Defective Groundwater Protection Practices at the Sandia National Laboratories' Mixed Waste Landfill – The Sandia MWL dump.
- Version January 22, 2011

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1.7. There are two zones of saturation below the Sandia MWL dump that require networks of monitoring wells. A reliable network of monitoring wells was not installed in either of the two zones.

1.7.1. The upper zone that requires a network of monitoring wells for early detection of contamination is the water table in the fine-grained alluvial fan sediments.

1.7.2. The deeper zone that requires a network of monitoring wells is the large groundwater producing zone in the Ancestral Rio Grande "A" Deposits (ARG Deposits) that are located below the layer of fine-grained alluvial fan sediments

1.8. Three important reports in the NMED Administrative Record (AR) show that all of the monitoring wells presented for the dirt cover remedy decision at the NMED December 2004 public hearing were defective and required replacement.

1.8.1. The "inadequate" monitoring well network in the 1993 NMED Report by Mr. Moats and Mr. Winn is the same network that was presented as "reliable" by Mr. Moats at the December 2004 Public Hearing.

1.8.2. The 1994 EPA Region 6 NOD Report recognized that the monitoring well network presented at the December 2004 Public Hearing was defective and did not prove the MWL dump had not contaminated the groundwater below the dump.

1.8.3. The 1998 NMED NOD Report identified major deficiencies in the DOE/Sandia Phase 2 RFI Report for the Sandia MWL dump. The deficiencies were not resolved.

2.0. The defective monitoring wells at the Sandia MWL dump were described in many expert reports in the NMED Administrative Record.

2.1. Defective monitoring wells MWL-MW1, -MW2, -MW3 and -BW1.

2.2. Defective monitoring wells MWL-MW5 and -MW6.

2.3. Defective monitoring well MWL-MW4.

3.0. The six contaminant detection monitoring wells in the current monitoring well network at the MWL dump fail to meet their intended purpose and require replacement.

3.1. The mistakes in the drilling and installation of the new monitoring wells MWL-MW7, -MW8, -MW9 and -BW2 render them useless for generating an accurate water table map and for detection of groundwater contamination from the Sandia MWL dump.

3.2. The water levels in the new monitoring wells MWL-MW7, -MW8, and -MW9 are too deep for the three wells to detect contamination at the water table and to measure the elevation of the water table.

3.3. Unreliable groundwater samples have been collected on a quarterly schedule from the three new defective monitoring wells MWL-MW7, -MW8 and -MW9 for a very large and expensive analytical suite.

3.4. DOE/Sandia made a mistake to use the erroneous deep water levels measured in the defective monitoring wells MWL-MW7, -MW8 and -MW9 to construct an incorrect water table contour map for the Sandia MWL dump.

3.5. The mistakes made in the drilling method, drilling operations and well design for monitoring wells MWL-MW7, -MW8, -MW9 and -BW2.

3.5.1. Use of the Air Rotary Casing Hammer (ARCH) drilling method was a mistake.

3.5.2. The careful drilling operations required by the NMED NOD Letter and the NMED Consent Order were not implemented for drilling the borehole for monitoring well MWL -BW2.

3.5.3. The drilling operations for monitoring well MWL-BW2 did not accurately locate the elevation of the water table in the fine-grained alluvial fan sediments as the borehole was drilled.

3.5.4. The careful drilling operations required by the NMED Consent Order were not implemented for drilling the boreholes for wells MWL-MW7, -MW8 and -MW9.

3.6. The incorrect well screen length of 30 feet in the four new monitoring wells MWL-MW7, -MW8, -MW9 and -BW2.

3.7. Conclusions about the current network of defective monitoring wells at the Sandia MWL dump.

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4.0. The NMED staff and DOE/Sandia staff provided incorrect testimony at the December 2004 public hearing and in many reports that there was a reliable network of monitoring wells at the Sandia MWL dump.

4.1. The NMED HWB was a partner with DOE/Sandia in the misrepresentation that there was a reliable network of monitoring wells at the Sandia MWL dump.

4.2. The NMED has failed to the present time to invalidate the incorrect information furnished by DOE/Sandia from the defective monitoring wells.

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5.0. Examples of documents in the NMED Administrative Record about the defective monitoring wells at the Sandia MWL dump.

5.1. Report #1. The 1991 DOE Tiger Team Assessment Report of monitoring activities at the Sandia National Laboratories Albuquerque Facility.

5.2. Report #2. The 1991 Los Alamos National Laboratory Report (NMED AR 003746) about the defective monitoring well network.

5.3. Report #3. The 1993 NMED report by Moats and Winn (NMED AR 006421) about the inadequate monitoring well network.

5.4. Report #4. The 1994 NMED DOE Oversight Bureau Review of the Sandia MWL dump 1993 Phase 2 RCRA RFI Work Plan (NMED AR 006462).

5.5. Report #5. The 1994 EPA Region 6 Notice of Deficiency (NOD) Report (NMED AR 006433).

5.6. Report #6. The 1998 NMED Notice of Deficiency (NOD) Report (NMED AR 010983).

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6.0. The staff of the NMED Hazardous Waste Bureau and DOE/Sandia provided incorrect testimony at the December 2004 public hearing on the Sandia MWL dump contrary to the facts in the NMED Administrative Record.

6.1. DOE/Sandia and NMED staff provided identical testimony at the December 2004 public hearing that did not accord with the NMED Administrative Record.

6.2. The NMED December 2004 Public Hearing and Final Order for the dirt cover remedy relied on the unusable water quality data from the defective monitoring well network at the Sandia MWL dump.

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7.0 Violations of environmental laws at the Sandia/DOE MWL dump have resulted from failure to enforce the April 29, 2004 Compliance Order on Consent (Consent Order) [1] and regulations adopted under the Resource Conservation and Recovery Act (RCRA).

7.1. The NMED HWB has not enforced the requirement in RCRA and the NMED 2004 Sandia Consent Order for a network of monitoring wells to be installed in the ARG Deposits below and downgradient of the Sandia MWL dump.

7.2. Requirements in the NMED Sandia Consent Order and RCRA that apply for installation of a Groundwater Monitoring Network in the ARG Deposits.

7.3. Corrective Action Requirements for Groundwater Monitoring of the ARG Deposits are not being met for protection of public health and the environment. 40 CFR 264.101.

7.4. A reliable network of monitoring wells was not installed at the water table below and downgradient from the Sandia MWL dump.

7.5. The Continued Acceptance and Failure to Invalidate the Flawed Data from the Defective Monitoring Wells for NMED Decision Making Violate both the Consent Order and RCRA.

7.6. The NMED admission that groundwater flow at the water table is to the southwest requires the installation of a reliable network of monitoring wells along the southern and western boundary of the MWL dump. (40 CFR 264.95).

7.7. The violation of public participation requirements.

7.8. The improper classification of the MWL dump as a "SWMU" and failure to provide a Post-Closure Plan. 40 CFR 264.118.

7.9. The Continuing Failure to Require Replacement of Defective Monitoring Wells MWL-MW4, -MW5, and -MW6 violates the Consent Order Section VIII.A and 40 CFR 264 Subpart F.

7.10. The NMED has violated the Consent Order Section VIII.A by not Requiring Replacement of Monitoring Wells MWL-MW7, -MW8 and -MW9.

7.11. RCRA requires the Compliance Monitoring Program at the Sandia MWL dump.

7.12. Contamination is present in the groundwater from the wastes buried in the Sandia MWL dump.

7.13. Consent Order Section IX.A Sampling of Groundwater.

7.14. Well Purging Consent Order Section IX.B.

7.15. The NMED has not required vadose zone monitoring beneath the MWL dump.

7.16. The Fate and Transport Model that currently relies on assumed values rather than hard data from vadose zone and other characterization should be abandoned.

7.17. Requirements to be met for Compliance with the Consent Order for the Sandia MWL dump:

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8.0. RCRA criteria indicate that the nickel contamination measured in the ground-water samples collected from the Sandia MWL dump monitoring wells MWL-MW1 and -MW3 are from the nickel wastes buried in the Sandia MWL dump.

8.1. The anomalous high concentrations of nickel measured in the groundwater samples collected from monitoring wells MWL-MW1 and MW3 are evidence of groundwater contamination from the nickel wastes buried in the MWL dump.

- Section 9 Pages 107 – 142
9.0. The methodology and conclusions of the NMED November 2006 Moats Report lack scientific basis, are known to be incorrect, and the Moats Report should be retracted.

9.1. The NMED 2006 Moats Report did not consider many important factors for why the seven monitoring wells at the Sandia MWL dump were defective and required replacement.

9.2. The NMED 2006 Moats Report evaluation methodology was rejected by the Environmental Protection Agency and the National Research Council.

9.3. The NMED 2006 Moats Report studied the median concentrations of the water quality data.

9.4. The NMED 2006 Moats Report did not study the dissolved constituents in the groundwater samples collected from the MWL dump monitoring wells.

9.5. The NMED 2006 Moats Report used unreliable and inaccurate background water quality data.

9.6. Four of the monitoring wells at the MWL dump had corroded stainless steel screens that prevented the detection of groundwater contamination.

9.7. The use of high-flow purging and sampling methods to collect groundwater samples several days later from the Sandia MWL dump monitoring wells prevented the detection of groundwater contamination from the wastes buried in the dump.

9.8. The groundwater contamination from the wastes buried in the Sandia MWL dump.

9.8.1. The nickel groundwater contamination from the Sandia MWL dump.

9.8.2. The chromium groundwater contamination from the Sandia MWL dump.

9.8.3. The cadmium groundwater contamination from the Sandia MWL dump.

9.8.4. The nitrate groundwater contamination from the Sandia MWL dump.

9.9. The NMED November 2006 Moats Report's conclusions are incorrect and ignore the many reasons that the groundwater monitoring wells were unreliable.

