. Flores, June 1995. *Preliminary Drilling Results for Boreholes LADP-3 and LADP-4*, pages 93-109 (Broxton *et al.* 1995, ER ID 50119)

Each investigation was reviewed for its applicability to understanding the geology and hydrogeology at MDAs G, H, and L at Technical Area 54.

Measurement and Analysis of Rock Fractures in the Tshirege Member of the Bandelier Tuff Along Los Alamos Canyon Adjacent to Technical Area-21

The TechLaw review showed that the fracture system appeared to be a predominant geomorphic feature of the Bandelier Tuff. The crosscutting of the fractures, both at various strike and dip planes, complicates the flow path through the tuff, as well as monitoring of the fracture system for contaminant transport. However, it was noted that such issues were not considered within the scope of the investigation.

Geomorphic Studies at DP Mesa and Vicinity

Although this investigation focused on surface runoff and cliff retreat as mechanisms for contaminant transport, the flow model for DP Spring illustrated the mechanism for contaminant transport via the fracture system within the Bandelier Tuff.

Reference 16: Interaction Matrix No. 3.3, Shallow (Mesa Top) Vadose Zone

TechLaw noted that the fracture aperture and dip characteristics at Pit 39 are similar to those measured at Technical Area 21.

Reference 17: Interaction Matrix No. 3.4, Shallow Vadose Zone Transport
Interaction Matrix No. 6.2-6.8, 6.10, and 6.12, Stormwater Interactions
Interaction Matrix No. 7.2, 7.5-7.10, and 7.12, Surface Water Interactions
Interaction Matrix No. 9.8-9.10, and 9.12, Alluvial Groundwater Interactions
Interaction Matrix No. 10.11, Intermediate Vadose Zone Transport
Interaction Matrix No. 11.10-11.12, Intermediate Groundwater Interactions

TechLaw noted that this study considered the flow path through the tuff itself, but not the fracture system, an important structural and, likely, transport pathway, within the Bandelier Tuff. It is likely that the fracture system provides a preferential flow pathway for water, contaminants, and particle transport over the flow path through the pore spaces in the tuff.

Reference 18: Excerpt from the RFI Report for MDAs G, H, and L at Technical Area 54: Section 1.0, Introduction

The RCRA Facility Investigation (RFI) Report presented the results for 37 of the 45 potential release sites (PRSs) associated with the MDAs at TA-54. Four MDAs have historically been used to store and/or dispose of solid, sensitive (i.e., classified), hazardous, radioactive, or mixed waste generated by the Laboratory.

The RFI considered two sources of contamination at MDAs G, H, and L: residual contamination in surface soils and sediments, and the waste disposed of or retrievably placed in pits, trenches, and shafts. The RFI addressed waste disposed at TA-54 from the beginning of operations (1957 at MDA G) through July 24, 1990 (EPA delegated regulatory authority over mixed waste to the State of New Mexico on July 25, 1990).

The RFI Report estimated present-day and future risk to human and ecological receptors. The risk assessment methodology was consistent with EPA's Risk Assessment Guidance for Superfund. Human health risks were estimated for recreational, industrial and residential exposure scenarios. A screening-level ecological risk assessment was conducted to determine present-day risk; future risk was determined through fate and transport modeling. The projected contaminant concentrations were used to estimate potential risks to plants and animals.

Reference 19: Interaction Matrix No. 3.4, Percolation/Unsaturated Flow and Gas Exchange

TechLaw again commented on the presence of fractures and their possible influence on transport in the Bandelier Tuff. It was not clear from this study whether the fracture system in the

Bandelier Tuff crosscut the contact between Units 1v and 2. However, a number of faults were documented. TechLaw noted that these could serve as flow pathways across the contact. However, the paper focused on the structural properties along the contact, not its hydrogeologic characteristics.

Reference 20: Interaction Matrix No. 3.4, Percolation/Unsaturated Flow

TechLaw noted that the conclusions of this study indicated that releases from waste management units will remain in the tuff until sufficient water, or other fluid, is available to drive it through the pores of the tuff. This study, however, does not consider the impact of the fracture system on the transport of water, contaminants, or particles. The fractures may act as a preferential flow pathway over the interstitial pore space in the tuff, particularly as the degree of welding increases.

