Presentation by Robert H. Gilkeson, Registered Geologist, to the September 24, 2008 Meeting of the Northern New Mexico Citizens' Advisory Board (CAB)

LANL performed experiments on safety of nuclear weapons At MDA AB in the early 1960's. MDA AB is a legacy waste dump located in the southern part of LANL a short distance north of Bandelier National Monument. See Figures 1 to 4.

- 70 tests at four test areas in shafts installed to depths from 30 to 100 ft.
- Tests were explosions of packages of uranium, plutonium, beryllium and lead.
- Debris from tests were not cleaned up and are wastes buried at MDA AB.
- The debris is a large inventory of plutonium, uranium, lead and high explosives.
- LANL data shows the groundwater below MDA AB to be contaminated with lead from the wastes buried in MDA AB. Many other contaminants including barium, plutonium, americium and high explosives may be present in the groundwater but there are no reliable monitoring wells for detection of the contamination.

## Dissolved Lead In The Groundwater Below LANL Waste Disposal Site MDA AB

- High levels of dissolved lead in three old LANL test wells DT-5A, DT-9, DT-10 Maximum Years Above Distance From Length Of Type Of Well Lead Value EPA DWS **Buried Wastes Well Screen Materials** - DT-5A 9,000 ug/L 1988 to 1994 800 feet 630 feet Carbon/galvanized Steel - DT-10 95 ug/L 1988 to 1994 Carbon/galvanized Steel 3,400 feet 300 feet - DT-9 55 ug/L 1988 to 1993 Carbon/galvanized Steel 4,500 feet 460 feet Carbon/galvanized Steel - TW-3 9 ug/L never > 4 miles north 10 feet
- The low dissolved lead in the water samples from Test Well TW-3 disprove the LANL claim that corrosion of the carbon steel and galvanized steel is the source for the high dissolved lead measured in the DT Test Wells at MDA AB.
- The Test Wells were installed in 1960. The features of the old test wells that prevent detection of contamination are the great distance from MDA AB, long length of well screens, and well-known properties of glavanized and carbon steel for masking the detection of the contaminants buried in MDA AB.
- The <u>irresponsible presentation</u> in LANL reports that the old test wells are technically defensible monitoring wells for detection of groundwater contamination from MDA AB is shown by the excerpt pasted below from the 2007 LANL report - Periodic Monitoring Report for Ancho Watershed, November 27 - December 8, 2006, (LA-UR-07-4872, August 2007):
  - "Three regional aquifer wells at TA-49 [i.e., wells DT-5A, DT-9 and DT- 10] have been sampled since the 1960s to monitor for effects of testing at that site [i.e., the hydronuclear testing at MDA AB]. In general no effects have been found. High metal concentrations (lead, zinc, iron, manganese) in samples are related to metal well casing and fittings. Occasional detections of organic compounds are not supported by follow-up sampling."
- The above statement that the old test wells have produced reliable data that MDA AB has not contaminated the regional aquifer is a serious problem. The claim that the high lead concentrations are only from the corrosion of the well casing and fittings in the old test wells is nothing more than an <u>assumption</u>.
- There is an immediate need to plug and abandon the old test wells and install a reliable network of monitoring wells at MDA AB.

# A LANL report estimates MDA AB to contain >80% of the LANL's inventory of buried transuranic material (TRU waste) by radioactivity content.

- 23,000 curies of plutonium wastes included 20,600 curies of Pu-241.
- LANL research in 2000 (Haschke, etal) determined plutonium to have a chemistry that may be mobile in the oxidized vadose zone below MDA AB.
- Pu-241 has a short half-life of 14.4 years and more than 90% of the Pu-241 has decayed into Americium-241. The Am-241 is decaying into Neptunium-237.
- Research (Los Alamos Science, 2000) shows Np-237 to have a much greater potential to contaminate the groundwater below MDA AB than for plutonium.
- The LANL data shows a very large groundwater resource in the region below and surrounding MDA AB. LANL, DOE, and NMED show <u>no concern</u> to protect this precious resource. The resource is displayed on Figure 4.
- The NMED Consent Order accepts data from the old test wells at MDA AB.
- The National Academy of Sciences (NAS) recognized the immediate need to install a reliable network of monitoring wells at MDA AB and the other large LANL MDAs because groundwater contamination from the wastes buried in the legacy waste dumps was possible. Excerpts from the 2007 NAS Report are pasted below:
  - "Solid wastes (e.g., the 25 MDAs) and certain contaminants deemed by LANL to be essentially immobile (e.g., plutonium) have the potential for impacting groundwater in the future. MDA AB in TA-49, which contains some 2300 Ci of Pu-239, is an example. The committee received little information that would provide assurance that these sources are well understood or well controlled." (p. 32).
  - "In looking at the regional monitoring network, the committee found that the southern portion of LANL [ the location of MDA AB ] is one area of the regional aquifer that is currently very sparsely monitored." (p. 44).

## What Can The CAB Do?

- Ask LANL for a presentation to 1). prove the high lead levels measured in the DT Test Wells are only from corrosion, 2). prove the old test wells are a reliable network of monitoring wells for accurate detection and measurement of the hazardous waste and TRU wastes that are buried in unlined shafts at MDA AB, and 3). prove the long screened intervals in the old test wells are not vertical conduits for spreading groundwater contamination at the water table.
- Ask EPA Region 6 for a position on the ability of the network of old test wells at MDA AB to provide detection of groundwater contamination below and away from MDA AB and to meet the requirements of monitoring wells at a RCRA facility.
- Ask the DOE Headquarters Team on Groundwater Technical Issues for a position on the ability of the old Test Wells at MDA AB to provide detection and reliable measurement of plutonium, americium, neptunium, lead, beryllium and High Explosives contamination in groundwater below MDA AB.
- Ask the DOE Headquarters Team for a position on the ability of <u>all</u> of the old LANL Test Wells installed at many locations across LANL to ever have produced technically defensible data on groundwater contamination below LANL, and specifically, technically defensible data on the LANL radionuclide contaminants.
- Ask the DOE Headquarters Team if <u>all</u> of the old LANL Test Wells should be plugged and abandoned because they do not meet the requirements of monitoring wells and they may serve as pathways for spreading contamination.

Comment on the lead contamination in the groundwater below the LANL legacy waste disposal site MDA AB and the deficiencies in the LANL groundwater protection practices for monitoring the groundwater contamination from MDA AB

- By Robert H. Gilkeson, Registered Geologist - Report date October 1, 2008

1.0 Executive Summary. From 1959 to 1961, the Los Alamos National Laboratory (LANL) conducted subcritical hydronuclear experiments in seventy shafts to depths of up to 100 feet at a test site that is now known as Material Disposal Area AB (MDA AB). MDA AB is located atop Frijoles Mesa just north of Bandelier National Monument. The hydronuclear experiments involved the explosion of packages of 1). fissile materials (plutonium and/or enriched uranium), 2). a large amount of lead, 3). beryllium, and 4). a large amount of high explosives usually in a nuclear weapons configuration.

The debris from the hydronuclear tests were not cleaned up and are now the large inventory of hazardous and radioactive wastes that are buried at MDA AB. LANL data show the improper waste disposal practices have caused a large plume of lead contamination in the regional aquifer below and downgradient of MDA AB. A LANL report estimates MDA AB to contain over 80% of the LANL's inventory of buried transuranic material by radioactivity content. The 23,000 curies of plutonium wastes buried at MDA AB included 20,600 curies of plutonium-241 (Pu-241) which has a half-life of 14.4 years. Over 90% of the Pu-241 has decayed to form americium-241 which is now decaying to form neptunium-237. The chemical properties of neptunium to cause groundwater contamination are much greater than for americium and plutonium.

Extensive contamination of the groundwater below MDA AB by the radionuclide and hazardous wastes may already have occurred but the contamination is not noticed because the monitoring wells at MDA AB are three old LANL test wells that were installed in 1960. The old test wells have many well-known features that prevent the detection of groundwater contamination by the large inventory of radioactive and hazardous wastes that are buried at MDA AB. However, from 1988 through 1994, the three old test wells did detect lead contamination in the groundwater at concentrations that greatly exceeded the State and Federal Drinking Water Standards. The groundwater below MDA AB may still be contaminated with lead and with the other wastes buried in MDA AB including plutonium at dangerous levels to public health but the contamination is not noticed because there are no reliable monitoring wells.