9.10. The NMED should retract the NMED November 2006 Moats Report without opportunity for revision.

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10.0. The new large release of contamination to the vadose zone below the unlined trenches and pits at the Sandia MWL dump was not investigated and is contrary to expectations.

10.1. The conceptual model recognized that the high tritium concentrations measured in the 2008 field investigation results were evidence of a new large release of tritium contamination from the wastes buried in the Sandia MWL dump.

10.2. The DOE/Sandia 2008 Vadose Zone Report [68] incorrectly states that no boreholes in the 1995 RCRA RFI Investigation were located inside the MWL dump.

10.3. The isopleth contour maps in the DOE/Sandia 2008 Vadose Zone Report [68] are not representative of the tritium contamination in the vadose zone below the Sandia MWL dump.

10.4. The 1994 and 2008 field investigations did not characterize the nature and vertical extent of Volatile Organic Compound (VOC) contamination in the vadose zone beneath the unlined trenches and pits at the Sandia MWL dump.

10.5. The limited knowledge from historic measurement of solvent contamination below the Sandia MWL dump in the 1994 RCRA RFI Investigations.

10.5.1 The characterization of VOC contamination in the vadose zone below the northern part of the unclassified area of the MWL dump is inadequate.

10.5.2. The characterization of VOC contamination in the vadose zone below the southern part of the unclassified area of the MWL dump is inadequate.

10.5.3. The characterization of VOC contamination in the vadose zone below the classified area of the MWL dump is inadequate.

10.6. The missing inventory of the wastes buried in four of the disposal pits in the classified area of the MWL dump.

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11.0. The DOE/Sandia proposed *Long-Term Monitoring and Maintenance Plan* does not provide protection to the groundwater below the Sandia MWL dump.

11.1. The proposed groundwater monitoring well network in the DOE/Sandia *Long-Term Monitoring and Maintenance Plan* is inadequate.

11.1.1. The current network of monitoring wells is defective to monitor at the water table and requires replacement.

11.1.2. A reliable network of monitoring Wells is required at the water table below the Sandia MWL dump but was not installed.

11.1.3. A reliable network of Monitoring Wells is required in the ARG Deposits at the Sandia MWL dump.

11.2. The proposed soil gas monitoring well network in the unsaturated zone below the Sandia MWL is technically unsupportable.

11.2.1. The proposed network of three vadose zone monitoring wells is not adequate to protect groundwater from contamination from the solvent and tritium wastes buried in the Sandia MWL dump.

11.3. The proposed soil moisture monitoring in the unsaturated zone is not effective.

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12.0. The DOE/Sandia fate and transport computer modeling does not accurately predict the groundwater contamination from the highly toxic wastes buried in the Sandia MWL dump.

12.1. The DOE/Sandia 2007 FTM Report does not recognize the groundwater contamination that has been present for more than the past 20 years from the wastes buried in the MWL dump.

12.2. The monitoring well network installed at the Sandia MWL dump during the Phase 2 RCRA Facility Investigation (RFI) was defective and all of the monitoring wells required replacement.

12.3. The DOE/Sandia 2007 FTM Report does not recognize the cadmium contamination in the groundwater below the MWL dump.

12.4. The DOE/Sandia 2007 FTM Report ignored the computer modeling that predicted tetrachloroethene (PCE) contamination in the groundwater below the MWL dump.

12.4.1. The PCE contamination predicted to be in the groundwater below the MWL dump is known to cause cancer from drinking the water.

12.5. The 2007 FTM Report 1). omits knowledge of the existing groundwater contamination and 2). omits knowledge of the defective monitoring well network.

- Appendices

Appendix A
Garcia, Benito M., October 30, 1998. New Mexico Environment Department Notice of Deficiency Report for the DOE/Sandia *Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation (RFI), Sandia National Laboratories, Albuquerque, New Mexico.*

Appendix B
Moats, William P. and Lee Winn, 1993. *Review Of Groundwater Monitoring At Sandia National Laboratories Mixed Waste Landfill*
AIP/DOE Oversight Group
Hazardous & Radioactive Materials Bureau
New Mexico Environment Department
March 1993

Appendix C
April 04, 2007 Email from Bennett Sample Pumps, Inc. informing Citizen Action New Mexico that Bennett groundwater sampling pumps can be modified with a flow valve for low-flow purging and sampling of the monitoring wells at the Sandia Mixed Waste Landfill (Sandia MWL dump).

Appendix D. Electronic Copy Only
Goering, T.J., G.M. Haggerty, D. Van Hart, and J.L. Peace, 2002. *Mixed Waste Landfill Groundwater Report, 1990 through 2001, Sandia National Laboratories, Albuquerque, New Mexico,* SAND2002-4098, Sandia National Laboratories, Albuquerque, New Mexico.

Appendix E.
Sandia MWL dump monitoring well field records for drilling wells MWL-MW7, -MW8, -MW9 and -BW2.

Appendix F.
Nickel and chromium water quality data in Goering et al., (2002) for monitoring wells MWL-MW1, -MW2, -MW3 and -BW1.

Appendix G.
Background water quality data for metals and total nitrate in the new background water quality monitoring well MWL-BW2.

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1.0. Introduction and Overview. Sandia National Laboratories Albuquerque, New Mexico Facility (Sandia) is owned by the U.S. Department of Energy (DOE) and is located on Kirtland Air Force Base. The Sandia Albuquerque Facility is regulated by the Federal Resource Conservation and Recovery Act (RCRA). The New Mexico Environment Department (NMED) has the responsibility to enforce RCRA. This report documents the past and ongoing non-enforcement of environmental laws by the NMED Hazardous Waste Bureau (HWB) required by the NMED SANDIA April 29, 2004 Compliance Order on Consent [1] (Consent Order) and RCRA for groundwater protection at the Sandia Mixed Waste Landfill (MWL or MWL dump).

1.01. The wastes buried in the unlined trenches and pits at the Sandia MWL dump have contaminated the groundwater. The monitoring well network installed at the Sandia MWL dump did not meet RCRA regulatory standards for many reasons that are described in this report. Only two of the nine contaminant detection monitoring wells (i.e., wells MWL-MW1 and -MW3) were capable of detecting groundwater contamination from the MWL dump. A review of the water quality data from the two monitoring wells MWL-MW1 and MWL-MW3 shows that the wastes buried in the MWL dump have contaminated the groundwater with cadmium, chromium, nickel and nitrate beginning in 1990. The determination that the MWL dump has contaminated the groundwater is from the comparison of the water quality data from monitoring wells MWL-MW1 and -MW3 to the water quality data from the original background monitoring well MWL-BW1 and the new background monitoring well MWL-BW2. The contaminants cadmium, chromium, nickel and nitrate are detected in the two monitoring wells MWL-MW1 and -MW3 beginning in 1990 using RCRA criteria. The exact amount of the four contaminants in the groundwater and the presence of other groundwater contamination is not known because a reliable monitoring well network was not installed from the first four monitoring wells installed in 1988 and 1989 to the most recent four new monitoring wells installed in 2008. The groundwater contamination is described in Section 9.8.

1.02. The Sandia MWL dump is misnamed a "mixed waste landfill" in DOE/Sandia and NMED reports. The Sandia MWL dump was not in compliance with the regulatory requirements of RCRA to be permitted to operate as an engineered landfill for disposal of mixed or hazardous wastes. The unlined pits and trenches are therefore most appropriately referred to as the Sandia MWL dump. In fact, the Sandia MWL dump was named the "TA-3 low-level radioactive waste dump" during the 30 years of waste burial operations from March 1959 through December 1988 [2]. The name of the TA-3 dump was arbitrarily changed to "mixed waste landfill" in reports issued by DOE/Sandia after April 1988 [3].

The location of the 2.6 acre Sandia MWL dump in Technical Area 3 (TA-3) at Sandia is displayed on Figure 1. Figure 2 is a map of the unlined disposal trenches in the 2 acre unclassified area and the unlined disposal pits in the 0.6 acre classified area of the MWL dump. Figure 3 is an enlarged view of the disposal pits in the classified area. Figure 4 is an aerial picture of the MWL dump in 1987. Figure 5 is a picture taken in 1987 of wastes dumped into the unlined Trench F in the southwestern quadrant in the unclassified area of the MWL dump.

1.1. The waste disposal operations at the Sandia MWL dump did not comply with federal RCRA regulations for hazardous waste landfills that became law in 1976. Commingled hazardous and mixed wastes were buried in the Sandia MWL dump during the thirty years of disposal operations from March 1959 through December 1988 [2]. The wastes at the MWL dump were disposed of in unlined trenches up to 20 feet deep and unlined pits up to 25 feet deep [3]. The waste disposal practices were not protective of public health and safety. To qualify as a "landfill", RCRA regulations require 40 CFR 264.301 as follows:

– 1. A liner on the bottom and sides of each disposal trench and pit,

– 2. A leachate detection and leachate collection and removal system above the liner on each disposal trench and pit.

– 3. Operation and maintenance of the leachate collection and removal systems during the active life of the waste disposal facility and during the closure and post-closure care periods,

– 4. Design, construction, operation, and maintenance of a run-on control system capable of preventing flow of surface water into the active trenches and pits during peak discharge from at least a 25-year storm.

– 5. Design, construction, operation, and maintenance of a run-off management system to collect and control at least the water volume resulting from a 24-hour, 25-year storm.

– 6. Installation and maintenance of a reliable network of groundwater monitoring wells that at a minimum includes three downgradient contaminant detection monitoring wells located close to the boundary of the waste disposal facility in the uppermost aquifer and one upgradient background water quality monitoring well. The network of monitoring wells is required during the active life of the waste disposal facility and during the closure and post-closure care periods and

– 7. Installation and maintenance of a reliable network of soil gas monitoring wells at appropriate locations below the unlined trenches and pits for the early detection of the release of contaminants from the unlined trenches and pits. A network of soil gas monitoring wells is important at the Sandia MWL dump because the distance to groundwater below the unlined disposal trenches and pits is greater than 450 feet.

