The Factors that Require the Replacement of LANL Monitoring Wells R-6 and R-6i

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Executive Summary. Monitoring wells R-6 and R-6i are examples of the failure of Los Alamos National Security (LANS) to install monitoring wells that are able detect the Los Alamos National Laboratory (LANL) contaminants. There are several reasons well R-6 and R-6i do not meet any of the intended purposes as monitoring wells.

A major mistake for monitoring well R-6 is the mud-rotary drilling method that pushed a very large amount of drilling mud (a mixture of bentonite clay and organic additives) into the sampling zone of the well screen. Removing the drilling muds from the sampling zone is not possible because the hydraulic force that pushed the muds into the sampling zone was more than 25 times greater than the maximum hydraulic force that is available for removing the muds. The drilling muds formed a new mineralogy in the sampling zone with well-known strong chemical properties to mask the detection of important LANL contaminants of concern in the water samples collected from monitoring well R-6.

- The primary purpose of well R-6 was to determine if the LANL radionuclide and metal contaminants that are detected at high concentrations in the shallow alluvium in Los Alamos and DP Canyons (see Figures 1 and 2) have migrated down to the regional aquifer. Well R-6 is not usable for this purpose because of

1). The mud-rotary drilling method,

2). The screened interval is too long; the well screen is 23 feet long and the filter pack extends 21 feet above and 29 feet below the screen, and

3). The top of the well screen is at a depth of 47 feet below the water table and this depth is too great for detection of contamination at the water table.

The New Mexico Environment Department (NMED) Notice of Disapproval (NOD) dated October 15, 2009 for LANL legacy waste disposal site MDA C described the importance to install a well close to the water table with a screen length not greater than 10 feet. The NMED October 15, 2009 NOD also described the importance to install a well at a distance below the water table in the fast pathway aquifer strata present in the upper 100 feet of the regional aquifer. Two new monitoring wells are necessary near the location of well R-6 to investigate LANL contaminants at the top of the regional aquifer and in the fast pathway zone in the upper 100 feet of the regional aquifer.

- Another purpose for well R-6 is detection of LANL contaminants from the many disposal sites for liquid and solid wastes at Technical Area 21 (TA-21). Well R-6 is not usable for this purpose because of the mud-rotary drilling method and because of the great lateral distance of well R-6 away from disposal sites at TA-21. The closest TA-21 disposal site is 2400 feet from well R-6 and the most distant disposal site is 4900 feet from well R-6. The October 15, 2009 NMED NOD for LANL legacy waste disposal site MDA C recognized the importance to install monitoring wells in the regional aquifer at locations as close as possible to the LANL legacy waste disposal sites. The many solid and liquid legacy waste sites at TA-21 occur over an east-west lateral distance of 2500 feet on the mesa top. This great distance requires a network of many monitoring wells installed into the regional aquifer below the large number of legacy waste disposal sites at TA-21 and wells installed east of the legacy waste disposal sites along the direction of groundwater travel.

- Another purpose for monitoring well R-6 is detection of LANL contaminants traveling to Los Alamos County drinking water supply well Otowi-4. Well R-6 is not usable for this

purpose because of the mud-rotary drilling method and because the well screen is not installed deep enough into the regional aquifer. Installation of a new monitoring well is necessary with the well screen installed in an aquifer zone with high permeability at a depth below the top of the screen in supply well Otowi-4. The top of the screen in well Otowi-4 is at depth of 326 feet below the water table as measured in well R-6.

Many LANS reports make a false claim that monitoring well R-6 meets all of the intended purposes that are described above. The reports include the LANL *Well Screen Analysis Report – Revision 2,* the LANL *Environmental Surveillance Reports*, the 2008 and 2009 LANL *Interim Facility-Wide Groundwater Monitoring Plans*, and the 2008 LANL *Los Alamos and Pueblo Canyons Groundwater Monitoring Well Network Evaluation and Recommendations, Revision 1*. **In fact, well R-6 requires replacement with a minimum of three new single-screen monitoring wells installed in the regional aquifer near Los Alamos County drinking water well Otowi-4 and a large network of monitoring wells installed at appropriate locations to investigate groundwater contamination in the regional aquifer below and away from the large number of legacy waste sites at TA-21.**

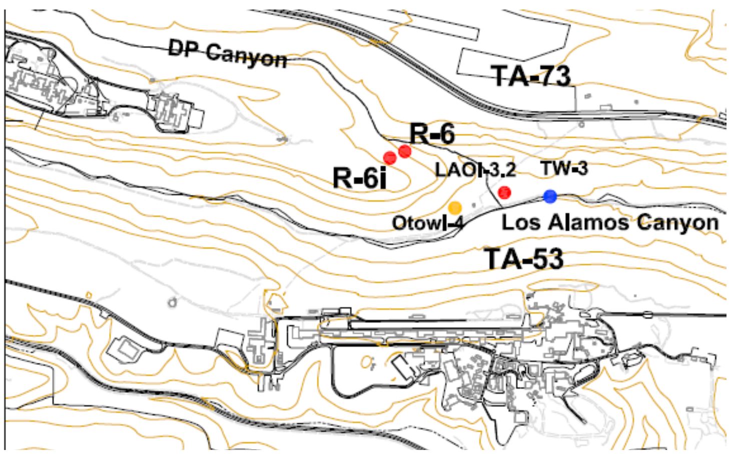
LANL monitoring well R-6i is installed in a perched zone of saturation and is located 20 feet southwest of well R-6 (see Figure 1). The 10 foot long screen is installed in the depth interval of 602 to 612 feet below ground surface. The drilling method invaded the sampling zone in well R-6i with a large quantity of organic drilling foam that was not removed by the well development methods. The drilling additives formed a new reactive mineralogy in the sampling zone with strong properties to mask the detection of trace metals and the LANL radionuclides plutonium and americium. The contaminants detected in well R-6i include perchlorate, tritium, chloride nitrate and sulfate. Other LANL contaminants may be present in the perched zone of saturation but the trends in water quality data are proof that well R-6i is not reliable to detect the full nature and extent of contamination because of the new reactive mineralogy from the organic drilling additives. Well R-6i is not reliable to detect many LANL contaminants including plutonium and americium. **Replacement of LANL monitoring well R-6i is necessary.**

The LANL *Well Screen Analysis Report – Revision 2* (WSAR-2) has made a mistake to assess that monitoring wells R-6 and R-6i are capable of detecting the LANL radionuclide contaminants including isotopes of cesium, plutonium and americium. The WSAR-2 is *still* only a study of the chemistry of the water samples produced from the LANL monitoring wells. However, reports by the author in 2004 and 2005, the Environmental Protection Agency (EPA) Kerr Research Laboratory over the years 2005 to 2009, and the National Academy of Sciences (NAS) in 2007 described the reasons why the study of only water chemistry data cannot determine that any of the LANL monitoring wells impacted by bentonite clay muds and organic drilling additives produce reliable and representative water samples. It is important for the Department of Energy (DOE) to order LANS to retract the badly flawed WSAR-2.

The NAS and the EPA Kerr Lab described the need to perform laboratory and field tests to determine the ability of each of the impacted monitoring wells to produce reliable and representative water samples for detection of the LANL contaminants. In addition, the May 25, 2007 NMED approval letter for the LANL *Well Screen Analysis Report – Revision 2* identified the great uncertainty in the assessment methodology in the report. NMED also recommended for DOE and LANS to perform laboratory and field tests to determine the ability of the impacted monitoring wells to reliably detect the highly adsorptive LANL contaminants and especially the radionuclides including plutonium and americium. **None of the tests have been performed.** It is important for the DOE to order LANS to perform the "push-pull" tracer injection - withdrawal field tests recommended by the EPA Kerr Laboratory in <u>all</u> of the LANL monitoring wells that were drilled with bentonite clay and/or organic additives and are now used by LANS as reliable monitoring wells for LANL contaminants.

Introduction. Figure 1 shows the locations of LANL monitoring wells R-6 and R-6i in DP Canyon ¼ mile northwest of Los Alamos Canyon. Well R-6 was drilled in October of 2004 with the mud-rotary method that pushed a large quantity of drilling muds into the sampling zone for the well. The drilling muds were a mixture of bentonite clay and organic additives. The well development was not able to remove the majority of the drilling muds. The drilling muds created a new highly reactive mineralogy in the screened zone of well R-6 with well known properties to prevent the detection of many LANL contaminants including trace metals, organics, and the strongly sorbing LANL radionuclides including plutonium and americium. The 23-foot long well screen is installed from 1205 to 1228 feet below ground surface (ft bgs). The water table of the regional aquifer is at 1158 ft bgs. The top of the well screen is 47 feet below the water table and too deep to detect contamination at the water table of the regional aquifer.

