Permit

ENTERED

STATE OF NEW MEXICO
BEFORE THE SECRETARY OF ENVIRONMENT

IN THE MATTERS OF THE APPLICATION OF
THE UNITED STATES DEPARTMENT OF ENERGY HWB 09-37
(P)
AND LOS ALAMOS NATIONAL SECURITY LLC HWB 10-04
(P)
FOR A HAZARDOUS WASTE FACILITY PERMIT
FOR LOS ALAMOS NATIONAL LABORATORY
AND THE NOTICE OF INTENT TO DENY A PERMIT
FOR OPEN BURN UNITS TA-16-388 AND TA-16-399 FOR
LOS ALAMOS NATIONAL LABORATORY

Exhibit GR-16

SUMMARY OF TESTIMONY OF MR. GEORGE RICE

The Testimony of Mr. Rice is focused on the deficiencies in the monitoring well network at Technical Area 54 (TA-54) at the Los Alamos National Laboratory (LANL).

Three of the Resource Conservation and Recovery Act (RCRA) legacy waste disposal regulated units are located atop Mesita del Buey at TA-54. The three disposal facilities are MDA G (~ 63 acres), MDA L (~ 2.5 acres), and MDA J (~0.6 acre). At the three regulated units, legacy waste are buried in unlined pits, shafts, trenches and surface impoundments. The period of disposal of RCRA hazardous waste at TA-54 was from approximately 1957 to 1990.

The depth to groundwater across TA-54 varies and is not well known at MDA H and MDA L because the nearest wells are more than 1000 feet from these units. The depth to the regional aquifer is approximately 1020 feet at MDA H, 940 feet at MDA L, and 900 feet at MDA G.

There is insufficient knowledge of the speed and direction of groundwater flow at each of the waste disposal units and site wide at TA-54 because of the sparse network of monitoring wells.

There is an immediate need to install networks of detection monitoring wells at locations close to the hydraulically downgradient boundary of the three waste disposal facilities. The monitoring well screens shall be located a short distance below the water table and also at depth in an appropriate zone of fast-pathway permeable strata.

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There is a need to install a minimum of one monitoring well at an appropriate location hydraulically upgradient from each of the three waste disposal facilities to provide background water quality data. The purpose of background wells is to determine the quality of groundwater that is unaffected by the regulated unit. Background wells should be close to the regulated unit so that water quality is not significantly altered between the time the water passes through the background well and the time it passes beneath the regulated unit.

It should be noted that background water quality for a regulated unit is not the same as 'native' water quality. The quality of native water is unaffected by human activity. The quality of background water may be affected by another contaminant source, but it cannot be affected by the unit for which it serves as a background.

At MDA G, a new monitor well should be installed near R-22. All contaminant detection monitor wells should be installed in the manner required by NMED at the LANL legacy waste disposal facility MDA C, i.e., one screen just below the water table, and one screen not more than 100 feet below the water table in a "*fast-pathway permeable strata*" (NMED 2009a, page 4).

LANL performed Monte Carlo modeling that showed that the sparse network of monitor wells at TA-54 would detect contaminants before they reached any drinking water supply wells or the LANL boundary. I don't believe the modeling was realistic. Many of the Monte Carlo results are clearly unrealistic. The Monte Carlo modeling should not be used to evaluate the effectiveness of monitor wells in detecting contaminant plumes emanating from the three regulated unit waste disposal facilities at TA-54.

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Testimony of George Rice
March 18, 2010

Q1: Please state your name and address.

A1: George Rice. 414 East French, San Antonio, TX 78212.

Q2: What is your professional background?

A2: I am a hydrologist. I have a BS and a MS in hydrology from the University of Arizona. My resume is attached as exhibit GR-1.

Q3: Please briefly describe TA-54.

A3: TA-54 is a technical area in the east central portion of the Los Alamos National Laboratory (LANL). It is on Mesita del Buey and contains three regulated waste disposal units: MDA H, MDA L, and MDA G (exhibits GR-2 and GR-3).

Q4: What types of wastes were disposed at TA-54?

A4: A wide variety of wastes were disposed in pits, shafts, and trenches. These included radionuclides (e.g., uranium, plutonium, tritium), explosives (e.g., RDX, TNT), metals (e.g., beryllium, lead, mercury), volatile organics (e.g., 1,1,1-TCA, TCE), oils, acids, and animal tissues (LANL 2007a, pages 2, 4, and 5; LANL, 2007c, appendix A; LANL 2009n, pages 179, 180, and 182).

Q5: What geologic units underlie TA-54?

A5: In descending order, TA-54 is underlain by the Bandelier Tuff, the Cerros del Rio Basalts, and the Puye Formation. These geologic units are depicted in exhibit GR-4. Depending on location, the water table of the regional aquifer is in either the Cerros del Rio Basalts or the Puye Formation (LANL 2009b, plate 3-2).

Q6: What is the depth to the regional aquifer beneath TA-54?

A6: The depth varies and is not well known at MDA H and MDA L because the nearest wells are more than 1000 feet from these units (exhibit GR-3). The following depths were estimated by comparing topographic maps of each site (LANL 2009f, page 11; LANL 2009c, page 14; and LANL 2009a, page 136) with the water table map for the regional aquifer at TA-54 (exhibit GR-3). The depth to the regional aquifer is approximately 1020 feet at MDA H, 940 feet at MDA L, and 900 feet at MDA G.

In addition, there are some perched intermediate zones of groundwater between land surface and the water table of the regional aquifer. For example, there are two intermediate zones at well R-40. The upper intermediate zone is about 210 feet above the top of the regional aquifer, and the lower intermediate zone is about 90 feet above the top of the regional aquifer (LANL 2009g, page 20). Groundwater flow directions in the intermediate zones may not be the same as flow directions in the underlying regional aquifer.

Q7: How could contaminants from TA-54 reach groundwater in the intermediate zones or the regional aquifer?

A7: Contaminants could be transported from the regulated units by water infiltrating from the surface of the mesa, or they could be transported as a vapor.

Water is known to flow along the fractures that pass through Mesita del Buey. At MDA G, water has been observed flowing from a fracture, into a waste disposal pit (Rogers 1977, pages G-70 and G-71).

Contaminant vapor plumes are known to exist beneath all of the regulated units at TA-54. At MDA L and MDA G, volatile organics have been found at depths greater than 500 feet below land surface (LANL 2009c, page 8; LANL 2009h, page 6). Tritium has been found more than 300 feet below land surface and MDA L and MDA G (LANL 2009c, page 8; LANL 2009h, page 70).

Q8: Is there a monitor well network at TA-54?

A8: Yes. Exhibit GR-3 shows the monitor wells that are installed in the regional aquifer near TA-54. There are also intermediate zone wells installed adjacent to wells R-23 (R-23i) and R-40 (R-40i).

Q9: What is the purpose of a monitor well network?

A9: A monitor well network is supposed to detect contaminants that are released by a regulated unit and enter underlying groundwater.

Q10: What makes an effective monitor well network?

A10: An effective network will satisfy the following requirements:

1) Monitor wells are screened in the hydrologic zone that is most likely to be affected by contaminants emanating from the regulated unit.

2) Detection monitor wells are directly down-gradient of the regulated unit. That is, the wells will be in a position to intercept contaminants because they are '*downstream*' of the unit.

3) Detection monitor wells are located such that contaminants that enter the groundwater system will be detected within a reasonable period of time.

4) At least one background monitor well is installed up-gradient of the regulated unit. Because background wells are 'upstream' of the unit, samples collected from them are not affected by contaminants emanating from the wastes.

Examples of monitor well networks are shown on exhibit GR-5. This exhibit is taken from the RCRA guidance on monitor well network design (EPA 1992a). The Compliance Order On Consent requires LANL to comply with this RCRA guidance (NMED 2008a, page 194).

Q11: Does the TA-54 monitor well network satisfy the requirements of an effective network as described above?

A11: The monitor well network at TA-54 satisfies some of the requirements and does not satisfy others. I will go through each of the requirements and explain whether it is satisfied.

Requirement 1): Monitor wells are screened in the hydrologic zone that is most likely to be affected by contaminants emanating from the regulated unit.

The wells in the TA-54 network satisfy this requirement, with the following exceptions.

Well R-21 appears to be screened approximately 85 feet below the top of the regional water table, although there is some uncertainty regarding the position of the water table at this well (LANL 2007a, pages A-23 and A-25). If R-21 is screened 85 feet below the water table, then it is not screened in the uppermost aquifer (Cerros del Rio Basalts) and may not intercept contaminants emanating from the unit.

Well R-22 is down-gradient of MDA G. It was built with five screens. However, the upper screen (1) and the lower screens (4 and 5) have been affected by drilling fluids (LANL 2009d, page A-1). Because of this, LANL is going to abandon (plug) screens 4 and 5, and isolate screen 1 with an inflatable packer. A dedicated sampling system will be installed for long-term sampling of screens 2 and 3 (LANL 2009d, pages 1 and B-1).

There are at least two problems with R-22. First, the top of screen 2 is approximately 60 feet below the water table (LANL 2007a, pages A-42 and A-43). Thus, if screen 1 is not sampled, no samples will be collected from the uppermost portion of the regional aquifer at R-22. All things being equal, the uppermost portion is the part of the aquifer that is most likely to be affected by contaminants emanating from MDA G.

Second, the hydraulic conductivity measured at screen 2 is much lower than the hydraulic conductivities measured in other wells that are screened in the Cerros del Rio at TA-54 (exhibit GR-7, table 1). Thus, screen 2 appears to have been installed in a low-permeability zone within the Cerros del Rio. Contaminants emanating from MDA G may not migrate through this low-permeability zone, or if they do, they will arrive at R-22 later than contaminants that are travelling through more permeable zones.

The problems associated with R-22; 1) not monitoring the uppermost portion of the aquifer, and 2) installing screens in low-permeability zones, have been addressed by NMED at MDA C. At MDA C, NMED is requiring monitor wells in the regional aquifer to be constructed with two screens: one screen just below the water table, and one screen not more than 100 feet below the water table in a "*fast-pathway permeable strata*" (NMED 2009a, page 4). I agree with this approach to installing monitor wells. However, if the most permeable zone occurs at the water table, then a single screen at the water table would be sufficient.

Requirement 2): Detection monitor wells are directly down-gradient of the regulated unit.

Some wells at TA-54 satisfy this requirement and others do not.

At MDA H, the location of well R-37 is not good. Based on the groundwater flow directions shown in exhibit GR-6, it appears that R-37 is not directly down-gradient of the unit. Instead, R-37 appears to be cross-gradient of MDA H. That is, it is off to the side of the flow path from MDA H and probably will not detect a contaminant plume emanating from the unit. Although dispersion will act to spread a contaminant plume as if moves along the flow path, we do not know whether it will spread enough to be intercepted by R-37.

At MDA L, the locations of wells R-21 and R-38 are not good. They do not appear to be directly down-gradient of the unit (exhibit GR-6). It appears that a contaminant plume emanating from MDA L could pass between these wells without being detected. As with MDA H, dispersion will act to spread a contaminant plume as if moves along the flow path. However, we do not know whether it will spread enough to be intercepted by either well R-21 or R-38.

At MDA G, the locations of wells R-22, R-23, R-39, and R-41 are good. They appear to be directly down-gradient of MDA G and should intercept contaminant plumes emanating from the unit (exhibit GR-6). In addition, well R-49 is side-gradient, within about 600 feet of MDA G. R-49 may detect contaminants emanating from the unit.

The statements above are based on the best available data (exhibit GR-6). However, it should be noted that the monitor well network in the vicinity of TA-54 is sparse. As a result, there is some uncertainty regarding groundwater flow directions.

Requirement 3): Detection monitor wells are located such that contaminants that enter the groundwater system will be detected within a reasonable period of time.

It is not known whether the wells at TA-54 satisfy this requirement.

The amount of time it takes for conservative groundwater contaminants to be detected in a well depends on 1) the distance between the contaminant source and the well, and 2) the speed of the groundwater. I attempted to estimate contaminant travel times from the regulated units to the down-gradient monitor wells.

Distances from the regulated units to the monitor wells are as follows. At MDA H, well R-37 is approximately 1700 feet from the unit. At MDA L, wells R-21 and R-38 are approximately 1200 feet from the unit. At MDA G, wells R-22, R-39, and R-41 are between about 200 feet and 500 feet from the unit, and well R-23 is approximately 3700 feet from the unit.

Groundwater speeds were calculated with data used by LANL to model groundwater flow at TA-54, and data collected from wells at TA-54 (exhibit GR-7). Estimates of groundwater speeds at TA-54 are highly variable due to the uncertainty associated with estimates of hydraulic conductivity and porosity. For MDA H, calculated speeds ranged from a low of 0.7 ft/yr to a high of 670 ft/yr. For MDA L, speeds ranged from a low of 0.2 ft/yr to a high of more than 1,000,000 ft/yr. For MDA G, speeds ranged from a low of 1 ft/yr to a high of more than 1,000,000 ft/yr. It should be noted that although groundwater speeds of more than 1,000,000 ft/yr occur in karst aquifers (caves, conduit flow), they probably do not occur at TA-54.

Even if the highest calculated speeds are ignored, the speeds at each regulated unit vary by a factor of approximately 1000. Thus, estimates of the amount of time required for contaminants to be detected in a well will also vary by a factor of approximately 1000.

In view of this uncertainty, the prudent thing to do is to place the monitor wells as close as practicable to the regulated units. However, monitor wells that are close to the contaminant source may not detect narrow plumes that have not yet broadened through the action of dispersion. This problem can be avoided by increasing the number of monitor wells.

Requirement 4: At least one background well is installed up-gradient of the regulated unit.

The purpose of background wells is to determine the quality of groundwater that is unaffected by the regulated unit. Background wells should be close to the regulated unit

so that water quality is not significantly altered between the time the water passes through the background well and the time it passes beneath the regulated unit. It should be noted that background water quality for a regulated unit is not the same as 'native' water quality. The quality of native water is unaffected by human activity. The quality of background water may be affected by another contaminant source, but it cannot be affected by the unit for which it serves as a background.

There is no background well for MDA H. The nearest up-gradient well, R-40, is approximately 1500 feet from the regulated unit, and it is not directly up-gradient of the unit (exhibit GR-6).

There is no background well for MDA L. The nearest up-gradient well, R-20, is approximately 1700 feet from the regulated unit, and it is not directly up-gradient of the unit (Exhibit GR-6).

The lack of background wells at a regulated unit can lead to two problems. First, the early signs of contamination (e.g., elevated concentrations of naturally occurring constituents such as nitrate or uranium) may not be recognized because unit-specific background data are not available. Second, if contaminants (e.g., TCE, tritium) are detected in a down-gradient monitor well, there is no way to determine whether they came from the regulated unit, or from some other source.

Two wells up-gradient of MDA G, R-21 and R-32, may serve as background wells for this unit. Although they are not directly up-gradient from the unit, they are nearly so. However, they are both relatively far from MDA G. R-21 is approximately 700 feet away, and R-32 is approximately 1400 feet away (Exhibit GR-6). Thus, they are not ideally located to determine background water quality at MDA G.

Q12: Please summarize your opinions concerning the TA-54 monitor well network.

A12: The monitor well network fails to satisfy some of the requirements of an effective network.

MDA H: The detection monitor well (R-37) is not directly down-gradient of the regulated unit. There is no background monitor well. MDA H is not effectively monitored.

MDA L: The detection monitor wells (R-21 and R-38) are not directly down-gradient of the regulated unit. There is no background monitor well. MDA L is not effectively monitored.

MDA G: The detection monitor wells (R-22, R-23, R-39, and R-41) are directly down-gradient of the regulated unit. The up-gradient wells (R-21 and R-32) are not ideally located to determine background water quality at MDA G.

Q13: You have questioned the ability of the monitor well network at TA-54 to detect contaminants. However, didn't LANL perform modeling that showed that the monitor

wells would detect contaminants before they reached any drinking water supply wells or the LANL boundary?

A13: Yes. However, I don't believe the modeling was realistic.

Q14: Please explain.

A14: The modeling employed the Monte Carlo technique where 1000 simulations were performed for each contaminant source: MDA H, MDA L, and three sources at MDA G (MDA G1, MDA G2, and MDA G3; exhibit GR-8). Each of the 1000 simulations used a different set of aquifer properties (hydraulic conductivity, porosity, dispersivity). The aquifer properties used for each simulation were randomly chosen from a probability distribution constructed for each property.