None of the RCRA landfill requirements listed above were provided at the Sandia MWL dump.

- Liners were not installed on the bottom or sides of the trenches and pits
- There was no leachate detection and leachate collection system at the bottom of the unlined trenches and pits.
- No contaminant detection soil gas monitoring wells were ever installed in the unsaturated zone (vadose zone) below the unlined trenches and pits.
- No reliable network of groundwater monitoring wells was provided to detect groundwater contamination from the MWL dump.
- The monitoring well network in the proposed long-term monitoring plan [4] is also unreliable and prevents the detection of contamination in the vadose zone below the unlined trenches and pits and in the groundwater below the MWL dump. The defective proposed long-term monitoring plan is discussed in Section 11.

The description of the Sandia MWL dump as a landfill in reports by DOE/Sandia and NMED is incorrect and misleading. An example is the mischaracterization of the MWL dump functions as a landfill in testimony by DOE staff person, Mr. John Gould, at the NMED December 2004 Public Hearing. The testimony was provided to bolster the NMED recommendation to leave the large inventory of commingled chemical and radioactive wastes buried in the Sandia MWL dump below a dirt cover. Examples of Mr. Gould's testimony follow:

> Landfills have a purpose. The purpose of landfills is to contain waste and isolate it to prevent impacts on human health and the environment (v. I, p. 34, l.17, 18 & 19).
>
> Also, we have found no evidence whatsoever that the mixed waste landfill has contaminated groundwater (v. I, p. 37, l.9 & 10).
>
> Also, this landfill is functioning as a landfill as it's designed to function (v. I, p. 38, l.2 & 3).
>
> We've done two studies to determine where it is [i.e., the tritium contamination in the vadose zone below the MWL dump]. We determined this material is not moving, it has a half-life of about 12-and-a-half years and is rapidly decaying away. As a result, we don't think it makes sense to excavate a landfill that's functioning as *a* landfill is intended to function (v. I, p. 38, l.2 & 3).
>
> In summary, the mixed waste landfill is functioning as a landfill is intended to function, it's not posing a threat to human health and the environment at this time, and we believe we can adequately monitor this landfill to assure that it does not cause a problem with human health or the environment in the future (v. I, p. 39, l.17 to 23).

<u>Comment from the authors:</u> Mr. Gould is correct that "<u>The purpose of landfills is to contain waste and isolate it to prevent impacts on human health and the environment.</u>" However, the historical record shows design and operation of the Sandia "mixed waste landfill" as a <u>dump.</u> Wastes were often not inventoried and were randomly cast into the dump in paper cartons, plastic bags and wooden crates. DOE/Sandia and the NMED have not recognized that the monitoring well data show the release of wastes buried in the MWL dump have contaminated the groundwater with cadmium, chromium, nickel and nitrate. In addition, the DOE/Sandia computer modeling studies in 1995 [79] and 2007 [2] identified that the wastes released from the MWL dump have contaminated the groundwater with the highly toxic solvent tetrachloroethene (PCE). The substandard monitoring wells are not reliable to detect the PCE contamination in the groundwater. The nature and extent of the groundwater contamination from the wastes released from the MWL dump is not known because a reliable network of monitoring wells was not installed.

Mr. Gould's testimony that the dump is not releasing tritium contamination is incorrect. The DOE/Sandia Field Investigation performed in 2008 [68] discovered a new large release of tritium contamination from the unlined trenches and pits in the MWL dump. The large release of tritium is evidence that the dump may have released other contamination. The required investigation to determine the nature and extent of the new contamination was not performed. This issue is discussed in Section 10.

1.2. There is great uncertainty in the amount and type of wastes buried in the Sandia MWL dump. At the MWL dump, a large and poorly documented inventory of commingled hazardous wastes, low-level radioactive wastes, and mixed wastes (i.e., radioactive wastes with a component of hazardous wastes) were buried in unlined trenches and pits. The contradictory information on the total quantity of wastes buried in the MWL dump ranges from 100,000 cubic feet [2] to greater than 780,000 cubic feet [76] and up to 1,500,000 cubic feet [80]**.** The NMED Compliance Order on Consent [1] (Consent Order) that was issued on April 29, 2004 lists the hazardous wastes buried in the MWL dump to "include acids, metals, organic solvents and other organic compounds" (p. 43). The solvents include in part cancer and disease causing tetrachloroethene (PCE), trichloroethene (TCE) and dichlorodifluoromethane (CFC-12). The metals include in part beryllium, cadmium, chromium, nickel and lead.

The DOE/Sandia 2007 fate and transport computer model (FTM) Report [2] lists the radioactive wastes buried in the MWL dump to include in part amercium-241, cesium-137, cobalt-60, plutonium-238, plutonium-239, radium-226, radon-222, strontium-90, thorium-232, tritium and uranium-238 (p.3).

1.3. The poorly managed disposal and maintenance practices at the Sandia MWL dump allowed a large amount of water to enter the buried wastes. The precipitation and uncontrolled surface water flows onto the MWL dump introduced a large and unknown amount of water into the buried wastes increasing the likelihood of contaminant transport to the groundwater. There was poor control of precipitation and surface water run-in to the wastes dumped into the unlined trenches and pits 1). during the 30 years of disposal operations from March 1959 through December 1988 and 2). during the 18 years from 1989 to 2006. The annual amount of precipitation that fell on the MWL dump was 8.5 inches [2]**.** The poor control of water entering the buried wastes at the MWL dump is illustrated by a memorandum [6] dated November 20, 1996 from Sandia staff person Mr. Jerry Peace to DOE staff person Mr. John Gould. The pertinent excerpt from the memo follows:

> Pit caps in the classified area [of the MWL dump] are in serious need of repair. Many concrete caps have collapsed under their own weight because they were not formed, reinforced, or finished when poured. Plywood caps need immediate attention because they are rotting and

> slumping into the pits. **These collapsed pit caps act as funnels, channeling precipitation into buried waste [Emphasis supplied].** These caps have collapsed because backfilled soils have settled over time, leaving a void directly beneath the concrete or plywood cap (p.2).

In 2006, berms were installed around the perimeter of the Sandia MWL dump to prevent surface water from rain storms from flowing on to the MWL dump during the installation of the subgrade layer of compacted dirt over the surface of the MWL dump. Citizen Action used the Freedom of Information Act (FOIA) process to obtain Stormwater Pollution Prevention Plan Inspection and Maintenance Report Forms that document the berms installed around the MWL dump were breached on August 16, 2006 by a rain storm. From the Stormwater Form dated August 16, 2006:

> Major rain event exceeded design criteria [for the berms]. Berms breached on east and west side. Three breaches on west side [of MWL dump]. Minor breaches on east side. Little ponding remains.

The surface water flows from rain storms breached the berms and flowed onto the MWL dump. The large volume of surface water that flowed onto the MWL dump in 2006 during the construction of the subgrade layer shows that large volumes of surface water were allowed to flow onto the MWL dump for 50 years from 1959 to 2006.

1.4. A reliable network of groundwater monitoring wells was not provided at the Sandia MWL dump from the first well installed in 1988 to the four new wells installed in 2008. A total of nine contaminant detection monitoring wells and two background water quality monitoring wells were installed at the MWL dump over the 20-year period from 1988 to 2008. Table 1 below on the next page is a summary of the year of installation and current status for the eleven defective monitoring wells at the MWL dump. The unreliable monitoring wells MWL-MW1, -MW2, -MW3 and -BW1 were plugged and abandoned in 2008 [7,8] and replaced with the four new unreliable monitoring wells MWL-MW7, -MW8, -MW9 and -BW2 [7,8]**.** All of the six contaminant detection monitoring wells in the current monitoring well network (wells MWL-MW4, -MW5, -MW6, -MW7, -MW8 and –MW9 are unreliable and require replacement. The current network of monitoring wells are displayed on Figure 8. The factors that require replacement of the six monitoring wells in the current network are described in Section 3 of this report.

Figure 6 is a map that shows the locations of the seven monitoring wells that collected unreliable groundwater samples during the 18-year period from 1990 through 2007. The defective wells include the six contaminant detection monitoring wells MWL-MW1, -MW2, -MW3, -MW4, -MW5 and -MW6 and the background water quality monitoring well MWL-BW1. The seven monitoring wells were known to be defective soon after their installation but were not replaced until 2008. The need to replace the seven monitoring wells was described in many reports written from 1991 to 1998. The reports are in the NMED Administrative Record (AR). Six of the reports are summarized in Section 5.

In the original network of seven monitoring wells, only the two defective monitoring wells MWL- MW1 and -MW3 were at locations that could detect groundwater contamination from the wastes buried in the Sandia MWL dump. The factors that prevented the monitoring wells MWL-MW1 and -MW3 from producing reliable and representative groundwater samples are described in Section 1.7.1 and Section 9 of this report. The two wells were known to be defective in 1992 but were not replaced until 2008.

Table 1. Sandia MWL Dump Monitoring Wells

*** The locations of the eleven monitoring wells are displayed on Figures 6 and 8.**

Year of Installation	Well No. / Current Status
- 1988	– well MWL-MW1 / The defective monitoring well was plugged and abandoned in 2008.
- 1989	– wells MWL-MW2, -MW3 and -BW1 / The three defective monitoring wells were plugged and abandoned in 2008.
- 1993	– well MWL-MW4 / The defective monitoring well is in the current network.
- 2000	– wells MWL-MW5 and -MW6 / The two defective monitoring wells are in the current network.
- 2008	– wells MWL-MW7, -MW8 and -MW9 / The three defective monitoring wells are in the current network.
- 2008	– well MWL-BW2 / The new background water quality well may be defective because the drilling and well construction requirements in the NMED 2004 Consent Order were not followed

Reasons the monitoring wells do not furnish reliable and representative groundwater samples.