Figure 1. The location of monitoring wells R-6 and R-6i in the eastern part of TA-21



Scale 0 . . . . 2000 feet

The requirements of Monitoring Well R-6 from page 1 in the LANL Well R-6 Completion Report – LANL Report Kleinfelder Project No. 37151, April 2005:

- "R-6 was installed to determine if radionuclide and metal constituents encountered in the shallow alluvium in Los Alamos and DP Canyons have migrated to the regional aquifer. R-6 will serve as a replacement well for the obsolete monitoring well TW-3 and as an upgradient monitoring point for municipal water supply well Otowi-4."
- "The potential contaminants being investigated in the intermediate and regional aquifers in this area are radionuclides, metals, nitrate, perchlorate, chloride, sulfate, fluoride, and excessive total dissolved solids (TDS), … Water quality, geochemical data, aquifer characteristics, and geologic information obtained from R-6 will augment knowledge of regional subsurface characteristics and contaminant distribution in the regional aquifer downgradient of potential release sites [at TA-21 including the five MDAs A, B, T, U, and V]."

Well R-6 does not meet <u>any</u> of the requirements listed above.

- The screen is installed too deep to monitor contamination at the water table.

- The screen is not installed deep enough to monitor contamination traveling to drinking water supply well Otowi-4. The top of the screened interval in well Otowi-4 is at a depth of 256 feet below the bottom of the screen in well R-6.

- Well R-6 is located too far from the five MDAs (i.e., legacy waste dumps) at TA-21. There are no monitoring wells located close to the five MDAs or the other large liquid waste disposal sites at TA-21 with potential to contaminate the groundwater.

- The mud-rotary drilling method was a mistake. The screened zone in well R-6 is contaminated with bentonite clay and organic additives from the mud-rotary drilling method. The clay and organic additives have created a new highly reactive mineralogy in the screened interval with well-known strong properties to
  - 1). prevent the detection of trace metal, organic and radionuclide contaminants, and
  - 2). lower the permeability of the screened zone.

- The weight of the 1158 foot high vertical column of drilling mud above the water table in the borehole for well R-6 created a very large hydraulic force with the mud-rotary drilling method for pushing a large quantity of the drilling muds (bentonite clay and organic additives) a great distance outward into the aquifer zone sampled by well R-6.

- The well development methods were not capable of removing the drilling muds from the screened interval (i.e., the aquifer sampling zone) in well R-6 because

- **1)** The combined hydraulic force of the column of drilling mud and the mud pump on the mud-rotary drill rig was greater than 500 pounds per square inch (pds/sqin) and
- **2)** The hydraulic force of well development and well rehabilitation methods for removing the drilling mud from the screened zone was less than 20 pds/sqin.
- **3)** Removing the drilling muds from the sampling zone is not possible because of the fact that the hydraulic force that pushed the drilling muds into the sampling zone was more than 25 times greater than the maximum hydraulic force for removing the drilling muds from the sampling zone.

In addition, the LANL *Workplan for R-Well Rehabilitation and Replacement* (LA-UR-06-3687 June 2006) recognized the requirement for the well development activities to remove <u>all</u> of the bentonite clay that was invaded into the aquifer formations in the groundwater sampling zone of the LANL monitoring wells. The pertinent excerpt from the LANL Workplan is pasted below:

> - "If not completely removed by subsequent development, bentonite can serve as both a source of ions to groundwater as well as a sink for sorbing cations [i.e., trace metals and especially the strongly sorbing radionuclides including isotopes of cesium, americium and plutonium] and organic species." (page 3)

The physical facts are proof that only a small portion of the bentonite clay and organic additives were removed from the aquifer zone from which well R-6 produces water. Well R-6 requires replacement with three new monitoring wells that are drilled with the correct application of the dual-rotary casing advance drilling method using only air or potable water as drilling fluids. One well shall be installed near the water table of the regional aquifer, the second well shall be installed in the first aquifer zone with high permeability and the third well shall be installed at an appropriate depth in the regional aquifer as a sentry well for the drinking water supply well Otowi-4. The location of well Otowi-4 is displayed on Figure 1. The pair of R-35 monitoring wells that were installed as sentry wells near Los Alamos County drinking water well PM-3 are the precedent for the three wells that must replace the mud-rotary monitoring well R-6. See the LANL Well R-35(a)(b) Completion Report (LA-UR-07-5324, September 2007).

The LANL well assessment methodology is not credible. The LANL *Well Screen Analysis Report* (WSAR-2) [LANL report LA-UR-07-2852, May 2007] has made a mistake to assign the mud-rotary monitoring well R-6 a high score of 97 out of 100 and the ability to produce reliable and representative water samples for all LANL contaminants [see Table 6-4 in the WSAR-2].

The WSAR-2 and the earlier versions of the Well Screen Analysis Reports were only a study of the chemistry of water samples produced from the approximately 100 screened intervals in the LANL monitoring wells that were invaded with organic or bentonite clay drilling additives. However, reports by Gilkeson, the National Academy of Sciences and the Environmental Protection Agency (EPA) Kerr Research Laboratory (EPA Kerr Lab) informed the LANL scientists repeatedly that the study only of water quality data could not be used to determine that the impacted wells produced reliable and representative water samples. Nevertheless, the WSAR-2 *still* is only a study of water quality data.

The EPA Kerr Lab published a review of the WSAR-2 on March 30, 2009. Pertinent excerpts from the EPA review are pasted below:

- "Although the current versions of the documents [i.e., the WSAR-2] attempt to address several of the issues raised during the previous reviews [by the EPA Kerr Lab], there is still a relatively high degree of uncertainty in the results reported in the WSAR" [emphasis added] (p.1) .
- "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" (p.2).
- "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) [emphasis added]. 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" (p.5).

Monitoring wells R-6 and R-6i are appropriate wells for the "push-pull tests" and for the comparison of water quality data with new wells. The installation of three new single-screen monitoring wells near the location of monitoring well R-6 is necessary because mud-rotary well R-6 is not reliable to detect contamination and the well is not screened in the appropriate aquifer zones for monitoring contamination in the upper part of the regional aquifer or contamination traveling to drinking water well Otowi-4. Well R-6i also requires replacement. See discussion about well R-6i beginning on page 20.

The New Mexico Environment Department (NMED) approval letter for the LANL Well Screen Analysis Report, Revision 2 (WSAR-2) described an important deficiency in the WSAR-2. The April 7, 2007 NMED approval letter described the great uncertainty of the assessment scheme in the WSAR-2 to identify that monitoring wells invaded with bentonite clay (such as well R-6) and/ or organic drilling additives (such as well R-6i) produced reliable and representative water samples for the detection of the highly adsorptive LANL radionuclide contaminants. The pertinent excerpt from the April 7, 2007 NMED approval letter for the WSAR-2 is pasted below:

> "NMED notes that the conclusions obtained in the Report [i.e., the WSAR-2] were derived mainly from analysis of extent data in the literature, possibly under conditions different from the Los Alamos National Laboratory's site (the site). The absence of critical site-specific data, such as adsorption properties, reaction kinetics and microbial activities, implies that there would be uncertainties and limitations in using the methodology developed in the Report to assess the quality of groundwater samples collected from monitoring wells installed at this site. NMED is especially concerned about the uncertainty with respect to monitoring certain potential contaminants of concern, such as the highly adsorptive radionuclides. NMED therefore suggests that the Permittees consider conducting proper laboratory and field studies to address the uncertainty regarding whether or not the monitoring wells installed as the monitoring network are capable of providing reliable data to monitor potential releases of the highly adsorptive radionuclides from operation of the Laboratory to groundwater" (p.1-2).

The highly adsorptive radionuclide contaminants plutonium and americium are a concern for the five MDAs at TA-21 (see Table 2 on page 11) and for the contaminated alluvial sediments in DP and Los Alamos Canyons (see Figure 2 on page 9). There is an immediate need to install the necessary network of monitoring wells in the regional aquifer below the five MDAs and other Solid Waste Management Units (SWMUs) at TA-21 to investigate the nature and extent of groundwater contamination in the regional aquifer from the many decades of disposal of solid and liquid wastes in the MDAs and liquid wastes at many other disposal sites (SWMUs) at TA-21. The drilling method for the monitoring wells must be dual rotary under-reamer casing advance with air and water as the only drilling fluids when drilling in the regional aquifer. The individual sections of the drill casings must be connected with flush joints.