Reference 21: Interaction Matrix No. 3.4, Percolation/Unsaturated Flow
Interaction Matrix No. 4.10, Unsaturated Flow/Saturated Flow
Interaction Matrix No. 10.11, Percolation/Unsaturated Flow
Interaction Matrix No. 11.12, Unsaturated Flow/Saturated Flow
Interaction Matrix No. 12.13, Percolation/Unsaturated Flow

TechLaw noted that the investigation appeared to be thorough as far as LANL's observations and measurements would allow. While the discussion supported the conditions LANL selected, the effect of the range of welding within the ash flows on vadose zone flow was not addressed. The barrier scenario should be modified to consider lateral flow along stratigraphic contacts and should further consider whether fracture flow through a welded tuff becomes a more dominant pathway under lateral flow conditions. LANL should determine if flow through the welded tuff ever becomes a rate-controlling factor in any member.

TechLaw pointed out that the investigators believe that there is a safety factor afforded by the low doses simulated by the models. Unless there are serious flaws in the three-dimensional models, this safety factor should absorb the uncertainties associated with the actual transport mechanism.

Reference 22: Interaction Matrix No. 3.4, Percolation/Unsaturated Flow

The reviewed document implied that water flow through the upper tuff is not continuous through all depths at the same rate, i.e., not a steady state condition.

Birdsell et al, 1999, conducted a groundwater modeling study of unsaturated and saturated zones beneath MDA G, which was reviewed as Reference 21. The model was developed subsequent to Vold's study of moisture profiles in the upper Bandelier Tuff. The model focused on steady state flow through the unsaturated zone, which does not appear to be supported by the moisture

profiles and, in particular, the presence of a potential source horizon at the vapor phase notch. Vold discussed in some detail the possibility of off-site sources of groundwater, as well as the surface infiltration transport via a fracture network downward to a hydrogeologic barrier (Tshirege Unit 1a) and the subsequent lateral movement of moisture at the vapor phase notch. Vold cautioned that additional information should be collected to confirm the existence of a flow pathway to the vapor phase notch. Confirmation may invalidate the transport model through the unsaturated zone or, at a minimum, lead to the revision of the model to account for either the off-site moisture source or the intermittent fracture flow. This scenario should be investigated.

Reference 23: 3.14 Root Uptake (Flora) and 3.15 Bioturbation, Ingestion, External Contact (Fauna): *A Model for the Biotic Translocation of Buried Low-Level Radioactive Waste to the Ground Surface in the Presence of Surface Erosion*, Vold (LANL) and Shuman (RAE), LA-UR-97-84.

The study concluded that biotic translocation is a potentially important mechanism in off-site migration of contamination from Area G of TA-54 and that this pathway should be considered in the overall dose assessment (performed in 1996 by Shuman, RAE). Given this, more site-specific information on the flora and fauna may be warranted and the references for the studies on the biotic translocation model parameters should be reviewed, including:

> G.D. Tierney, T.S. Foxx, "Root Lengths of Plants on Los Alamos National laboratory Lands", Los Alamos National Laboratory Report, LA-10865-MS, Los Alamos, NM, January 1987.
>
> BIOPORT code documentation referenced from McKenzie, et al., "Relevance of Biotic Pathways to the Long-Term Regulation of Nuclear Waste Disposal", PNL, NUREG/CR-2675, Vol. 2, October 1982.

TechLaw noted that the analysis described in this document was a simplification of the model used in the Performance Assessment and dose assessment modeling conducted by Shuman 1996.

Reference 24: Interaction Matrix No. 10.10, Intermediate Vadose Zone
Interaction Matrix No. 10.11, Intermediate Vadose Zone percolation/unsaturated flow
Interaction Matrix No. 11.11, Intermediate Water in Cañada del Buey

TechLaw noted that the groundwater modeling study conducted by Birdsell et al 1999 did not address the contribution of the perched groundwater to the unsaturated zone steady state conditions.

Reference 25: Interaction Matrix No. 11.11, Intermediate Groundwater—Potential for Presence near Technical Areas 21 and 54

The groundwater modeling study conducted by Birdsell et al 1999 did not address the contribution of the tritiated groundwater plume to the unsaturated zone steady state conditions, or include the tritium in the dose assessment.