LANL assessed the effectiveness of each monitor well by counting the number of simulations in which a contaminant plume emanating from a source was detected at the well. For example, in the simulations for MDA G2 and MDA G3, the contaminant plumes were detected at wells R-22, R-23, R-39, and R-41 in 999 of the 1000 simulations (LANL 2007a, page C-16). These seem to be reasonable results, given that all of these wells are directly down-gradient of MDA G2 and MDA G3 (exhibits GR-6 and GR-8).

However, the contaminant plumes from MDA G2 and MDA G3 were also detected at well R-21 in 531 of the simulations, in R-32 in 554 of the simulations, and in R-38 in 132 of the simulations. These results are clearly unrealistic. First, wells R-21, R-32, and R-38 are up-gradient of MDA G2 and MDA G3 (exhibits GR-6 and GR-8). Second, the results mean that in more than 500 of the simulations, the contaminant plumes from MDA G2 and MDA G3 were simultaneously travelling down-gradient (to wells R-22, R-23, R-39, and R-41), and up-gradient (to wells R-21 and R-32).

The modeling results should not be used to evaluate the effectiveness of monitor wells in detecting contaminant plumes emanating from TA-54.

Q15: Do you recommend any changes to the TA-54 monitor well network?

A15: Yes.

At MDA H, at least two monitor wells should be installed in the regional aquifer immediately down-gradient of the regulated unit. At least one background well should be installed in the regional aquifer up-gradient of the regulated unit.

At MDA L, at least three monitor wells should be installed in the regional aquifer down-gradient of the regulated unit. The wells should be as close as practicable to the unit. At least one background well should be installed in the regional aquifer up-gradient of the regulated unit.

At MDA G, at least one background monitor well should be installed in the regional aquifer up-gradient of the regulated unit. A new monitor well should be installed near R-22.

All monitor wells should be installed in the manner required by NMED at MDA C, i.e., one screen just below the water table, and one screen not more than 100 feet below the water table in a "*fast-pathway permeable strata*" (NMED 2009a, page 4). However, if the most permeable zone occurs at the water table, then a single screen at the water table would be sufficient.

In addition, monitor wells should be installed in any perched intermediate zones that are encountered.

At some locations there may be a concern that installing monitor wells will create pathways through which contaminants could migrate to intermediate zones or to the regional aquifer. Where this is a concern, wells could be installed at an angle, or directionally drilled, such that the creation of a contaminant pathway is avoided.

Finally, all background monitor wells should be installed as close as practicable to the regulated units, while ensuring they are not installed beneath contaminated vapor plumes that could affect the quality of water in the wells.

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Exhibits

Exhibit GR-1
Resume of George Rice

George Rice
Groundwater Hydrologist

414 East French Place
San Antonio, TX 78212
(210) 737-6180
jorje44@yahoo.com

General

More than 20 years experience in groundwater contamination investigations.

Education

M.S. Hydrology, University of Arizona, 1991
B.S. Hydrology, University of Arizona, 1979

Employment History

1993: Consultant
1988 - 1993: The MITRE Corporation, Brooks Air Force Base, Texas
1983 - 1988: SHB Geotechnical Engineers, Inc., Albuquerque, New Mexico
1980 - 1983: University of Arizona, Tucson, Arizona
1979 - 1980: U.S. Forest Service, Gifford Pinchot National Forest, Vancouver, Washington

Experience

- Design and install monitor well networks.
- Design, perform, and analyze aquifer tests.
- Design and install vadose zone monitor networks.
- Design and conduct groundwater sampling programs.
- Apply groundwater flow and contaminant transport models to predict the fate of groundwater contaminants (MODFLOW, MT3D, MOC3D).
- Participate in multidisciplinary teams to select and design hazardous waste disposal sites.
- Conduct third party reviews of environmental documents and field programs.

- Expert Witness.

Representative Projects

Site Characterization - Principal hydrologist responsible for the hydrologic characterization of low-level radioactive and hazardous waste sites throughout the western United States. The goals of these studies were to determine the extent and intensity of any metals or radionuclide contamination, estimate the rate and direction of contaminant movement, and predict future concentrations at receptor sites. Achievement of these goals required the installation of monitor well networks, installation of vadose zone monitoring instruments, groundwater sampling, the performance and analysis of aquifer tests, and the integration of data into a coherent conceptual model of each site.

Contaminant Transport Modeling - Used two and three-dimensional models to design pump and treat systems and estimate the effects of proposed remedial actions on future water quality. Conducted studies to estimate the time required for contaminants to reach potential receptors and estimate contaminant concentrations after plumes reached receptors.

Waste Repository Design - Principal hydrologist responsible for estimating the effects of remedial designs on future groundwater quality at low-level nuclear waste repositories in Arizona and Colorado. This required working closely with geotechnical and civil engineers to produce designs that incorporated the hydrologic characteristics required to meet water quality standards.

Field Methods Instructor - Member of a team that taught environmental field techniques to Air Force personnel. The four-day course consisted of lectures and field trips. It focused on monitor well design, monitor well construction, sampling program design, and groundwater sampling techniques.

Quality Assurance Manager - Manager of hydrology group responsible for evaluating environmental work performed at Air Force bases throughout the United States. Evaluated reports, hydrologic analyses, and field work related to Preliminary Assessments and Site Inspections (PA/SI), Remedial Investigations and Feasibility Studies (RI/FS), and Remedial Actions (RA). These evaluations usually resulted in recommendations for improving overall program design, analytical techniques, or field procedures.

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Rice, G., 2004, *The Potential for Groundwater Contaminants from Los Alamos National Laboratory to Reach the Rio Grande*, July 2004.

Rice, G., 2006, *Effects of URI's Kingsville Dome Mine on Groundwater Quality*, Prepared for the Kleberg County URI Citizen Review Board, July 2007.

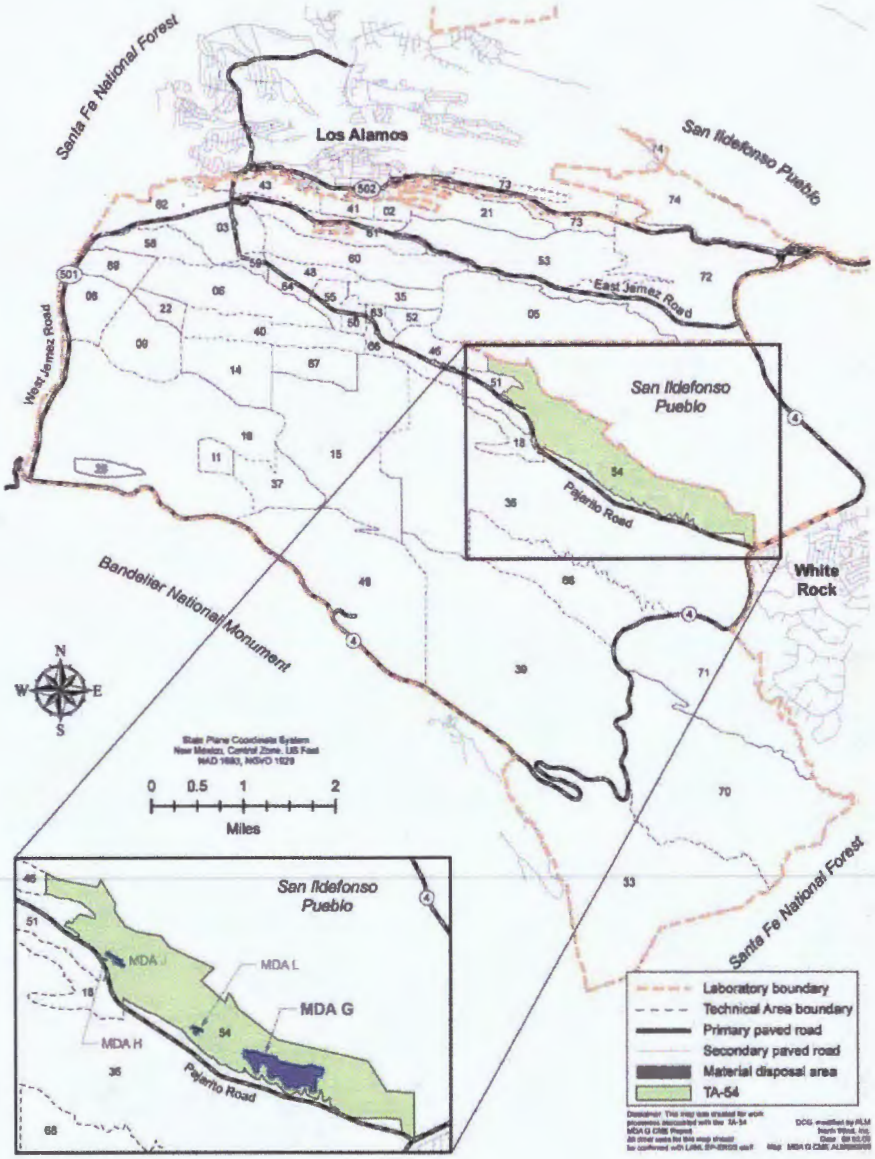


Exhibit GR-2
Location of TA-54
(adapted from LANL, 2009a, page 127)

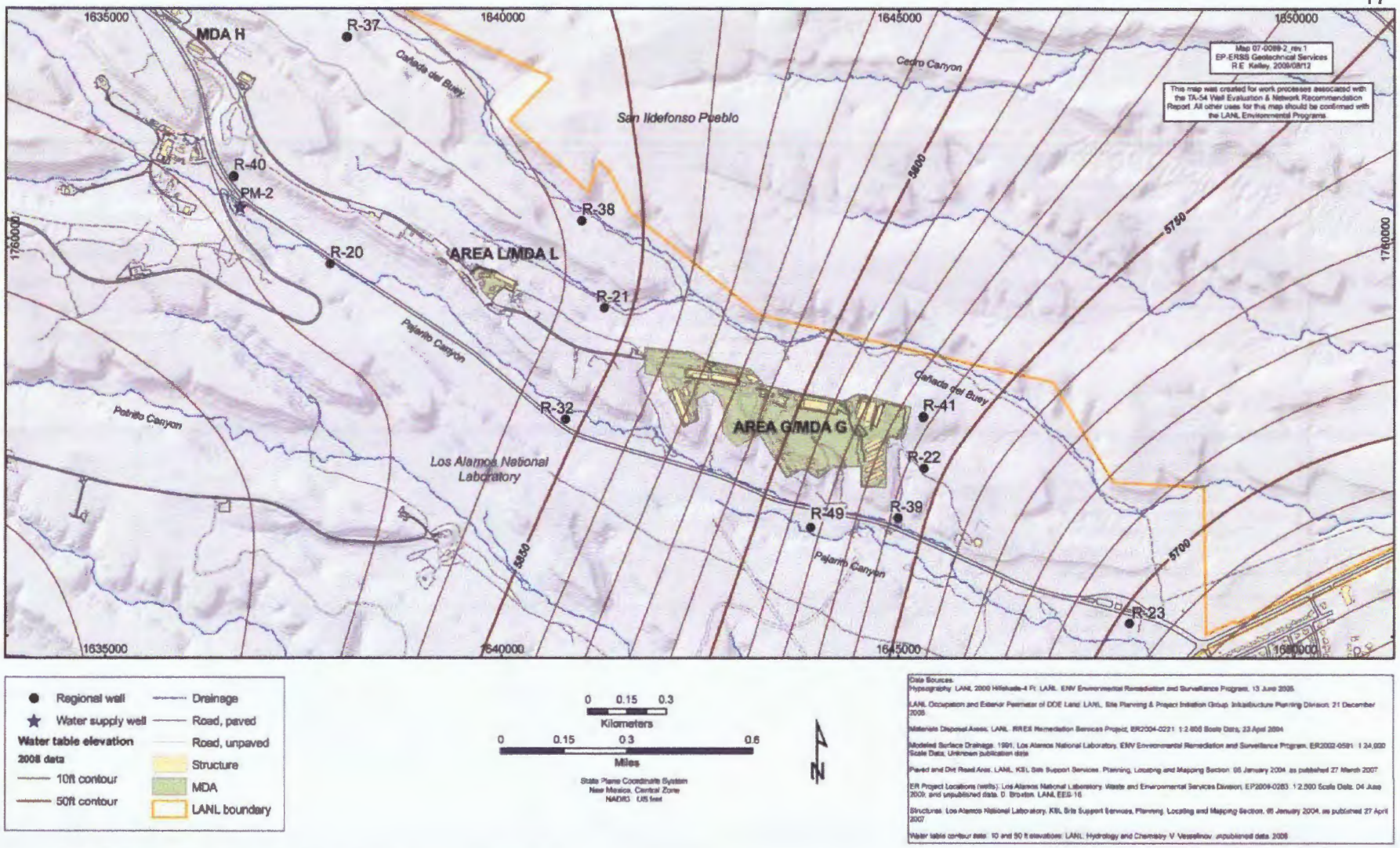
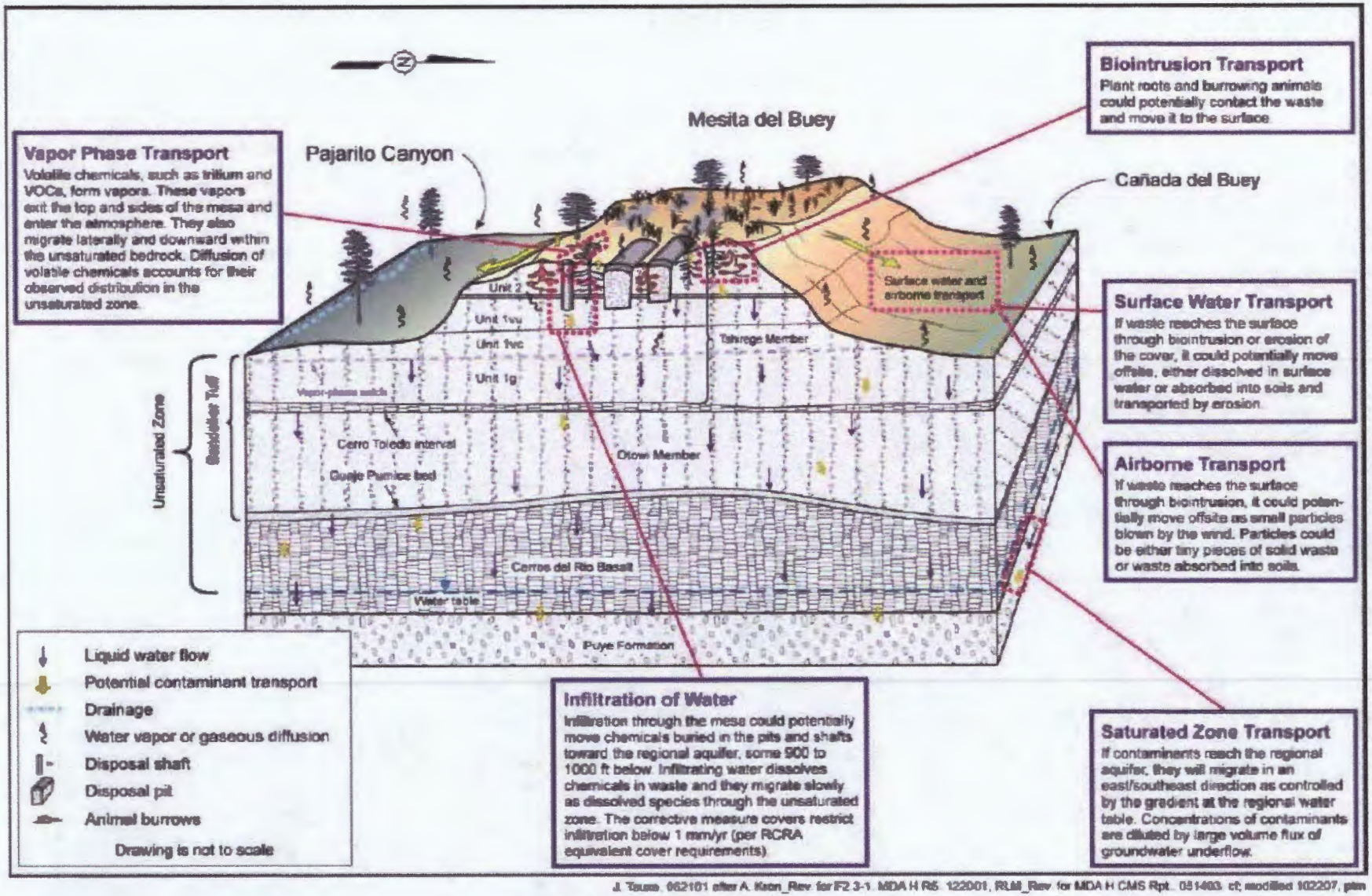