In addition, the statistical methods used in the WSAR-2 are badly flawed even as a study of water quality data from the impacted wells. Indeed, the proper study of the trends over time in the water quality data provides irrefutable evidence that the LANL mud-rotary monitoring well R-6 does not produce reliable and representative water samples for the detection of many LANL contaminants including organics, trace metals and the highly adsorptive LANL radionuclides including americium, plutonium and cesium.

Table 1 presents selected water quality data for the water samples produced from LANL monitoring well R-6. At any specific sampling zone in the regional aquifer, there will be little variation between successive sampling events in the concentrations of dissolved constituents in the *in situ* groundwater. In the absence of plumes of contaminated groundwater, the change that is observed in the measured dissolved concentrations in water samples produced from properly installed and sampled monitoring wells should be limited to the measurement error of the analytical method. This error would be observed as random small increases and decreases in the measured concentrations between successive sampling events. However, the data in Table 1 show a marked trend of decreasing concentrations over time for many of the constituents that are analyzed in the water samples collected from well R-6.

Table 1. RACER[R] water quality data for LANL monitoring well R-6

-	01-05-2005	08-23-2005	11-17-2005	03-01-2006
	FILT / UNF	FILT / UNF	FILT / UNF	FILT / UNF
- Zn (ug/L)		8.7 J, 6.9 J / 12.9, 9.3 J	< 2 U / < 2 U	3.7 J / 12.7, 6
- Mo (ug/L)		2.3, 2.3 / 2.9, 2.9	2.3 / 2.6	2.9 / 2, < 2 U
- Ba (ug/L)		27.1, 26.8 / 26.6, 26	27.3 / 26.5	27.8 / 26.7
- B (ug/L)		23.2 J / 23.8 J	20.4 J / 20.7 J	27.2 J / 26.5 J
- Cl (ug/L)		2495 / 2455	NL / 2600	2420 / 3200
- SO_4 (ug/L)		3200 / 2960	2790 / 3090	2820 / 3540
- N (ug/L)		305, 271 / 265, 248	280 / 233	292 / NL
- Mn (ug/L)		60.7, 59.8 / 59.8, 56.6	36.9 / 32.1	40.4 / 36.8

-	05-11-2006	07-26-2006	04-12-2007	07-17-2007
	FILT / UNF	FILT / UNF	FILT / UNF	FILT / UNF
- Zn (ug/L)	10.2 / 10.3	17.8, 6.4 J / 29.3, 26.1	< 2 U / 8.1 J	2.4 J / 5.3 J
- Mo (ug/L)	3 / 2.3	3, 2.4 / 2.1 J, < 2 U	2.2 J / 2.1 J	2.5 J / < 2 U
- Ba (ug/L)	24.5 / 29	21.8, 21.6 / 21.3, 21.3	21.3 / 21.8	20.7 / 21
- B (ug/L)	28.7 J / 21.2 J	24.1 J / 22.2 J	21.2 J / 21.8 J	26.9 J / 25.8 J
- Cl (ug/L)	2250 / NL	2200 / 2185	2240 / NL	2090 / NL
- SO_4 (ug/L)	2760 / NL	2690 / 2730	2600 / NL	2710 / NL
- N (ug/L)	262 / NL	280, 252 / 246, 240	350 / NL	335 / NL
- Mn (ug/L)	28.2 / 11.5	16, 16 / 17.6, 16.7	14.2 / 15.8	< 2 U / < 2 U

-	01-17-2008	08-27-2008	01-20-2009	07-14-2009
	FILT / UNF	FILT / UNF	FILT / UNF	FILT / UNF
- Zn (ug/L)	79.3? / 57.2?	11.7 J / 9 J	NL / NL	< 10 U / 4.11 J
- Mo (ug/L)	< 1 U / < 1 U	< 1.5 U / < 1.5 U	NL / NL	1.64 / 1.68
- Ba (ug/L)	20.7 / 22.2	20 / 20.4	NL / NL	20 / 19.9
- B (ug/L)	26.6 / 27.3	15.9 J / 16.7 J	NL / NL	17.4 J / 16.9 J
- Cl (ug/L)	2450 / NL	1940 / NL	2060 / NL	2090 / NL
- SO_4 (ug/L)	1268 / NL	2420 J / NL	2510 / NL	2430 / NL
- N (ug/L)	NL / NL	< 89.7 U / NL	350 / NL	< 132 U / NL
- Mn (ug/L)	1.11 / 1.28	< 10 U / < 10 U	NL / NL	< 10 U / < 10 U

- **FILT = filtered water sample UNFILT = unfiltered water sample**
- **Zn = zinc, Mo = molybdenum, Ba = barium, B= boron, Cl = chloride, SO_4 = sulfate**
- **N = nitrate plus nitrite, Mn = manganese**
- **ug/L = micrograms per liter or parts per billion**
- **U = not detected at listed concentration - J = estimated concentration**
- **NL = analytical result not listed in the RACER[R] data base.**
- **01-05-2005 is the date for completion of well development. A water sample was collected on this date but analytical results are not listed in RACER[R].**

- **The high concentrations of zinc in water samples collected on 01-17-08 are uncertain, especially because the dissolved (filtered) concentration is markedly higher than the concentration measured in the unfiltered water sample.**

The trend to decreasing concentrations for the dissolved concentrations of the trace metals zinc, molybdenum, barium and boron is because of the new reactive mineralogy that was created in the sampling zone by the drilling muds that contained bentonite clay and organic additives.

- Zinc in filtered water samples declines by > 80 % from 10.2 ug/L on May 11, 2006 to not detected (< 2 ug/L) on November 17, 2005, April 12, 2007 and July 14, 2009.

- Molybdenum in filtered water samples declines by > 70% from 3 ug/L on May 11, 2006 to not detected (< 1 ug/L) on January 17, 2008.

- Barium in filtered water samples declines by > 25% from ~27 ug/L in the first three sampling events to 20 ug/L on July 14, 2009.

- Boron in filtered water samples declines by ~ 37% from ~27 ug/L in many sampling events to ~ 17 ug/L on July 14, 2009.

The measured decline in the dissolved concentrations of the naturally occurring trace metals is evidence that monitoring well R-6 does not produce reliable and representative water samples for detection of the LANL trace metal contaminants or for the detection of the highly adsorptive radionuclides that are a concern at the location of the well.

The elevated levels of dissolved manganese in the water samples produced from monitoring well R-6 during 2005 and 2006 are direct evidence that the organic drilling additives were a fuel for enhanced activities by bacteria to create a new reactive mineralogy in the sampling zone. The data in Table 1 show a large decline over time of greater than 95% for the measured concentrations of dissolved manganese. The decline is from 60 ug/L on August 25, 2005 to 1.11 ug/L on January 17, 2008.

In addition, the large decline in measured dissolved nitrate concentrations and large change in measured nitrate concentrations between successive sampling events is also evidence of the enhanced activities by bacteria to create a new reactive mineralogy in the sampling zone of monitoring well R-6. The measured nitrate concentration declines from greater than 300 ug/L for many sampling events to less than 90 ug/L (not detected) on August 27, 2008 and less than 132 ug/L (not detected) on July 14, 2009. The low concentrations of nitrate measured in the most recent water samples are evidence that enhanced microbial reactions are still occurring in the sampling zone of well R-6.

Furthermore, the moderate decline over time in the measured concentrations of dissolved sulfate may also be evidence of enhanced activities by bacteria. However, the bentonite clay drilling muds were also a source for elevated concentrations of sulfate in the early water samples collected from well R-6.

The mud-rotary monitoring well R-6 is not reliable for detection of LANL contamination present in the wet alluvial sediments present in DP Canyon and Los Alamos Canyon that have migrated to the regional aquifer. An important requirement at the location of monitoring well R-6 is accurate knowledge of groundwater contamination in the regional aquifer from the highly adsorptive radionuclide contaminants americium and plutonium and also strontium-90. These contaminants are measured in the groundwater samples collected from the water saturated alluvial sediments along DP Canyon east of TA-21 and at the confluence of DP Canyon with Los Alamos Canyon . The one mile long zone of radionuclide contamination in the alluvial sediments beginning at drinking water well O-4 and along DP Canyon west of the confluence with Los Alamos Canyon is displayed on Figure 2 on the next page.