Reference 26: Interaction Matrix No. 11.11, Intermediate Groundwater—Observation of Perched Groundwater in Cañada del Buey

Since the perched groundwater was found at a depth of 592 feet beneath Mesita del Buey and the organic compounds were found as deep as 597 feet, any perched groundwater could be contaminated by the organics. Also, the groundwater modeling study conducted by Birdsell et al 1999 addressed metals and radionuclides in the radionuclide dose assessment required by the DOE Performance Assessment, but organic compounds apparently fall outside the realm of consideration.

Reference 27: Interaction Matrix No. 11.11, Intermediate Groundwater

Water level data and a location map of intermediate wells were obtained from the online Water Level Database for the LANL, at http://www.esh.lanl.gov/~esh18/. The charts indicate that the water level has fluctuated in each well, but the changes in Wells LADP-3 and LAOI-1.1 do not seem out of the ordinary, at least on the surface; they may indicate the passage of a plume or transient plug of groundwater. The water level in Well TW-1A fluctuated approximately 14 feet from mid-1996 to early 1997. Without further information, this fluctuation cannot be explained as a function of precipitation infiltration, a release from a waste management unit, or some other source. This phenomenon should be investigated further.

Reference 28: Interaction Matrix No. 11.11, Intermediate Groundwater

TechLaw pointed out that it is important to keep in mind that perched zones may not be laterally extensive and it is easy to install a number of boreholes and never encounter an existing zone of perched water. Other reviewed documents indicated that perched groundwater was encountered in boreholes drilled in Cañada del Buey and Pajarito Canyon, which are located on either side of Technical Areas 21 and 54. Angled drilling beneath MDA L encountered perched groundwater at a depth of 592 feet beneath the mesa top, where MDA L is located.

Reference 30: *Quarterly Pore Gas Sampling at TA-54 MDA L and MDA G, First Quarter FY2000.* MDA Focus Area, Environmental Restoration Project. Los Alamos National Laboratory. February 2000

Reference 31: *Subsurface Vapor-Phase Transport of TCA at MDA L: Model Predictions.* Stauffer, Birdsell, Witkowski, Cherry, and Hopkins. Earth and Environmental Sciences Division, LANL, April 2000.

TechLaw agreed with the statement that: "Future fitting should include all relevant data sets, perhaps with quality control at the level of the data collectors to remove questionable data based on knowledge of the sampling apparatus and site-specific problems." Such an approach would be preferred over that used in this document 31 where one data set was used.

The text should be revised to include a discussion that relates the Lyon et al., 1996 paper (Lyon, Holmes, Kosiewicz, Wilber, Travis; Estimation of corrosion of carbon steel TRU waste drums using Poisson Distribution; Journal of Hazardous Materials; 51; pp. 165-179) to MDA L.

According to the modeling analysis, it takes 19 years for a single drum failure to "disappear" from the subsurface. However, the actual drum failure rate is not given. It seems that the actual, historic drum failure frequency should be considered in modeling this situation unless the failure rate of one drum every 19 years can be shown to be conservative. Also, it should be confirmed that the current monitoring plan provides sufficient coverage and monitoring frequency to detect a drum failure. This is not discussed in the text.

While the results indicated that the plume will start to shrink when the source is depleted, before 2060, it is not clear that the treatment of source strength in the simulations generated "worst-case" results. For example, it is not known if the source strength considered in the simulations was accurate, representative, and/or conservative. The document had stated that two levels of source contamination would be simulated. Results were discussed only for a level of 3,000 ppmv. A discussion of all simulation results should be provided. Further, TechLaw noted that confidence in the modeling analysis would increase if the model were calibrated against all other available data sets.

It is implied, but not specifically stated, that measured increases in concentrations observed in field data can be attributed to drum failures. The text should be expanded to discuss this point. While the results of the modeled simulations imply that drum failures can be detected through annual field monitoring, other reviewed papers have hypothesized that increases in measured field data may be attributable to other sources such as a high bias in laboratory results. This underscores the need for more frequent monitoring than the annual monitoring proposed in this document. A shorter period (such as the quarterly monitoring currently used) between monitoring events should allow for the establishment and analysis of trends and provide the time needed to correctly identify the reason for any changes observed in the data.