- **Wells MWL-MW1 and -MW3 were the only two monitoring wells with any capability to detect contamination from the MWL dump.**
- **Wells MWL-MW2, -MW5, -MW6 and -BW1 – four wells installed at incorrect locations and too distant from MWL dump to detect groundwater contamination.**
- **Wells MWL-MW1, -MW2, -MW3 and -BW1 – corroded stainless steel well screens prevented the detection of many contaminants.**
- **Wells MWL-MW2, -MW3 and -BW1 – mud-rotary drilling method contaminated the three wells with bentonite clay drilling muds that prevented the detection of many contaminants and prevented collection of reliable data on speed of groundwater travel.**
- **Wells MWL-MW4, -MW5 and -MW6 – three wells with screens installed too deep to detect contamination at water table and measure elevation of water table.**
- **Well MWL-MW5 – screen installed across two zones of saturation prevented well from having any use. In addition, the screen is contaminated with bentonite clay/cement grout with properties to prevent the detection of contamination and prevent collection of reliable data on speed of groundwater travel.**
- **Wells MWL-MW7, -MW8 and -MW9 – three wells installed in 2008 were drilled with improper methods with 30-ft screens installed too deep to detect contamination and measure the elevation of the water table below the MWL dump.**
- **Wells MWL-MW1, -MW2, -MW3, -MW4, -MW7, -MW8, -MW9 and -BW1 – the high-flow pumping methods purged the wells dry and highly aerated water samples were collected up to a week later. This sampling method removes volatile and trace metal contaminants from the collected water samples.**

The current monitoring well network at the Sandia MWL dump includes the six unreliable contaminant detection monitoring wells MWL-MW4, -MW5, -MW6, -MW7, -MW8 and -MW9 and the background water quality monitoring well MWL-BW2. The locations of the seven wells are shown on Figure 8. The six contaminant detection monitoring wells in the current network require replacement because they do not meet the intended purpose to 1). monitor contamination at the water table below and downgradient from the MWL dump, 2). measure the elevation of the water table and 3). accurately determine the direction and speed of groundwater travel at the water table below and hydraulically downgradient from the MWL dump. The NMED HWB has not, but should enforce the requirement in the NMED Sandia Consent Order [1] and RCRA for replacement of the six defective monitoring wells in the current network. The regulatory requirements are described in Section 7 of this report.

1.5. Ten of the eleven monitoring wells at the Sandia MWL dump were known to be defective and required replacement soon after their installation but none of the wells were replaced until 2008. Unreliable groundwater samples were collected from the defective and unreliable monitoring wells at the Sandia MWL dump from 1990 to the present time. The unreliable water samples were analyzed for a very expensive suite of analytes. All of the eleven monitoring wells required replacement with the possible exception of the new background water quality monitoring well MWL-BW2 that was installed in 2008. There is uncertainty in the water quality data and water level data collected from the new well MWL-BW2 because the NMED HWB did not enforce the requirements in the NMED Sandia Consent Order [1] for the drilling method, drilling operations, or well design. The NMED HWB also did not enforce the requirements for drilling operations in the borehole of well MWL-BW2 in the NMED Notice of Deficiency letter issued on June 19, 2007 [36]. These issues are discussed in Section 3.5 of this report.

1.6. The NMED HWB required DOE/Sandia to collect a very expensive suite of unusable water quality data from the seven defective monitoring wells at the Sandia MWL dump over the 18-year period from 1990 through 2007. The incorrect and unreliable water quality data were used improperly in a large number of DOE/Sandia reports, NMED reports, administrative proceedings and for corrective action up to the present time that: there was always a reliable network of monitoring wells at the Sandia MWL dump and that the dump is not a cause for groundwater contamination. In fact, of the seven defective monitoring wells, the monitoring wells MWL-MW1 and -MW3 were the only monitoring wells at locations that could detect groundwater contamination at the water table below the MWL dump.

The comparison of the water quality data from the two monitoring wells MWL-MW1 and -MW3 to the water quality data from the new hydraulically upgradient background groundwater quality monitoring well MWL-BW2 show evidence using RCRA criteria [11] that the wastes buried in the MWL dump contaminated the groundwater with cadmium, chromium, nickel and nitrate. Other contamination including the highly toxic solvents tetrachloroethene (PCE) and trichloroethene (TCE) may be present in the groundwater at the locations of wells MWL-MW1 and MW3. However, the two wells were defective and unreliable to detect solvents including PCE and TCE because of 1). the corroded stainless steel well screens and 2). the routine use of high-flow purging and sampling methods that stripped the volatile solvent contaminants from the highly aerated water samples that were collected from the two defective monitoring wells.

In fact, the DOE/Sandia 2007 FTM Report [2] determined that the groundwater below the MWL dump is contaminated with PCE at the present time at concentrations above where EPA will set the revised drinking water standards (DWS) for PCE and TCE in 2011 [66]**.** The computer simulations in the 2007 DOE/Sandia FTM Report [2] show that the groundwater below the MWL dump is contaminated with PCE far above where EPA indicates the new DWS Maximum Contaminant Level (MCL) will be set in 2011 [66]**.** This issue is discussed in Sections 10.5 and 12.

The evidence that the wastes buried in the MWL dump have contaminated the groundwater with cadmium, chromium, nickel and nitrate is discussed in Section 9.8. The evidence for nickel groundwater contamination from the MWL dump is also discussed in Section 8.

1.7. There are two zones of saturation below the Sandia MWL dump that require networks of monitoring wells. A reliable network of monitoring wells was not installed in either of the two zones. Figure 7 is a geologic cross section that shows the two zones of saturation below the MWL dump that require networks of monitoring wells. The upper zone is the water table in the fine-grained alluvial fan sediments. The deeper zone is the Ancestral Rio Grande Deposits (ARG Deposits) that are below the layer of fine-grained alluvial fan sediments that form a leaky confining bed above the ARG Deposits.

1.7.1. The upper zone that requires a network of monitoring wells for early detection of contamination is the water table in the fine-grained alluvial fan sediments. The fine-grained alluvial fan sediments have low permeability [i.e., low saturated hydraulic conductivity (Ksat)] and produce small flows of groundwater that are insufficient for a water supply [9]**.** The intended purpose for all of the eleven monitoring wells installed at the Sandia MWL dump was to determine the elevation of the water table in the fine-grained alluvial fan sediments and to monitor for early detection of groundwater contamination at the water table.

However, the monitoring well network at the MWL dump did not monitor contamination at the water table as demonstrated by the fact that the NMED HWB issued a Notice of Deficiency (NOD) Report in 1998 [10] that recognized well MWL-MW3 was the only downgradient monitoring well. In addition, the background monitoring well MWL-BW1 was not properly installed upgradient to the MWL dump given the southwest direction of flow at the water table. The NMED 1998 NOD Report [10] is summarized in Section 5.6 and a copy of the NOD Report is in Appendix A.

From 1989 to the present time in 2011, well MWL-MW3 was always the only downgradient monitoring well installed across the water table at the Sandia MWL dump. Well MWL-MW3 was plugged and abandoned in 2008 [38]**.** But even well MWL-MW3 did not produce reliable and representative water samples for the detection of contaminants of concern for the wastes buried in the MWL dump because of the following three reasons:

– 1). The mud-rotary drilling method contaminated the screened interval in well MWL-MW3 with a large amount of bentonite clay drilling mud that was not removed by well development. The properties of bentonite clay to prevent the detection of groundwater contamination from the wastes buried in the Sandia MWL dump are described in the technical literature [11.12,13,14,15,16,17,18] and in four reports from the EPA Kerr Lab [19,20,21,22]**.** The three monitoring wells at the MWL dump that were drilled with the mud-rotary method using bentonite clay drilling muds include MWL-MW2, -MW3 and -BW1.

A March 1993 report in the NMED Administrative Record titled *"Review of Ground Water Monitoring at Sandia National Laboratories' Mixed Waste Landfill"* [23] by NMED staff Mr. William Moats and Ms. Lee Winn shows that the NMED was well aware that the mud-rotary drilling method prevented the three MWL dump monitoring wells MWL-MW2, -MW3 and -BW1 from producing reliable and representative data for 1). detection of groundwater contamination and 2). measurement of the hydraulic properties of the *in situ* geologic formation where the screened intervals were installed. The pertinent excerpt from Moats and Winn (1993) [23] follows:

> The use of mud-rotary drilling methods should be avoided in any future monitor well installations at the MWL. Mud rotary is not a preferred drilling technology due to its potential detrimental impacts to ground-water quality and the hydraulic characteristics of an aquifer (p. 3).

The NMED HWB recognized in 1993 that the mud-rotary drilling method prevented the three monitoring wells MWL-MW2, -MW3 and -BW1 from producing reliable water quality data and reliable measurement of the speed of groundwater travel at the water table below the MWL dump, Despite the knowledge of impairment, the NMED HWB accepted reports from DOE/Sandia up to the present time that the three mud-rotary monitoring wells produced reliable and representative water samples for the detection of groundwater contamination from the wastes buried in the MWL dump.

In addition, the NMED HWB allowed DOE/Sandia to use the incorrect pumping test and slug test hydraulic data collected from the three mud-rotary wells to calculate the speed of groundwater travel at the water table below and away from the MWL dump [9]**.** The NMED HWB ordered DOE/Sandia to replace the three mud-rotary monitoring wells in 2007 [24,25] with new monitoring wells that were not drilled with the mud-rotary method. The pertinent excerpt from the NMED HWB letter dated March 23, 2007 [24] that ordered replacement of well MWL-BW1 follows:

> The permittees [i.e., DOE/Sandia] shall install the well 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 (p. 2).

The pertinent excerpt from the NMED HWB letter dated July 2, 2007 [25] that ordered replacement of well MWL-MW1 and -MW3 follows:

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

The mistake by the NMED HWB in approving the water quality data and hydraulic property data from the three mud-rotary monitoring wells MWL-MW2, MW3 and BW1 is described further in sections in this report and specifically in Section 9.