Figure 2. Figure 5-11 in *Environmental Surveillance at Los Alamos During 2008*

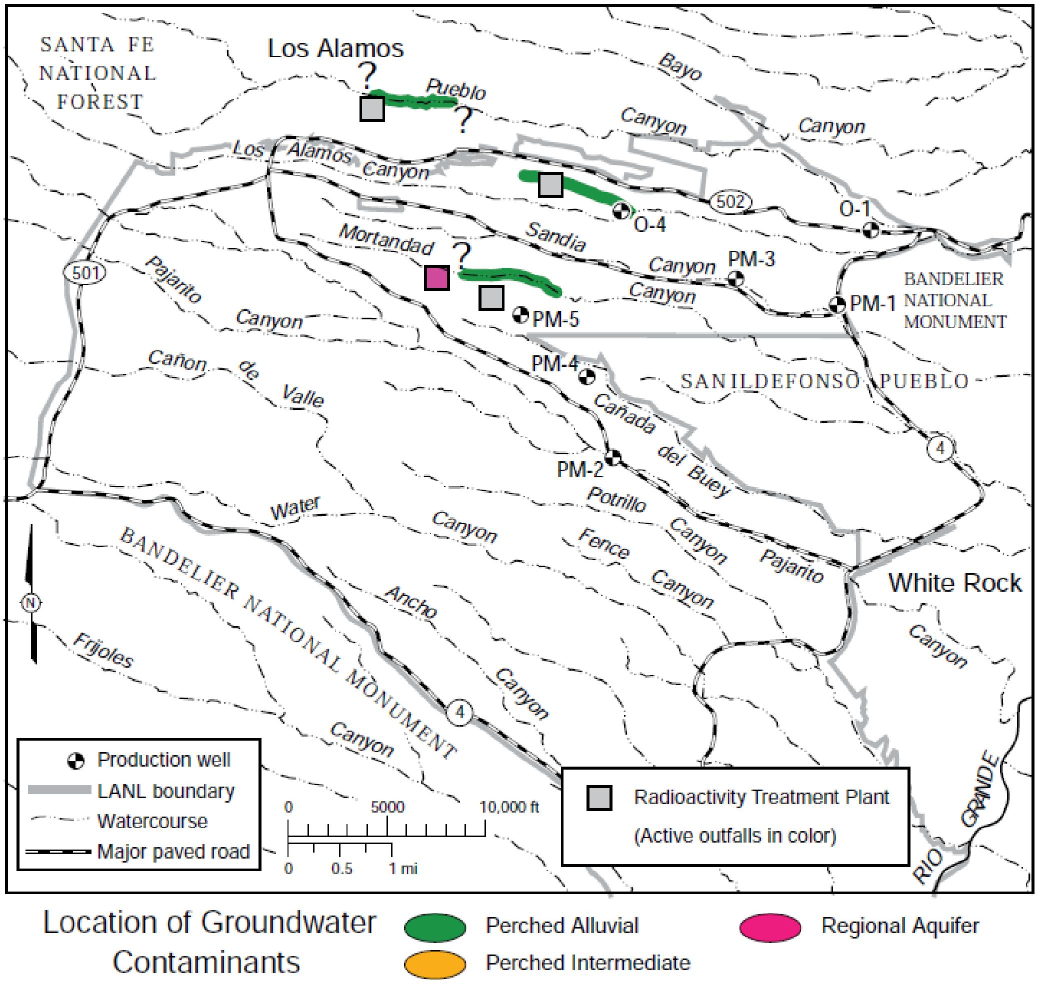


Figure 5-11. **Location of groundwater contaminated by radioactivity: areas indicated have the sum of radioactivity from a DOE source (that is, Sr-90, Pu-238, Pu-239/240, and Am-241) above the 4-mrem/yr DOE DCG screening level (the 4-mrem/yr DOE DCG applies only to drinking water, not to alluvial groundwater). Different colors indicate the affected groundwater zones. Question marks indicate where contaminant extent is inferred but not confirmed by monitoring coverage.**

Figure 1 on page 3 of this report shows that well R-6 is located west of drinking water well O-4 in the green zone on Figure 2 where alluvial sediments are contaminated with high concentrations of isotopes of plutonium, americium and strontium.

The LANL scientists informed the National Academy of Sciences that travel times for contaminated liquids from below the wet canyons to the regional aquifer are only a few decades. From the NAS Final Report:

> **-** “Travel time of liquids from waste sources in the wet canyons to the regional groundwater is predicted to be relatively short (LANL, 2003; Nylander et al., 2003). The presence of anthropogenic contaminants in regional groundwater confirms that beneath wet canyons at least some vadose zone pathways have travel times on the order of a few decades (Birdsell et al., 2005; Robinson et al., 2005c). Data suggest vertical transport velocities of up to 9 m/yr (30 ft/yr) in Mortandad Canyon.

Laboratory-derived contaminants (tritium, perchlorate) released in liquid effluents in Los Alamos and Pueblo Canyon have reached the regional aquifer and are present in [drinking water well] Otowi-1" (page 37 in the 2007 NAS Final Report).

However, the factors that prevent LANL Monitoring Well R-6 from detection of the LANL radionuclide contamination known to be present in the saturated alluvial sediments at the location of well R-6 are the following:

- The screen is installed too deep below the water table of the regional aquifer.
- The 73-foot long screened interval is too long and will cause dilution of contamination.
- The mud-rotary drilling method invaded the screened zone (i.e. aquifer sampling zone) with a large quantity of bentonite clay and organic additives with well known strong properties to prevent the detection of the LANL contaminants of concern that are present in the saturated alluvium.

There is an immediate need to replace monitoring well R-6 with three new monitoring wells; one well installed near the water table of the regional aquifer, a second well installed in the first aquifer zone with high permeability, and a third well installed at an appropriate depth to monitor contamination traveling to the Los Alamos County drinking water well Otowi-4 (O-4). Well O-4 is the most productive drinking water supply well in the network of supply wells for Los Alamos County. The precedent for the three monitoring wells that must be installed near well O-4 are the two monitoring wells R-35a and R-35b that were installed in 2007 as sentry wells for the Los Alamos County drinking water supply well PM-3. The locations of wells O-4 and PM-3 are displayed on Figure 2. It is important to drill the new sentry wells for drinking water supply well O-4 with dual rotary casing advance drilling methods that only use air and water during drilling into the regional aquifer.

Well R-6 is too far away from the five legacy waste dumps (MDAs) at TA-21. Figure 3 on page 12 displays the locations of the five MDAs at TA-21. The direction of groundwater travel in the regional aquifer below TA-21 is from west to east toward monitoring well R-6. The necessary field tests to measure the lateral speed of groundwater travel in the regional aquifer below TA-21 have not been done. The best estimate of groundwater travel in the regional aquifer is described as follows in the LANL Environmental Surveillance Report that was published in 2008:

- "Groundwater velocities [in the regional aquifer] vary spatially but are typically 30 ft/yr [30 feet per year]." (from page 133)

Regional aquifer monitoring well R-6 is the closest hydraulically downgradient monitoring well to the five legacy waste dumps at TA-21. However, the lateral distance between well R-6 and the five TA-21 dumps is too great. The time for groundwater in the regional aquifer to travel from below each of the five legacy waste dumps (i.e., MDAs) to monitoring well R-6 is summarized below with travel time based on a groundwater lateral velocity of 30 feet/year:

TA-21 MDA	Distance From MDA to Well R-6	Groundwater Travel Time
- B	3900 to 4850 feet	130 to 160 years
- V	3800 feet	125 years
- T	3000 feet	100 years
- A	2800 feet	95 years
- U	2400 feet	80 years

In the 2007 National Academy of Sciences (NAS) Final Report on the LANL Groundwater Protection Practices, the LANL scientists consider the five MDAs at TA-21 listed above to have "a significant potential to contaminate groundwater with radionuclides." The pertinent discussion from page 21 of the NAS Final Report is pasted below:

- "LANL considers that 9 of its 25 MDAs have a significant potential to contaminate groundwater with radionuclides. Of the nine MDAs considered significant, the inventory for two [MDA U and MDA V at TA-21] is "unknown" (see Table 3.2)."

Note: Five of the nine MDAs listed in Table 3.2 in the NAS report (Table 2 in this report) are located at TA-21.