Over the years, the LANL scientists have taken the <u>irresponsible position</u> in reports to the public that the old test wells prove that MDA AB has not released contaminants to the regional aquifer and that the lead contamination measured in the groundwater by the old test wells was only from the lead in the galvanized steel plumbing systems installed in the wells. The scientists do not inform the public of the many features of the old wells that <u>mask</u> the detection of groundwater contamination.

The LANL scientists adhere to the <u>assumption</u> that the 1,100 foot thickness of the unsaturated zone below MDA AB prevents contamination of groundwater. The reliance on computer models built on unproven assumptions to protect groundwater below the LANL MDAs is an irresponsible practice of the LANL scientists that must stop.

The 2007 final report of the National Academy of Sciences (NAS) recognized the overall failure to install reliable monitoring wells at LANL and the need for reliable networks of monitoring wells at all of the large LANL MDAs. In particular, the NAS report identified the need for a reliable network of monitoring wells at MDA AB.

## 2.0 Table of Contents

- Page No. Topic
- 1 Presentation to the Northern New Mexico Citzens' Advisory Board.
- 3 1.0 Executive Summary.
- 4 2.0 Table of Contents
- 5 3.0 Introduction.
- 7 4.0 The large plume of lead contamination in the precious groundwater resource in the regional aquifer below and downgradient of MDA AB.
- 8 5.0 NMED accepts the LANL mistake to assign the well construction materials as responsible for the high lead levels measured in the old test wells.
- 8 6.0 The poorly maintained asphalt pad installed over test area 2 from 1961 to 1998 recharged water through the buried wastes and mobilized the wastes for traveling down through the vadose zone to contaminate the groundwater.
- 9 7.0 Health effects from lead in drinking water.
- 9 8.0 <u>LANL, DOE and NMED plan to use the unreliable old test wells and the unreliable characterization wells for the long-term surveillance monitoring for releases from MDA AB.</u>
- 10 9.0 The factors that prevented the new LANL characterization wells from ever producing reliable and representative water samples.
- 12 10.0 The factors that prevented the old test wells DT-5A, DT-9 and DT-10 from \
  ever producing reliable and representative water samples.
- 12 10.1 The importance to not construct monitoring wells with carbon steel casing and screens and galvanized steel sampling systems is described in the NMED Consent Order but NMED allows LANL to use monitoring wells with these materials for the reliable detection of contamination.
- 13 10.2 The three old test wells are located too distant from MDA AB for monitoring releases.
- 13 10.3 The long screens in the old LANL test wells mask the detection of contamination and will spread contamination released from MDA AB deep into the highly productive regional aquifer.
- 15 10.4 The mud-rotary drilling method that was used for drilling well DT-5A masks the detection of contamination from MDA AB.
- 15 11.0 The inconsistent practice of the NMED for requiring reliable monitoring wells located very close to the legacy waste disposal sites at Sandia National Laboratories Albuquerque Facility but NMED does not place this requirement for monitoring wells at the LANL disposal sites.
- 17 12.0 The National Academy of Sciences described the "watershed monitoring approach" in the NMED LANL Consent Order as a serious mistake that must be corrected.
- 17 13.0 The careless groundwater protection practices of LANL, DOE and NMED leave the large groundwater resource in the southern region of the Laboratory at risk of groundwater contamination from MDA AB.
- 19 14.0 Required activities for groundwater protection at MDA AB.
- 19 15.0 The need for monitoring wells to be located close to all of the LANL MDAs.
- 20 **-** 16.0 <u>References</u>.

3.0 <u>Introduction</u>. From 1959 to 1961, the Los Alamos National Laboratory (LANL) conducted subcritical hydronuclear experiments in seventy (70) shallow shafts at a test site (MDA AB) located atop Frijoles Mesa in Technical Area 49 (TA-49). TA-49 is located in the south-central region of LANL just north of Bandelier National Monument.

The underground experiments were designed and conducted to investigate safety issues 1 for several of the nuclear weapons systems in the active stockpile at that time. Seventy hydronuclear safety, tracer, and containment test experiments 2 were conducted in unlined shafts installed to total depths ranging between 30 feet to 100 feet below ground surface. The hydronuclear experiments 1 involved packages of 1). fissile materials (plutonium and/or enriched uranium), 2). a large amount of lead, 3). beryllium, and 4). a large amount of high explosives usually in a nuclear weapons configuration.

The debris from the high explosive tests were not cleaned up and are the wastes buried in unlined shafts at MDA AB. The improper waste disposal practices have caused a large plume of lead contamination in the regional aquifer below Frijoles Mesa. The nature and extent of groundwater contamination below MDA AB is not known because there are <u>no</u> reliable groundwater monitoring wells. The groundwater may be contaminated with the other hazardous and radioactive wastes that are buried in MDA AB. Figure 1 is a map that shows the locations of the four test areas in MDA AB (Areas 1, 2, 3 and 4) where the shafts were located for the hydronuclear tests. A large number of the underground tests were performed in Area 2 and the amount of land where the tests were performed at Area 2 is much larger than displayed on Figure 1.

A LANL report<sup>2</sup> makes the following finding about the large inventory of radioactive wastes permanently disposed of at Material Disposal Area AB (MDA AB):

"MDA AB is estimated to contain over 80% of the LANL's inventory of buried transuranic material by radioactivity content."

In 2007, the National Academy of Sciences (NAS) Final Report<sup>3</sup> on the LANL groundwater protection practices listed the 23,000 curies of plutonium wastes at MDA AB to include 20,600 curies of plutonium-241.

- Plutonium-241 (Pu-241) decays into americium-241 by emitting a beta particle. The half-life of Pu-241 is 14.4 years.
- Americium-241 (Am-241) decays into neptunium-237 by emitting an alpha particle. The half-life of Am-241 is 432.7 years.
- Neptunium-237 (Np-237) decays into palladium-233 by emitting an alpha particle.
   The half-life of Np-237 is 2.14 million years.

From 1960 to 2008, more than 90% of the Pu-241 has decayed to form Am-241 which is now decaying to form Np-237. Research<sup>4</sup> has established the much greater mobility of Np-237 compared to isotopes of americium and plutonium. In addition, LANL research<sup>5</sup> describes the much greater mobility of plutonium in the vadose zone and in groundwater than previously believed because of the higher oxidation states that are now recognized.

Table 1 is an incomplete summary of the inventory of hazardous and radioactive materials that were used for the hydronuclear tests. The large inventory of highly toxic hazardous and radionuclide materials disposed of at MDA AB are the debris from the explosive tests in the unlined shafts. The explosives<sup>2</sup> that were used in the experiments consisted largely of TNT, RDX, HMX and barium nitrate.

**Table 1**. Incomplete Inventory of hazardous and radionuclide wastes disposed of at LANL Legacy Waste Disposal Site MDA AB.

<ul> <li>Waste Inventory<sup>2</sup></li> </ul>	Plutonium (lb.)	Uranium-235 (lb.)	Uranium-238 (lb.)
- Area 1	2.34	0.00	137.37
- Area 2	48.6	140.24	171.55
<ul> <li>Area 3</li> </ul>	0.00	0.01	0.07
<ul> <li>Area 4</li> </ul>	37.57	64.83	63.95

- Total Waste Inventory
  - Plutonium 88.2 lb. ~ 23,000 Ci (includes ~ 20,600 Ci of Pu-241, which has a 14.4-year half-life, and ~ 2300 Ci of Pu-239, which has a 24,000-year half-life) <sup>3</sup>
  - Uranium-235 - - 205.07 lb.
    Uranium-238 - - 374.85 lb.
    Beryllium - - 24.26 lb.
  - Lead ----- > 198,450 lb. = > 99.25 tons
  - High Explosives - Amount unknown

The Department of Energy (DOE) and the New Mexico Environment Department (NMED) never required a reliable network of monitoring wells installed at MDA AB (or the other LANL MDAs) for monitoring groundwater contamination from the large inventory of hazardous and radionuclide wastes. Plutonium, americium, neptunium, lead, beryllium, barium, high explosives and other toxic contaminants may be present in the groundwater below MDA AB at the present time but the contaminants are not noticed because of the unreliable monitoring wells.

The network of unreliable monitoring wells that the NMED Consent Order requires to be sampled for monitoring MDA AB include the three old test wells (wells DT-5A, DT-9 and DT-10) and the three LANL characterization wells CdV-R-37-2. R-27 and R-31. Figure 2 shows the location of MDA AB and the three old test wells. The locations of all six wells are displayed on the map in Figure 3.