Figure 2.3-13 Regional monitoring wells, water-supply wells, and groundwater gradient

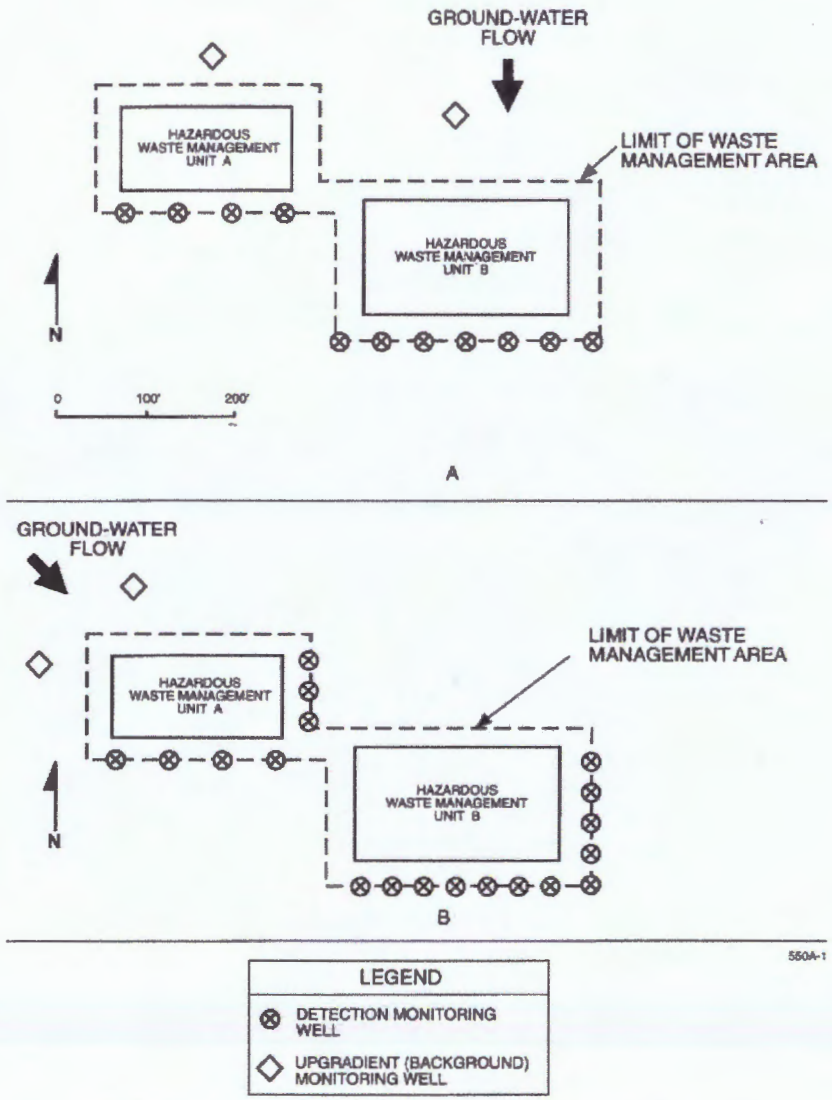
Exhibit GR-3
(adapted from LANL, 2009a, page 142)



J. Tauxe, 062101 after A. Keon, Rev. for IF2 3-1, MDA H R6, 122001, RLM, Rev. for MDA H CMS Rpt., 051403, cf; modified 102207, ptm

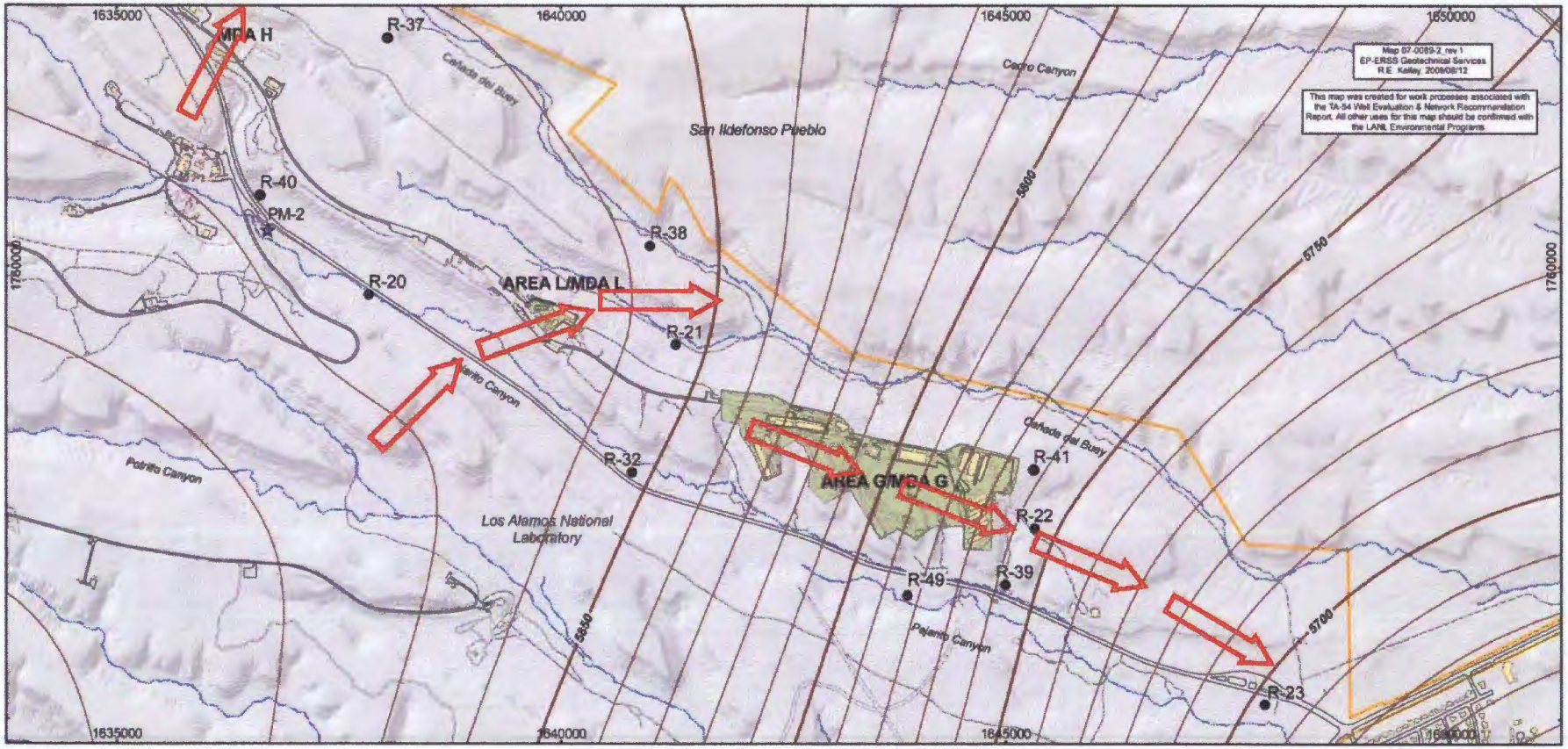
Figure 3.2-6 Hydrogeologic conceptual site model for Area G

Exhibit GR-4
(adapted from LANL, 2009a, page 148)



DOWNGRADIENT WELLS IMMEDIATELY ADJACENT TO THE HAZARDOUS WASTE MANAGEMENT AREA LIMITS

Exhibit GR-5
(adapted from EPA 1992a, page 5-3)



Regional well
Water supply well
Water table elevation
2008 data
10ft contour
50ft contour
Drainage
Road, paved
Road, unpaved
Structure
MDA
LANL boundary

0 0.15 0.3
Kilometers
0 0.15 0.3 0.6
Miles
State Plane Coordinate System
New Mexico, Central Zone
NAD83, US feet

N

Groundwater flow direction

Figure 2.3-13 Regional monitoring wells, water-supply wells, and groundwater gradient

Exhibit GR-6
(adapted from LANL, 2009a, page 142)

Exhibit GR-7
Calculation of Groundwater Speeds at TA-54

Table 1
Hydrologic Properties

Property	Cerros del Rio Basalt (Tb4)	Puye Formation (Tpf)	Source of data
Intrinsic permeability, low value used in model	$10^{-15.0}$ M^2	$10^{-14.0}$ M^2	LANL, 2007a, page C-10
Intrinsic permeability, mean value used in model	$10^{-12.0}$ M^2	$10^{-12.5}$ M^2	LANL, 2007a, page C-13
Intrinsic permeability, high value used in model	$10^{-9.0}$ M^2	$10^{-11.0}$ M^2	LANL, 2007a, page C-10
Hydraulic conductivity, R-22 screen 2[1], 947.0'-988.9'	0.04 ft/day (14.6 ft/yr)		LANL, 2007a, pages A-38, A-42; LANL, 2009d, page B-5
Hydraulic conductivity, R-22 screen 3, 1272.2'-1278.9'		0.21ft/day (76.7 ft/yr)	LANL, 2007a, pages A-38, A-42; LANL, 2009d, page B-5
Hydraulic conductivity, R-38 single screen, 821.2'-831.2'	17 – 37 ft/day (6200 – 13,500 ft/yr)		LANL, 2009e, pages 14, 16, C-15, E-10
Hydraulic conductivity, R-39 single screen, 859.0'-869.0'	≥ 1.3 ft/day (474 ft/yr)		LANL 2009k, pages 15, 16, and F-16
Hydraulic conductivity, R-40 screen 2, 849.3'-870.0'		3.0 - 4.4 ft/day (1100 – 1600 ft/yr)	LANL, 2009g, page F-24
Porosity, geometric mean of values used in model	0.001	0.045	LANL, 2007a. page C-13
Porosity, R-20 screen 1, 904.6'-912.2'	0.35 – 0.45		LANL, 2003a, page 4; LANL, 2007a, page A-7
Porosity, R-20 screen 2, 1147.1'-1154.7'		0.45	LANL, 2003a, page 4; LANL, 2007a, page A-7
Porosity, R-21 single screen, 888.8'-906.8' [2]		0.2 – 0.3	LANL, 2007a, pages A-21, A22
Porosity, R-38 single screen, 821.2'-831.2'	0.3		LANL, 2009e, pages 14, 16, C-15, E-10
Hydraulic gradient, MDA H		0.003	LANL, 2009a. page 142
Hydraulic gradient, MDA L	0.005		LANL, 2009a. page 142
Hydraulic gradient, MDA G	0.02		LANL, 2009a. page 142

[1] No test performed for screen 1 (LANL, 2009d, page B-1).
[2] Top of screen approximately 85 feet below water table. Water table in Cerros del Rio Basalts (LANL, 2007a, page A-25).

To convert intrinsic permeability (k) to hydraulic conductivity (K):

$K = (k\ \rho\ g)/\mu$ [3]

where:

K = hydraulic conductivity
k = intrinsic permeability
ρ = density of water = 1000 kg/M^3
g = gravitational acceleration = 9.8 M/s^2
μ = dynamic viscosity of water at 20 C = 1.002×10^{-3} kg/(s M) [4]

For the Cerros del Rio Basalt:

$K_{(low)} = [10^{-15.0}\ M^2\ (1000\ kg/M^3)\ 9.8\ M/s^2] / [1.002 \times 10^{-3}\ kg/(s\ M)]$
$= 9.8 \times 10^{-9}$ M/s = 2.8×10^{-3} ft/day = 1.0 ft/yr

$K_{(mean)} = [10^{-12.0}\ M^2\ (1000\ kg/M^3)\ 9.8\ M/s^2] / [1.002 \times 10^{-3}\ kg/(s\ M)]$
$= 9.8 \times 10^{-6}$ M/s = 2.8 ft/day = 1010 ft/yr

$K_{(high)} = [10^{-9.0}\ M^2\ (1000\ kg/M^3)\ 9.8\ M/s^2] / [1.002 \times 10^{-3}\ kg/(s\ M)]$
$= 9.8 \times 10^{-3}$ M/s = 2770 ft/day = 1,010,000 ft/yr

For the Puye Formation:

$K_{(low)} = [10^{-14.0}\ M^2\ (1000\ kg/M^3)\ 9.8\ M/s^2] / [1.002 \times 10^{-3}\ kg/(s\ M)]$
$= 9.8 \times 10^{-8}$ M/s = 2.8×10^{-2} ft/day = 10.1 ft/yr

$K_{(mean)} = [10^{-12.5}\ M^2\ (1000\ kg/M^3)\ 9.8\ M/s^2] / [1.002 \times 10^{-3}\ kg/(s\ M)]$
$= 3.1 \times 10^{-6}$ M/s = 8.8×10^{-1} ft/day = 320 ft/yr

$K_{(high)} = [10^{-11.0}\ M^2\ (1000\ kg/M^3)\ 9.8\ M/s^2] / [1.002 \times 10^{-3}\ kg/(s\ M)]$
$= 9.8 \times 10^{-5}$ M/s = 28 ft/day = 10,100 ft/yr

---

[3] Freeze, R.A., and J.A. Cherry, 1979, *Groundwater*, page 27.
[4] Vennard, J.K, and R.L. Street, 1975, *Elementary Fluid Mechanics*, 5th Edition, page 706.

To calculate groundwater speed:

$q = [K \Delta h/\Delta L] / n$

where:

q = groundwater speed
K = hydraulic conductivity
$\Delta h/\Delta L$ = intrinsic permeability
n = porosity

For MDA H (Puye Formation):

Calculations with properties used in model:

$q_{(low)}$ = [10.1 ft/yr (0.003)] / 0.045 = 0.7 ft/yr

$q_{(mean)}$ = [320 ft/yr (0.003)] / 0.045 = 21 ft/yr

$q_{(high)}$ = [10,100 ft/yr (0.003)] / 0.045 = 670 ft/yr

Calculation with properties from wells R-21 R-22, and R-40:

q = [76.7 ft/yr (0.003)] / 0.3 = 0.8 ft/yr

q = [1600 ft/yr (0.003)] / 0.3 = 16 ft/yr

For MDA L (Cerros del Rio Basalt):

Calculations with properties used in model:

$q_{(low)}$ = [1.0 ft/yr (0.005)] / 0.001 = 5.0 ft/yr

$q_{(mean)}$ = [1010 ft/yr (0.005)] / 0.001 = 5050 ft/yr

$q_{(high)}$ = [1,010,000 ft/yr (0.005)] / 0.001 = 5,050,000 ft/yr

Calculations with properties from wells R-22 and R-38:

q = [14.6 ft/yr (0.005)] / 0.3 = 0.2 ft/yr

q = [13,500 ft/yr (0.005)] / 0.3 = 230 ft/yr

For MDA G (Cerros del Rio Basalt):

Calculations with properties used in model:

$q_{(low)}$ = [1.0 ft/yr (0.02)] / 0.001 = 20 ft/yr

$q_{(mean)}$ = [1010 ft/yr (0.02)] / 0.001 = 20,200 ft/yr

$q_{(mean)}$ = [1,010,000 ft/yr (0.02)] / 0.001 = 20,200,000 ft/yr

Calculations with properties from wells R-22 and R-38:

q = [14.6 ft/yr (0.02)] / 0.3 = 1 ft/yr

q = [13,500 ft/yr (0.02)] / 0.3 = 900 ft/yr

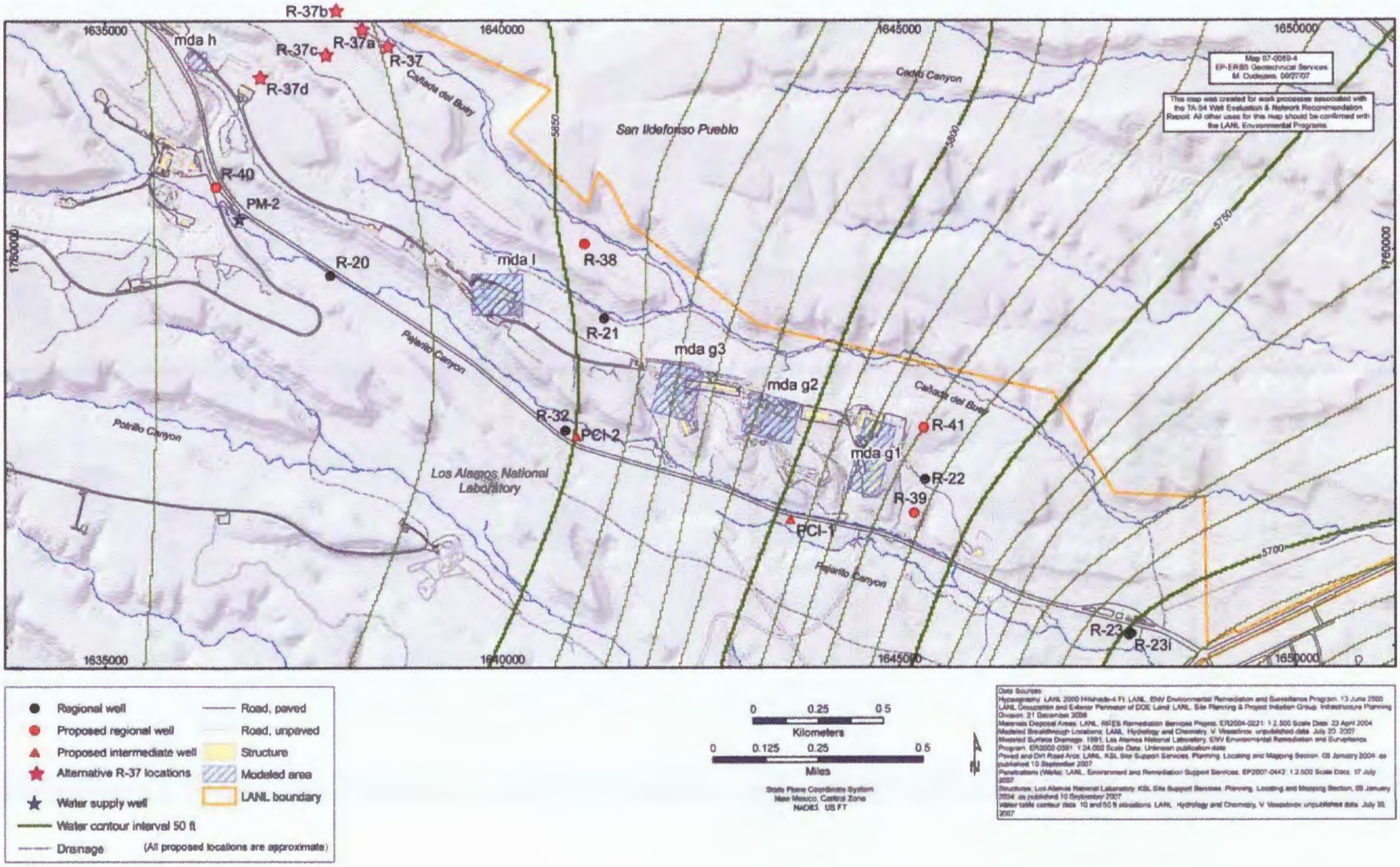


Exhibit GR-8
(adapted from LANL, 2007a, page C-7)

STATE OF NEW MEXICO
BEFORE THE SECRETARY OF ENVIRONMENT

IN THE MATTERS OF THE APPLICATION OF
THE UNITED STATES DEPARTMENT OF ENERGY **HWB 09-37 (P)**
AND LOS ALAMOS NATIONAL SECURITY LLC **HWB 10-04 (P)**
FOR A HAZARDOUS WASTE FACILITY PERMIT
FOR LOS ALAMOS NATIONAL LABORATORY
AND THE NOTICE OF INTENT TO DENY A PERMIT
FOR OPEN BURN UNITS TA-16-388 AND TA-16-399 FOR
LOS ALAMOS NATIONAL LABORATORY

AFFIDAVIT OF GEORGE RICE

I, GEORGE RICE, hereby submit this Affidavit in support of my Statement of Intent to Present Technical Testimony in the above-captioned matter.

I hereby swear under penalty of perjury under the laws of the United States of America and the State of Texas that the above statement is true and correct to the best of my knowledge.

Date: March 18, 2010.

George Rice
414 East French
San Antonio, TX
(210) 737-6180

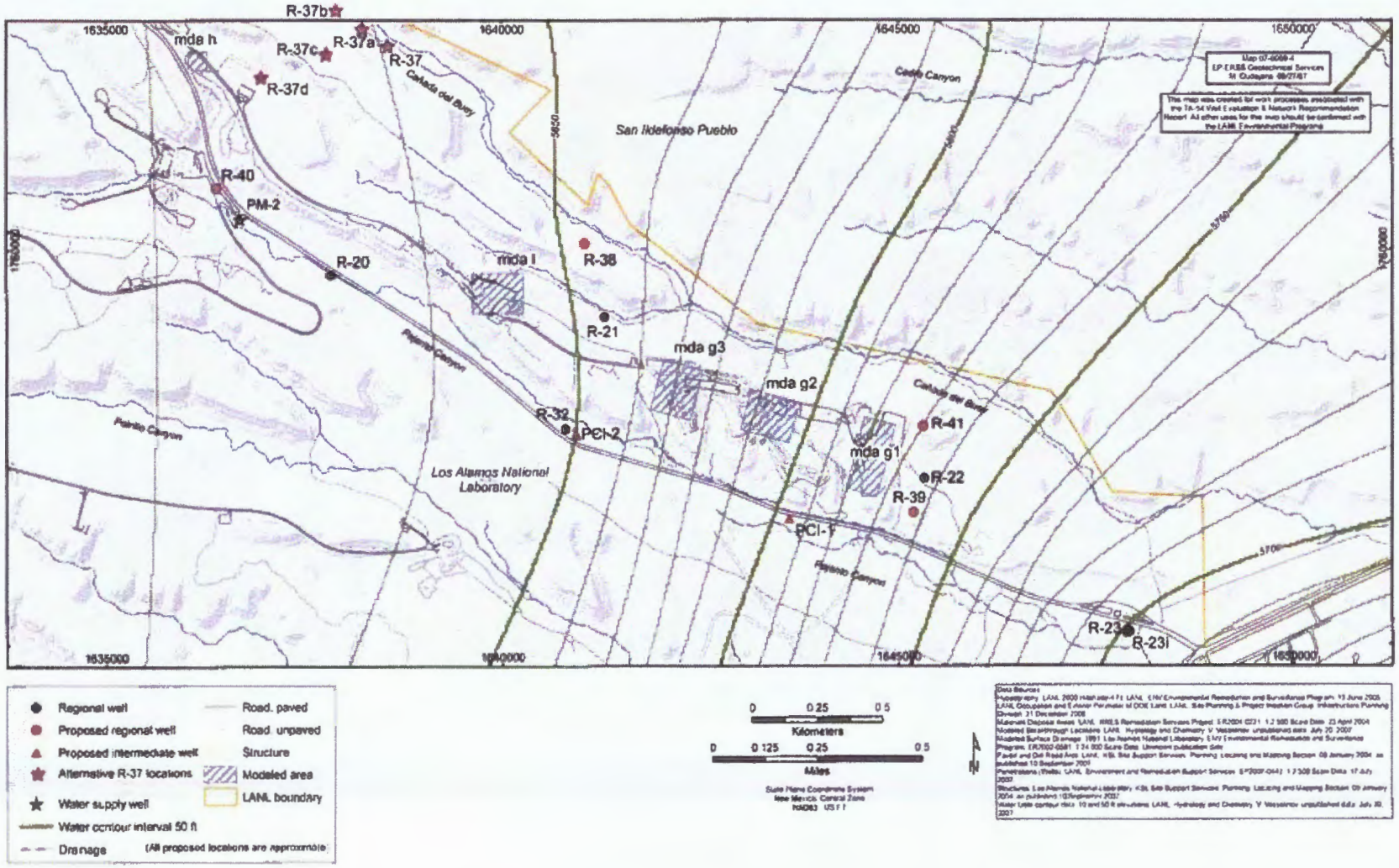


Exhibit GR-8
(adapted from LANL, 2007a, page C-7)

RCRA GROUND-WATER MONITORING:

DRAFT TECHNICAL GUIDANCE

OFFICE OF SOLID WASTE
U.S. ENVIRONMENTAL PROTECTION AGENCY
401 M STREET, S.W.
WASHINGTON, D.C. 20460

NOVEMBER 1992

This document is distributed by the USEPA to update technical information contained in other sources of USEPA guidance, such as Chapter Eleven of SW-846 (Revision 0, September 1986) and the Technical Enforcement Guidance Document (TEGD).

EXHIBIT
GR-9

LA-6848-MS, Vol. I

Informal Report

Special Distribution

Issued: June 1977

History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and T)

A Source Document

Margaret Anne Rogers

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87545

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UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
CONTRACT W-7405-ENG. 36

EXHIBIT
GR-15

STATE OF NEW MEXICO
BEFORE THE SECRETARY OF ENVIRONMENT

IN THE MATTERS OF THE APPLICATION OF	
THE UNITED STATES DEPARTMENT OF ENERGY	HWB 09-37
(P)	
AND LOS ALAMOS NATIONAL SECURITY LLC	HWB 10-04
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FOR A HAZARDOUS WASTE FACILITY PERMIT	
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AND THE NOTICE OF INTENT TO DENY A PERMIT	
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LOS ALAMOS NATIONAL LABORATORY	

Exhibit GR-16

SUMMARY OF TESTIMONY OF MR. GEORGE RICE

The Testimony of Mr. Rice is focused on the deficiencies in the monitoring well network at Technical Area 54 (TA-54) at the Los Alamos National Laboratory (LANL).

Three of the Resource Conservation and Recovery Act (RCRA) legacy waste disposal regulated units are located atop Mesita del Buey at TA-54. The three disposal facilities are MDA G (~ 63 acres), MDA L (~ 2.5 acres), and MDA J (~0.6 acre). At the three regulated units, legacy waste are buried in unlined pits, shafts, trenches and surface impoundments. The period of disposal of RCRA hazardous waste at TA-54 was from approximately 1957 to 1990.

The depth to groundwater across TA-54 varies and is not well known at MDA H and MDA L because the nearest wells are more than 1000 feet from these units. The depth to the regional aquifer is approximately 1020 feet at MDA H, 940 feet at MDA L, and 900 feet at MDA G.

There is insufficient knowledge of the speed and direction of groundwater flow at each of the waste disposal units and site wide at TA-54 because of the sparse network of monitoring wells.

There is an immediate need to install networks of detection monitoring wells at locations close to the hydraulically downgradient boundary of the three waste disposal facilities. The monitoring well screens shall be located a short distance below the water table and also at depth in an appropriate zone of fast-pathway permeable strata.

There is a need to install a minimum of one monitoring well at an appropriate location hydraulically upgradient from each of the three waste disposal facilities to provide background water quality data. The purpose of background wells is to determine the quality of groundwater that is unaffected by the regulated unit. Background wells should be close to the regulated unit so that water quality is not significantly altered between the time the water passes through the background well and the time it passes beneath the regulated unit.

It should be noted that background water quality for a regulated unit is not the same as 'native' water quality. The quality of native water is unaffected by human activity. The quality of background water may be affected by another contaminant source, but it cannot be affected by the unit for which it serves as a background.

At MDA G, a new monitor well should be installed near R-22. All contaminant detection monitor wells should be installed in the manner required by NMED at the LANL legacy waste disposal facility MDA C, i.e., one screen just below the water table, and one screen not more than 100 feet below the water table in a "*fast-pathway permeable strata*" (NMED 2009a, page 4).

LANL performed Monte Carlo modeling that showed that the sparse network of monitor wells at TA-54 would detect contaminants before they reached any drinking water supply wells or the LANL boundary. I don't believe the modeling was realistic. Many of the Monte Carlo results are clearly unrealistic. The Monte Carlo modeling should not be used to evaluate the effectiveness of monitor wells in detecting contaminant plumes emanating from the three regulated unit waste disposal facilities at TA-54.

STATE OF NEW MEXICO
BEFORE THE SECRETARY OF ENVIRONMENT

IN THE MATTERS OF THE APPLICATION OF
THE UNITED STATES DEPARTMENT OF ENERGY **HWB 09-37 (P)**
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FOR A HAZARDOUS WASTE FACILITY PERMIT
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STATE OF NEW MEXICO
BEFORE THE SECRETARY OF ENVIRONMENT

IN THE MATTERS OF THE APPLICATION OF THE UNITED STATES DEPARTMENT OF ENERGY AND LOS ALAMOS NATIONAL SECURITY LLC FOR A HAZARDOUS WASTE FACILITY PERMIT FOR LOS ALAMOS NATIONAL LABORATORY AND THE NOTICE OF INTENT TO DENY A PERMIT FOR OPEN BURN UNITS TA-16-388 AND TA-16-399 FOR LOS ALAMOS NATIONAL LABORATORY	**HWB 09-37 (P)** **HWB 10-04 (P)**

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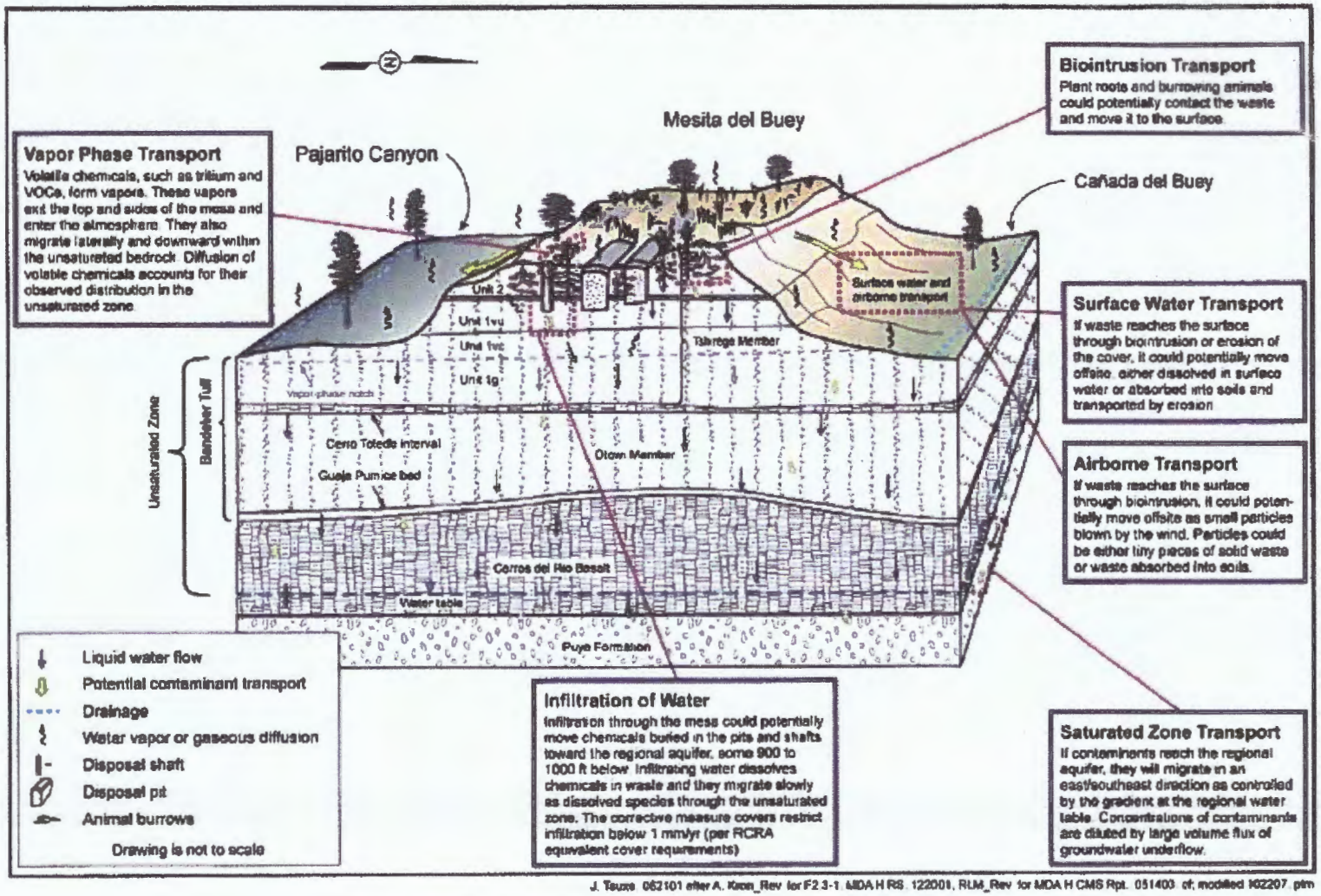
Date: March 18, 2010.