– 2). The corrosion of the stainless steel well screen prevented the detection of contamination. The properties of corroded stainless steel screens to prevent the detection of groundwater contamination from the wastes buried in the Sandia MWL dump are described in the technical literature [11.26,27,28]. Type 304 stainless steel well screens were installed in the four defective monitoring wells MWL-MW1, -MW2, -MW3 and -BW1. The corrosion of the stainless steel screens was assumed to be the source for the high concentrations of nickel and chromium measured in the groundwater samples collected from wells MWL-MW1 and -MW3 beginning in 1992 [43].

In fact, the high concentrations of chromium and nickel were present in the first ground-water samples collected from monitoring wells MWL-MW1 and -MW3 in 1990 (see Appendix F). The high concentrations of nickel continued to be measured in the water samples from wells MWL-MW1 and -MW3 over all time to when the wells were plugged and abandoned in 2008. In fact, RCRA criteria identify that the source for the high concentrations of dissolved chromium and nickel measured in the groundwater samples collected from wells MWL-MW1 and MW3 are the wastes buried in the MWL dump. This issue is discussed in Section 8 and 9.8 of this report. Section 9.6 describes the properties of corroded stainless steel well screens to prevent the detection of the trace metal and organic contaminants buried in the MWL dump.

– 3). The improper high-flow purging and sampling methods prevented the detection of contamination. *Aerated water purges volatile organic contaminants and precipitates trace metal contaminants out of the groundwater samples collected from the MWL dump monitoring wells* [11.15.16,17,63]. The improper use of high-flow pumping was not necessary because the Bennett[R] sampling pump [29] could have been modified for the required low-flow purging and sampling. The five monitoring wells with screens installed in the fine-grained alluvial fan sediments including wells MWL-MW1, -MW2, -MW3, -MW4 and -BW1 were purged to dryness by the high-flow submersible pump and water samples were collected one to many days later from the highly aerated water that slowly refilled the wells. This issue is discussed in Section 9.7.

As described above, Figure 7 shows that the screens in the three monitoring wells MWL -MW4, -MW5 and -MW6 are installed too deep below the water table for the intended purpose to monitor contamination at the water table and for measurement of the elevation of the water table. The NMED HWB has not enforced the requirement in the NMED 1998 NOD Report [10], the 2004 NMED Consent Order [1] and RCRA for DOE/Sandia to replace the three defective wells. Figure 8 shows that the three wells are in the current network of monitoring wells at the MWL dump.

In addition, the three new contaminant detection monitoring wells MWL-MW7, -MW8 and -MW9 are also installed too deep to monitor groundwater contamination at the water table and to measure the elevation of the water table along the western boundary of the MWL dump. NMED HWB should but has not enforced the requirement in the NMED Consent Order [1] and RCRA for DOE/Sandia to replace the three defective wells. Figure 8 shows that the three defective wells are in the current network of monitoring wells at the MWL dump. These issues are discussed below in Sections 3 and 7.

1.7.2. The deeper zone that requires a network of monitoring wells is the large groundwater producing zone in the Ancestral Rio Grande "A" Deposits (ARG Deposits) that are located below the layer of fine-grained alluvial fan sediments. The ARG Deposits are displayed on the geologic cross section in Figure 7. The ARG Deposits are the regionally extensive aquifer that produces large amounts of groundwater to the large capacity drinking water wells in the vicinity of Albuquerque. RCRA and the NMED Sandia Consent Order [1] require a network of monitoring wells at the Sandia MWL dump in the uppermost aquifer zone that produces large supplies of groundwater. The uppermost zone is the ARG Deposits. The NMED HWB has not required DOE/Sandia to install a network of monitoring wells in the ARG Deposits. This issue is discussed in Section 7.

1.8. Three important reports in the NMED Administrative Record (AR) show that <u>ALL</u> of the monitoring wells presented for the dirt cover remedy decision at the NMED December 2004 Public Hearing were defective and required replacement. ***<u>Both the staff of the NMED HWB and DOE/Sandia provided 1). incorrect testimony at the December 2004 Public Hearing that there was a reliable network of monitoring wells at the MWL dump and 2). Incorrect testimony that the groundwater below the dump was not contaminated.</u>*** At the time of the NMED December 2004 Public Hearing, there were many reports in the NMED Administrative Record (AR) over the years from 1991 to 1998 that described the reasons all of the monitoring wells used at the NMED December 2004 Public Hearing were defective and required replacement. Those reports were known and available to the NMED and DOE/Sandia witnesses testifying at the December 2004 Public Hearing. Six of the reports are summarized in Section 5. The important information in three of the reports follows:

1.8.1. The "inadequate" monitoring well network in the 1993 NMED Report by Mr. Moats and Ms. Winn [23] is the same network that was presented as "reliable" by Mr. Moats at the December 2004 Public Hearing. The 1993 NMED Report by Mr. Moats and Ms. Winn recognized that the monitoring well network presented to the NMED December 2004 Public Hearing was inadequate because the direction of groundwater flow at the water table below the Sandia MWL dump was not to the northwest as presented at the public hearing but was instead to the south or southwest as follows:

> The hydrogeologic conditions at the MWL have not been adequately characterized. . . <u>Water level data from July 1992 indicate south-directed or southwest directed flow</u> [Emphasis supplied]. However, the gradient and direction of ground-water flow are not known with reasonable certainty (p. 3).

The NMED 1993 Moats and Winn Report [23] recognized well MWL-MW3 was the only downgradient monitoring well and that no upgradient background well existed. The Moats and Winn report recognized that the necessary network of monitoring wells was not installed at the MWL dump including the time of the NMED December 2004 Public Hearing

As described above in Section 1.7.1, the NMED 1993 Moats and Winn Report [23] recognized the three mud rotary monitoring wells MWL-MW2, -MW3 and -BW1 did not produce 1). reliable and representative groundwater samples for detection of contamination or 2). Reliable and representative data for measurement of hydraulic properties of the geologic formation where the screen was installed.

Nevertheless, the NMED HWB did not require replacement of the three defective mud-rotary monitoring wells until 2008 [24,25]**.** A summary of the NMED 1993 Moats and Winn Report [23] is in Section 5.3. A copy of the report is in Appendix B.

1.8.2. The 1994 EPA Region 6 Notice of Deficiency (NOD) Report [30] recognized that the monitoring well network presented at the NMED December 2004 Public Hearing was defective and did not prove the MWL dump had not contaminated the groundwater below the dump. A summary of the 1994 EPA Region 6 NOD Report is in Section 5.5. The unresolved deficiencies described by the 1994 EPA Region 6 NOD Report were not mentioned at the NMED December 2004 Public Hearing for the decision to leave the toxic wastes buried in unlined trenches and pits under a dirt cover.

1.8.3. The 1998 NMED NOD Report[10] identified major deficiencies in the Phase 2 RCRA Facility Investigation Report for the Sandia MWL dump[69]. The deficiencies were not resolved. A summary of the 1998 NMED NOD Report is in Section 5.6. A copy of the NOD Report is in Appendix A. The 1998 NMED NOD Report [10] is especially important because the report described the overall failure of the network of monitoring wells that were presented in the DOE/Sandia Phase 2 RCRA Facility Investigation Report (RFI Report) for the MWL dump. *The Phase 2 RFI Report was a key document at the December 2004 Public Hearing. The 1998 NMED NOD Report was not mentioned at the NMED December 2004 Public Hearing.*

The 1998 NMED NOD Report [10] recognized:

- 1). the on-site monitoring well MWL-MW4 was defective and required replacement,
- 2). the well MWL-MW3 was the only downgradient monitoring well,
- 3). the high levels of nickel measured in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 were groundwater contamination from the wastes buried in the MWL dump,
- 4). the data collected from pumping tests were defective and not usable to calculate the speed of groundwater travel below the MWL dump, and
- 5). a risk assessment was required of the potential impacts of the Sandia MWL dump on local and regional groundwater quality.

The reasons wells MWL-MW1 and -MW3 did not provide reliable and representative water samples are described above in Section 1.7.1 and in Section 9.8. The nickel groundwater contamination from the MWL dump is discussed in Section 8.

- The facts and findings presented in the above three reports and the three additional reports in Section 5 about the defective monitoring wells were not provided at the NMED December 2004 Public Hearing. Instead, the testimony by NMED and DOE/Sandia witnesses at the public hearing presented incorrect and misleading information that the DOE/Sandia Phase 2 RFI Report was based on a reliable network of five downgradient monitoring wells and one onsite monitoring well. Examples of the incorrect testimony are presented often in this report and mainly in Section 6. Legal requirements under RCRA regarding full disclosure of relevant facts and misrepresentation of relevant facts at any time, are discussed in Section 7.

2.0. The defective monitoring wells at the Sandia MWL dump were described in many expert reports in the NMED Administrative Record. A series of reports written over the years 1991 through 1998 described the reasons the seven monitoring wells on Figure 6 were defective and required replacement. ***The seven defective monitoring wells were presented as reliable at the NMED December 2004 Public Hearing and in many DOE/Sandia and NMED reports up to the present time.*** The seven defective monitoring wells were used to collect unreliable groundwater samples over the 18-year period from 1990 through 2007. The seven defective monitoring wells had many features to prevent the detection of groundwater contamination from the wastes buried in the MWL dump. Section 5 presents the summaries for six of the expert reports written previous to the NMED May 26, 2005 Final Order [46] to install the dirt cover over the wastes buried in unlined pits and trenches at the MWL dump. The reports are in the NMED Administrative Record (AR). The reports about the defective monitoring wells at the Sandia MWL dump were written from 1991 to 1998 by 1). the DOE Tiger Team (report #1 in Section 5), 2). the Los Alamos National Laboratory (LANL) (report #2 in Section 5), 3). the NMED Hazardous Waste Bureau (HWB) (reports #3 & #6 in Section 5), 4). the NMED DOE Oversight Bureau (report #4 in Section 5) and 5). the Region 6 of the Environmental Protection Agency (EPA) (report #5 in Section 5).