4.0 The large plume of lead contamination in the groundwater below and downgradient of MDA AB. Lead is a toxic trace metal that is recognized by the Environmental Protection Agency (EPA) as a danger to public health. The historical record in the LANL Water Quality Data Base (WQDB) is proof that there was a large release of the lead disposed of in MDA AB to contaminate the groundwater in the regional aquifer. The complete, but sparse record of LANL water quality data for the concentration of lead measured in the groundwater samples collected from test wells DT-5A, DT-9 and DT-10 is presented below in Table 2.

In 1988, lead first appeared in the water samples produced from wells DT-5a, DT-9 and DT-10 at concentrations that exceed the EPA National Primary Drinking Water Standard (DWS) Action Level of 15 ug/L (15 parts per billion). The lead levels increased over time to a maximum concentration of 9000 ug/L (a level 600 times greater than the EPA Action Level of 15 ug/L) measured in a water sample collected from well DT-5A in 1993. The data in Table 2 show that lead concentrations measured in water samples produced from wells DT-5A, DT-9 and DT-10 exceeded the EPA DWS Action Level for lead over a seven (7) year period from 1988 through 1994. However, note that there may have been high levels of lead in the groundwater before 1988 but Table 2 shows that there are no water quality data for the nine year period from 1979 through 1987.

**Table 2.** Lead measured in water samples collected from the old LANL Test Wells DT-5A, DT-9, DT-10, and Test Well TW-3.

Test W DT-5 Lead	A	est Well DT-9 Lead	Test Well DT-10 Lead	Test Well TW-3 Lead
Sample F / 1		F/T Sample	F/T	Sample F/T
Date ug/L	Date	ug/L Date	ug/L	Date ug/L
<b>-</b> 05-01-60 -/-	05-07-60	- / - 05-06-60	) -/-	1960 to
-11-13-63 -/-	02-20-69	- / - 02-15-67	-/-	1973 - no data
<u>-04-24-74</u> <sup>3</sup> -/0	11-05-71	-/- 04-30-70	-/-	<u>04-23-74</u> -/0
-03-10-78 -/8	<u>04-03-78</u>	- / 5 <u>03-20-78</u>	-/5	03-10-78 - / 4
-03-30-88 -/48	03-30-88	- / 17 03-30-88	- / 39	03-31-88 -/<1U
-09-23-91 -/33	09-23-91	- / 26 09-23-91	- / 28	05-21-91 - / 1
-11-18-92 - / 209	1992 - no	o data 1992 -	no data	1992 - no data
-02-93 - no da	ta 02-24-93	55 / - 02-24-93	50 / -	02-93 - no data
-05-20-93 <sup>4</sup> 9000	/ - 05-20-93	53 / - 05-20-93	75 / -	05-20-93 9/-
<b>-</b> 09-08-94 26 / 28	30 09-08-94	14 / 11 09-08-94	95 / 27	06-02-94 < 2.5U / -
-11-21-94 12/56	6 11-94 - n	o data 11-94 -	no data	
-05-95 - no dat	ta 05-30-95	6 / 11 05-31-95	8/-	07-18-95 - / 24
-11-13-95 < 2U /	< 2U			
-09-18-96 -/-	09-18-96 <	3U / 6 09-19-06	-/4	09-30-96 - / 11
-11-27-96 -/4	12-05-96 -	· / 4 12-06-96	- / < 3U	11-15-96 -/<3U
<b>-</b> 05-13-97 - / 4	05-13-97 -	- / 5 05-14-97	' -/<3U	
<b>-</b> 09-11-97 - / < 3	U			08-11-97 - / < 3U
<b>-</b> 10-16-97 - / < 3	U 10-15-97 -	· / < 3U		
-10-26-00 - / < 1	.83U	10-27-00	- / < 1.83U	05-03-00 -/<1U
-06-06- 01 - / 0.5	505 06-07-01 -	· / 1.12 06-06-01	- / 0.69	06-04-01 -/3.64
-04-12-02 - / 0.3	9 04-10-02 -	·/ < 0.077U 04-12-02	- / 0.96	05-09-02 - / 11.7
-08-18-03 - / 3.8	7 08-06-03 -	· / 2.62 08-18-03	- / 0.855	07-17-03 - / 3.19
-07-13-04 - / 0.7	2 07-07-04	- / 0.61 06-22-04	- / 0.703	09-29-04 - / 22.1
-08-24-05 < 0.5U	<b>1 / 0.9</b> 07-20-05 <	0.5U / 0.61 07-19-05	2.6 / 1.1	04-29-05 - / 14
-12-06-06 < 0.5U	1/0.8 12-05-06 0	0.77 / 0.72 12-04-06	< 0.5 / 0.9	01-19-06 < 0.5U / 10.4
-05-17-07 < 0.5U	//< 0.5U 05-09-07 <	0.5U / 0.88	< 0.5 / 0.68	
-11-10-07 < 0.5U	/< 0.5U 11-02-07 <	0.5U / 2.5 10-30-07	< 0.5 / < 0.5	
-04-18-08 0.56 /	1.2 04-07-08 <	2U / 0.72 04-16-08	< 2U / < 2U	

<sup>■</sup> EPA Lead Drinking Water Standard Action Level = 15 ug/L (15 parts per billion)

 $<sup>\</sup>frac{1}{2}$  F/T F = dissolved lead in filtered samples T = total lead in unfiltered samples

<sup>&</sup>lt;sup>2</sup> ug/L = microgram per liter or parts per billion

<sup>3 &</sup>lt;u>04-24-74</u> = underlined date is first time a water sample from each well was analyzed for lead according to the electronic LANL water quality data base (WQDB)

<sup>&</sup>lt;sup>4</sup> 9000 ug/L = reported value in LANL water quality data base for dissolved lead measured in well DT-5A in 1993. In a Los Alamos Monitor newspaper article on September 25, 2008, a LANL spokesman claimed the reported value was a mistake in the LANL WQDB.

<sup>&</sup>lt;sup>5</sup> < 2U, < 3U, etc. = lead was not detected in the water sample at the listed 2 ug/L, 3 ug/L, etc., limit of detection for the analytical method

5.0 The NMED accepts the LANL mistake to assign the well construction materials as responsible for the high lead levels measured in wells DT-5A, DT-9, and DT-10. Many of the LANL environmental surveillance reports and other LANL reports have a long history of blaming corrosion of the carbon steel well casing and screens, and the galvanized pipes and fittings used in the submersible pump sampling systems as responsible for the high levels of lead measured in the three wells.

However, for comparison, Table 2 presents the markedly lower lead levels measured in the old test well TW-3 which is located over four (4) miles from MDA AB in the north-central region of LANL. The location of well TW-3 is displayed on Figure 3. Well TW-3 was also installed in 1960 with carbon steel casing and screen and galvanized pipe and fittings in the submersible pump water sampling system. The occasional measurement of lead in the unfiltered water samples produced from well TW-3 at levels slightly above the 15 ug/L EPA DWS Action Level are because of the galvanized pipes and fittings.

Nevertheless, note the remarkably lower levels of lead in water samples from old test well TW-3 over the years 1988 to 1994 when the old test wells DT-5A, -9, and -10 located near and downgradient of MDA AB produced water samples much above the EPA MCL. The available information indicate that the high levels of lead measured in water samples from wells DT-5A, DT-9 and DT-10 over the years 1988 through 1994 are because of a release of lead from the large lead inventory disposed of at MDA AB.

Table 2 shows a very high concentration of dissolved lead at 9,000 ug/L was measured in a water sample produced from well DT-5A in 1993. The high concentration was in a presentation the author made to the September 24, 2008 meeting of the Northern New Mexico Citizens' Advisory Board. In a Los Alamos Monitor newspaper article on September 25, 2008, a LANL spokesman claimed the reported value was an error in the LANL Water Quality Data Base, and that the analytical result was mistakenly listed as for a dissolved sample when in fact, the 9,000 ug/L concentration was measured for an unfiltered water sample. Even so, the entire data set for the three old test wells DT-5A, DT-9 and DT-10 are evidence of a large lead plume in the regional aquifer below and downgradient of MDA AB.

Table 2 shows high concentrations with a increasing trend in lead measured in unfiltered water samples produced from the three DT test wells beginning in 1988. Because of the lead in the plumbing systems, LANL should have started the collection of both filtered and unfiltered samples from the three wells at that time. The first filtered samples were not collected until 1993, but note that the measured concentrations in the filtered samples continue the increasing trend for wells DT-9 and DT-10, and the measured dissolved concentrations are far above the EPA drinking water standard of 15 ug/L. The LANL claim that the 9,000 ug/L concentration was for an unfiltered sample does not change the fact that all of the data from the three test wells indicate a large plume of lead contamination because of a release of lead from MDA AB.