George Rice
414 East French
San Antonio, TX
(210) 737-6180

Figure 1. Source: Figure 3.2-6 *in* LANL Report *MDA G CME Report – Rev 1* (LA-UR-09- 5509 September 2009). (AR 32022)



J. Tauxe 062101 after A. Kron_Rev for F2.3-1 MDA H RS 122001, RUM_Rev for MDA H CMS Rpt. 051403 cf; modified 102207 ptm

Figure 3.2-6 Hydrogeologic conceptual site model for Area G

Fig 1

Figure 2. Figure 2.3-13 "Regional monitoring wells, water supply wells, and groundwater gradient" in LANL MDA G CME Report – Rev. 1 (LA-UR-09-5509 September 2009. (AR 32022)

- The distance from the northern boundary of MDA L to well R-38 is ~ 1/4 mile
- The contour lines are the elevation of the water table of the regional aquifer
- The direction of groundwater flow below MDA G is to the southeast.
- The R-wells are the monitoring wells installed in the regional aquifer.

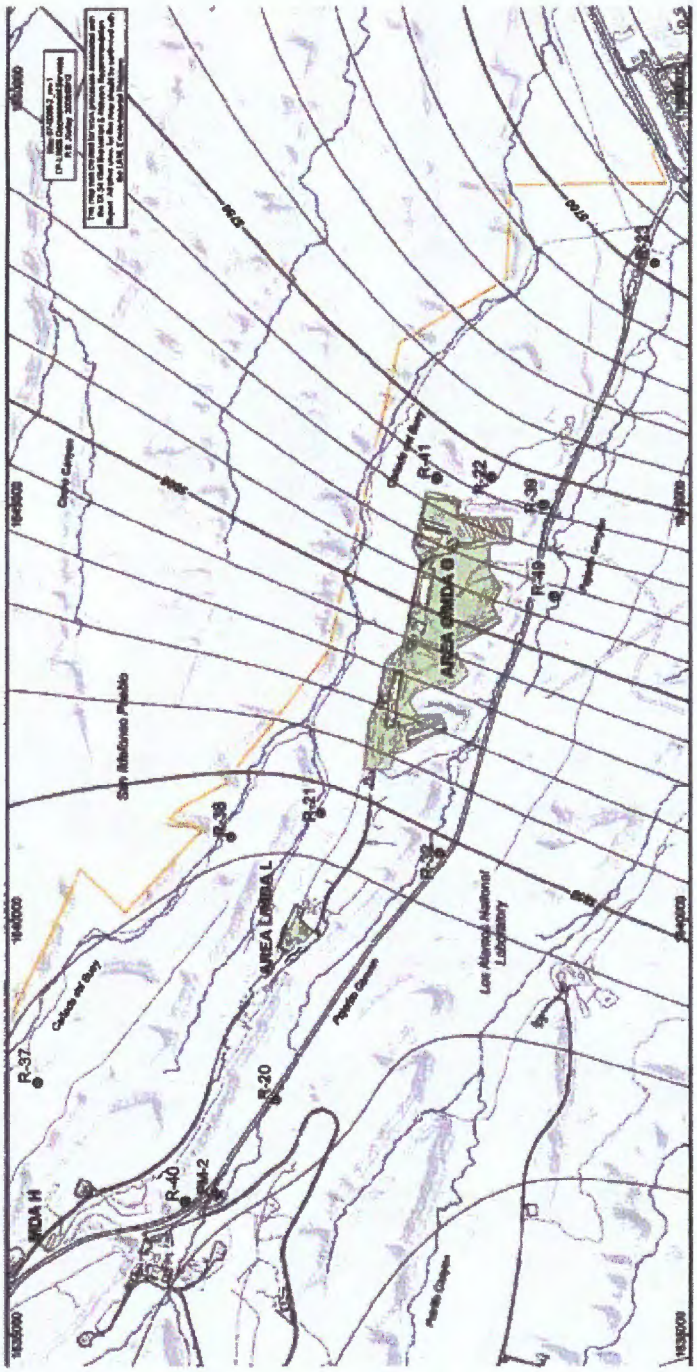
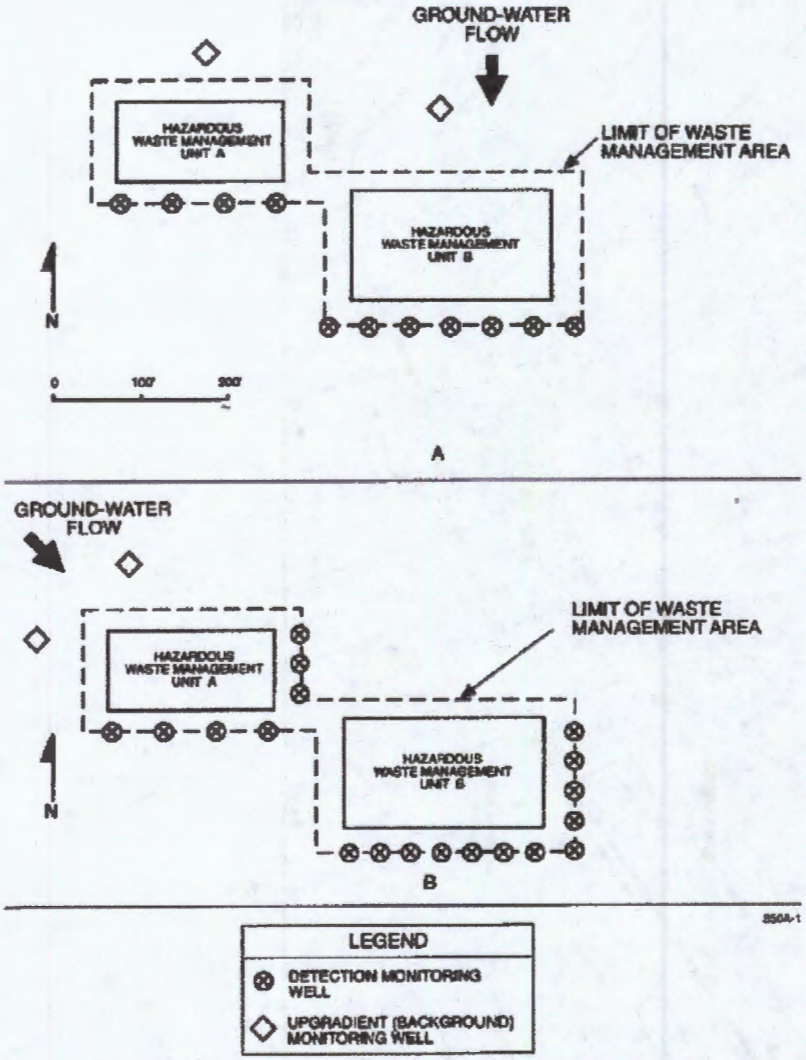


Fig 2 + 3

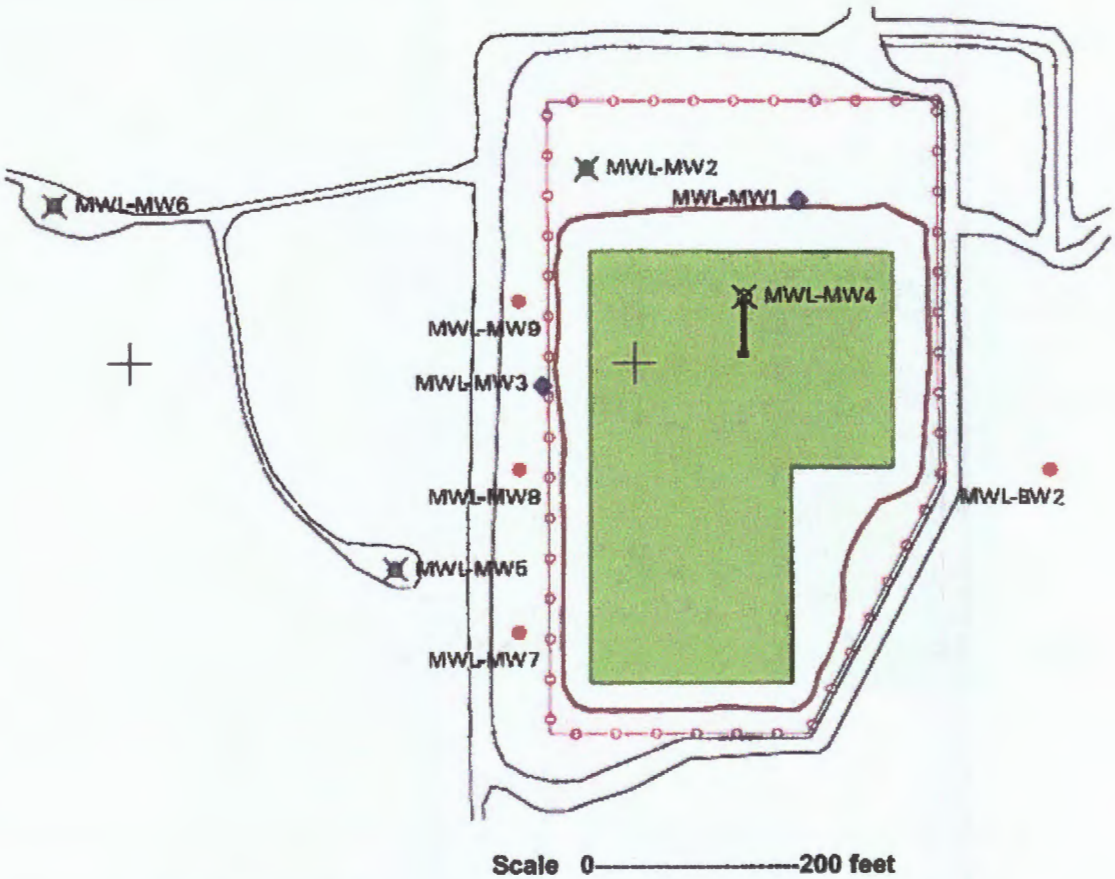
Figure 3. Schematic of locations for "point of compliance" contaminant detection monitoring wells and upgradient background water quality wells for RCRA "regulated units."

Source: Figure 9 in *RCRA GROUND-WATER MONITORING: DRAFT TECHNICAL GUIDANCE* OFFICE OF SOLID WASTE U.S. ENVIRONMENTAL PROTECTION AGENCY 401 M STREET, S.W. WASHINGTON, D.C. 20460 NOVEMBER 1992



DOWNGRADIENT WELLS IMMEDIATELY ADJACENT TO THE HAZARDOUS WASTE MANAGEMENT AREA LIMITS

Figure 4. The NMED requirements for the network of monitoring wells at the Sandia National Laboratories Mixed Waste Landfill in Albuquerque, New Mexico.



Source: Sandia National Laboratories *Long-Term Monitoring and Maintenance Plan* for the Mixed Waste Landfill, September 2007.

- **The down-gradient detection monitoring wells required for the long-term monitoring program are MWL-MW5, -MW6, -MW7, -MW8 and -MW9.**

- **Well MWL-MW4 is a detection monitoring well installed inside the Mixed Waste Landfill to monitor groundwater contamination below an unlined trench.**

- **Well MWL-BW-2 is the background water quality well that is located hydraulically upgradient of the Mixed Waste Landfill.**

- **The 2.6 acre Mixed Waste Landfill was in operation from 1959 through 1988. The hazardous and mixed waste are buried in unlined pits and trenches. The NMED has approved a plan to leave the wastes buried below a dirt cover.**

Fig 4

Figure 5. The NMED requirements for the network of monitoring wells at the Sandia National Laboratories Chemical Waste Landfill in Albuquerque, New Mexico.

- The Chemical Waste Landfill is a RCRA "regulated unit" waste disposal facility.

Scale 0.....200 feet

- **MW-9, MW-10 and MW-11 Contaminant detection monitoring wells**
- **BW-5 Background water quality monitoring well**

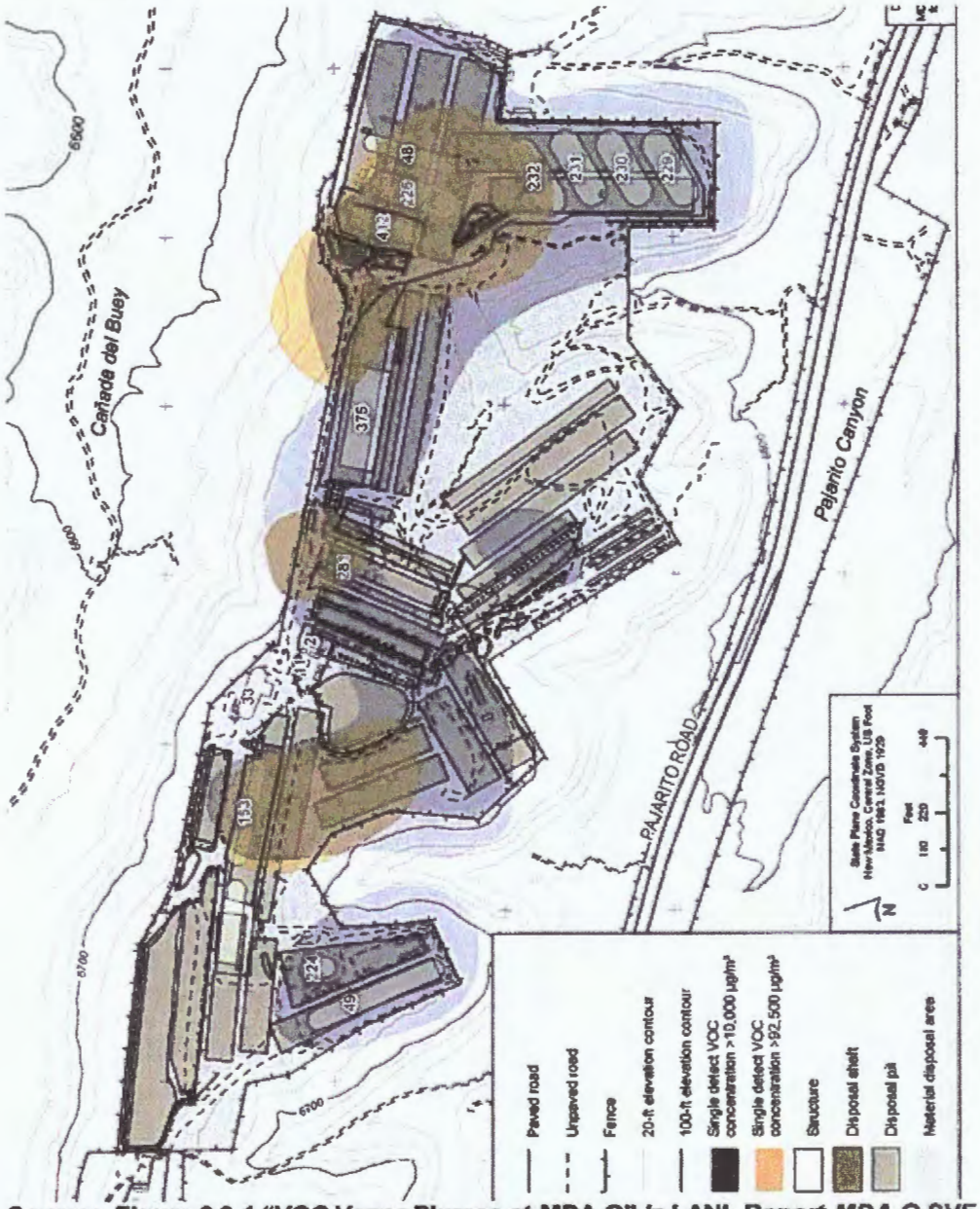
- **The contour lines show the direction of groundwater travel at the water table of the regional aquifer**

Source: Sandia National Laboratories Chemical Waste Landfill Closure Plan, August 2009

Fig 5

Figure 6. Location of Three Volatile Organic Compound (VOC) Vapor Plumes at Los Alamos National Laboratory Legacy Waste Dump MDA G.