Table. 2 *TABLE 3.2** *Nine of 25 Principal Material Disposal Areas at LANL*

Material Disposal Area (MDA)	Location (Technical Area)	Period of Operation	Key Radionuclide Inventory
- A	21	1944-1978	Pu ~ 701 Ci, Am ~ 1.5 Ci
- B	21	1945-1952	Pu ~ 6.22 Ci, Sr-90 ~ 0.285 Ci, Cs ~ 0.005 Ci
- T	21	1945-1986	Pu ~ 182 Ci, Am ~ 3740 Ci, U ~ 6.9 Ci
- U	21	1948-1976	Unknown (Am, Cs, Pu, tritium, Sr, U)
- V	21	1945-1961	Unknown (Am, Cs, Pu, Sr-90, U, tritium)
- AB	49	1959-1961	Pu ~ 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), U ~ 0.246 Ci
- C	50	1948-1974	Tritium ~ 20000 Ci, Sr-90 ~ 21 Ci, U ~ 25 Ci, Pu ~ 26 Ci, Am ~ 145 Ci
- G	54	1957-1997**	Am ~ 2360 Ci, Cs ~2810 Ci, Tritium ~ 3,610,000 Ci, Pu ~ 16,000 Ci, Sr-90 ~ 3500 Ci, U ~ 124 Ci
- H	54	1960-1986	Tritium ~ 240 Ci, Pu ~ 0.0267 Ci, U ~ 75.2 Ci

***Table 3.2 is from the NAS Final Report on the LANL Groundwater Protection Practices**

**** (Parts of MDA G remain active today for disposal of radioactive wastes as "Area G")**

- **Ci = Curies of radioactivity**
- **Pu = plutonium, Am = americium, Sr = strontium, Cs = Cesium, U = uranium**

The record for the radioactive wastes and hazardous wastes disposed of in the legacy waste dumps at TA-21 is poorly known. Table 2 lists the radioactive waste inventory at TA-21 legacy waste dumps U and V as "unknown." Also, Table 2 does not provide information on the hazardous wastes disposed of in the TA-21 legacy waste dumps.

In addition, MDA T at TA-21 and also the disposal well known as "dry well" SWMU 21-02(b) are RCRA "regulated units" because hazardous wastes were disposed of into the two waste disposal sites after July 26, 1982. However, monitoring well R-6 is located too far from the two "regulated units" at TA-21 for early detection of groundwater contamination as required by the state and federal laws. A later section of this report presents the RCRA regulations that require monitoring well networks at MDA T and at the TA-21 disposal well [i.e., SWMU 21-02(b)] that meet the requirements in RCRA 40 CFR Sections 264.91 through 264.100.

Further discussion from the 2007 NAS Final Report:

> "LANL has given generally lower priority to understanding and controlling its solid waste emplacements than its liquid waste discharges. While LANL presented a clear rationale for doing so, dealing with these solid wastes will become technically more challenging and economically more demanding as time progresses. Over time, waste materials will degrade and become more vulnerable to leaching. Contaminants will migrate away from the wastes, thereby contaminating an increasingly larger volume in the subsurface." (page 21 to 23),
>
> **"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."** (page 32)
>
> **"Findings and Recommendations on Monitoring and Data Quality - General Findings.** Any monitoring activity faces a conundrum: If little or no contamination is found, does it mean that there is in fact little or no contamination, or that the monitoring itself is flawed? During this study the committee was presented a good deal of information suggesting that most or all wells into the regional aquifer at LANL (R-wells) are flawed for the purpose of monitoring. The committee did not disagree, but rather found a lack of basic scientific knowledge [in the LANL *Well Screen Assessment Reports*] that could help ensure future success. Evidence about the conditions prevalent around the screens in the compromised wells is indirect—relying on plausible but unproven chemical interactions, general literature data, analyses of surrogates, and apparent trends in sampling data that may not be statistically valid." (page 60)
>
> ***"Recommendation: LANL should design and install new monitoring wells with the following attributes:***
> - ***A borehole drilled through the monitoring zone without the introduction of drilling muds or additives (i.e., use air or water),***
> - ***One screened interval that targets a single saturated zone, and***
> - ***A carefully planned design (length and depth) of the well screen, which is confirmed with information collected in the drilling process."*** (page 69)

The locations of the five legacy waste dumps at TA-21 are displayed below on Figure 3. There is an immediate need to install an appropriate network of monitoring wells at TA-21 to investigate and monitor groundwater contamination from the legacy waste dumps and also from the other disposal sites at TA-21 where large volumes of liquid wastes were disposed of in seepage pits, disposal wells and sumps.

Figure 3. (MDAs) at TA-21 and their SWMU numbers.

- **MDA B (SWMU 21-015), MDA V (SWMU 21-018), MDA T (SWMUs 21-016, 21-010, 21-011), MDA A (SWMU 21-014), and MDA U (SWMU 21-017).**

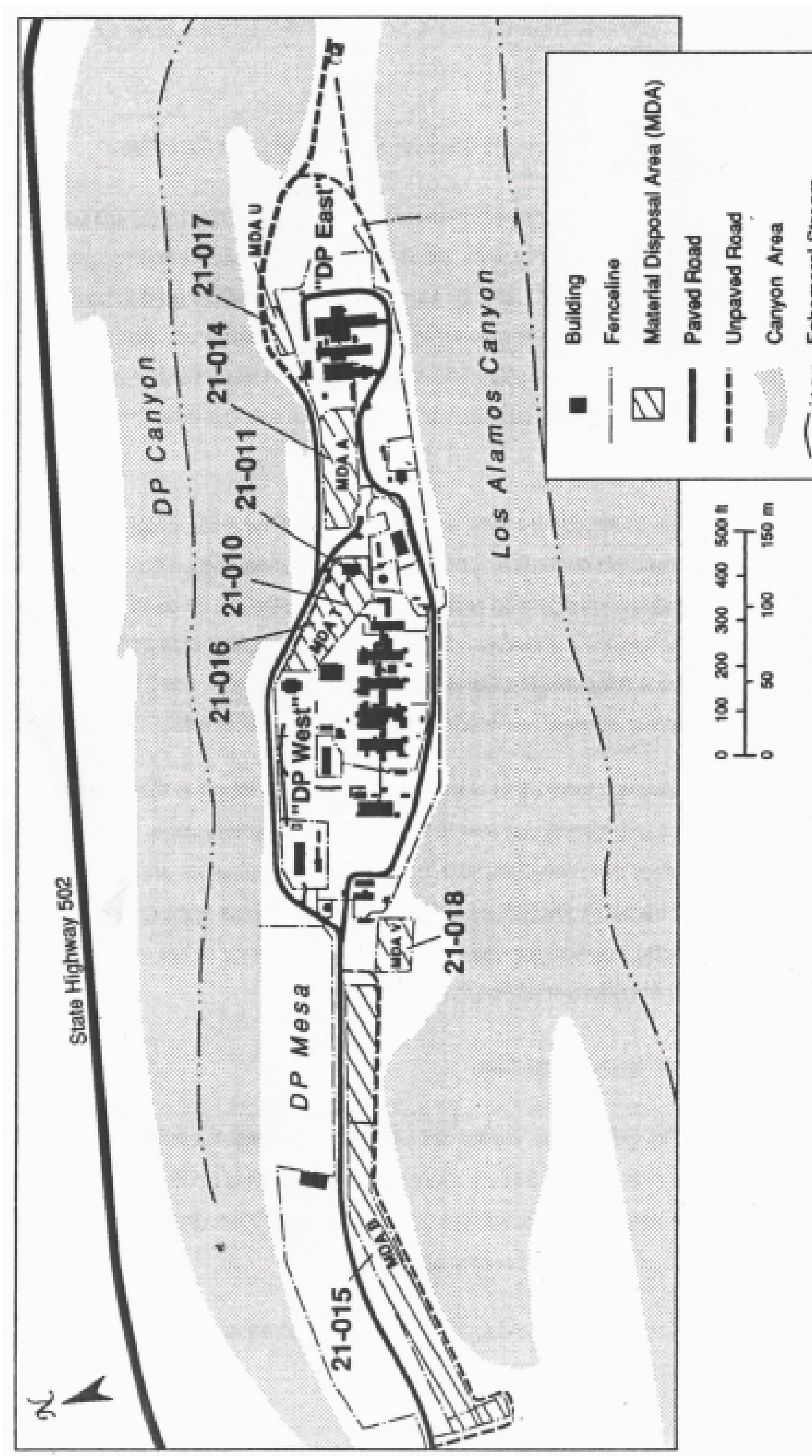


Fig. 16.1-1 Location of MDAs (and their SWMU numbers) and associated structures at TA-21.