Reference 32: *Pore Gas Sampling at Technical Areas 50 and 54 Material Disposal Areas C, G, and L, Annual Report for Fiscal Year 2000.* MDA Focus Area, Environmental Restoration Project. Los Alamos National Laboratory. November 2000.

Figure 9, MDA L field-screening results for the fourth quarter of FY 2000, shows that the 10 ppmv contour is extending to the northwest past well 2034. This is not discussed in the text. The ramifications of this plume migration should be addressed as it appears from the information

available in the report that well 2034 is the last well in the northwest direction. Also, no discussion of Figures 10 and 11 is provided. A discussion should be furnished as the figures do not show a consistent pattern and, thus, warrant explanation.

Appendix B of Document 30 shows that chloroform was detected above the reporting limit in many of the wells sampled at MDA L. It was also detected at the one well (54-2033) in MDA G for which analytical results were reported. Additional information concerning how frequently chloroform and 1,2-dichloroethane have been identified should be provided. An indication should be given as to whether these compounds were considered to be constituents of either vapor plume based on their historical identification by laboratory analysis. If so, a detailed description of the validation procedures performed to determine that they were identified falsely should be provided for review.

TechLaw noted that while it appeared that the nature of the vapor plumes remained constant during FY 2000, it was not clearly demonstrated that the extent of contamination remained static. Additional interpretation of the screening results for both MDA G and MDA L is needed. Further, it should be noted in the text that any change to the monitoring frequency would be implemented in accordance with approved work plans and subject to the review by federal and state regulatory agencies.

In addition, the following documents cited in Document 32 should be obtained for review:

> Driscoll. November 30, 1992. EPA NOD to LANL. EPA memorandum to C. Rofer, Los Alamos National Laboratory. Los Alamos, NM. (Driscoll 1992).
>
> Glatzmaier. November 12, 1993. Final Notice of Deficiency (NOD) Response for Operable Unit (OU) 1148. Los Alamos National Laboratory memorandum EM-13:93-A232. Los Alamos, NM. (Glatzmaier 1993).

Reference 33: *Measurement of Surface Emission Flux Rates for Volatile Organic Compounds at Technical Area 54*. Trujillo, Gilkeson, Morgenstern, and Krier. Los Alamos National Laboratory. Los Alamos, New Mexico. June, 1998.

This survey was conducted to estimate the mass of volatile organic compounds being vented to the atmosphere from active and inactive waste disposal sites at Technical Area 54.

No explanation was offered for the observed behavior of 1,1-dichloroethylene. An explanation should be offered as this was the only compound that exhibited a higher emission rate toward the canyon.

Results like total emission rates for an area should be compared to RIP and FEHM model predictions for the same area, if appropriate. Such comparisons should appear in the modeling

reports or the RFI report.

No explanation was offered for the high concentration area of trichloroethylene at MDA L. Some discussion should have been provided to help guide future investigations and sampling events at MDA L.

Reference 34: *EMFLUX Soil-Gas Survey of Technical Area 54, Los Alamos National Laboratory*; Los Alamos, New Mexico; Quadrel Services, Inc.; September 30, 1993.

It is not clear where the control samples were taken. Therefore, it is not known if vented gases could affect the sampler at the locations of the control samples. Additional information on the control samples is needed.

Further, information on where the samples in Field Kits B, D, and E were deployed should be provided.

2. Review of Section 6.0 of the RCRA Facility Investigation Report for Material Disposal Areas G, H and L at Technical Area 54 (TA-54) (Deliverable was e-mailed on Tuesday, July 3, 2001)

TechLaw felt that the Revised Conceptual Model for TA-54 was not complete in that it did not identify primary and secondary transport pathways, off-site transport, exposure routes and receptors, or demographics and land use (current and future). In addition, much of the information and assumptions contained within the Model were not adequately substantiated.

TechLaw found that LANL had eliminated several chemicals detected at MDAs G, H, and L from their respective conceptual site models without adequate justification. These include: mercury, silver, and selenium detected in surface soils and any organic that was not detected in at least 4 of 8 air samples at MDA G; Lead and tritium detected in sediments, Acetone detected at MDA H during surface flux sampling, and Copper detected in the subsurface at MDA H; and Cadmium, selenium, and silver with reporting limits that exceeded the laboratory background levels, Plutonium-238 detected in sediments, and Cadmium, mercury, uranium, chromium and barium detected in boreholes 54-1010 and 54-1011at MDA L.