6.0 The poorly maintained asphalt pad installed over Area 2 from 1961 to 1998 invaded the buried wastes with water and mobilized the wastes for traveling down through the vadose zone to contaminate the groundwater in the regional aquifer. An accident in 1960 brought plutonium contamination out of a test shaft to the surface and spread the contamination across a large part of Area 2. In 1961, the contamination was covered by an asphalt pad. According to a LANL report<sup>2</sup>, In 1975, many long cracks and a large collapsed area (~3 by 6 ft wide and ~ 3 to 4 ft deep) were discovered in the asphalt cover. It was also discovered that Core-Hole 2 (CH-2 on Figure 2), a 2-inch diameter

500-ft deep cased borehole located in the center of Area 2 contained about 50-ft of standing water. In 1976, the asphalt cover was repaired, but more cracks and standing water were again found in CH-2 in 1979, 1980, and 1991<sup>2</sup>.

The asphalt cover was an evapotranspiration barrier that provided a moist environment within the debris buried in Area 2 and allowed focused infiltration of precipitation and snowmelt through the buried debris. The water standing in Core-Hole 2 is evidence of a large flow of water through the buried debris. The asphalt pad covered a large part of Area 2 for thirty seven years. The asphalt pad was replaced in 1998 with a dirt cover designed to facilitate evapotranspiration<sup>2</sup>.

The long period of time that the asphalt pad was over Area 2 raises a concern that the flow of water through the buried debris transported contamination to the regional aquifer. The historical record of the cracks in the asphalt pad and the water measured in CH-2 require the installation of a network of monitoring wells at Area 2 to investigate contamination in the regional aquifer. The data from shallow boreholes and the speculation from computer models cannot replace the need for a reliable network of monitoring wells.

- 7.0 <u>Health effects from lead in drinking water</u>. The current EPA *Technical Factsheet on Lead* published on the EPA website contains the following Health Effects Summary:
  - Acute: Lead can cause a variety of adverse health effects in humans. At relatively low levels of exposure, these effects may include interference with red blood cell chemistry, delays in normal physical and mental development in babies and young children, slight deficits in the attention span, hearing, and learning abilities of children, and slight increases in the blood pressure of some adults. It appears that some of these effects, particularly changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold.
  - Chronic: Chronic exposure to lead has been linked to cerebrovascular and kidney disease in humans.
  - Cancer: Lead has the potential to cause cancer from a lifetime exposure at levels above the action level [of 15 ug/L, i.e., 15 parts per billion].
- 8.0 LANL, DOE and NMED plan to use the unreliable old test wells and the unreliable characterization wells for long-term surveillance monitoring for releases from MDA AB. Over the period of 1995 to the present, the measured concentrations of lead have declined and in the recent years lead is often not detected in the water samples produced from the three old test wells. However, lead and other contaminants may be present in the groundwater below MDA AB at levels above the EPA MCL, but the contaminants are not detected because of the many features of the old LANL test wells and the newly installed LANL characterization wells that mask the detection and accurate measurement of lead and many other LANL contaminants of potential concern (COPC) for the large inventory of wastes that are buried in unlined shafts in MDA AB. The LANL Interim Facility-Wide Groundwater Monitoring Plan, Rev. 1 (May 2007) (LA-UR-07-3271) has the following description of the buried wastes at MDA AB:

"The [explosive] testing produced large inventories of radioactive and hazardous materials, such as isotopes of uranium and plutonium, lead, and beryllium; explosives such as 2,4,6-trinitrotoluene (TNT), hexahydro-1,3,5-trinitro-1,3,5-triazine (research department explosive, or RDX), and octahydro-1,3,5,7-tetranitro-

1,3,5,7-tetrazocine (high-melting explosive, or HMX); and barium nitrate. <u>Much of</u> this material remains in [unlined] shafts on the mesa top." [emphasis supplied].

The NMED LANL Consent Order signed into law on March 1, 2005 has the following discussion of TA-49 MDA AB. From page 124 of the Consent Order:

"Activities conducted at MDA AB included nuclear device safety tests and HE detonations conducted in 37 shafts at depths ranging from 30 to 78 ft. Materials released at MDA AB include HE, lead, beryllium, and radionuclides, which are not addressed under this Consent Order."

From pages 131 and 132 of the Consent Order:

"Install one monitoring well that intersects the regional aquifer downgradient of TA-49. Respondents may address this requirement through the installation of Regional well R-30." [Regional well R-30 was never installed.]

"IV.C.4.c.viii Technical Area 49 Groundwater Monitoring - Groundwater samples shall be collected from each saturated zone intersecting the regional aquifer wells CdV-R-37-2, DT-5A, DT-9, DT-10, and all regional wells installed in the future." [emphasis added. None of the wells in this list produce reliable and representative groundwater samples for the reasons described below]

- 9.0 The factors that prevented the new LANL characterization wells from ever producing reliable and representative water samples. The regional wells "installed in the future" are characterization wells R-27 and R-31. The locations of the two wells and well CdV-R-37-2 are shown on Figure 3. However, all three of the characterization wells do not meet the requirements to be monitoring wells for MDA AB because
- 1). the wells are located too far away CdV-R-37-2 is over 1.5 miles to the northwest, R-27 is over 0.5 miles to the northeast and R-31 is over 2.5 miles to the southeast,
- 2). the screened intervals in the three wells were invaded with organic drilling fluids that formed a new mineralogy with well-known strong properties to prevent the detection and accurate measurement of the hazardous and radionuclide wastes buried at MDA AB and
- 3). the stainless steel screens in the three characterization wells also have well-known strong adsorption properties<sup>6,7</sup> for the RCRA trace metals and DOE radionuclide contaminants buried at MDA AB.

In addition, wells R-31 and CdV-R-37-2 are multiple-screen wells where water samples are collected with the Westbay<sup>R</sup> no-purge sampling systems that collect stagnant water samples that were in contact for a long period of time with the new mineralogy and with the stainless steel well screens. The NMED has not enforced the requirement in the Consent Order to purge a sufficient amount of water from the LANL multiple-screen characterization wells before samples are collected. The purging requirements in the Consent Order are pasted below:

## "IX.B.2.i.i Well Purging

All zones in each monitoring well shall be purged by removing groundwater prior to sampling and in order to ensure that formation water is being sampled. Purge volumes shall be determined by monitoring, at a minimum, groundwater pH, specific conductance, dissolved oxygen concentrations, turbidity, redox

potential, and temperature during purging of volumes and at measurement intervals approved by the Department in writing." (page 177)

"The groundwater quality parameters shall be measured using a flow-through cell and instruments approved by the Department in writing. The volume of groundwater purged, the instruments used, and the readings obtained at each interval shall be recorded on the field monitoring log. Water samples may be obtained from the well after the measured parameters of the purge water have stabilized to within ten percent for three consecutive measurements." (page 177)

## "IX.B.2.i.ii Groundwater Sample Collection

Groundwater samples shall be obtained from each well after a sufficient amount of water has been removed from the well casing to ensure that the sample is representative of formation water." (page 177)

However, NMED does not enforce the purging requirements in the Consent Order. Instead, NMED allows LANL to collect <u>spurious</u> water samples from the old test wells and from the three unreliable characterization wells, and to present the <u>unreliable</u> water quality data as proof the groundwater beneath MDA AB is not contaminated.

The <u>irresponsible plan</u> of LANL, DOE, and NMED to use the old test wells as the permanent reliable monitoring wells for releases from MDA AB is shown by the excerpts pasted below from the LANL report - *Periodic Monitoring Report for Ancho Watershed, November 27 - December 8, 2006,* (LA-UR-07-4872, August 2007).

