Attachment 2. Data Gaps Prevent Accurate Calculation of Contaminant Travel Times by Computer Models.

***Vadose Zone Journal* Article.** The conclusion to the August 2005 *Vadose Zone Journal* article, by LANL employees Elizabeth H. Keating, Bruce Robinson, and Velimir V. Vesselinov, entitled "Development and Application of Numerical Models to Estimate Fluxes through the Regional Aquifer beneath the Pajarito Plateau," states:

> The implications of this work for water resources beneath the [Pajarito] plateau is that groundwater production is mining an old aquifer that has not received significant recharge on the time scale of this study (decades). The implications of this work for contaminant transport issues is that because of parameter uncertainty, predicted fluxes and velocities are quite uncertain. Part of the reason for this is uncertainty in total recharge to the aquifer. Uncertainties in permeability and porosity values lead to additional model uncertainty. These uncertainties can be reduced meaningfully with more data collection, including multiwell pumping and tracer tests. Finally, local recharge does occur along canyons that cross the LANL property. From a large-scale water budget perspective, local recharge is relatively small. Nevertheless, this recharge has important water quality implications in locations where contaminated effluent discharges have been released. Vol. 4, August 2005, p. 668.

The high number of uncertainties (parameter, predicted fluxes, velocities, total recharge, permeability, porosity values) is of concern. The lack of representative data presents other problems, including the use of spurious, unreliable and unrepresentative data in expensive computer models. In order to validate any computer model, representative groundwater data must be obtained. Data uncertainties magnify our inability to trust in the computer models.

Accordingly, we are concerned about how the series of articles in the *Vadose Zone Journal* provide the basis for analysis in the draft LANL SWEIS, specifically Appendix F. The articles are not readily available for review. If the articles continue to form the basis for decision making in the final LANL SWEIS, the articles should be reprinted in that document.

Need for Pristine Groundwater Samples. Groundwater samples must be pristine because of the small amount of contamination that can cause health problems if ingested. For example, the EPA drinking water standard for strontium-90 is 8 pCi/L. A conversion of 8 pCi/L equals 60 parts per quintillion (ppq). One part per quintillion is one trillionth of a millionth. Further, over the years there have been problems with the sampling, detection and analysis of strontium-90 in groundwater, a subject that we will not discuss in this letter.

Unjustified Reliance on Computer Contaminant Transport Models. LANL scientists have a record of over-reliance on models built on "assumptions" to demonstrate that LANL wastes will not reach the groundwater resource. This over-reliance was presented to the NAS study committee that is investigating LANL groundwater protection practices. The NAS was told by LANL scientists that travel times to the regional aquifer from atop mesas is in excess of 1000 years.

A 2000 National Academy of Sciences (NAS) report by Shlomo P. Neuman and Benjamin Ross described the over reliance by the DOE with on transport models to demonstrate the effects of waste disposal sites on groundwater resources. *Long-Term Institutional Management of U.S. Department of Energy Legacy Waste Sites*. The report by Neuman and Ross contained the following closing remarks:

> There has been a tendency by the DOE and some other agencies to rely excessively on models in the context of waste disposal and site contamination issues. Models have been used repeatedly to "demonstrate" that a potential waste disposal site or remedial option complies with regulations and is therefore "safe." More often than not, the ability of models to provide such safety assurances has been taken for granted without a serious attempt to validate them against site data. The tendency has been to rely on models at the expense of detailed site investigations, site monitoring, and field experimentation. In fact, models have often been used to "demonstrate" that additional site or experimental data would be of little value for a project. The reasons for this state of affairs are easily identified as regulatory and budgetary pressures.
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> It is often tempting to "demonstrate" by means of a model that a given waste disposal or remedial option is safe, or that additional site data would be of little value, by basing the model on assumptions, parameters and inputs that favor a predetermined outcome. A common example of such bias is the assignment of lower permeability's to a groundwater flow model than is justified by available data. It is likewise tempting to help a model appear credible by basing it on a unique system conceptualization and subjecting it to sensitivity and uncertainty analyses in which parameters and input variables are constrained to vary within narrower ranges of values than is warranted by the available information. Such practices are common and ultimately detract from the credibility of agencies that employ them. Appendix G "Mathematical Models Used for Site Closure Decisions."