Also, LANL assumed, without adequate support, that detections of bis-2-ethylhexyl phthalate at MDAs H and L and di-n-butyl phthalate and pentachlorphenol at MDA L are laboratory artifacts. TechLaw also stated that LANL should address several additional transport mechanisms before the Model is viewed as encompassing all possible contaminant transport pathways. These include:

- Treatment of the subsurface solute transport pathway at MDA L;
- Further consideration of advection in the transport of VOCs and tritium in the subsurface;
- Consideration of wet and dry deposition processes for particles and vapors entering the atmosphere from TA-54; and
- Consideration of exposure of ecological receptors, and possibly humans, through the food chain.

Further, TechLaw felt that a clear understanding of the influence of fracture flow on contaminant transport was not demonstrated.

In Section 6.1.3.3, TechLaw recommended that a figure illustrating the location of all the boreholes where samples were taken at MDA L be provided.

In Section 6.1.3.3, the text states that some analytes were detected above background levels at discrete sampling depths. These compounds are not identified and the locations of the detections are not illustrated in a figure. A reference to the location of the sampling results or to figures illustrating the results should be provided for these analytes.

Further, Section 6.1.3.3 states that tritium is the only radionuclide in the subsurface at MDA L. While the text implies that sampling results for radionuclides other than tritium were analyzed to determine if a pattern indicative of a release was present, the analysis is not described. The text should be modified to present the locations of the detections and describe the analyses performed that led to the stated conclusion.

The second paragraph on page 6-33 states that an analysis was performed to evaluate the potential for VOC flux. The text should be revised to describe the analysis in detail or provide a reference to the location of such a description.

Reference citations should be provided in the text for previous work performed at TA-54 that supports the conclusions stated in Section 6.1.3.4. For example, a reference should be provided to the document that indicates that the tuff may be "...homogeneous media subject to atmospheric pressure variations..."

In Section 6.2.1.1, the first full paragraph on page 6-36 provides estimates of the percentage of pit, impoundment, and disposal shaft volume actually occupied by waste. The text reads as if LANL is not confident in any of the estimates. For example, an estimate of 10% is offered for the pit based on "...limited data..." LANL should reference all information sources used to develop these estimates. For disposal units where uncertainty exists, TechLaw recommended that a range of possible volumes occupied be reported.

The first paragraph at the top of page 6-37 includes unsupported statements concerning present-day surface fluxes at TA-54, releases appear to have reached, or surpassed, steady-state release conditions, pore gas concentrations are steadily decreasing, and that the tritium inventory will be halved about every 12 years. TechLaw recommended that these statements, and others contained in this paragraph, be accompanied by references to LANL documents that support the claims.

While laboratory investigators have estimated the time it would take for cliff retreat to expose the wastes in the subsurface, there is no discussion of how cliff retreat influences the fate and transport of vapor contamination beneath the MDAs. Such a discussion should be provided.

With respect to leaching, references to LANL documents that identify the probable source of the liquid that led to metals migration and that characterize the level of residual pore water at MDA L should be provided.

Section 6.2.13 hypothesized that alternating periods of high and low barometric pressure and changes in atmospheric temperature may influence subsurface VOC migration and, thus, flux at the surface. Because advective transport had been discounted in previous analyses, any analysis that has been performed to investigate the source of the seasonal variation in the surface flux of tritium should be referenced in the text and made available for review.

The second paragraph on page 6-40 discusses the variation in the direction of prevailing winds in the vicinity of TA-54. The text should be augmented to include a discussion of how well the different wind patterns (those on the mesa top and those in the canyon) are understood. Any air dispersion models that may be used to predict the atmospheric transport and dispersion of VOCs emitted from TA-54 into this complex wind field should be identified and discussed.