- The three VOC plumes are colored brown and are present in the eastern, central and western parts of MDA G. The highest VOC concentrations are in the eastern plume at the shaft field that is located west of pits 2 and 4 ~ 700 feet from the eastern boundary of MDA G. Pits 2 and 4 are identified on Figure 2. The dominant subsurface VOC vapor contaminant is 1,1,1-trichloroethane (TCA) in the eastern and central portion of MDA G; trichloroethene (TCE) is more dominant in the western portion of MDA G.



Source: Figure 2.3-1 "VOC Vapor Plumes at MDA G" ***In*** **LANL Report** ***MDA G SVE Pilot Test Report*** **(LA-UR-08-6883 October 2008) (AR 30572)**

Fig 6

Figure 7. Location of three tritium hot spot areas below MDA G.

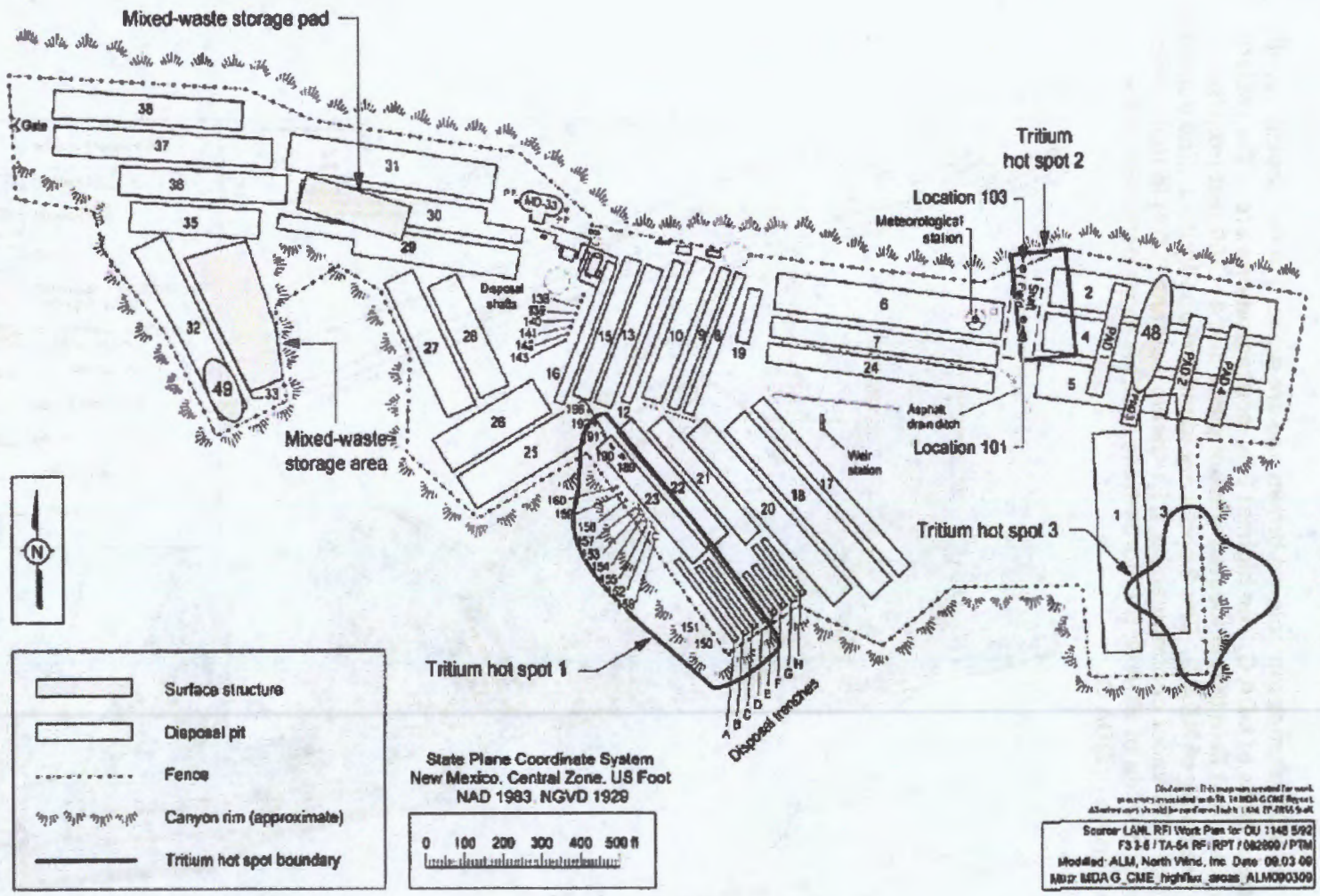
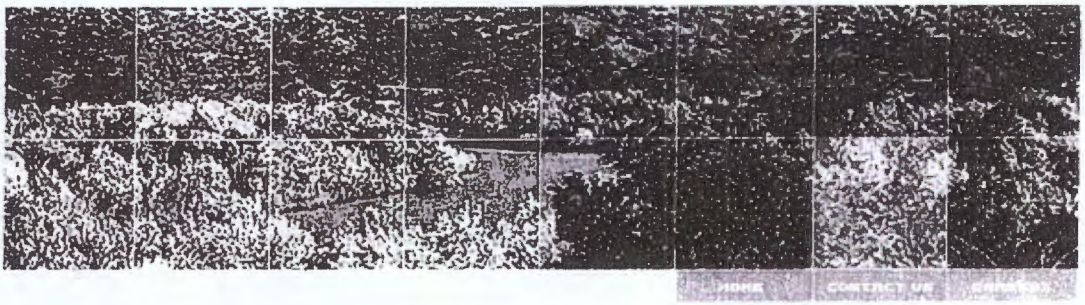


Figure 2.3-5 Locations of tritium high-flux areas at Area G

Source: Figure 2.3-5 *In* LANL Report *MDA G CME Report – Rev 1* (LA-UR-09-5509 September 2009. (AR 32022)

Fig 7

Buckman Direct Diversion Project



Water Quality

BDD Asks LANL to Ensure Water Quality

In November 2007, the BDD Board sent a **letter** to the U.S. Department of Energy (DOE) and LANL asking them to take and fund actions to address LANL-origin contaminants in storm water runoff that flows down Los Alamos and Pueblo Canyons to the Rio Grande, thereby contaminating the BDD Project's raw water supply.

Specific requests include providing an early notification system that the BDD Project will rely on (a) to stop diversions from the Rio Grande when storm water that may contain LANL-origin contaminants from Los Alamos and Pueblo Canyons is flowing to the Rio Grande; and (b) to resume diversion when the contaminated flows have passed. The BDD Board also has asked LANL to prevent migration of contaminants in storm water and properly monitor the contaminant flows that do occur.

In March 2009, the BDD sent a **second letter** asking the federal agency that oversees LANL, the U.S. Department of Energy, to consider entering negotiations with the BDD on the remaining, uncompleted action steps. The Department agreed, and negotiations resumed in the Spring of 2009.

In March 2009, the Legislature passed **House Memorial 120**, requesting a Memorandum of Understanding to address contamination emanating from LANL so the BDD Project could ensure safe drinking water to its customers.

In October 2009, the BDD Board sent a **letter** again requesting a Memorandum of Understanding that remained unaddressed with the BDD Project describing the DOE and LANL commitments with regard to the six action steps, along with an **update** on the status of the six action steps as of September 2009.

In January 2010, the BDD Board sent a **letter** to the Assistant Secretary of the United States Department of Energy requesting assistance and intervention related to the delay of a Memorandum of Agreement for the early warning notification system, LANL data sharing and gauge maintenance.

In January 2010, the Legislature introduced **House Memorial 21** to address the same concerns and issues, including a specific timeline for reporting progress on the Memorandum of Agreement.

In February 2010, the Assistant Secretary of the U.S. Department of Energy **responded** directing LANL to formally initiate discussions regarding the scope of the Memorandum of Agreement and to establish a schedule for completion of discussions.

- The formal Memorandum of Agreement has multiple goals and would formally set forth specific commitments including cost sharing, operation responsibilities, maintenance, sample testing and a completion schedule for an early warning system. These terms would be contained in an agreement, or contract, and would contain provisions for non-performance.

BDD Project Board and Staff are continuing to work with DOE/LANL, the U.S. Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED) to develop mutually satisfactory responses to the BDD Board's request for DOE/LANL actions.

BDD Board Asks LANL to Take Six Specific Action Steps - Update

As of September 2009, an update on the current status of these action steps is as follows:

IN PROGRESS

1. Stop migration of LANL contaminants to the Rio Grande and to groundwater through the construction of additional sediment barrier and containment systems, improved waste treatment and disposal practices, stabilization and cleanup of sediment beds and banks in the Rio Grande tributary canyons that have received LANL waste discharges, and other appropriate management actions. *The New Mexico Environment Department (NMED), under applicable federal and state law, has ordered DOE to implement numerous improvements to reduce contaminated storm water runoff to the Rio Grande, before the BDD begins operations. Similar Environmental Protection Agency (EPA) requirements are not yet in place. The EPA has stayed the NPDES (National Pollutant Discharge Elimination System) permit requirements, since they are under an appeal that seeks to make the requirements more stringent. As enacted or underway, both agencies' requirements include performance monitoring and subsequent preventive actions where additional monitoring indicates additional steps are necessary to meet explicit and stringent*

limitations. These regulatory requirements satisfy the BDD Board's request for actions to stop the migration of contaminants. No significant actions have yet resulted from this request with regard to the groundwater pathway. However, that has been a major focus of the NMED Consent order.

IN PROGRESS

2. Properly monitor the transport of legacy contaminants (contaminants from the 1940s-1960s) in both the surface water and groundwater flow systems, including implementation of all recommendations contained in a report entitled "Plans and Practices for Groundwater Protection at Los Alamos National Laboratory, Final Report (2007)," published by the National Academy of Sciences with especially high priority placed on improvements in monitoring the transport of contaminants in the regional groundwater flow toward the Buckman well field and implementation of the recommendations addressing surface water and transport of contaminants from LANL property.

Monitoring is a major component of the regulatory requirements described under Action Step 1 and the Early Notification System, Action Step 4. LANL also has undertaken significant voluntary monitoring for a comprehensive group of contaminants from paired samples collected six times a year at Otowi Bridge, which is upstream from the mouths of canyons that drain LANL, and at the Buckman Diversion site. NMED's DOE Oversight Bureau is conducting a sampling program in summer 2009 to collect samples from the Rio Grande at five locations when stormy weather has caused runoff to the Rio Grande. NMED also is conducting an infrequent but routine water quality survey of the northern Rio Grande. NMED is collecting an extra gallon of water for each mainstem Rio Grande sample. NMED will analyze for the radionuclide screening parameters "gross alpha" and "gross beta." If either of these screens is elevated, the BDD Project has indicated it will pay for additional specific radionuclide analyses.

In the aggregate, these different monitoring programs adequately address the BDD Board's requested action to "properly monitor" transport of contaminants in surface water. Additionally, LANL has orally indicated its interest in evaluating existing monitoring wells in the immediate vicinity of the Rio Grande and the western area of the Buckman well field. Intensive water level monitoring of different wells in conjunction with Los Alamos County and Buckman well fields pumping may provide additional knowledge of the complex hydrogeologic groundwater flow system linking LANL, the Rio Grande, and the Buckman wells.

Representatives of LANL have met with the BDD Board and City of Santa Fe Water Division Staff to discuss strategies for technical plans for storm water quality monitoring in Los Alamos and Pueblo Canyons. LANL is required to submit a storm water quality monitoring plan to the NMED under the Consent Order. Representatives of LANL have also met with City of Santa Fe Water Division staff regarding use of existing infrastructure at the Buckman well field to gain additional knowledge of the groundwater flow system.

None of the river samples collected to date by NMED as part of their comprehensive Upper Rio Grande monitoring program have exceeded the screening level for radionuclides that would trigger additional analyses paid for by the BDD Project Board.

COMPLETED

3. Measure the radioactive and toxic contamination of buried sediments containing higher concentrations of post World War II LANL legacy contaminants now buried in the slough (side channel) upstream of the BDD diversion site to determine whether the BDD, as currently aligned, will intersect areas with elevated concentrations of these contaminants and help the BDD determine if minor realignment of project facilities could avoid these areas. *NMED and the BDD Board designed, funded and completed this work in 2008. The U.S. Forest Service, which required this work, approved it. For more information, visit Core Sampling Study.*

IN PROGRESS

4. Provide an early notification system so the BDD can temporarily stop diversions of any water from the Rio Grande when the Rio Grande is expected to contain elevated levels of contaminants of LANL origin.

As the result of negotiations held in March 2009, LANL and BDD Board representatives have agreed that LANL will rebuild three stream gages in Los Alamos and Pueblo Canyons, and transmit the information to the BDD Project control room in near-real-time. LANL, in cooperation with the BDD Project Manager, has secured the written permission of the Pueblo of San Ildefonso to rebuild the LANL gage at the mouth of Los Alamos Canyon. LANL plans to reconstruct the gages on Los Alamos and Pueblo Canyons above their confluence, although construction has not yet started. LANL will also install automatic samplers that will collect samples at times of storm water runoff flow at these gages and will perform analyses of contaminants.

The BDD Project Manager has asked DOE/LANL to provide additional features for the early notification system. These remain in negotiation. Nonetheless, the agreements to date represent a significant step toward completion of the Early Notification System. Design is ongoing. Representatives of LANL have stated that their goal is to complete the Early Notification System design, construction and communications by October 31, 2009; however, no discussions have been held regarding the additional Early Notification System features requested by BDD Board and Staff.

UNDER NEGOTIATION

5. Monitor LANL Contaminants in BDD Diversions, Sand Return, Residuals, and Drinking Water. *DOE/LANL and BDD Project Representatives discussed this requested action during reinvigorated negotiations held in spring 2009. BDD Project representatives offered the alternate, simpler request per the title above and explained that these analyses would not be required or needed but for LANL historical waste discharges. One to two years of initial monitoring is required for quality assurance, safe drinking water compliance, and public confidence.*

DOE and LANL have not yet made any commitment regarding this requested action. BDD Project

Representatives have compiled a detailed description of the needed monitoring.

COMPLETED

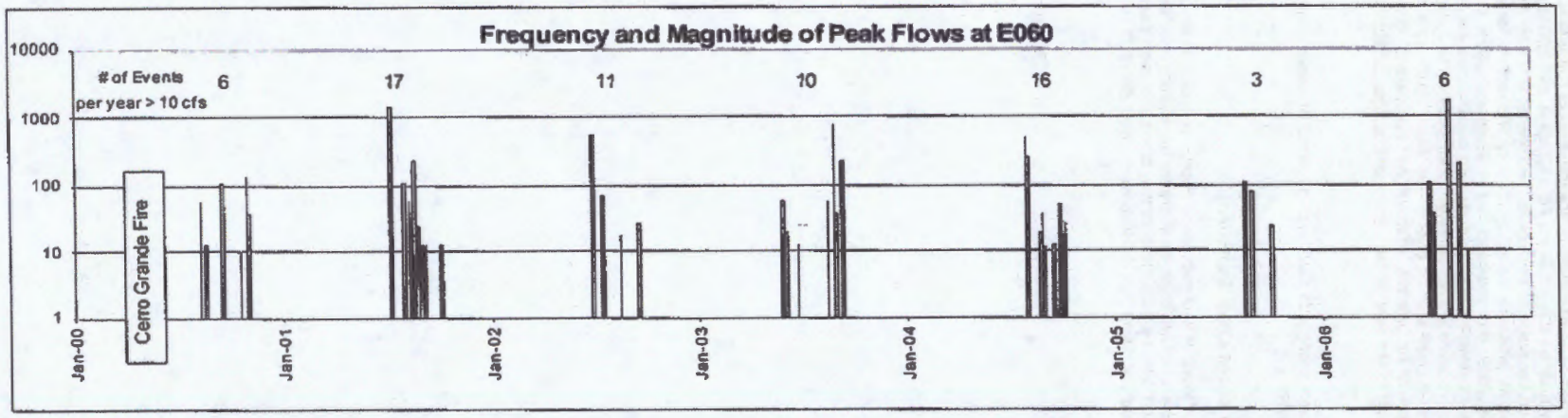
6. Provide funding for the BDD Board to retain independent peer review by qualified persons with regard to matters of LANL-origin contamination of the public drinking water resources of Santa Fe County and the City of Santa Fe. *DOE/LANL and BDD Project representatives have reached agreement on the scope of services for an Independent Peer Review for the BDD Board, as set forth in a request for proposals issued by the City of Santa Fe for the BDD Board. The RFP was advertised in summer 2009, with proposals due in September 2009. DOE/LANL will have no further role in the BDD Board's selection of or contract with the Independent Peer Reviewer. In September 2009, the BDD Board received a $200,000 DOE grant to fund the independent peer review work. Three proposals were received and the BDD Project Board approved a $200,000 contract with ChemRisk, LLC to provide an "efficient, effective, and transparent" independent peer review. More information is available in the next section, Independent Peer Reviewer.*

The BDD Board and Staff will continue working with LANL and the NMED on these issues and will provide updates as the status of these action steps changes.