The six reports summarized in Section 5 described the reasons it was necessary to replace all of the seven defective monitoring wells at the Sandia MWL dump that are displayed on Figure 6. The seven monitoring wells were installed for the intended purpose to monitor groundwater contamination at the water table below and hydraulically downgradient of the MWL dump but all of the seven wells were unreliable for this purpose. However, none of the defective monitoring wells were replaced until 2008 [7,8]. The reasons it was necessary to replace all seven monitoring wells immediately after they were installed or within a few years after installation are summarized below.

2.1. Defective monitoring wells MWL-MW1, -MW2, -MW3 and -BW1. The minimum requirement in RCRA is for a network of three downgradient contaminant detection monitoring wells and one upgradient background water quality monitoring well. The minimum number of locations of upgradient and downgradient monitoring wells in the monitoring well networks required by RCRA at waste disposal facilities are displayed on Figure 10. In addition, RCRA recognizes that monitoring wells at other locations to those shown on Figure 10 may be necessary to provide the required monitoring well network.

The first four monitoring wells installed in 1988 and 1989 at the Sandia MWL dump (i.e., wells MWL-MW1, -MW2, -MW3 and -BW1) were installed at the wrong locations. The incorrect assumption had been made that the direction of groundwater flow at the water table below the MWL dump was to the ***northwest*.** The six reports in Section 5 show that it was conclusively recognized beginning in 1991 that the direction of groundwater flow below and downgradient from the MWL dump was to the ***south or southwest.*** This meant that monitoring well MWL-MW3 was the **only** downgradient monitoring well and that no upgradient background monitoring well existed. But well MWL-MW3 did not produce reliable and representative water samples for the factors described above in Section 1.7.1. and in Section 9.

2.2. Defective monitoring wells MWL-MW5 and -MW6. The NMED HWB 1998 NOD Report [10] (report #6 in Section 5) ordered DOE/Sandia to install the two additional down-gradient monitoring wells MWL-MW5 and -MW6 at locations west of the Sandia MWL dump. The purpose was to monitor for contamination at the water table and to improve knowledge of the direction and speed of groundwater travel at the water table below and away from the MWL dump. The pertinent excerpts from the 1998 NMED NOD Report [10] are below:

> Deficiency #3. Response #37 - - "The water-table map [i.e., the water table map in Figure 9 in this report] indicates that there is only one downgradient monitoring well at the mixed waste landfill [i.e., well MWL-MW3]. Normally, a minimum of three downgradient wells is required for an adequate detection monitoring system" (p. 2-3).
>
> "After the two new wells are installed [i.e., wells MWL-MW5 and -MW6], and the water table map is revised, the HRMB [now the NMED HWB] will reevaluate the adequacy of the detection monitoring system. HRMB requests a meeting with DOE/SNL technical and management staff to discuss the location and design of the two new wells" (p. 2-3).

DOE/Sandia installed the monitoring wells MWL-MW5 and -MW6 in 2000 to meet the requirement in the NMED 1998 NOD Report [10] for three downgradient monitoring wells at the water table. However, the locations of the two monitoring wells MWL-MW5 and MWL-MW6 are too far away from the dump for detection of contamination at the water table, especially for well MW6. Figure 6 shows that well MWL-MW6 is located 500 feet west of the dump and not downgradient but instead cross-gradient to the southwest direction of groundwater flow at the water table.

Moreover, the two wells MWL-MW5 and -MW6 do not monitor groundwater contamination at the water table. Figure 7 is a geologic cross section of the hydrogeologic setting below the MWL dump. Figure 7 shows that the screens in wells MWL-MW5 and -MW6 were installed too deep below the water table to resolve the deficiency in the NMED 1998 NOD Report that there was only one monitoring well at the water table below and hydraulically downgradient from the MWL dump. Figure 7 shows that well MW5 was installed across the contact of the fine-grained alluvial fan sediments with the ARG deposits and well MW6 was installed only in the ARG Deposits. The two wells did not monitor at the water table as required by the 1998 NMED NOD Report [10].

The NMED HWB did not require DOE/Sandia to replace the two defective monitoring wells MWL-MW5 and -MW6. Instead, the NMED HWB accepted the water quality data from the two defective monitoring wells as reliable and representative over all time to the present in 2011. Figure 8 shows that the two defective wells are in the current network. In addition, DOE staff person Mr. John Gould presented incorrect testimony at the NMED December 2004 Public Hearing that the two defective monitoring wells MWL-MW5 and -MW6 were two wells in a reliable network of seven monitoring wells. The testimony of Mr. Gould at the December 24, 2005 Public Hearing follows:

> We have seven groundwater monitoring wells right now which we think are sufficient. We put in two recently at the request of NMED. Currently, we feel that NMED thinks the system we have in place is right now is [sic] sufficient. If we're ever required to put in additional wells, we'll do so (v. I, p. 202, l.19-24).

In the above testimony by Mr. Gould, the two wells put in "recently" were wells MWL-MW5 and -MW6 which were installed too deep to resolve the deficiency in the NMED

1998 NOD Report that there was only one downgradient monitoring well installed across the water table. There was only one downgradient monitoring well at the time of the testimony of Mr. Gould to the NMED December 2004 Public Hearing and that well was the defective monitoring well MWL-MW3. In addition, the network of seven monitoring wells that ***"we [DOE] think are sufficient"*** is the network that the six expert reports written from 1991 to 1998 described as inadequate necessitating replacement of the seven defective monitoring wells*.* The six reports are in the NMED Administrative Record (AR) and are summarized in Section 5.

Figure 7 shows that well MWL-MW5 is not usable for any purpose because the screen is installed in both the fine-grained alluvial fan sediments and the deeper ARG Deposits. In addition, the screen was contaminated with bentonite clay/cement grout because of mistakes made during well construction [31]**.** The impact of the grout contamination on the collection of reliable and representative groundwater samples from well MWL-MW5 is discussed further in Section 9.2. Well MWL-MW5 requires replacement but the defective and unusable monitoring well is in the current network displayed on Figure 8. DOE/Sandia plan to include the defective monitoring well MWL-MW5 in the Long-Term Monitoring and Maintenance Plan [4]**.**

Figure 7 shows that well MWL-MW6 is not usable for the intended purpose to monitor contamination at the water table in the fine-grained alluvial fan sediments and to determine the elevation of the water table. Because of its 500 foot lateral distance from the MWL dump, well MW6 has limited use as a monitoring well in the network of monitoring wells that is required in the ARG Deposits by RCRA and the April 29, 2004 Consent Order [1]**.** The regulatory requirements are discussed in Section 7.

The NMED HWB has not required DOE/Sandia to accurately determine the direction and speed of groundwater flow at the water table below and downgradient from the MWL dump as required by RCRA. Figure 7 shows that the two defective monitoring wells MWL-MW5 and -MW6 were not usable for that intended purpose. As discussed below in Section 7, replacement of the defective monitoring wells MWL-MW5 and -MW6 is required under both RCRA and the Consent Order.

The NMED HWB did not require DOE/Sandia to install the required network of downgradient monitoring wells at the water table at appropriate locations hydraulically downgradient from the western and southern side of the MWL dump. No monitoring wells were installed at appropriate locations south of the MWL dump although the requirement for monitoring wells on the south side of the dump was identified in the 1993 NMED report by Moats and Winn [23] as follows:

> The hydrogeologic conditions at the MWL have not been adequately characterized. . . Water level data from July 1992 indicate south-directed or southwest directed flow. However, the gradient and direction of ground-water flow are not known with reasonable certainty (p. 3).

The NMED HWB did not require DOE/Sandia to acquire accurate knowledge of the direction and speed of groundwater travel at the water table below the MWL dump. The gradient and direction of groundwater flow are ***still*** not known with reasonable certainty at the present time in 2011. However, the new information from the water table elevation measured in the new background monitoring well MWL-BW2 (see Figure 14) shows the direction of groundwater flow at the water table below the MWL dump is more to the south than to the west. A serious issue is that monitoring wells were not installed south of the MWL dump.

2.3. Defective monitoring well MWL-MW4. In 1993 DOE/Sandia installed angle monitoring well MWL-MW4 inside the MWL dump to monitor groundwater contamination at the water table below Trench D. The location of multiple-screen angle well MWL-MW4 below Trench D is shown on Figure 6. There was a concern for groundwater contamination at the water table below Trench D because of the 271,500 gallons of reactor coolant waste water disposed of in Trench D [2]**.**

However, Figure 7 shows that the upper screen in well MWL-MW4 was installed too deep below the water table to monitor groundwater contamination from Trench D or to measure the elevation of the water table. The 1998 NMED NOD Report [10] described the need to replace well MWL-MW4 as follows:

> Additional Comment #3. Response #38 - - "The top of the upper screen of MWL-MW4 is located approximately 22 ft below the water table. Because of the vertical gradient and the way the well is constructed, <u>MWL-MW4 is of **no value** for determining the elevation of the water table (and therefore, the horizontal direction of ground-water flow and the horizontal gradient</u> [Emphasis supplied] (p.7).
>
> Also, because the top of the upper screen of MWL-MW4 is located 22 ft. below the water table, <u>the well is of **little value** for detecting any groundwater contamination (if any exists) that may be present in the saturated zone just below the water table</u> [Emphasis supplied] (p. 7).

The NMED HWB did not require DOE/Sandia to replace the defective monitoring well MWL-MW4. Instead, the NMED staff person Ms. Carolyn Cooper provided incorrect testimony at the NMED December 2004 Public Hearing that the screen in well MWL-MW4 *intersected* the water table. The testimony by Ms. Cooper follows:

> Monitoring well MW-4 was installed at an angle of six degrees from vertical and <u>intersects the water table</u> at a location beneath disposal Trench D (v. III, p. 919, l. 13-16). [Emphasis supplied].