- From Table A-1 on page A-2 in Appendix A to the 2007 LANL report: "Three regional aquifer wells at TA-49 [i.e., wells DT-5A, DT-9 and DT-10] have been sampled since the 1960s to monitor for effects of testing at that site [i.e., the hydronuclear testing at MDA AB]. In general no effects have been found. High metal concentrations (lead, zinc, iron, manganese) in samples are related to metal well casing and fittings. Occasional detections of organic compounds are not supported by follow-up sampling."
- From Appendix F-1 Approved Waste Characterization Strategy Form (WCSF): "This Waste Characterization Strategy Form (WCSF) pertains to the groundwater and surface water monitoring activities performed by the Los Alamos National Laboratory (LANL or the Laboratory) Water Stewardship Project (LWSP) in the Ancho/Frijoles/Chaquehui Canyons watersheds. LWSP will collect and analyze groundwater and surface water samples for specific constituents (Table 1 [in the LANL report]) and at specific locations (Table 2 [in the LANL report]) in order to fulfill the requirements of New Mexico Environment Department's (NMED) Compliance Order on Consent and in support of LANL's Interim Facility-Wide Groundwater Monitoring Plan, Revision 1 to monitor the impacts of LANL's operations on the Pajarito Plateau groundwater. Specifically, to provide information in advance of the detailed characterization to be conducted in 2009 2010 for an investigation report due to NMED in 2011." (page F-9) [Note: The wells listed in Table 2 of the LANL report are DT-5A, DT-9, DT-10 and R-31.]

"Contaminants that have been detected in Ancho Canyon sediments, surface water, or shallow groundwater during previous investigations include, mercury and other metals, HE, organics and radionuclides. <u>Three decades of water</u> quality records from regional wells in this area (DT-5A, DT-9, and DT-10), as well

presence of Laboratory contaminants in the regional aquifer." [emphasis supplied] (page F-10).

There is no scientific basis for the position by the LANL scientists that wells DT-5A, DT-9, DT-10, and LANL characterization wells R-27, R-31 and CdV-R-37-2 ever produced water samples that were reliable and representative for the detection of groundwater contamination due to releases from MDA AB. In addition, because of the many detections of high concentrations of lead, It is a mistake for LANL to claim that water samples from wells DT-5A, DT-9 and DT-10 have not shown the presence of Laboratory contaminants in the regional aquifer. In fact, the data in Table 2 of this report are proof of a large plume of lead contamination in the regional aquifer at the location of the three old test wells due to a release from MDA AB.

- 10.0 The factors that prevented the old test wells DT-5A, DT-9 and DT-10 from ever producing reliable and representative water samples. The three old test wells were drilled in 1960 before the rigorous requirements for drilling methods and well construction materials for monitoring wells were known. The factors that prevented the three old test wells from being reliable to detect and accurately measure the contamination released from MDA AB include a). the carbon steel casing and screens and the galvanized steel pipes and fittings used in the sampling equipment, b). the wells are located too far away from the buried wastes, c). the very long length of the well screens which cause dilution and may spread contamination deep into the regional aquifer, and d). the mud-rotary drilling method that was used for drilling well DT-5A.
- 10.1 The importance to not construct monitoring wells with carbon steel casing and screens and galvanized steel sampling systems is described in the NMED Consent Order:
  - "X.C.1 Well Construction Materials Well construction materials shall be selected based on the goals and objectives of the proposed monitoring program and the geologic conditions at the site. When selecting well construction materials, the primary concern shall be selecting materials that will not contribute foreign constituents or remove contaminants from the groundwater." [emphasis supplied] (page 192-193).

"In addition, there are other materials available for the construction of monitoring wells including ..... <u>carbon steel</u>, <u>and galvanized steel</u>, <u>but these materials are not recommended for use in long term monitoring wells due to their low resistance to chemical attack and potential contribution of contamination to the groundwater." [emphasis supplied] (page 193).</u>

The carbon steel and galvanized steel materials in the old test wells have well known properties to contribute foreign constituents (i.e., zinc and lead, etc) to the water samples produced from the wells and to remove contaminants from the groundwater samples produced from the wells (i.e., plutonium, americium, neptunium and RCRA trace metals including lead, barium, etc.). The LANL reports acknowledge that the corroded carbon steel screen and casing and the galvanized steel sampling systems are contributing lead contamination to the groundwater samples collected from the old test wells. NMED is making a serious mistake to not enforce the requirement in the Consent Order that these materials shall not be used in the LANL monitoring wells. Water

samples from the old test wells do not provide knowledge for decisions required by the Consent Order for corrective action "cleanup" and for long-term monitoring.

A 1996 journal article<sup>6</sup> presents findings from research at the DOE Nevada Test Site for the sorption of the radionuclides cesium-137 (monovalent cations) and cobalt-57 (divalent cations) on well casing and screens made of carbon steel. The groundwater used in the experiments was oxidizing with a sodium bicarbonate chemistry similar to the groundwater below LANL. The groundwater was spiked with trace levels (less than 1 ug/L) of cesium-137 (Cs-137) and cobalt-57 (Co-57) that were purchased as chloride salts in dilute hydrochloric acid.

The coupons of carbon steel were placed in contact with the spiked groundwater in glass containers for periods of time ranging from two hours to three weeks. The research found that carbon steel well materials had strong properties for sorption of both Co-57 and Cs-137 from groundwater:

"Both Cs-137 and Co-57 disappeared rapidly from the solution in contact with the carbon steel pipe. This effect began almost immediately and continued throughout the duration of the experiment." (page 166).

The screens in the old LANL test wells were formed by using an acetylene torch to cut slots in the carbon steel casing. The isotopes of plutonium, americium and neptunium in the buried wastes in MDA AB are more strongly sorbing than Cs-137 and Co-60. The research at the Nevada Test Site is proof that the old test wells will not produce reliable water samples for the detection and accurate measurement of these contaminants.

Under the Atomic Energy Act, DOE is self-regulating for groundwater contamination by the large inventory of radioactive wastes in the debris buried at MDA AB. Therefore, it is <u>irresponsible</u> for DOE to not install a reliable network of monitoring wells constructed with appropriate well casings and screens immediately close to the buried wastes at MDA AB and at the other LA NL legacy waste disposal sites.

- 10.2 <u>The three old test wells are located too distant from MDA AB for monitoring releases</u>. The locations of the three test wells and the location of MDA AB atop Frijoles Mesa are shown on Figure 2. The direction of groundwater flow below MDA AB is to the east. The distance of the wells from the disposal areas is summarized below:
- Well DT-5A is approximately 1,100 ft southeast of Area 1.
- Well DT-5A is approximately 800 ft south-southwest of Area 2.
- Well DT-5A is approximately 1,000 ft north-northwest of Area 4.
- Well DT-10 is approximately 4,800 ft east of Area 1, 3,400 feet east of Area 2 and 3.600 feet northeast of Area 4.
- Well DT-9 is approximately 6,000 ft southeast of Area 2, 7,000 feet southeast of Area 1 and 4,500 ft southeast of Area 4.
- Monitoring wells should be located at distances not greater than a few hundred feet from the test areas. The fact that NMED is aware of the need for monitoring wells to be located close to MDA AB is described below in Section 11.0.
- 10.3 The long screens in the old LANL test wells mask the detection of contamination and will spread contamination released from MDA AB deep into the highly productive regional aquifer. The NMED Consent Order recommends that the LANL monitoring

wells are constructed with a single, relatively short (5- to 10-foot) screen in zones of relatively high hydraulic conductivity to monitor so-called fast paths for lateral flow. In addition, the EPA and the American Society for Testing and Materials recommend screened intervals of 2 to 10 feet<sup>6</sup>.

A major concern for the monitoring wells at MDA AB is the early detection of contamination that reaches the water table of the regional aquifer and this requires wells located close to MDA AB with short screens installed near the water table. Another important concern at MDA AB is that the very long well screens in the old test wells are installed across a thick basalt formation that may have laterally continuous zones with very low hydraulic conductivity (Ksat). The basalt may be a natural barrier to protect contamination from MDA AB from invading deep into the regional aquifer.

The available geologic data indicate that the basalt formation is continuous in the region of the four wells. The Schlumberger<sup>R</sup> geophysics report for well R-27<sup>7</sup> describes the basalt to have thick intervals that are massive with very low Ksat. Additional evidence that the basalt formation has a very low Ksat is the presence of a perched zone of saturation above the basalt at the location of well R-27<sup>7</sup>.