<u>The history of waste disposal to surface impoundments and shafts at MDA T</u>.
MDA T is a 2.21 acre legacy waste dump and RCRA "regulated unit" where wastes were disposed of from 1943 through 1985. Liquid wastes were disposed of in four surface impoundments at MDA T beginning in "about 1945." Records show that liquid wastes were discharged to the impoundments at MDA T until 1965. In addition, the disposal of slurry wastes to disposal shafts at MDA T started in May of 1968 and continued until 1983 (See page 16 - 173 in the TA-21 RFI Workplan). The disposal activities are summarized in the excerpts pasted below from the LANL TA-21 RCRA Facility Investigation (RFI) Workplan (LANL ER Report, May 1991):

> "The shafts were augered starting on May 1, 1968, and were used to dispose of cement paste wastes from liquid waste treatment processes at Building 257. Forty-nine of the shafts were 2.4m (8 ft) in diameter. , , Thirteen of the shafts were 1.8 m (6 ft) in diameter" (page 16 – 96 in the TA-21 RFI Workplan).
>
> "The operation of filling these shafts involved mixing wastes such as "neutralized americium," "strip," alkaline fluoride and plant sludge with cement in a pug mill operation at Building 257 [i.e., the liquid waste treatment plant] and discharging the slurry to the asphalt lined shafts. In addition, some shafts during certain intervals received unspecified volumes of wash water" (page 16 – 97 in the TA-21 Workplan).
>
> "(A) number of drums of mixed waste were also stored along the fence south of TA-21-257 for about 1 year. . . From 1968 until 1983, disposal operations at TA-21-257 included a direct flow system which was used to pipe radioactive wastes mixed with cement from TA-21-257 to asphalt-lined disposal shafts at MDA T. During certain periods, (i.e., during routine maintenance of the cement-waste piping system, drilling additional disposal shafts, etc.), the wastes that were generally disposed of at MDA T were drummed and stored at the southwest corner" (from page 16 – 172 in the TA-21 RFI Workplan).
>
> "Highly acidic solutions were also delivered to TA-21-257 in 270 gal. tanker trailers. Most of these wastes were treated by neutralization in special stainless steel, water-cooled tanks. Batch wastes that required the greatest treatment were those that had high –dissolved solids or were highly acidic. Treatment of these types of batch wastes included neutralization with 50 % sodium hydroxide, then mixing with cement in a pug mill, and finally, pumping the cement paste to asphalt-lined shafts at MDA T. <u>This type of disposal was in operation from 1968 until 1983 when it was discontinued</u>" [emphasis added] (from page 16 – 173 in the TA-21 RFI Workplan).

The regulatory requirements under RCRA for the RCRA "regulated unit" MDA T are described below. These RCRA requirements also apply to the "regulated unit" disposal well (SWMU 21-02(b) that disposed of liquid waste discharges from the former steam plant during the period of 1980 to 1985.

- **RCRA 40 CFR 264 Subpart F—Releases From Solid Waste Management Units**
  - §264.90(a)(2). All solid waste management units must comply with the requirements in §264.101. A surface impoundment, waste pile, and land treatment unit or landfill that receives hazardous waste after July 26, 1982 (hereinafter referred to as a "regulated unit") must comply with the requirements of §§264.91 through 264.100 in lieu of §264.101 for purposes of detecting, characterizing and responding to releases to the uppermost aquifer.

<u>The history of the disposal of the blowdown waste water from the TA-21 former steam plant that operated from 1945 to 1985 – SWMU 21-02(b)</u>. The liquid wastes discharged from the former steam plant to surface impoundments, seepage pits and the injection well (i.e., SWMU 21-02(b) are described in the excerpts pasted below from the TA-21 RFI Workplan:

> "The former steam plant was constructed between May 1, 1945, and September 1, 1945. For several years, boiler blowdown (pressurized discharge of gaseous steam from the boiler) was discharged from the building into two concrete steam blowdown pits adjacent to the south side of the steam plant. . . In 1971, boiler blowdown was routed to a 2500-gal. blowdown tank. The tank released overflow liquid into a 6-ft square by 2-ft deep seepage pit filled with river stones". . . (page 17-37 in TA-21 RFI Workplan).
>
> "In May 1980, a dry well [SWMU 21-02(b)] was installed south of the blowdown tank to replace the seepage pit. . . The dry well [i.e., disposal well] was 4-ft square by 54-ft deep" (page 17-37 in TA-21 RFI Workplan).
>
> "The old steam plant was removed in 1985 and was replaced by the new steam plant, TA-21 -357" (page 17-40 in TA-21 RFI Workplan).
>
> "The contaminant source term represented by steam plant blowdown is unknown. Common constituents in boiler blowdown include sulfite and copper salts to control dissolved oxygen and to catalyze the oxidation of manganese, and chromates as scale inhibitors, respectively" (page 17-40 in TA-21 RFI Workplan).

The "former steam plant" was in operation from September, 1945 until 1985. The blowdown water from the former steam plant was contaminated with RCRA hazardous waste constituents. The actual amount of blowdown water and the contaminant source term in the blowdown water is not accurately known. However, for the five year period from May 1980 until 1985, the blowdown water was discharged to a 54-foot deep injection well identified as "dry well" SWMU 21-02(b).

<u>RCRA hazardous wastes were disposed of in SWMU 21-02(b) after JULY 26, 1982 and until 1985. Accordingly, the "dry well" SWMU is a RCRA "regulated unit" and must comply with the groundwater characterization and monitoring requirements in 40 CFR §§264.91 through 264.100.</u>

In addition, an earlier section of this report presented the disposal activities at the legacy waste dump MDA T that continued until 1985.

<u>RCRA hazardous wastes were disposed of in the shafts at MDA T after JULY 26, 1982 and until 1985. Accordingly, the legacy waste dump SWMU is a RCRA "regulated unit" and must comply with the groundwater characterization and monitoring requirements in 40 §§264.91 through 264.100.</u>

Furthermore, the RCRA regulations and the New Mexico regulations require detection of contamination beneath the "regulated units" and the legacy waste disposal sites – not far away from the MDAs and SWMUs as is the current situation for TA-21– thus resulting in a more expensive and prolonged cleanup.

Specifically, it is a mistake that the NMED Consent Order does not identify the need to characterize and monitor groundwater contamination from injection well SWMU 21-02(b) and from MDA T because they are RCRA “regulated units.” However, the Consent Order is an “enforceable document” under RCRA and the requirement of the Consent Order to comply with the groundwater monitoring requirements in 40 CFR §§264.91 through 264.100 are described in 40CFR § 270.1(c)(7) and § 265.121. The regulations are pasted below:

PART 270—EPA ADMINISTERED PERMIT PROGRAMS: THE HAZARDOUS WASTE PERMIT PROGRAM

§ 270.1 Purpose and scope of these regulations.
– Part 270.1(c). Owners and operators of hazardous waste management units must have permits during the active life (including the closure period) of the unit. Owners and operators of surface impoundments, landfills, land treatment units, and waste pile units that received waste after July 26, 1982, or that certified closure (according to § 265.115 of this chapter) after January 26, 1983, must have post-closure permits, unless they demonstrate closure by removal or decontamination as provided under § 270.1(c)(5) and (6), or obtain an enforceable document in lieu of a post-closure permit, as provided under paragraph (c)(7) of this section *[paragraph 270.1(c)(7) is pasted below*]. If a post-closure permit is required, the permit must address applicable 40 CFR part 264 groundwater monitoring, unsaturated zone monitoring, corrective action, and post-closure care requirements of this chapter. The denial of a permit for the active life of a hazardous waste management facility or unit does not affect the requirement to obtain a post-closure permit under this section.

– Paragraph 270.1(c)(7). *Enforceable documents for post-closure care.* At the discretion of the Regional Administrator, an owner or operator may obtain, in lieu of a post-closure permit, an enforceable document imposing the requirements of 40 CFR 265.121.

40 CFR § 265.121 Post-closure requirements for facilities that obtain enforceable documents in lieu of post-closure permits.