Figure 7 shows that the upper screen in well MWL-MW4 does <u>**not**</u> intersect the water table. The defective monitoring well MWL-MW4 should have been plugged and abandoned and replaced with a new reliable monitoring well before the NMED approved the installation of the dirt cover over the MWL dump.

The large amount of leakage of groundwater that has occurred between the upper and lower screen is an additional important reason that replacement of the defective multiple-screen monitoring well MWL-MW4 is required. The large amount of leakage from the upper screen to the lower screen is illustrated by the low water level measured in the upper screen in well MWL-MW4 on Figure 7. The water level measured in the upper screen should be above the top of the screen. Instead, Figure 7 shows the water level is approximately 10 feet below the top of the screen. The deep location of the water level in the screen is evidence of leakage of a very large amount of groundwater from the fine-grained alluvial fan sediments at the location of the upper screen in well MWL-MW4 down the well and out through the lower screen into the ARG Deposits.

Both DOE/Sandia reports[9, 34] and the NMED reports [31] show that there were long periods of time when no inflatable packer was installed between the upper and lower screen in well MWL-MW4 to prevent the open flow of groundwater from the upper screen down the open well and out into the ARG Deposits through the lower screen. The drilling of the borehole for the multiple-screen monitoring well MWL-MW4 began on December 16, 1992 [9]**.** The construction of the multiple-screen monitoring well MWL-MW4 was completed on February 10, 1993 [9]**.** However, an inflatable packer to prevent groundwater flow between the upper and lower screen in well MWL-MW4 was not installed until May 23,1994 based on the following statement in the NMED November 2006 Moats Report [31]**:**

> For MW4, the majority of post-05/23/1994 groundwater sample data are derived from samples from the upper screen, which also samples the AF Facies [i.e., the fine-grained alluvial fan sediments]. However, data from earlier groundwater samples were composites of groundwater from both screens, with groundwater hydrochemistry from the lower more-conductive ARG facies presumably dominant (Goering, 09/21/2006).

More than 16 months passed after the installation of monitoring well MWL-MW4 before a packer was installed on May 23, 1994 to prevent the open flow of possibly contaminated groundwater from the upper screen to the lower screen. In addition, the figure below from the DOE/Sandia report by Goering et al. (2002) [9] shows that the packer was removed from well MWL-MW4 for unknown periods of time in 1998 and 2001 because the figure describes the water levels measured in many years as "Commingled Upper and Lower Zones."

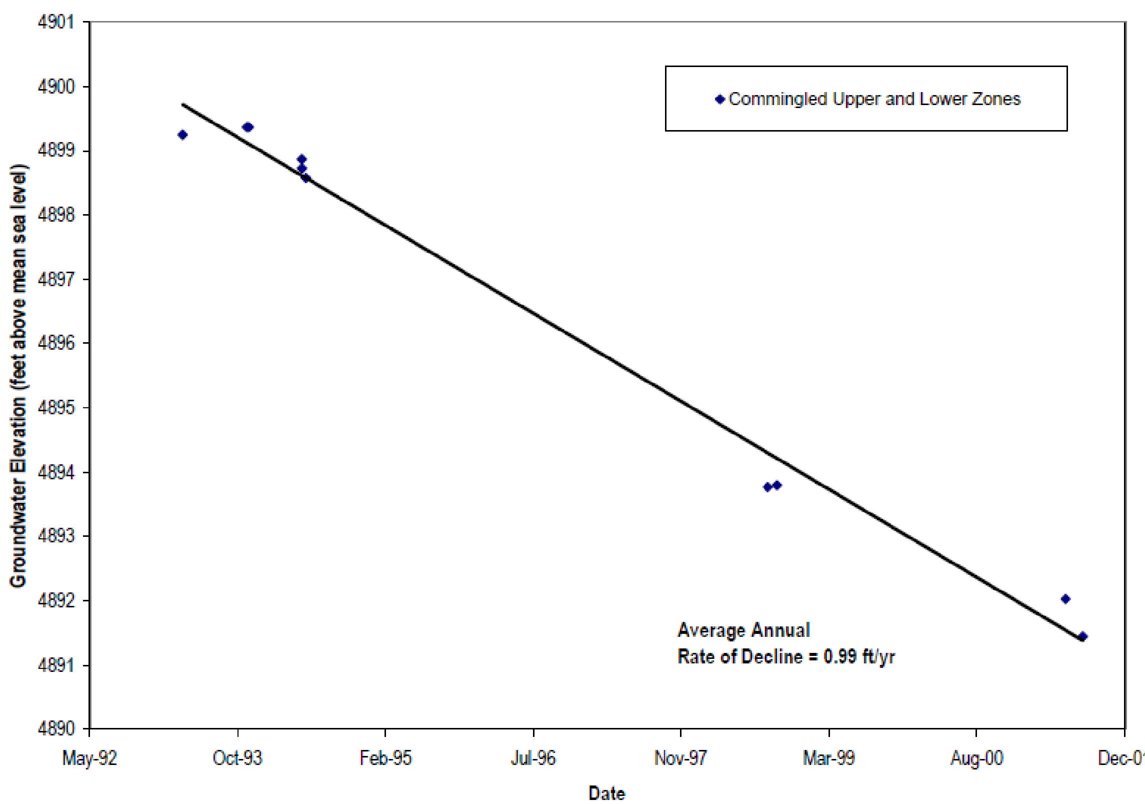

Figure 3-8. Hydrograph of Water Levels in MWL-MW4

Cross-contamination between different zones of saturation is not permissible under RCRA or the NMED Sandia Consent Order [1]. The long periods of groundwater flow between the upper and lower screen in well MWL-MW4 is an example of the failure of the NMED HWB to enforce the regulations and protect public health.

On the above figure from Goering et al. (2002), the large rate of decline of the water levels measured in the upper screen in well MWL-MW4 of 0.99 feet per year over the nine year period from late 1992 through November 2001 is evidence of downward flow of a large amount of groundwater from the upper screen to the lower screen. This is because the average rate of decline of the water table below the MWL dump is cited to be 0.5 feet per year in the DOE/Sandia November 2007 LTMMP Report [4]. <u>The rate of decline of 0.99 feet per year measured in well MWL-MW4 over the nine year period is double the average rate of decline for the water table below the MWL dump.</u>

The Gilkeson / Citizen Action presentation to the Albuquerque Groundwater Protection Advisory Board (GPAB) in 2006 about the deficient groundwater protection practices at the MWL dump described the ongoing leakage of groundwater that was occurring between the upper and lower screen in well MWL-MW4. Despite denials of leakage by DOE/Sandia and NMED, the water level data below shows that leakage was occurring and actions were subsequently taken by DOE/Sandia to stop the leakage. The action to stop the leakage is shown by the data in the table below:

- **<u>Water levels measured in the upper screen in monitoring well MWL-MW4</u>**

Measurement Date	Water Level Elevation (feet above mean sea level)
- December 4, 2001[9]	4890.91
- April 18, 2005 [61]	4888.56
- April 5, 2006 [65]	4888.29 change from April 18, 2005 = - 0.27 feet
- April 2, 2007 [32]	4891.98 change from April 05, 2006 = + 3.69 feet*
- June 4, 2007 [32]	4891.81
- April 7, 2008 [34]	4891.73
- October 2008 [34]	4891.68
- April 10,2009 [34]	4891.49
- October 2009 [34]	no measurement – packer was removed from well MWL-MW4

*The large rise of 3.69 feet for the water level measured on April 2, 2007 is evidence that leakage was occurring across the inflatable packer when the water level was measured on April 5, 2006.

The large upward change in the water level measured on April 2, 2007 is evidence the leakage was temporarily stopped after the presentation about the leaky packer by Mr. Gilkeson to the Albuquerque GPAB meeting. However, the 2010 [34] DOE/Sandia annual groundwater monitoring report describes the open flow of groundwater was allowed once again between the upper and lower screens. The packer was removed from well MWL-MW4 for a period of at least 5 months in 2009 as follows:

> Groundwater elevation data were not available in October 2009 for MWL-MW4. The inflatable packer, which was removed in May 2009 to allow the

surface well casing to be extended as part of the MWL Evapotranspirative Cover construction activities, had not been reinstalled between the two screen intervals at the time groundwater elevation measurements were obtained (p. 4-1).

The double screen monitoring well MWL-MW4 has been a conduit for a very large flow of groundwater from the fine-grained alluvial fan sediments downward to the ARG Deposits for a period of more than seventeen years from January 1993 to October 2009. The low water elevation measured in the partially drained screen in well MWL-MW4 of 5891.68 ft asl on the water table contour map in Figure 13 from the DOE/Sandia 2009 Report [33] is not representative of the elevation of the water table below the MWL dump.

The incorrect use of the water level measured in well MWL-MW4 as representative of the elevation of the water table below the MWL dump shows miscalculation by the staff of DOE/Sandia and NMED for groundwater hydrology in the fine-grained alluvial sediments at the water table below the MWL dump. This issue is discussed in Section 3.2 of this report for the anomalous low water levels that are measured in the new monitoring wells MWL-MW7, -MW8 and -MW9.

In summary, the NMED HWB has not enforced the requirement in the Consent Order [1] (p. 63) for the replacement of the leaky well MWL-MW4 as follows:

> Groundwater monitoring wells must be designed and constructed in a manner that will yield high quality, representative samples. . . <u>In the event of a well failure, or if a well is any way no longer usable for its intended purpose, it must be replaced with an equivalent well.</u> . . <u>Respondents shall ensure that the well will not serve as a conduit for Contaminants to migrate between different zones of saturation</u> (Emphasis supplied).

<u>First,</u> the 1998 NMED NOD Report [10] described the requirement to replace monitoring well MWL-MW4 because the upper screen was installed too deep below the water table for the well to meet the intended purpose to detect groundwater contamination from Trench D.