The length of the well screens below the water table in test wells DT-5A, DT-9 and DT-10 and the total thickness of the basalt formation at each well and also at well R-27 are summarized below:

Well No.	Saturated screen length (feet)	Thickness of basalt layer (feet)	Depth to Regional water table (ft bgs)	Depth to top of basalt (ft bgs)	Regional water table (ft asl)	top of basalt (ft asl)	top of screen (ft asl)
- Well DT-5A	635	126	1,186	1,167	5958	5977	5972
- Well DT-9	461	238	1,020	924	5915	6011	5895
- Well DT-10	308	319	1,101	972	5919	6048	5940
- Well R-27	23	131	811	634	5903	6080	5862

- (ft bgs) = feet below ground surface, (ft asl) = elevation in feet above sea level

The data in the above table indicate that the basalt layer is continuous in the region of the four wells and that the surface of the basalt layer slopes to the southwest toward MDA AB. The thickness of the basalt layer ranges from 126 to 319 feet. At well R-27, the entire thickness of the basalt layer is above the water table. The data also show that the long screens in the test wells penetrate through the basalt layer. However, the NMED Consent Order requires for the LANL monitoring wells to not have long screens that serve as a conduit for contaminants to invade deep into the regional aquifer:

"Groundwater monitoring wells and piezometers must be designed and constructed in a manner which will yield high quality samples, ensure that the well will last the duration of the project, and ensure that the well will not serve as a conduit for contaminants to migrate between different stratigraphic units or aquifers." (page 189)

Compliance with the NMED Consent Order requires the NMED to order LANL to plug and abandon the three old test wells DT-5A, DT-9 and DT-10 and install a reliable network of monitoring wells close to the buried wastes in the test areas at MDA AB with short screens installed in appropriate strata near the water table.

- 10.4 The mud-rotary drilling method was used for drilling well DT-5A. The mud-rotary drilling method used for drilling well DT-5A caused the invasion of a very large quantity of bentonite clay drilling mud into the aquifer zones with high Ksat that surround the well screen. The power of the mud pump on the drill rig and the depth of greater than 1,170 feet to the water table provided a hydraulic power of greater than 550 pounds per square inch for invasion of a large quantity of the bentonite clay drilling muds a great lateral distance into the permeable zones. The energy available to the well development methods for removing the bentonite clay muds was less than 5% of the energy for invasion of the muds into the aquifer zones surrounding the borehole. Bentonite clay has well-known properties to remove beryllium, lead, plutonium, americium, and neptunium from the water samples produced from well DT-5A. The discussion below in Section 7 shows that NMED is well aware that bentonite clay invasion into screened intervals prevents monitoring wells from being reliable for detecting the COPC at MDA AB.
- 11.0 The inconsistent practice of the NMED for requiring reliable monitoring wells located very close to the legacy waste disposal sites at Sandia National Laboratories Albuquerque Facility (SNL or Sandia) but NMED does not place this requirement for monitoring wells at the LANL disposal sites. An example of the inconsistent practice of the NMED for monitoring wells at LANL and at Sandia is a letter to Sandia from James Bearzi, Chief of the NMED Hazardous Waste Bureau, that describes the requirements for the network of monitoring wells to be installed at the Sandia Mixed Waste Landfill (MWL) for long-term monitoring.

Similar to LANL, NMED has issued a Consent Order for Sandia that requires the performance of corrective action activities to install reliable networks of monitoring wells at waste disposal sites that disposed of hazardous and mixed wastes. To meet the requirements of the Sandia Consent Order, the NMED letter orders the replacement of two of the monitoring wells at the Sandia MWL. Pertinent excerpts from the NMED letter dated July 2, 2007 are pasted below:

1) The NMED letter requires replacement of Sandia monitoring wells because of corroded well screens:

"(b)oth wells are also constructed with stainless steel screens which are suffering corrosion to such a degree that the wells can no longer produce water samples that are representative of aquifer conditions for chromium, iron, and nickel." (page 1).

"Because of problems associated with stainless-steel screened wells at the MWL (chromium and nickel detections), the replacement wells shall be screened with polyvinyl (PVC) plastic casing." (page 2).

Unfortunately, the NMED letter does not describe the well known properties of the new and also the corroded stainless steel well screens to prevent the wells from producing water samples that are reliable for the detection of many contaminants of concern for the buried wastes in the Sandia MWL.

- 2) The NMED letter requires installation of the long-term Sandia monitoring wells with screen lengths of appropriate length and location to provide early detection of contamination at the water table:

"Each well shall be installed to monitor groundwater at the water table." (p. 2).

In addition, the Sandia workplan approved by NMED for the new network of long-term monitoring wells at the Sandia MWL limits the total length of the well screens to 30 feet with the upper 5 feet installed above the water table.

■ 3) The NMED letter requires the installation of the long-term Sandia monitoring wells as close as possible to the hydraulic downgradient boundary of the buried wastes in the Sandia MWL:

"Additionally, each well shall be installed at locations as close as possible to the western boundary of the landfill, taking into account the footprint of the future landfill cover. The change in well locations, particularly for [well] MWL-MW1, is based on better preparing the MWL for long-term monitoring of the groundwater which flows west-southwest." (page 2)

- 4) The NMED letter requires the installation of the long-term Sandia monitoring wells with drilling methods that do not invade the screened intervals with any organic drilling additives or bentonite clay muds:

"The mud-rotary drilling method shall not be used to install the wells." (p.2)

A NMED letter to Sandia dated March 23, 2007 provided additional instruction for the drilling methods that would be used for installing the new network of monitoring wells at the Sandia MWL:

"The Permittees [i.e., SNL and DOE] shall install the well [SNL MWL well BW-1] in a manner that avoids the use of drilling fluids or construction materials that have the potential to interfere with the reliability of hydrologic or analytical data obtained from the well." (page 2)

The record shows that the NMED has ordered Sandia to install reliable networks of monitoring wells but NMED has failed to require LANL to install a reliable network of monitoring wells at MDA AB and the other LANL waste disposal sites. This is a serious problem that must be corrected.

In fact, LANL has only installed a total of two monitoring wells within 1000 feet from any of the LANL MDAs where large inventories of hazardous and radionuclide wastes are buried in unlined shafts, pits and trenches:

- 1) Well DT-5A at MDA AB and
- 2) Well R-22 500 feet downgradient from MDA G. The well location is on Figure 3.

Both wells detected RCRA hazardous wastes at concentrations well above the EPA Drinking Water Standards for successive sampling events. LANL installed characterization well R-22 for monitoring the groundwater from beneath MDA G that is traveling to the San Ildefonso Pueblo, the Rio Grande, and on to the Buckman well field, an important water supply for Santa Fe.

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

"Thirty-one volatile and semi-volatile organic compounds have also been detected in water from well R-22. Only two of these, pentachlorophenol (1 detection, 6.2 ppb, MCL = 1 ppb) and benzo(a)pyrene (2 detections, 0.24 ppb,

MCL = 0.2 ppb) were present at concentrations above the MCL. <u>Monitoring for organic compounds at well R-22 will continue</u>" [Emphasis Added. MCL means Maximum Contaminant Level allowed in the EPA Drinking Water Standards].

Below is a list of the contaminant data for well R-22 from LANL reports:

```
*tritium (109 picocuries per liter (pCi/L)),
*technetium-99 (4.3 and 4.9 pCi/L),
*pentachlorophenol (6.2 micrograms per liter (ug/L)),
*chloroform (0.94 ug/L).
*phenol (19 and 32 ug/L),
*4-methylphenol (44 to 210 ug/L),
*2-butanone (6.9 to 8.9 ug/L).
*diethylphthalate (1.3 ug/L),
benzoic acid (3 to 12.5 ug/L),
butyl benzyl phthalate (9.8 ug/L),
toluene (0.2 to 0.76 ug/L).
methylene chloride (0.62 and 2.2 ug/L),
bis(2-ethylhexyl)phthalate (1.0 and 3.9 ug/L),
several substituted benzene compounds including
isopropylbenzene (0.16 to 0.54 ug/L), and
1,4-dichlorobenzene (0.16 to 0.23 ug/L).
```

 Mobile Contaminants. Tritium, Technetium-99, and the six chemical contaminants with asterisks in the above list are highly mobile in groundwater. The six chemical contaminants are commonly found in groundwater beneath hazardous waste landfills.

The LANL report cited above described the water quality data produced from the five screened intervals in multiple-screen well R-22 as follows:

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

However, screen #2 in well R-22 does not produce representative water samples that meet RCRA requirements for detection monitoring because the measured permeability of the screened interval is a very low 0.04 ft/day compared to values of 50 to > 100 ft/day for the aquifer strata located above and below screen #2. RCRA requires monitoring wells to be installed in the permeable zones. In addition, LANL collects no-purge water samples from the screened intervals in well R-22 which do not meet the purging requirements of the NMED Consent Order (see page 8 and 9 above).

NMED should enforce the requirements of the Consent Order and the Resource Conservation and Recovery Act (RCRA) for protecting the groundwater resource below and away from LANL to the property of the San Ildefonso Pueblo, the Rio Grande, and on to the Buckman well field. NMED has not ordered LANL to install reliable networks of monitoring wells at any of the LANL MDAs in stark contrast to the requirements NMED has ordered for the networks of monitoring wells at the Sandia MWL and also at the Sandia Chemical Waste Landfill.