3. Review of *Advective-Dispersive Transport of Dense Organic Vapors in the Unsaturated Zone: 2. Sensitivity Analysis.* Carl A. Mendoza and Emil O. Frind. Waterloo Centre for Groundwater Research, University of Waterloo, Ontario, Canada. Water Resources Research, Volume 26, Number 3, pages 388-398. March 1990 and *Monitoring of Pore Gas Pressures and Chemical Constituents at Wells 54-1015 and 54-1016 During 1995 and 1996.* Donald A. Neeper. Science and Engineering Associates, Inc., Santa Fe, New Mexico. SEA-SF-TR-97-170. Los Alamos National Laboratory, Los Alamos, New Mexico. LA-UR-01-3808. October 1997.

At the request of NMED, TechLaw reviewed these two references used by LANL in developing the site conceptual model for MDA L. The deliverable was e-mailed to NMED and formally submitted on October 5, 2001.

Advective-Dispersive Transport of Dense Organic Vapors in the Unsaturated Zone: 2. Sensitivity Analysis by Carl A. Mendoza and Emil O. Frind.

In considering an actual case such as the Bandelier Tuff at TA-54, Mendoza and Frind point out that among other property values, the Henry's Law Constant must be known as it controls retardation. This underscores the need to determine the retardation in the Tuff at TA-54 as suggested in the *Conceptual Model for Vapor Movement at MDAs: Organic Vapor Plume Movement at MDA L* (Reference 12). Based on the documents reviewed for this work assignment, it is not known if retardation was formally studied.

Reference 12 suggested that consideration be given to the reliability of the permeability values presented in other LANL documents for the Bandelier Tuff. This is supported by the information presented in Mendoza and Frind which points out that the transition from advective dominated transport to diffusion dominated transport occurs over a fairly narrow range of permeabilities. Further, the upper end of the range of permeabilities reported in Reference 12 (1×10^{-11} m^2) corresponds to the maximum value of permeability indicative of diffusion dominated transport reported by Mendoza and Frind. Therefore, LANL and NMED should be sure that the upper range of Tuff permeabilities has been adequately defined.

The Mendoza and Frind paper referenced in Reference 12 described a sensitivity analysis performed on a model derived to determine the importance of advection in the transport of organic vapors. However, the physical scenario considered in Mendoza and Frind differed from the physical conditions at TA-54. LANL applied the results of the Mendoza and Frind analysis to TA-54 without documenting the applicability of the study to conditions at TA-54. Further, it is not clear that consideration was given to chemical property values such as vapor pressure, Henry's Law constant, and molecular weight as suggested by Mendoza and Frind. TechLaw recommended that LANL relate the conditions and findings from the Mendoza and Frind paper to TA-54 as originally suggested in the reviewer comments on Reference 12.

Monitoring of Pore Gas Pressures and Chemical Constituents at Wells 54-1015 and 54-1016 During 1995 and 1996 by Donald A. Neeper.

It is not known if an area-average permeability was determined for the soil layer overlying the Basalt beneath MDA L. TechLaw recommended that this parameter value be determined as it would aid in understanding the effect that the soil layer has on vapor flow between the Tuff and Basalt.

Based on the documents reviewed for this work assignment, it is not known if monitoring at 54-1015 and 54-1016 using CO_2, O_2, and SF_6 as tracers was implemented (the Neeper document stated that monitoring of this type could provide a firm estimate of the ventilation rate in the Basalts). Further, it is not known if any analysis or monitoring of any kind was performed for the purpose of developing an estimate of the ventilation rate in the Basalts beneath MDA L.

TechLaw noted that Reference 12 cited the Neeper document as the source of air permeabilty values for the Basalt ($2x10^{-6}$ to 10^{-4} cm^2 or 240 to 1200 darcies). The Neeper document stated that this range represented the upper limit of permeability in the Basalt as calculated in the harmonic analysis for the 0.33-day component of the pressure distribution and corresponded to porosities in the range of 0.1 to 0.5, respectively. The text stated further: "The connected porosity in the basalt may be sufficiently nonuniform that Darcy's law, and the associated parameter of permeability, do not apply." Therefore, additional information supporting the use of the cited range of permeability values in Reference 12 may be needed.