N.M. House Memorial and BDD Board Chair Statement

On March 18, 2009, the New Mexico House of Representatives Energy and Natural Resource Committee unanimously passed a **Memorial** sponsored by Representative Brian Egolf urging the National Nuclear Security Administration of the U.S. Department of Energy to work actively with the Buckman Direct Diversion Board and the Los Alamos National Laboratory to ensure the safety of Santa Fe's drinking water. BDD Board Chair Virginia Vigil issued **comments** on the Memorial.

Previous page: Surface Water Quality Next page: Independent Peer Reviewer



This chart identifies the number of stormwater flows per year and the flow rates in cubic feet per second at E060 since the Cerro Grande fire in May of 2000. E060 is the storm water gage in lower Pueblo Canyon near the state road intersection of 502 and 4, commonly called the Y. This gage monitors Pueblo Canyon flows near its confluence with Los Alamos Canyon.

Note that there were 6 flows greater than 10 cfs in 2006. The greatest flow was 1868 cfs on August 8th. Prior to that stormwater event, the largest flood was 1440 cfs on July 2nd, 2001. There were 17 events in 2001 measured greater than 10 cfs. Very few storm events created flows greater than 10 cfs before the Cerro Grande fire. One 12 cfs flood occurred in the preceding 8 years of gage data. During the early years of Laboratory operation, in the 40's, 50's, and 60's, intermittent gages and modeled events indicate there were common flood events, but not to the degree seen after the Cerro Grande fire.

We had expected the frequent and intense floods after the Cerro Grande fire, but we had also expected the frequency and magnitude to diminish more quickly. We suspect the severity of the fire in upper portion of the steep, rocky Pueblo watershed has delayed

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Governors: Don't Make RES Wait For Climate Legislation

BY CHRIS HOLLY

The leaders of a bipartisan coalition of 29 state governors formed to develop recommendations for accelerating U.S. deployment of wind and other renewable generation said Tuesday that Congress should delay action on climate change legislation and instead focus on establishing a national renewable electricity standard that would require utilities to obtain 25 percent of their power from renewables by 2025.

Govs. Chester Culver (D-Iowa) and Donald Carcieri (R-R.I.), chairman and vice chairman, respectively, of the Governor's Wind Energy Coalition, said in a press conference that Congress should pair the ambitious renewable electricity standard with legislation to streamline federal permitting for on- and offshore wind projects; dramatically increase wind research; and facilitate state and regional coordination in the siting and construction of new interstate transmission projects to deliver large amounts

(Continued on p. 2)

NNSA Letting Los Alamos Flout Public Safety Rule—DNFSB

BY GEORGE LOBSENZ

The National Nuclear Security Administration has approved safety analyses for Los Alamos National Laboratory's plutonium facility that allow accidents that could result in worst-case radiation exposures to the public exceeding Energy Department guidelines limiting such potential doses to 25 rems, the Defense Nuclear Facilities Safety Board says.

In a Monday letter to Deputy Energy Secretary Daniel Poneman, the federal safety board said the action by the National Nuclear Security Administration (NNSA), DOE's semi-autonomous nuclear weapons agency, in regard to Los Alamos' Technical Area 55 is "fundamentally in conflict with the board's understanding" of DOE safety policies put in place 15 years ago.

The board, which provides independent oversight of nuclear safety at DOE sites, noted that DOE's so-called "evaluation guideline" for public protection called for limiting potential accident-related doses to the public to 25 rems. In addition, the board, known as the DNFSB, said the DOE public protection standard called for

(Continued on p. 3)

New Coal Ash Rules May Focus On Conversion To Dry Storage

BY JOHNATHAN RICKMAN

While the Environmental Protection Agency appears to have initially proposed to regulate power plant coal ash as hazardous waste, there are indications the Obama administration is preparing new federal rules that will at a minimum require utilities to convert coal ash impoundments from wet to dry storage to prevent leaks—a change that would cost tens of millions of dollars but also potentially increase regulated utilities' rate base and earnings, a Wall Street firm says.

Those assertions by Bernstein Research come as the Tennessee Valley Authority (TVA) this month released a draft environmental assessment of its proposal to convert wet ash facilities at its Kingston, Tenn., plant to a dry system that it says would reduce leaks of waterborne toxic metals by about 80 percent.

The environmental assessment (EA) follows the adoption by the TVA board in August of a 10-year plan for similar conversion of wet ash impoundments throughout its fleet of coal-fired power plants—an initiative that the federal utility believes will cost between $1.5 billion and $2 billion.

The move to dry storage was prompted by the catastrophic failure of an ash pond at the Kingston plant in late 2008 that spread vast amounts of toxic-laced sludge into nearby waterways and across 300 acres of local land.

The massive spill spurred the EPA to make a detailed assessment of utility ash ponds and develop a proposed rule for their management, which was sent to the White House Office of Information and Regulatory Affairs (OIRA) for review and approval in October 2009.

However, the rulemaking—initially due out in December and now scheduled for release in April—has been held up at OIRA amid allegations by environmentalists that the White House has been

(Continued on p. 4)

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Aventine Comes Out Of Bankruptcy

In a possible sign of better times ahead for the corn-based ethanol industry, a slimmed-down Aventine Renewable Energy Holdings Inc.—once one of the sector's largest producers before getting slammed by high corn prices and low fuel prices in 2008--announced Tuesday it has come out of bankruptcy.

Aventine said in a press release that a federal bankruptcy judge approved the company's reorganization plan last month and that it emerged from Chapter 11 restructuring Monday in relatively good shape and with new leadership.

"Emerging from bankruptcy with good liquidity, modest debt and lower overhead costs, Aventine is well positioned to be one of the low-cost providers of ethanol on a national basis," said Thomas Manuel, Aventine's new chief executive officer and board member.

The company, which produced 690 million gallons of ethanol in 2007, now has a capacity of 207 million gallons at facilities in Illinois and Nebraska.

Aventine also said it plans to resume construction of 108-million-gallon biorefineries in Aurora, Neb., and Mt. Vernon, Ind., that the company partially completed prior to its voluntary filing for bankruptcy protection in February 2009.

Don't Make RES Wait For Climate Legislation... *(Continued from p. 1)*

of renewable power.

Culver and Carcieri said legislation to achieve these goals would create many thousands of new jobs, reduce pollution and greenhouse gas emissions and reduce U.S dependence on foreign oil. These goals should trump efforts to pass climate change legislation, they said.

"I have actually urged leaders in Washington to not complicate this legislation related to wind energy and renewables with... the more complicated issue of climate change," Culver said. "We don't want these things to be brought up in a broader debate and discussion of carbon because they will just slow us down. There is a great sense of urgency in doing these things, and it's a much longer conversation when you are talking about trying to get consensus on climate change anywhere in the world now."

Culver and Carcieri formed the coalition more than a year ago to develop a consensus among governors on how to more rapidly harness wind and other clean energy resources and capture their job-creation and economic benefits. In a report released by the coalition Tuesday, the governors said that a national RES has strong public support across the nation because it would boost employment, reduce pollution and cut reliance on foreign fuels.

"Nearly every survey of public opinion—no matter where it has been conducted throughout the nation—demonstrates strong public support for expanded development and use of renewable electricity," the report said. "This support is founded in a public desire to reduce our dependence on imported fuels, create new jobs, and to obtain our electricity from sources that will not hasten climate change, endanger public health, or otherwise harm our national environment.

"This public desire needs to be reflected in effective policies that encourage and enable the expansion of renewable electricity."

In addition to calling for the RES of 25 percent by 2025, the coalition urged lawmakers to beef up federal support for research to answer key questions about offshore wind energy in the United States, where potential sites are located in deeper, rougher waters than in the United Kingdom, Denmark and Germany, which lead the world in offshore wind production.

"The U.S. now has an opportunity to take the lead in developing these advances and techniques, but will soon lose this opportunity to Europe and China if aggressive action is not undertaken," the report said.

In addition, the governors called for legislation "that will allow for the efficient and timely review of wind projects on federal lands and in offshore coastal regions. While legislation is needed to improve the permitting process, dramatically improved coordination among state, federal and industry participants is equally important. The administration should establish a pilot process for streamlining the permitting process across federal agencies and jurisdictional roles, and should support collaborative processes with states where multiple state and federal jurisdictions collide."

In other recommendations, the report urged Congress to extend the American Recovery and Reinvestment Act program providing federal grants to renewable developers in lieu of tax credits. It also called for adoption of a long-term renewable energy production tax credit with provisions to broaden the pool of investors eligible to participate.

On the tricky issue of how to pay for new transmission necessary to bring renewable energy to load centers, the governors appeared to embrace a cost-allocation model in which the lowest-cost renewable energy projects get priority for access to the grid.

"The primary barrier to [transmission expansion] is determining which generation developers should pay which share of the cost, and how such costs could be included in delivered electricity prices," the report said. "In particular, actual transmission investment should flow from successful renewable power projects that can offer to purchasers the lowest delivered price of power for their product."

On the even trickier issue of whether states should surrender some of their long-held authority to site transmission lines to the Federal Energy Regulatory Commission to speed siting and construction, Culver and Carcieri deferred to the coalition's executive director, Larry Pierce.

"That is probably the one area that requires the most thought, the most work and the most compromise among the governors in the coalition," Pierce said, adding that the issue of giving FERC more authority "probably needs more discussion."

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Letting Los Alamos Flout Public Safety Rule... *(Continued from p. 1)*

operators of DOE nuclear facilities to install safety equipment and take other steps to ensure potential doses to the public at site boundaries were limited to "a small fraction" of the 25-rem evaluation guideline.

However, the board said DOE and NNSA are "essentially nullifying" those public protection standards by allowing new "safe harbor" exemptions for DOE facility operators that effectively permit them to forgo installation of expensive safety equipment to mitigate potential doses to the public above 25 rems.

"The Defense Nuclear Facilities Safety Board is concerned that a recent regulatory interpretation by the Department of Energy of [the department's nuclear safety management regulations] undermines the principles of providing adequate protection of the public, workers, and the environment from DOE's defense nuclear facility operations," the board told Poneman in a letter demanding DOE clarify its position on the issue.

"Specifically, the NNSA has recently approved documented safety analyses in which the mitigated dose consequences to the public exceed DOE's evaluation guideline. Such approval implies that exceeding the evaluation guideline is an acceptable outcome of the prescribed safety analysis and control selection process."

The DNFSB said it was concerned that DOE officials appear to have endorsed NNSA's use of the "safe harbor" exemptions to allow potential accident-related doses from Los Alamos' plutonium facility to exceed the 25-rem guideline for protecting the public.

Specifically, the board said that in discussions with the DNFSB, DOE officials appeared to back a white paper by NNSA's chief of defense nuclear safety outlining how the safe harbor exemption was applied at Los Alamos—and how it might be applied at other NNSA or DOE facilities—to allow doses to the public exceeding DOE's protection standard, which is known as Standard 3009.

"The expectations outlined in the white paper, presented by DOE and NNSA personnel during extensive discussions, and evident (for example) in NNSA's approval of the documented safety analysis for Technical Area 55 at Los Alamos National Laboratory are fundamentally in conflict with the board's understanding of DOE's past practices during the 15 years since DOE Standard 3009 was established, as well as the board's explicit position as outlined in past correspondence," the DNFSB told Poneman.

The board said the DOE standard called for operators of DOE nuclear facilities to analyze possible accidents to determine potential doses to the public at the site boundary, and then to compare those doses to the 25-rem evaluation guideline. Operators then are supposed to install safety controls and equipment as needed in facilities to bring down any potential doses above 25 rems.

"DOE Standard 3009 is clear about the application of the evaluation guideline and the fact that its [25-rem] value is not considered an acceptable public exposure; rather, its use sets a clear guideline for establishing when to invoke an effective set of safety class controls that reduce the potential dose consequences to the public to acceptably low values, referred to as a 'small fraction of the evaluation guideline.'

"By accepting documented safety analyses with calculated mitigated consequences greater than the evaluation guideline, DOE is essentially nullifying the consequence-based methodology established by [DOE safety regulations] and evident in DOE's practices since DOE issued the rule," the board said.

DOE and NNSA officials had no immediate response to the DNFSB's letter Tuesday.

The 25-rem public protection standard is five times as high as the five-rem annual limit that DOE sets for doses to its nuclear workers. The average person receives 36 rems from everyday radiation sources, such as dental x-rays, radon gas from soil or cosmic rays.

The DNFSB did not say what specific Los Alamos facility was involved in the NNSA's action to allow potential doses about 25 rems, nor what accident scenario might cause such doses.

However, in a Jan. 15, 2010, memo to DNFSB headquarters, DNFSB inspectors at Los Alamos said Los Alamos National Security LLC, which operates the New Mexico weapons lab for NNSA, had submitted a safety analysis to NNSA to justify operations past 2010 at the aging Chemistry and Metallurgy Research (CMR) Building, and that one earthquake accident scenario resulted in potential doses to the public exceeding the 25-rem evaluation guideline.

"The scenario with the highest mitigated offsite dose consequence and only mitigated consequence that exceeds the DOE evaluation guideline is for a seismic collapse and fire, with an offsite dose of approximately 36 rem[s]," the memo said.

DOE is making upgrades to the CMR building to address the earthquake/fire scenario, but the memo indicates controls will not be sufficient to all potential offsite doses below 25 rems.

The department is moving to replace the CMR, but NNSA officials say continued operations at the facility are vital to nuclear weapons and nonproliferation programs. NNSA also has been reluctant to make expensive safety upgrades at the existing CMR building because it is scheduled to close down eventually.

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NARUC Protests DOE Decision To Kill Yucca

State regulators filed a protest at the Nuclear Regulatory Commission Monday over the Energy Department's recent decision to scuttle the Yucca Mountain nuclear repository project, calling the move an "incredible waste" of billions of dollars that would forestall by another quarter-century the nation's efforts to solve its nuclear waste management problems.

In the filing, the National Association of Regulatory Utility Commissioners (NARUC) merely seeks NRC approval to intervene in the Yucca licensing proceeding, but also makes clear its substantive view of DOE's withdrawal plans.

"Dismissal...in the absence of any rational explanation or record-based findings to justify it, is an incredible waste of the billions in ratepayer dollars spent on the licensing proceeding to date," said NARUC.

NARUC said the move would waste money paid by ratepayers into the Nuclear Waste Fund, which is intended to pay for disposal of that material.

If Yucca is scuttled, "ratepayers across the country continue to pay for a national storage 'solution,' enhanced litigation costs, and the clearly documented increased costs of interim storage," NARUC said.

"If the motion is successful, and history is any indication, it will effectively delay DOE's ability to...accept waste for at least 25 years."

NARUC joins South Carolina's Aiken County and the attorneys general of South Carolina and Washington in protesting DOE's attempts to withdraw Yucca. Those protests are based on concerns that DOE is abandoning a facility needed to dispose of radioactive material at DOE's Savannah River site in South Carolina and Hanford site in Washington.