12.0 The National Academy of Sciences described the "watershed monitoring approach" in the NMED LANL Consent Order as a serious mistake that must be corrected. The "watershed monitoring approach" in the NMED Consent Order allows LANL to locate monitoring wells a great distance away from the LANL waste disposal sites such as MDA AB and MDA G. There is no technical basis for the watershed monitoring approach. In addition, this approach does not comply with the requirements of RCRA for monitoring wells to be located as close as possible to the buried wastes.

The NAS final report <sup>3</sup> identified the "watershed monitoring approach" in the NMED Consent Order to be a serious mistake. Excerpts from the NAS report are pasted below:

"However, there are areas where the Interim Plan [LANL Interim Groundwater Monitoring Plan] does not appear to follow good scientific practice. The most important of these is the focus on a watershed approach, where the monitoring plan for each watershed within LANL is developed and laid out individually in the Interim Plan. This structure, which is specified in the Consent Order, works quite well for monitoring surface base flows and alluvial groundwater that are confined to the canyons. However, it does not work well for the intermediate aquifers and even less for the regional aquifer." (p. 43)

"Even without a quantitative analysis of the sample locations in the intermediate and regional aquifers, the committee noted several modifications that could be made to the current monitoring network. Given the tendency for regional aquifer monitoring wells to be located in canyon bottoms, <u>large portions of the intermediate and regional aquifers</u>, namely, the portions beneath the mesas, are not monitored given the current monitoring plans and approach. This makes it far less likely that the current monitoring plan will provide early identification and response to potential environmental impacts from the Laboratory" [emphasis supplied]. (p. 44)

"Although the committee understands that there are strong economic and drilling incentives to locate regional monitoring wells in the canyons, and a number of additional monitoring locations could be placed in canyon bottoms that would contribute significantly to the existing network, eventually a way must be found to increase the area of the intermediate and regional aquifers that are monitored [emphasis supplied]. This may require locating some deep monitoring wells on mesa tops, and/or the drilling of slant holes from canyon bottoms to monitor the regional aquifer beneath the mesas." (p.44)

"In looking at the regional monitoring network, the committee found that the southern portion of LANL [i.e., the location of MDA AB] is one area of the regional aquifer that is currently very sparsely monitored." (p.44)

NMED, DOE and LANL have not revised the NMED Consent Order to address the NAS finding that the "watershed monitoring approach" prevents early identification of groundwater contamination from the large inventory of buried wastes at the disposal sites located atop the mesas. In addition, despite the findings of the NAS, nothing has been done to install a reliable network of monitoring wells at MDA AB where over 80% of the LANL's inventory of buried transuranic wastes are disposed of in unlined shafts, and a poorly maintained asphalt cover allowed focused infiltration of rain and snowmelt to travel through the buried debris, and possibly carry contaminants down to the regional aquifer.

13.0 <u>LANL's careless groundwater protection practices leave the large groundwater resource in the southern region of the Laboratory at risk of groundwater contamination by the wastes buried at MDA AB</u>. Figure 4 is a map from a LANL report that identifies a zone in the southern part of LANL where the regional aquifer is highly productive. Figure 4 identifies the productive zone to be located immediately east of MDA AB based on the low Ksat measured by the pumping test performed in old test well DT-5A.

However, the reason a low Ksat was measured for well DT-5A was probably because the ability of the well to produce water was greatly reduced by the plugging action of the bentonite clay from the mud-rotary drilling method. For comparison, the screened intervals in wells DT-9 and DT-10 were installed with the cable-tool drilling method that did not use any bentonite clay drilling muds. In addition, the regional data show that the Totavi Lentil Formation is a formation of layers of coarse river gravels that are highly productive of groundwater in the southern part of LANL. The greatest thickness of the Totavi Lentil strata is at well DT-5A. The thickness of the Totavi Lentil at each of the three old test wells is as follows: DT-5A - 52 ft; DT-10 - 46 ft; and DT-9 - 38 ft.

In fact, the available information shows that the southern "High Permeability Zone" is at least double the size displayed on Figure 4 and is present below MDA AB and to the southeast the zone includes well R-31 which is shown on Figure 4 as the red symbol located approximately one mile to the southeast of the high permeability zone.

The thick section of basalt present below MDA AB may afford protection to prevent contamination from MDA AB from invading deep into the highly productive regional aquifer. However, LANL and DOE have no plans to characterize the properties of the basalt to provide protection or even to install a reliable network of monitoring wells for the early detection of groundwater contamination from MDA AB.

## 14.0 Required activities for groundwater protection at MDA AB.

- Plug and abandon the old test wells DT-5A, DT-9 and DT-10.
- Install a network of reliable monitoring wells close to the buried wastes with short screens installed near the water table and also below the thick formation of basalt.
- Install a background monitoring well at an appropriate location upgradient of MDA AB.
- Install monitoring wells at locations hydraulically downgradient and away from MDA AB for characterization and long-term surveillance monitoring.
- After the wells are installed, perform a pumping test to acquire accurate knowledge of the importance of the basalt formation to prevent the large inventory of buried wastes at MDA AB from deep invasion of contamination into the regional aquifer.
- 15.0 The need for monitoring wells to be located close to all of the LANL MDAs. The "watershed monitoring approach" in the Consent Order does not require LANL to locate monitoring wells close to the LANL MDAs as required for the technically sound monitoring identified in the NAS final report and as required by RCRA. The NAS final report described the importance for locating networks of reliable monitoring wells close to all of the LANL MDAs:
  - "Solid wastes (e.g., the 25 MDAs) and certain contaminants deemed by LANL to be essentially immobile (e.g., Pu) have the potential for impacting groundwater in the future. MDA AB in TA-49, which contains some 2300 Ci of Pu-239, is an example. The committee received little information that

## would provide assurance that these sources are well understood or well controlled." [bold print emphasis supplied in NAS report] (p. 32)

The concern of the NAS for locating monitoring wells close to all of the LANL MDAs is described earlier in Section 12.0 of this report. The technically incorrect position of the LANL scientists is that groundwater monitoring at the MDAs is not necessary because of the thickness of the unsaturated zone below the MDAs. The unsaturated zone below the buried wastes at MDA AB is over 1,100 feet thick. However, the large plume of lead contamination in the regional aquifer below MDA AB (see Table 2) is proof that the thick unsaturated zone does not protect the regional aquifer from contamination from the wastes buried in the LANL MDAs. Similarly, the hazardous and radionuclide contaminants measured in water samples produced from well R-22 (see discussion on pages 11 and 12) are proof that the buried wastes in MDA G are contaminating the regional aquifer. The unsaturated zone at MDA G is approximately 890 feet thick. DOE, LANL and NMED must correct the mistake of not installing reliable networks of monitoring wells close to and at appropriate distances away from the LANL MDAs.

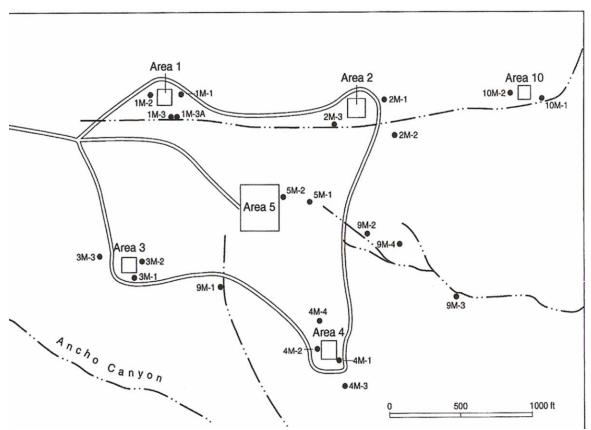
There is a contradiction in the NMED practice of requiring networks of monitoring wells close to the disposal sites at Sandia while allowing monitoring wells to be located great distances away from the disposal sites at LANL.