Material Disposal Area G. An example of LANL dependence on the assumptions in the computer models is Material Disposal Area (MDA) G, the LANL active waste disposal facility for radionuclide waste. This 65-acre site has disposed of chemical and radioactive waste for a period of over 50 years. A transport model was used to demonstrate that the buried wastes at Area G, would not reach the regional aquifer for a period in excess of 1000 years. DOE/LANL use the results from the Area G transport model to “demonstrate” that groundwater monitoring is not necessary for the many historical waste disposal sites that are located atop mesas across the laboratory facility.

LANL scientists adhere to their model, even though groundwater contamination is present in the regional aquifer beneath Area G.

Data Gaps as a Result of Poor Well Construction and Sampling. As an example, LANL drilled Regional Well R-22 with five screened intervals for monitoring groundwater 500 feet east of the Area G boundary. The groundwater contamination is summarized below and is evidence that the transport of chemical and radionuclide contamination to the regional aquifer has occurred over a period of time that is less than 50 years.

Contaminants Listed in the LANL Well R-22 Geochemistry Report
(LA-13986-MS, 2002)

Contaminant	*Listed Hazardous Constituent*	*Exceedance Requiring Corrective Action*	*Appendix IX Groundwater Monitoring List*	*Level Measured in Water Samples*
tritium				109 picocuries per liter (pCi/L) at the water table of the regional aquifer
technetium-99				4.3 and 4.9 pCi/L
*pentachlorophenol	**X**	**X**	**X**	6.2 parts per billion (ppb)
*chloroform	**X**		**X**	0.94 ppb
*phenol	**X**		**X**	19 and 32 ppb
*4-methylphenol				44 to 210 ppb
*2-butanone				6.9 to 8.9 ppb
*diethylphthalate	**X**		**X**	1.3 ppb
benz(a)pyrene	**X**	**X**	**X**	0.24 ppb
benzoic acid				3 to 12.5 ppb
butyl benzyl phthalate	**X**		**X**	9.8 ppb
Toluene	**X**		**X**	0.2 to 0.76 ppb
methylene chloride	**X**		**X**	0.62 and 2.2 ppb
bis(2-ethylhexyl) phthalate			**X**	1.0 and 3.9 ppb

* The six contaminants are highly mobile in groundwater and are all commonly found in groundwater beneath toxic waste landfills.

Several substituted benzene compounds including:

isopropylbenzene	0.16 to 0.54 ppb
1,4-dichlorobenzene	0.16 to 0.23 ppb

The water-based drilling fluids diluted the tritium contamination of 109 pCi/L at the water table. The well drilling penetrated a confining bed at a distance of less than 60 feet below the water table. Drilling an open borehole through the confining bed allowed the contamination at the water table to drain deep into the regional groundwater resource for a period of approximately 70 days.

A September 2004 LANL report, LA-UR-04-6777, recognizes the contamination detected in the water samples produced from well R-22 as follows:

> Thirty-one volatile and semi-volatile organic compounds have also been detected in water from well R-22. Only two of these, pentachlorophenol (1 detection, 6.2 ppb, MCL = 1 ppb) and benzo(a)pyrene (2 detections, 0.24 ppb, MCL = 0.2 ppb) were present at concentrations above the MCL [Maximum Contaminant Level for EPA Drinking Water Standards]. Monitoring for organic compounds at well R-22 will continue. [Emphasis added.]