Interaction Matrix No. 11.11, Intermediate Groundwater - Observation of Perched Groundwater in Cañada del Buey (Reference 26), stated that volatile and semi-volatile compounds including 1,1,1-trichloroethane, were detected at depths from 129 to 597 feet beneath Mesia del Buey. It should be noted that the pore gas concentration measurements described in the Neeper document looked at only six gases. Of the detected compounds identified in Reference 26, only 1,1,1-trichloroethane was among the six gases considered in Neeper's analyses. Neeper concluded that TCE contamination likely did not extend into the Basalt. TechLaw recommended that Reference 26 be reviewed to determine if TCE detection occurred within the Basalt.

Reference 26 also discussed an area of perched ground water found at 592 feet beneath Mesita del Buey. This was confirmed in the Neeper document where the unit was described as an irregular soil layer experiencing near saturation conditions. This was the explanation offered in the ITRD LANL MDA L TAG meeting in December 2001. It is not known if LANL reports describing the conceptual model at MDA L have been revised to reflect Neeper's finding.

5. Reformatted Comments on the *Subsurface Vapor-Phase Transport of TCA at MDA L: Model Predictions*. Stauffer, Birdsell, Witkowski, Cherry, and Hopkins of the Earth and Environmental Sciences Division, LANL, April 2000.

The comments originally forwarded to NMED, as a review of Reference 31, were reformatted for possible submission to ITRD and submitted to NMED by email. The summary material was removed and the comments were recast as general and specific comments on the report. The comments themselves were revised based on additional information obtained during the TAG meeting held on December 12, 2002. TechLaw recommended that LANL be encouraged to refine the conceptual and numerical models at MDA L and use the numerical model to test concepts related to subsurface vapor-phase transport.

TechLaw further stated that this is not an appropriate time to lengthen the time between monitoring events, however, a redesign of the entire monitoring effort was felt to be appropriate. A program should be put in place that ensures that the wells and ports most likely to provide first detections of changes in the plume (e.g., plume growth, drum failure) are always sampled. The sampling events could provide, hopefully, information useful in characterization as well. If necessary, additional wells should be installed. While a catastrophic drum failure might be obvious in the field monitoring data, the reason for slightly elevated readings may be more difficult to identify. A shorter period (such as the quarterly monitoring currently used) between monitoring events should allow for the establishment and analysis of trends and provide the time needed to correctly identify the reason for any changes observed in the data. While it may not be prudent to monitor solely on an annual basis, monitoring strategies that allow for more frequent sampling of some wells and ports could be considered in the redesign of the monitoring effort.

TechLaw noted that some thin layers were not addressed individually in the numerical modeling of the subsurface at MDA L. TechLaw pointed out that LANL should consider incorporating these layers into the modeling approach where available information suggested that a layer would impact flow. Section 5.7 of the draft of *Vadose Zone Flow and Transport Model of Los Alamos Canyon* (dated May 29, 2001) was cited as a technique applied by LANL at another location that could possibly be used at MDA L.

As in previous reviews of the conceptual model for MDA L, TechLaw commented on the treatment of source strengths and the use of the Lyon et al reference on drum failures without appropriate justification in the modeling report.

6. Text Supplied for the Draft ITRD MDA L TAG Modeling Subgroup Report

At the request of the ITRD MDA L Project Coordinator, TechLaw furnished a draft of report text that for Review Criteria number 4. The text is presented here in its entirety:

> *4. Have the practical limits of detection been determined in terms of minimum and maximum depth, plume size, and type of contaminant being detected?*
>
> *While the best fit simulation shows that the vapor plume is unlikely to reach the water table, the vertical extent of the plume as illustrated by field data is not presented in the report. Two issues are of concern:*
>
> *NMED, EPA Region 6, and the public may require site-specific data before they accept that the vapor plume has not and will not reach the water table; and*
>
> *While the imposition of a zero concentration condition appears justified, its exact location as determined by field data or a comparison of modeling results to field data is not known.*
>
> *Installation of deeper wells capable of providing concentration data at the bottom of the plume is recommended. Data from such wells will directly address the first concern and can also be used to refine the modeling of transport processes at the bottom of the plume.*

At the time the report was written, no core sample measurements were available for the Cerros del Rio Basalts. Therefore, the numerical model was formulated using a surrogate porosity and a modeled saturation value. Further refinements to the numerical simulations can be realized if property measurements can be made on the basalts via the deep wells.