#### 16.0 References.

- **-** 1. Thorn, Robert N. and Donald R. Westervelt, "Hydronuclear Experiments" Los Alamos National Laboratory Report LA-10902-MS, February 1987
- **-** 2. Levitt, D. G. et al., 2003. "Site Characterization and Monitoring of Technical Area 49 at the Los Alamos National Laboratory" DOE Waste Management 2003 Conference, Tucson, Arizona, Feb 23-27, 2003.
- 3. NAS (National Academies of Science), 2007. "Plans and Practices for Groundwater Protection at the Los Alamos National Laboratory." Report by the NAS Committee for Technical Assessment of Environmental Programs at the Los Alamos National Laboratory. THE NATIONAL ACADEMIES PRESS Washington, D.C.
- **-** 4. Eckhardt, Roger C., 2000. "Yucca Mountain Looking Ten Thousand Years Into The Future" in Los Alamos Science, November 26, 2000.
- **-** 5. Haschke, John, M. etal., 2000. "Reaction of Plutonium Dioxide with Water: Formation and Properties of PuO<sub>2+x</sub>," in Science, Vol 287, January 14, 2000.
- 6. Thompson, Joseph L., 1996. "Radionuclide Sorption on Well Construction Materials." Groundwater Monitoring Review, Summer 1996. pages 163 167.
- 7. Gilkeson, Robert H., 2008. "Properties of the Stainless Steel Screens in the LANL Characterization Wells to Prevent the Detection of Radionuclide and Hazardous Waste Contamination in Groundwater -Revision 1." May 6, 2008.
- **-** 8. Kleinfelder, 2006. "Final Completion Report Characterization Well R-27 Los Alamos National Laboratory" Kleinfelder Project No. 40436, March 2006.

Please contact Robert H. Gilkeson with questions or comments.
Robert H. Gilkeson
Registered Geologist and EPA Credentialed RCRA Groundwater Scientist
P.O. Box 670, Los Alamos, NM 87544
505-412-1930 rhgilkeson@aol.com

**Figure 1.** Map showing the location of the 4 test areas (Area 1, 2, 3 and 4) at LANL MDA AB where legacy mixed wastes are disposed of in unlined shafts from the hydronuclear tests performed in the early 1960's to study the safety of nuclear weapons. Unlined shafts were drilled to depths of 30 ft and 100 ft.



Map Source: Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, January 1995

<ul> <li>Waste Inventory</li> </ul>	Plutonium (lb.)	Uranium-235 (lb.)	Uranium-238 (lb.)
- Area 1	2.34	0.00	137.37
- Area 2	48.6	140.24	171.55
- Area 3	0.00	0.01	0.07
- Area 4	37.57	64.83	63.95

## - Total Waste Inventory

- Plutonium 88.2 lb. ~ 23,000 Ci (includes ~ 20,600 Ci of Pu-241, which has a 14.4-year half-life, and ~ 2300 Ci of Pu-239, which has a 24,000-year half-life)
- Uranium-235 205.07 lb.Uranium-238 374.85 lb.Beryllium 24.26 lb.
- Lead > 198,450 lb. = > 99.25 tons

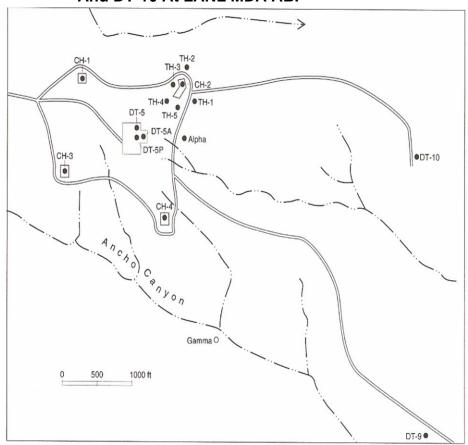


Figure 2. Map Showing The Locations Of The Old Test Wells DT-5A, DT-9 And DT-10 At LANL MDA AB.

- The four areas where the large inventory of wastes are buried are identified on Figure 1.
- The water table of the regional aquifer is approximately 1,185 ft below ground surface at MDA AB. The direction of groundwater flow in the regional aquifer is from west to east.
- Maximum dissolved lead\* measured in well DT-5A was 9,000 ug/L.
- Well DT-5A is approximately 1,100 ft southeast of Area 1.
- Well DT-5A is approximately 800 ft south-southwest of Area 2.
- Well DT-5A is approximately 1,000 ft north-northwest of Area 4.
- Maximum dissolved lead measured in well DT-10 was 55 ug/L.
- Well DT-10 is approximately 4,800 ft east of Area 1, 3,400 feet east of Area 2 and 3,600 feet northeast of Area 4.
- Maximum dissolved lead measured in well DT-9 was 95 ug/L.
- Well DT-9 is approximately 6,000 ft southeast of Area 2, 7,000 feet southeast of Area 1 and 4,500 ft southeast of Area 4.
- The EPA drinking water standard for lead is 15 ug/L (15 parts per billion).
- On September 25, 2008, a LANL spokesman claimed that the 9,000 ug/L dissolved lead in the LANL water quality data base was an entry error, and the analysis was for an unfiltered sample.

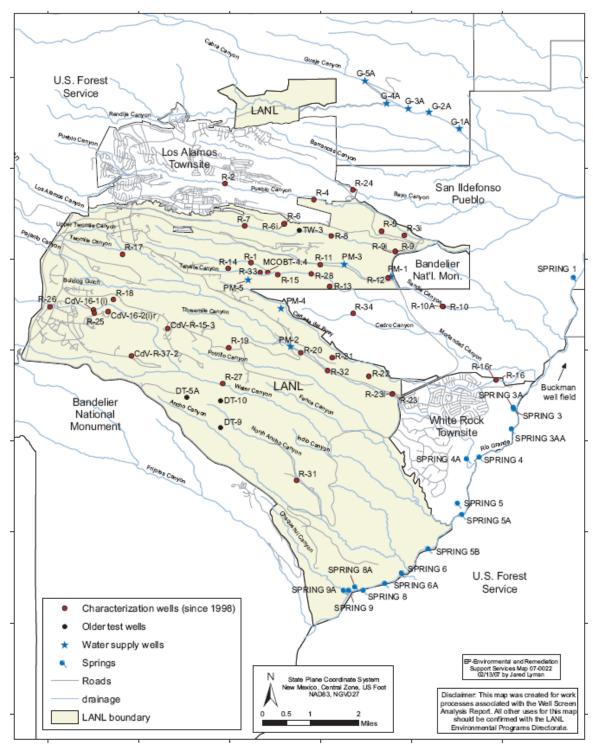


Figure 3. Map showing the locations of R-wells installed in the Regional Aquifer by the LANL Hydrogeologic Workplan Project.

The new LANL characterization wells in the regional aquifer include wells R-1 to R-34, CdV- R-15-3 and CdV-R-37-2. The Los Alamos County G- and PM- series drinking water wells are displayed with star symbols,

Source: LANL Well Screen Analysis Report, Revision-2. LA-UR-07-2852, May, 2007.

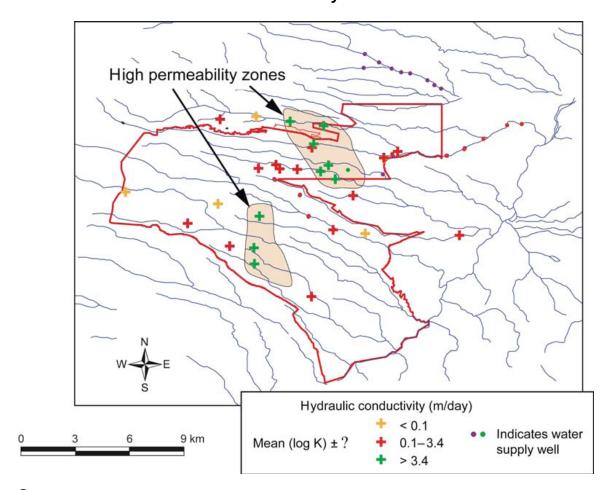


Figure 4. The High Permeability Zones In The Regional Aquifer Below The Los Alamos National Laboratory

Source. Figure 2-26 in LANL Hydrogeologic Synthesis Report, LA-14263-MS, December 2005

The Two High Permeability Zones Are Capable To Provide Large Supplies Of Groundwater To Drinking Water Wells. There Are Supply Wells Installed In The Northern Zone But None In The Southern Zone.

- LANL Legacy Waste Disposal Site MDA AB is located above the Southern High Permeability Zone.
- MDA AB has contaminated the precious groundwater resource with lead and possibly other toxic radioactive and hazardous wastes.
- Wells DT-9 and DT-10 are the two green symbols located inside the southern part of the Southern High Permeability Zone.
- Well DT-5A installed within MDA AB is the red symbol located immediately west of the Southern High Permeability Zone.
- The size of the Southern High Permeability Zone is much larger in all directions and greater than double the size displayed on the above figure. There are no reliable monitoring wells installed in the Zone.