Administration officials say they are killing Yucca because a better plan can be found for managing the nation's radioactive waste, but many feel the decision fulfills a political promise Obama made to Senate Democratic Leader Harry Reid (Nev.), who opposes the project.

New Coal Ash Rules May Focus On Conversion... *(Continued from p. 1)*

watering down the new regulatory requirements at the behest of utilities and other affected industries.

In increasingly bitter attacks, the environmentalists have accused OIRA Director Cass Sunstein of making a mockery of the Obama administration's pledge of open government that would not be beholden to special interests. One particularly cheeky Web campaign, which pictures Sunstein soiled with coal ash and emerging from a trash can, charges the official with using "Bush administration-style bureaucratic maneuver[s]" to block or weaken impending environmental protections.

While no one knows what EPA initially proposed doing, a new report released Friday by Bernstein Research asserts that the agency "apparently" sought to classify coal ash as hazardous waste under the Resource Conservation and Recovery Act (RCRA), which would subject coal ash to management and disposal requirements that are more stringent than those currently applied by states.

Such an EPA proposal would contradict actions taken on coal ash by Carol Browner, Obama's top environmental aide, when she was EPA administrator in 2000. In that role, she rejected classifying coal ash as hazardous under RCRA, agreeing with industry that levels of toxic metals in coal ash were too small to warrant such sweeping regulation.

Despite Browner's past position on the issue, the Bernstein report says EPA under current Administrator Lisa Jackson has advocated within the administration to regulate coal ash as a hazardous waste—an action that the report appears to question.

"While the details of the EPA's proposed rule are not publicly available, the agency has apparently sought to classify coal ash as a hazardous waste under Subtitle C of the Resource Conservation and Recovery Act," said Bernstein Research Senior Analyst Hugh Wynne, author of the new report.

"The EPA's principal objective in doing so is to facilitate federal permitting of coal ash storage facilities; the storage of non-hazardous wastes is subject to a state permitting system which the EPA believes has been proved inadequate by the Kingston spill."

Echoing concerns raised by those opposed to classifying coal ash as hazardous, Wynne said such a designation would make ash handling much more expensive as well as possibly "trigger violations of local zoning requirements, limit the willingness of communities to permit new coal-fired power plants, and curtail the beneficial use of coal ash" for cement.

"Whether or not the EPA succeeds in designating coal ash a hazardous waste, the future regulation of coal ash storage facilities is likely to be significantly more stringent," said Wynne, adding that "it is probable that forthcoming EPA regulations may prohibit the operation of wet coal ash storage ponds, requiring the use of dry ash handling...."

Wynne noted that EPA has identified approximately 100 coal plants, or about a third of the nation's coal-fired capacity, that have wet ash handling or storage systems.

Environmentalists say an ash management system that employs drying coal combustion waste with blowers and hauling the dried ash offsite is preferable to a wet system, which creates more opportunities for heavy metals and other contaminants to leach out from impoundments and into groundwater.

In its new EA on converting its Kingston plant to a dry ash system, TVA said under current permitting its proposed conversion plan would cut the plant's water use by some 25 million gallons per day "with an approximate 80 percent reduction in the discharge of arsenic, boron, chloride, fluoride, sulfur, and selenium from the ash pond."

While acknowledging that cost estimates for wet-to-dry conversion of ash storage systems are scant, Wynne said estimates provided by the Edison Electric Institute, which represents investor-owned electric utilities, and Washington-based consulting firm EOP Group Inc. show the average cost per plant of converting bottom ash handling systems to be some $20 million, the average cost per unit of converting fly ash handling systems to be $10- $15 million, and the cost of new landfills for the dry ash to be $30 to $50 million.

Interestingly, Wynne says such investments "could represent a material opportunity for rate base growth" for some investor-owned utilities, noting that the capital cost of conversion to dry ash handling is likely to be incorporated in utilities' regulated rate base.

"For these companies, not only is this capital expenditure likely to be recovered, but it may accelerate growth in rate base and thus in regulated earnings," said Wynne, though he noted that capital outlays associated with conversion to dry ash handling would represent a small percentage of regulated rate base for most utilities.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
GROUND WATER AND ECOSYSTEMS RESTORATION DIVISION
P.O. Box 1198 Ada, OK 74820

March 30, 2009

MEMORANDUM

SUBJECT: Los Alamos National Laboratory (LANL), Los Alamos, NM (09RC06-001)
Well Screen Analysis Report (WSAR), Rev. 2 (LA-UR-07-2852)
Groundwater Background Investigation Report (GBIR), Rev. 3 (LA-UR-07-2853)

FROM: Steven D. Acree, Hydrologist
Applied Research & Technical Support Branch

Richard T. Wilkin, Ph.D., Environmental Scientist
Subsurface Remediation Branch

TO: Richard Mayer
U.S. EPA, Region 6

As requested, the referenced documents have been reviewed by the above named staff of the National Risk Management Research Laboratory (NRMRL) – Ground Water and Ecosystems Restoration Division. Additional review was provided by Dr. Bruce Pivetz of Shaw Environmental, Inc. Shaw is an on-site contractor providing technical support services to this laboratory. The review focused on the methods and conclusions of the WSAR. The GBIR was reviewed in the context of its use in the WSAR. The review and recommendations contained in this memorandum represent a technical evaluation of site-specific conditions based on the current state of the science and are neither policy nor prescriptive guidance.

As in the review of previous versions of these documents (Ford and Acree to Mayer, 2/16/06), this review is focused on the evaluation of the effects of drilling additives on the collection of representative samples from wells installed under the hydrogeologic characterization program. It is noted that factors other than the effects of drilling additives (*e.g.*, screen length, position within the hydrostratigraphic section, location with respect to potential contaminant source areas, groundwater sampling methods) may have a greater impact on whether groundwater samples are suitable for the purpose of early detection of contaminant releases or migration. Such location-specific issues are beyond the scope of this review.

Although the current versions of the documents attempt to address several of the issues raised during the previous reviews, there is still a relatively high degree of uncertainty in the results reported in the WSAR. For example, additional species indicative of a range of contaminant reactivity have been incorporated into the evaluations. However, several potential indicators are

not routinely measured or available. The uncertainty related to this issue is illustrated by the following example. At locations where bentonite additives were used, the WSAR (Section 4.11) concludes that indicators suitable for directly evaluating the reliability of non-detects of highly adsorbing radionuclides are not available. Consequently, this section of the document concludes that it was not possible to evaluate the affected well screen intervals for detections of strongly adsorbing radionuclides. The document appears to modify this conclusion in later sections and indicates that these non-detect results would be accepted as representative of actual conditions if the well passed all other applicable criteria. Regardless of the conclusion stated in Section 4.11, the WSAR ultimately determines that some well screens drilled using bentonite, such as well R-32, screen 1 (Table 4-5) produce reliable samples for highly sorbing constituents such as plutonium (Table 6-4). Such assessments appear to be contradictory and are, at best, confusing. Given the lack of appropriate indicators, a more conservative and defensible approach would appear to be the one advocated in Section 4.11 rather than the approach ultimately used. Many similar issues contribute to the uncertainty inherent in the screening results.

In general, the criteria used to evaluate wells in the WSAR are complex and may ultimately prove to be unreliable. The most significant concerns noted in review of the current versions of the WSAR and GBIR are related to three areas:

- The results of the WSAR and related assessments have not been fully validated using site-specific data from laboratory and field studies.

- The criteria rely heavily on "background" data obtained from long-screened production wells and springs that do not necessarily represent water quality upgradient of the hydrogeologic characterization monitoring wells.

- The reliability of criteria used to evaluate the representativeness of groundwater samples from well screens following transformations of residual organic drilling additives and the return of groundwater samples to oxidized conditions is uncertain due to a lack of direct assessments of the site-specific mineralogical transformations and the reliance on groundwater sampling data.

Each of these issues increases the uncertainty in the conclusions of the WSAR and is discussed in detail below.

Validation of the Screening Results

As noted by the National Research Council (2007: National Research Council, Plans and Practices for Groundwater Protection at the Los Alamos National Laboratory, Final Report), evidence regarding the conditions surrounding the monitoring well screens is indirect. Additional laboratory and field investigations to better determine the nature and evolution of the interactions between the drilling, well construction, and aquifer materials; quantify sorption parameters; and to demonstrate the accuracy of the screening results presented in the WSAR are

recommended to validate the results. Without such validation, assessments of the impacts on the representativeness of groundwater samples should be considered to be of uncertain quality.

Uncertain Background Conditions

The WSAR criteria rely heavily on comparisons between data obtained from the impacted well screens and data reported in the GBIR. The data used to characterize "background" conditions is sparse, derived mainly from sources representing mixtures of water that are significantly different from the samples obtained from the hydrogeologic characterization wells, and are representative of significantly different flow paths and residence times within the aquifer. Actual background values at the locations of the individual characterization well screens may be significantly different from the proposed values.

As noted many times in the GBIR, water chemistry is determined by the lithologies of aquifer materials through which the water migrates and the residence time. Data from springs near the Rio Grande and the long-screened production wells does not necessarily represent the flowpaths monitored by the individual short-screened characterization wells. The GBIR recognizes this limitation. However, it indicates that the appropriate data (*i.e*, data from similarly screened wells immediately upgradient of the regulated units) may never be available. This approach introduces unavoidable uncertainty in evaluations of screens with residual effects because it does not allow for spatially distinctive geochemical zones or variability in groundwater chemistry in different aquifer lithologies.

It is quite possible that constituent concentrations observed in unimpacted monitoring wells may be significantly different from the data provided in the GBIR. For example, it appears the well R-35B was recently installed near the top of the regional aquifer without the use of harmful drilling additives within the screened interval. Concentrations of zinc measured in filtered groundwater samples have varied from approximately 40 ug/l to 60 ug/l. This range is above the maximum value of approximately 32 ug/l reported in Table 4.2-3 of the GBIR and is at or above the maximum value reported in Table 4-3a of the WSAR. This example illustrates the uncertainty inherent in using "background" data obtained from sources that are not constructed to monitor the same flowpaths as the monitoring wells in question.

It is also noted that the current evaluation methods may not fully identify conditions representative of the unimpacted regional aquifer. Footnote K in Table E2 indicates that although screens 6, 7, and 8 of well R-25 had a perfect score in the evaluation, the screens may still be impacted by water from perched zones above the regional water table.

Continuing Impacts to Aquifer Materials after Return to Oxidizing Conditions

The geochemical analysis appears to rely heavily on a determination of the overall redox status of groundwater as inferred from water quality parameters, such as dissolved oxygen, oxidized forms of nitrogen (nitrate) and sulfur (sulfate), low dissolved concentrations of iron and manganese, and detection of contaminants in oxidized forms. Part of the analysis includes an

evaluation of potential solid-phase processes (modification of surface-active minerals, changes to carbonate mineral stability) based upon the groundwater chemistry. Modification of in situ redox conditions is clearly an important aspect of the problem being dealt with here. As pointed out, the organic drilling fluids provide a source of carbon for native microbial populations in the aquifer. These organisms can have long-term impacts on water chemistry and aquifer mineralogy in the vicinity of the well screen. In general, anaerobic conditions resulting from the respiration of microbes shift the types of minerals and contaminant-reactivity of mineral surfaces that may be in equilibrium or near equilibrium with the specific water chemistry.

Using criteria established in this report, an undesirable component of uncertainty will persist regarding screen impacts because it is not possible to understand all possible mineral-contaminant interactions solely by evaluating water chemistry. As an example, consider a well that shows redox-status evolution from iron-reducing conditions, linked to residual drilling fluids, to oxidizing conditions comparable to the targeted background conditions. In this case, the geochemical criteria would suggest that water chemistry has achieved or is approaching pre-drilling conditions and, furthermore, that contaminant species can be monitored accordingly for their presence or absence. During the evolution of this system, when native microbes supported mobilization of ferrous iron, it is possible that reactive Fe(II)-bearing minerals formed in the available pore spaces adjacent to the well screen. As portrayed in the conceptual model presented in the WSAR (*e.g.*, Figure 4-9), possible phases include ferrous carbonate, ferrous sulfide (in sulfate-reducing compartments or micro-environments), but also could include green rust minerals, ferrous hydroxycarbonate, and magnetite. These Fe(II)-bearing phases are all known to interact with and possibly sequester potential contaminants of concern (*i.e.*, nickel, cadmium, cobalt, arsenic, zinc, americium, technetium, chromium, uranium). In this scenario, as organic carbon is consumed and levels of dissolved oxygen begin to increase, these previously formed Fe(II)-bearing minerals would be anticipated to undergo oxidative transformation to hydrous ferric oxide or iron oxyhydroxides. It might be further anticipated that these newly formed Fe(III)-bearing phases would be very fine-grained and highly sorbent, again with the ability to sequester contaminant species of concern. So along with the shift to oxidizing conditions, as indicated in water chemistry parameters, comes an anticipated shift in reactive iron mineralogy. Based on the criteria proposed, it is not possible to clearly assess: i) how long reduced, Fe(II)-bearing minerals might persist, and ii) what type of mineral phase or assemblage would result as a consequence of the return to more oxidizing conditions.

The critical point is that the nature of the reactive iron mineralogy cannot be assessed by examining water chemistry alone. In order to have a sense of the reactive nature of the aquifer solids, other testing would be required. At some point, it would be expected that any reactive minerals present in the system may become saturated or modified to the extent that they would no longer influence water chemistry in regions adjacent to the well screen. However, there are no compelling lines of evidence provided in the report that would indicate when this desired point is ultimately reached.

Recommendations to Reduce Uncertainty

Due to uncertainties in the mineralogical alterations induced by the drilling additives, uncertainty in the utility of aqueous chemistry assessments for the determination of whether samples are fully representative of aquifer conditions, and the lack of appropriate data for the assessment of water quality immediately upgradient of the impacted characterization wells, it is recommended that additional laboratory/field studies be designed to reduce uncertainty and validate the results of the WSAR. In this regard, the following studies may significantly improve the understanding of the site-specific impacts of the drilling additives and the potential time frames over which the impacts may be expected to continue.

1. **Upgradient Well Installations.** Install wells immediately upgradient of the regulated units of most concern, screening intervals equivalent to those of monitoring wells located downgradient of the regulated units. If such wells were installed without the use of harmful drilling additives in the screened zone, the data should be useful in better defining pre-drilling conditions within the particular hydrostratigraphic units of interest. The data would also provide insight into the representativeness of the "background" ranges used in the WSAR.

2. **Laboratory Investigations.** Laboratory studies could be performed to more fully understand impacts of the drilling additives on the evolution of redox conditions and secondary mineral formation. Subsequently, impacted materials from the studies could be subjected to redox conditions representative of the unimpacted aquifer allowing investigation of the evolution of mineral phases. Aquifer materials obtained during these studies could be used to quantify interactions with contaminants of concern. The results could be used as a baseline to understand the geochemical behavior of subsurface materials and validate conceptual models for the transformations that are occurring as well as aid in the validation of the criteria proposed in the WSAR. It is noted that similar studies were recommended by the National Research Council (2007: National Research Council, Plans and Practices for Groundwater Protection at the Los Alamos National Laboratory, Final Report). Laboratory studies could also be performed to quantify sorption of the inorganic constituents of concern onto the materials used during well construction at LANL.

3. **Field Studies**. Ultimately, lines of evidence from field studies will be needed to reduce uncertainty in the validation of criteria used in the WSAR. Useful lines of evidence would include: characterization of aquifer solids obtained from impacted wells, evaluation of the effects of well purging prior to sampling of impacted wells, and push-pull tests to directly examine sorption properties at impacted wells. A primary line of evidence would also be the installation of new well(s) drilled without the use of additives in the screened zone near impacted well(s). A comparison of water quality data from the two wells would provide direct evidence of the degree of impact and the effects on water quality. Such installations could be performed near regulatory units of greatest concern to maximize the benefits of the data.

If you have any questions concerning this review, please do not hesitate to call us (Acree: 580-436-8609; Wilkin: 580-436-8874) at your convenience. We look forward to future interactions with you concerning this and other sites.

cc: Mike Fitzpatrick (5303W)
Vince Malott, Region 6
Terry Burton, Region 6