– § 265.121(a)(3). <u>The [groundwater characterization and monitoring] requirements of 40 CFR 264.91 through 264.100</u> [emphasis added].

– § 265.121(b)(1). The Regional Administrator, in issuing enforceable documents under § 265.121 in lieu of permits, will assure a meaningful opportunity for public involvement which, at a minimum, includes public notice and opportunity for public comment: (i) When the Agency becomes involved in a remediation at the facility as a regulatory or enforcement matter; (ii) On the proposed preferred remedy and the assumptions upon which the remedy is based, in particular those related to land use and site characterization; and (iii) At the time of a proposed decision that remedial action is complete at the facility. These requirements must be met before the Regional Administrator may consider that the facility has met the requirements of 40 CFR 270.1(c)(7), unless the facility qualifies for a modification to these public involvement procedures under paragraph (b)(2) or (3) of this section.

The serious deficiencies in the NMED Consent Order Section IV.C.2.e.ix. MDA T Groundwater Monitoring. The inappropriate groundwater monitoring requirements in the Consent Order for MDA T and the other four legacy waste dumps at TA-21 are pasted below:

> **MDA T Groundwater Monitoring. Section IV.C.2.e.ix.1.** Groundwater samples shall be obtained from Los Alamos Canyon monitoring wells LAO-1.6(g), LAO-2, LAO-3A, LAO-4.5C, LAO-5, LAO-6, LAO-6A, LAUZ-1, LAUZ-2, LADP-3, R-9i, R-5, R-7, R-8, R-9, TW-3, and any wells installed in the future determined by the Department to be required and at the frequency described in Section XII of this Consent Order. As described in Section IV.B.1.b.iv, TW-3 shall be plugged and abandoned according to the procedures in Section X.D. Groundwater shall be monitored from TW-3 until the well is properly abandoned. (from page 109 in the Consent Order).

The regional aquifer monitoring wells in the above list are wells R-5, R-7, R-8, R-9 and old test well TW-3. Monitoring well R-6 was installed to replace well TW-3. The locations of wells R-6 and TW-3 are displayed on Figure 1. All of the wells are displayed below on Figure 4. However, it is very important to understand that **none** of the six regional aquifer monitoring wells listed in the NMED Consent Order are at appropriate locations for monitoring groundwater contamination beneath MDA T or the other legacy waste MDAs at TA-21. The lateral distances from the center of MDA T to the inappropriate monitoring wells listed in the NMED Consent Order are summarized below:

Monitoring Well	**- Direction and Distance From MDA T** **- Groundwater travel is to the east**	**Groundwater Travel Time at 30 feet per year.**
- R-6	**east ~ 3000 feet**	**100 years**
- TW-3	**east ~ 4700 feet**	**160 years**
- R-8	**east ~ 8300 feet**	**275 years**
- R-5	**east ~ 13600 feet**	**450 years**
- R-9	**east ~ 15400 feet**	**510 years**
- R-7	**southwest ~ 850 feet - well R-7 is located in Los Alamos Canyon hydraulically cross- gradient from TA-21 and hydraulically upgradient from MDA T**	

The NMED Consent Order has made a serious mistake to stipulate that the above six monitoring wells are usable to detect groundwater contamination from the legacy waste dumps and other SWMUs at TA-21. In addition, it is a serious mistake that the NMED Consent Order does not require the necessary studies to understand the physical properties of the aquifer strata below TA-21 and the direction and velocity of lateral groundwater travel below and away from TA-21. The above knowledge is a requirement of RCRA 40 CFR §§264.91 through 264.100.

In addition, the NMED Consent Order has made a mistake to not recognize the danger for groundwater contamination from the large number of SWMUs at TA-21 that disposed of liquid wastes for a period longer than 40 years.

Figure 4. The network of monitoring wells and drinking water supply wells at the Los Alamos National Laboratory.

Source: LANL *Well Screen Analysis Report – Revision 2* (LA-UR-07-2852, May 2007)

- Liquid Wastes Disposed of to TA-21 SWMU 21-006(b) Underground Seepage Pit. The underground seepage pit TA-21 -118 [i.e., TA-21 SWMU 21-006(b)] may have been installed in 1945 as a part of new plutonium extraction facilities at TA-21 -2. The inlet line, TA-21 -134, originated from the east side of Building TA-21 -2 and ran south to the pit. The trench for the seepage pit was 16 ft by 70 ft, with a depth of 6 ft. Ether wastes from processes to purify plutonium were disposed of in the seepage pit. The pertinent excerpt describing the disposal operations to the seepage pit is pasted below:

> "It **is** suspected that given the size of the seepage pit, and even though the inlet pipe was only 3 in. in diameter, the volume of ether waste fed into the seepage pit was quite large" (page 17-17 in the TA-21 RFI Workplan).

The years of operation and the nature and volume of liquid wastes disposed of in the SWMU 21-006(b) underground seepage pit are not accurately known.

- Liquid Wastes Were Disposed of to five Underground Seepage Pits – TA-21 SWMUs 21-006(a), 21-006(c), 21-006(d), 21-006(e), and 21-006(f). The five underground seepage pits are located close to the buildings that are being removed with the Recovery Act. Pertinent excerpts from the TA-21 workplan are pasted below:

> "Five underground liquid waste holding sumps (SWMUS 21-022(b)-(e), (g) were located along the north side of the plutonium-processing complex at TA-21 (Fig. 18.8-1). During removal of these sumps in 1979-1980, extensive contamination around and beneath the sumps was documented. <u>Leakage of plutonium-bearing liquid wastes over the nearly 40-yr history of some of the sumps may have resulted in considerable migration of contaminants into the subsurface</u>" . [emphasis added] (from page 18-37 in the TA-21 RFI Workplan).

> **"SWMU 21-006(a)** is described as an unmarked, underground seepage pit, approximately 0.1 acre, located between buildings TA-21 -2 and TA-21 -3 (LASL 1978). This pit was used to dispose of liquids from the Hanford container washing operation" (from page 18-10 in the TA-21 RFI Workplan).

> **"SWMU 21-006(c)** is 15 ft outside of the door to the bomb cleaning room 322, at Building TA-21 -3. This seepage pit reportedly received "bomb electrolytic decontamination solution" from a drain in Room 322, which may have been contaminated with plutonium (Tribby 1947). The length of time this seepage pit was used is not known" (from page 18-10 in the TA-21 RFI Workplan).

> **"SWMU 21-006(d)** may be associated with a concrete pad and French drain system called the TA-21-272 dock. Waste from a second story chemical make-up room was dumped or pumped into a stone-filled seepage pit (Walker 1979; Maraman and Christensen 1987) somewhere in the area. No other information regarding this seepage pit is available" (from page 18-10 in the TA-21 RFI Workplan).

> **"SWMU 21-006(e)** may be located south of BuildingTA-21-4. The location of this seepage pit is unclear. No other information regarding this potential release-site exists. Seepage pit, SWMU 21-O06(e), may be the same release-site as seepage pit, SWMU 21-006(f)" (from page 18-13 in the TA-21 RFI Workplan).

"SWMU 21-006(f) has been described as a gravel seepage pit located on the south side of the DP West complex (Tnbby 1947) (Fig. 18.2-1). This seepage pit may have received up to 4,000 L per day of hydrogen fluoride waste water effluent from a hydrofluorination process located in Room 413, the southernmost room of Building TA-21-4 (Tribby 1947). Wastewater from this seepage pit may have emptied into Los Alamos Canyon, although how this occurred is unknown. The length of time this seepage pit was used is also not known" (from page 18-13 in the TA-21 RFI Workplan).

"SWMUS 21-022(b)-(e) are brick sumps constructed to receive liquid wastes before disposal and to provide a point where samples could be collected. . . Each sump was approximately 5 ft 5 in. in diameter and 10-ft deep" (from page 18-13 in the TA-21 RFI Workplan).

The historical record of the large inventory of solid and liquid wastes disposal at TA-21 over a period longer than 40 years is proof of the need to install a network of monitoring wells in the regional aquifer below the waste disposal sites at TA-21 to characterize the geologic setting and investigate the nature and extent of groundwater contamination.

- **LANL Monitoring Well R-6i.** The drilling and well construction activities for monitoring well R-6i were in December of 2004. The well is installed in a perched zone of saturation and is located 20 feet southwest of well R-6 (see Figure 1). The 10 foot long screen is installed in the depth interval of 602 to 612 feet below ground surface. The drilling method pushed a large quantity of organic drilling foam into the sampling zone of well R-6i. The organic foam was not removed by the well development methods. The organic foam formed a new reactive mineralogy in the sampling zone with strong properties to prevent the detection of trace metals and the LANL radionuclides plutonium and americium.