It is important to note that the mistakes in the drilling and installation of well R-22 have prevented all of the water samples taken there from being reliable and representative. The new mineralogy (i.e., chemistry) formed by the organic drilling additives and the no-purge water sampling methodology are now preventing the detection of contamination in the water samples produced from the well. With this knowledge, the scheme to continue collecting spurious water samples from well R-22 is irresponsible and a violation of both RCRA and DOE Orders.

Table 4 in the 2004 LANL report cited above describes the water quality data produced from the five-screened intervals in well R-22 as follows:

> Screens 1, 3, 4, 5 are not yet representative, although residual drilling fluid is breaking down through oxidation reactions and concentrations of sulfate are returning above detection. Screen #2 is the least affected by residual drilling fluid and has representative water chemistry.

The measured permeability of screen #2 is a very low 0.04 ft/day compared to values of 50 to greater than 100 ft/day for strata above and below screen #2. The recent plan of DOE/LANL to block-off screen #1 and use the water produced from screen #2 to monitor releases from Area G does not comply with RCRA groundwater monitoring requirements to monitor groundwater from the "uppermost aquifer," the aquifer strata nearest the water table that produce a significant amount of groundwater. The poorly productive basalt rock surrounding screen #2 does not meet the RCRA definition of "aquifer."

The well screens in R-22 are misplaced and/or permanently damaged and do not meet the monitoring requirements of RCRA or DOE Orders.

Regulatory Issues. RCRA describes waste disposal facilities, such as the LANL MDAs G, H, and L at Technical Area 54 that received hazardous waste after July 26, 1982, as "regulated units" that must comply with the groundwater monitoring requirements in the Detection Monitoring Section of RCRA §§264.91 through 264.101 (RCRA Subpart F). Further, the release of hazardous materials from LANL activities found in well R-22 requires LANL to install of a network of monitoring wells to investigate groundwater contamination beneath and away from MDA G as ordered by the Compliance Monitoring Section of RCRA Subpart F. DOE/LANL have not installed the set of monitoring wells required by RCRA for the regulated units at Technical Area 54.

The groundwater monitoring requirements under RCRA Subpart F for the LANL SWMUs are summarized in an email to CCNS on February 20, 2007 from Richard Mayer, an EPA scientist in EPA Region 6:

> The groundwater monitoring requirements for [solid waste management units] SWMUs should mirror the requirements for regulated units under Subpart F. The groundwater monitoring wells should be located (hydraulically down-gradient) close/near/next to the SWMU or regulated unit in adequate/sufficient numbers. Also, for the monitoring wells located next to the SWMU/regulated unit, the uppermost aquifer should be monitored (in addition, other deeper zones may need to be monitored according to site conditions, other factors, etc.). The site should also have a sufficient number of "background" groundwater monitoring wells in order to determine a release for natural occurring contaminants like metals and some radionuclides.
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> If contamination is found in the monitoring wells next to the SWMU/regulated unit, then further horizontal and vertical delineation of the groundwater plume is required with additional wells.
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> Also, the words sufficient or adequate can be interpreted differently. For example, if a SWMU/regulated unit was 300' by 300' and the groundwater flow direction was from Northwest to Southeast, two downgradient monitoring wells next to the unit (initial wells) would not be a sufficient/adequate number. Now if you had a unit that was 50' by 50', with groundwater flow from Northwest to Southeast, then 2 downgradient monitoring wells next to the unit/SWMU probably would be sufficient.

> This is just a brief general summary. As you know, each site can have its own unique groundwater monitoring issues."

During the past ten years, DOE/LANL have installed a network of 25 characterization wells across the LANL facility with screens installed in the regional aquifer. Well R-22 is the only well installed close enough to a LANL waste disposal facility to investigate contamination in groundwater flowing from beneath the facility. The mistakes in the installation of well R-22 and the failure of DOE/LANL to install characterization wells at appropriate locations to investigate and monitor for groundwater contamination from the other LANL waste disposal sites is a serious problem that requires immediate attention.