The elevated levels of dissolved manganese in the water samples produced from monitoring well R-6i during 2005 and 2006 are direct evidence that the organic drilling additives were a fuel for enhanced activities by bacteria to create a new reactive mineralogy in the sampling zone with strong properties to bind up the strongly adsorptive radionuclides. The low oxidation reduction potential (ORP) values measured in most water samples are also evidence of chemical reactions that are formed a new reactive mineralogy in the sampling zone of well R-6i. The oxidation-reduction potential of the *in situ* groundwater is expected to be above 300 mV and a value this high was only measured in the most recent water sample collected on July 14, 2009.

The contaminants detected in well R-6i include perchlorate, tritium, chloride, nitrate and sulfate. Other LANL contaminants may be present in the perched zone of saturation but the trends in water quality data in Table 3 are proof that well R-6i is not reliable to detect the full nature and extent of contamination because of the new reactive mineralogy from the organic drilling additives.

The declining trends for the dissolved concentrations of the trace metals zinc, boron and barium presented in Table 3 for water samples collected from well R-6i are summarized below:

- Zinc in filtered water samples declines by 70 % from 22 ug/L on August 24, 2005 to 6.7 ug/L on July 14, 2009.

Table 3. RACER[R] water quality data for LANL monitoring well R-6i

-	02-21-2005	08-24-2005	11-17-2005	03-01-2006
	FILT / UNF	FILT / UNF	FILT / UNF	FILT / UNF
- Zn (ug/L)		24.6, 19 / 72.1, 22	12.9 / 18.1	16.5 / 28.5
- ClO4 (ug/L)		5 / 8.15, 4.9	NL / 7.4, 6	NL / 7.28, 5.5
- H-3 (pCi/L)		NL / 4212	NL / 4272	NL / 4365
- B (ug/L)		22 / 21	16.8J / 16.2J	23.4J / 26
- Ba (ug/L)		32.3. 30 / 35.4, 34	35.2 / 30.7	33.3 / 36.2
- Cl (ug/L)		19200 / 19100	17100 / 19300	17700 / 21000
- SO_4 (ug/L)		13200 / 14400	12300 / 13300	12000 / 14600
- N (ug/L)		3530 / 3580	3770 / 3720	4870 / NL
- Mn (ug/L)		11 / 10.4	18.9 / 24.3	6.7 J / 29.4
- ORP (mV)		NL / 116	NL / 100	NL / 120

-	05-11-2006	07-26-2006	04-12-2007	07-17-2007
	FILT / UNF	FILT / UNF	FILT / UNF	FILT / UNF
- Zn (ug/L)	12.4 / 13.2	45.7? / 9.6 J	14.3 / 6.4 J	6 J / 7.3 J
- ClO4 (ug/L)	NL / 9.5J, 6.6	8.32, 6.5J / NL	8.6J, 7.04 / NL	7J, 6.87 / NL
- H-3 (pCi/L)	NL / 4250	NL / 4333	NL / 4230	NL / 4060
- B (ug/L)	22.3J / 24.2J	20.5J / 10.3J	21.8J / 20.4J	22J / 24.5J
- Ba (ug/L)	29.2 / 23.8	26.1 / 24.3	24.8 / 25.2	26.3 / 26.5
- Cl (ug/L)	17600 / NL	17400 / 17400	18000 / NL	17000 / NL
- SO_4 (ug/L)	11000 / NL	9860 / 10000	9690 / NL	9140 / NL
- N (ug/L)	3450 / NL	4970 / 4990	4740 / NL	4780 / NL
- Mn (ug/L)	6.4 J / 20	4.5 J / 4.4 J	2.2 J / 2.4 J	2.2 J / 2.2 J
- ORP (mV)	NL / 90	NL / 120	NL / 157	NL / 157

-	01-23-2008	08-27-2008	01-20-2009	07-14-2009
	FILT / UNF	FILT / UNF	FILT / UNF	FILT / UNF
- Zn (ug/L)	14.1 / 13.4	14 / 13.9	NL / NL	6.65 J / 7.02 J
- ClO4 (ug/L)	7.51, 7.47 / NL	7.51, 7.47 / NL	6.62, 6.39 / NL	7 / NL
- H-3 (pCi/L)	NL / 3830	NL / 3176, 3080	NL / 3880, 3770	NL / 3230
- B (ug/L)	23.5J / 22.7J	16.1J / 16.4J	NL / NL	16.1 J / 17 J
- Ba (ug/L)	23.8 / 23.7	23.1 / 23.3	NL / NL	22.7 / 22.7
- Cl (ug/L)	16600 / NL	15900 / NL	16800, 16700 / NL	16600 / NL
- SO_4 (ug/L)	9095 / NL	8600 / NL	9210, 9200 / NL	8860 / NL
- N (ug/L)	4860 / NL	4450 / NL	4080, 4050 / NL	4570 / NL
- Mn (ug/L)	< 10 U / < 10 U	2.6J,<10U / 3.1J, 2.6J	NL / NL	< 10 U / < 10 U
- ORP (mV)	NL / 208	NL / 125	NL / 227	NL / 383

- FILT = filtered water sample UNFILT = unfiltered water sample
- Zn = zinc, ClO4 = perchlorate, H-3 = tritium, B = boron, Ba = barium, Cl = chloride, SO_4 = sulfate, N = nitrate plus nitrite, Mn = manganese,
- ug/L = micrograms per liter or parts per billion
- ORP = oxidation reduction potential mV = millivolts
- U = not detected at listed concentration J = estimated concentration
- NL = analytical data not listed in RACER data base
- 02-21-2005 is the date for completion of well development and aquifer testing. A water sample was collected on this date but analytical results are not listed in RACER[R].

- Barium in filtered water samples declines by > 30% from 33.3 ug/L on March 1, 2006 to 22.7 ug/L on July 14, 2009.

- Boron in filtered water samples declines by > 25 % from 22 ug/L on August 24, 2005 to ~ 16.1 ug/L on July 14, 2009.

The measured decline in the dissolved concentrations of the naturally occurring trace metals zinc, barium and boron is evidence that monitoring well R-6i is not reliable to detect many of the LANL contaminants including the highly adsorptive radionuclides plutonium and americium.

In fact, Table 6-4 in the WSAR-2 concluded well R-6i was not reliable to detect zinc and barium, and therefore, the well is also not reliable to detect the strongly adsorbing radionuclides plutonium and americium that are contaminants of concern in the perched zone where monitoring well R-6i is installed. The discussion in the text of the WSAR-2 required the reliable detection and accurate measurement of the trace metals zinc and barium as the proof that the monitoring wells impacted with organic drilling additives were able to detect the strongly adsorbing radionuclide contaminants (see discussion on page 34 in the WSAR-2).

Many LANS reports misrepresent that monitoring well R-6i is reliable to detect LANL contaminants that are traveling down to the perched zone from the contaminated alluvial sediments along DP and Los Alamos Canyon. The region of contamination in the two canyons is shown on Figure 2. The reports that make a mistake about the ability of well R-6i to detect the LANL contaminants, and especially plutonium and americium include the LANL *Environmental Surveillance Reports*, the 2008 and 2009 LANL *Interim Facility-Wide Groundwater Monitoring Plans*, and the 2008 LANL *Los Alamos and Pueblo Canyons Groundwater Monitoring Well Network Evaluation and Recommendations, Revision 1*.

In fact, the trends over time in the water quality data produced from well R-6i are proof that the well is not reliable to detect the LANL contaminants and the well requires replacement with a new single-screen monitoring well installed in the perched zone of saturation near the present location of the defective and unreliable monitoring well R-6i.

In addition, there is a need to install a new reliable monitoring well east of well R-6i in the perched zone of saturation close to supply well Otowi-4 and there is a need to install at least one new reliable monitoring well in the perched zone of saturation at an appropriate location west of well R-6i in DP Canyon. Accurate knowledge of the travel of contaminated groundwater downward below the contaminated setting in DP Canyon is very important. LANS has not installed reliable monitoring wells to accomplish that objective. The groundwater samples produced from well R-6i are proof that LANL contaminants are traveling downward a distance of greater than 600 feet below DP Canyon. The nature and extent of the contamination is not known at the present time

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