<u>Second,</u> the double screen monitoring well MWL-MW4 has been a conduit for a very large flow of groundwater from the fine-grained alluvial fan sediments to the ARG Deposits for a period of more than seventeen years from January 1993 to October 2009.

<u>Third</u>, well MWL-MW4 is not usable to measure the elevation of the water table in the fine-grained alluvial fan sediments below the MWL dump but the water table contour map in the 2009 DOE/Sandia annual groundwater monitoring report [33] used the water level measured in well MW4 for that purpose (see Figures 13 and 13A. For comparison, Figures 12 and 12A show that the water table contour map in the 2008 DOE/Sandia annual groundwater monitoring report did not use the water level measured in well MWL-MW4 because the measured water level was greater than 20 feet below the elevation of the water table below the MWL dump in 2007. The greater than 20 foot drop in the water table below the MWL dump from 2007 to 2008 is not possible because of the very low permeability of the fine-grained alluvial fan sediments. This issue is discussed in Section 3.2 of this report.

In addition, the water level measured in well MWL-MW4 in 2007 was 4891.98 feet above sea level (ft asl) compared to only a 0.3 foot decline to 4891.68 ft asl in 2008. The overall low water levels measured in well MWL-MW4 are because of the large flow of groundwater that was allowed for many years between the upper and lower screen. <u>The use of the unusable water level measured in well MWL-MW4 to represent the water table on the incorrect water table contour map in the 2009 DOE/Sandia Report [33] is a serious mistake that requires correction .</u>

Monitoring well MWL-MW4 does not provide usable data for any purpose and RCRA, the NMED 1998 NOD Report [10] and the NMED Consent Order [1] require that the well be plugged and abandoned and replaced with a reliable monitoring well to investigate groundwater contamination at the water table below Trench D.

3.0. All of the six contaminant detection monitoring wells in the current monitoring well network at the MWL dump fail to meet their intended purpose and require replacement. The six unreliable monitoring wells in the current monitoring well network are displayed on Figure 8 and include wells MWL-MW4, -MW5, -MW6. -MW7, -MW8 and -MW9. The intended purpose of the six monitoring wells is to 1). monitor contamination at the water table below and hydraulically downgradient from the MWL dump; 2). measure the elevation of the water table; and 3). determine the lateral speed and direction of groundwater flow at the water table.

As described above, Figure 7 shows that the screens in wells MWL-MW4, -MW5, and -MW6 are installed too deep below the water table. The three defective wells require replacement. The NMED HWB has not enforced the requirement in the Consent Order [1], the 1998 NMED NOD Report [10] and RCRA for replacement of the three defective monitoring wells that are unusable to monitor contamination at the water table below and hydraulically downgradient of the MWL dump.

3.1. The mistakes in the drilling and installation of the new monitoring wells MWL-MW7, -MW8, -MW9 render them useless for generating an accurate water table map and for detection of groundwater contamination from the Sandia MWL dump. The intended purpose of the current network of seven monitoring wells on Figure 8 is to ensure early detection of groundwater contamination at the water table below and hydraulically downgradient of the Sandia MWL dump. The current network is a failure for this purpose because the six contaminant detection monitoring wells (wells MWL-MW4, -MW5, -MW6, -MW7, -MW8 and -MW9) ***do not*** monitor contamination at the water table. As described above, the geologic cross section in Figure 7 shows that the screens in wells MWL-MW4, -MW5 and -MW6 are installed too deep below the water table for the wells to meet the intended purpose to monitor contamination at the water table and to measure the elevation of the water table.

RCRA and the NMED Consent Order [1] require that reliable monitoring well networks be installed in two specific zones of saturation below and downgradient from the Sandia MWL dump. The upper zone is at the water table in the fine-grained alluvial fan sediments. The deeper zone is in the layer of Ancestral Rio Grande "A" Deposits (ARG deposits) that are below the layer of fine-grained alluvial fan sediments. The two zones are displayed on Figure 7. The NMED HWB did not require DOE/Sandia to install a reliable network of monitoring wells in either zone. **The five defective monitoring wells MWL-MW4, -MW5, -MW7, -MW8 and -MW9 do not monitor either of the two zones.** Well MWL-MW6 does monitor groundwater in the ARG Deposits, but the 500 foot lateral distance away from the western boundary of the MWL dump is too great for use of well MW6 as a contaminant detection monitoring well. The regulatory requirements for monitoring well networks in both zones are discussed in Section 7.

The July 2, 2007 letter by NMED HWB Chief James Bearzi [25] ordered DOE/Sandia to replace the two defective contaminant detection monitoring wells MWL-MW1 and -MW3 with the new monitoring wells MWL-MW7 and -MW8 for the purpose to monitor ground-water at the water table. The pertinent excerpts from the letter follow:

> In accordance with Section VIII.A of the Order on Consent (April 24, 2004), if a well is any way unusable for its intended purpose, it must be replaced [Emphasis supplied]. The U. S. Department of Energy and Sandia

> Corporation (the Permittees) shall therefore replace wells MWL-MW1 and MWL-MW3 (p. 1).
>
> Each [replacement] well shall be installed to monitor groundwater at the water table [Emphasis supplied]. 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. This change in well locations, particularly for MWL-MW1, is based on better preparing the MWL for long-term monitoring of the groundwater which flows west-southwest (p.2).

In addition, the new monitoring well MWL-MW9 was also installed along the western side of the MWL dump as a replacement for the defective monitoring well MWL-MW2. The intended purpose of well MWL-MW9 was also to monitor groundwater contamination at the water table in the fine-grained alluvial fan sediments. The locations of the monitoring wells MWL-MW7, -MW8 and -MW9 are displayed on Figure 8.

Figure 8 shows the locations of the three new monitoring wells MWL-MW7, -MW8 and -MW9 close to the western boundary of the MWL dump. Figure 8 also shows the location of the plugged and abandoned monitoring well MWL-MW3 close to the western boundary of the MWL dump and between wells MW8 and MW9. Well MW3 was located approximately 80 feet north of well MW8 and 80 feet south of well MW9.

3.2. The water levels in the new monitoring wells MWL-MW7, -MW8, and -MW9 are too deep for the three wells to detect contamination at the water table and to measure the elevation of the water table. The water levels measured in the three new wells MWL-MW7, -MW8 and -MW9 are approximately 20 feet below the known elevation of the water table at the western side of the MWL dump. The known elevation of the water table is based on the last water table elevation measured in well MWL-MW3 in April 2007 [32].

The deep water levels measured in the three new defective and unusable monitoring wells MWL-MW7, -MW8 and -MW9 are not correct for the elevation of the water table along the western side of the MWL dump. The erroneous water table elevations measured in the three new wells MW7, MW8 and MW9 represent an impossible, sudden decline of approximately 20 feet in a one year period of time when the known rate of decline of the water table for the past 18 years is 0.62 ft per year. The anomalous low water levels measured in the three new monitoring wells are not indicative of the water table although they are presented as such in two DOE/Sandia reports [33, 34] issued in 2009 and 2010. The large decline in the water table represented on DOE/Sandia contour maps [33,34] (see Figures 13 and 13A), based on the erroneous low water levels measured in the three new wells MWL-7, -MW8 and -MW9, is physically not possible because of the very low permeability (i.e., saturated hydraulic conductivity) of the fine-grained alluvial fan sediments.

The very low saturated hydraulic conductivity of the fine-grained alluvial fan sediments is described in the DOE/Sandia report by Goering et al (2002) [9] as follows:

> The fine-grained unit forms the lower part of the vadose zone and the upper part of the saturated zone. This unit is characterized by extremely low saturated hydraulic conductivities on the order of 10-7 centimeters/second (cm/sec) (3x10-4 ft/day) or lower, calculated from

> grain-size analyses of core samples. . . Five of the seven monitoring wells, MWL-BW1, MWL-MW1, MWL-MW2, MWL-MW3, and the upper screen of MWL-MW4, are screened in this fine-grained unit of alluvial fan deposits (p. 24).

The DOE/Sandia 2007 Long-Term Monitoring and Maintenance Plan (LTMMP) [4] describes the rate of decline of the water table in the fine-grained alluvial fan sediments below the MWL dump as follows:

> Groundwater levels beneath the MWL declined an average rate of 0.5 feet/yr between April 2001 and October 2006 (p. 3-21).

As described above, Figure 8 shows that well MWL-MW3 was located along the western boundary of the MWL dump between wells MWL-MW8 and -MW9. Figure 15 shows that the average rate of decline of the water table at the location of well MWL-MW3 over the 12-year period from 1990 through 2001 was 0.62 feet per year. In addition, the water table elevation data for well MWL-MW3 on Figure 11 (4915.61 feet above sea level (ft asl) and on Figure 12 (4911.26 ft asl) also show an average rate of decline or 0.62 feet per year over the 7-year period between April 2000 and April 2007. The calculated change in water table elevation over the 7-year period follows:

> 4915.61 ft asl – 4911.26 ft asl = 4.35 feet / 7 years = 0.62 feet per year.

In conclusion, the water level data over the 18-year period from 1990 to April 2007 show an average rate of decline of the water table at the location of well MWL-MW3 along the western side of the MWL dump of 0.62 feet per year. The erroneous low water levels measured in the three new monitoring wells MWL-MW7, -MW8 and -MW9 that represent a sudden decline in the water table of approximately 20 feet are because of mistakes in the drilling method, drilling operations and the 30-foot length of the well screens.

Table 2 below on the next page compares the erroneous water levels measured in the new wells MWL-MW7, -MW8 and -MW9 in October 2008 [33] and October 2009 [34] to the expected water table elevation at the western side of the MWL dump based on the water table elevation measured in well MWL-MW3 in April 2007 [32]. Table 2 also presents the water levels measured in the new background water quality monitoring well MWL-BW2 in October 2008 [33] and October 2009 [34].

Table 2 shows that the erroneous water levels measured in wells MWL-MW7, -MW8 and -MW9 are 18.4 feet, 18.7 feet and 22.1 feet deeper than the elevation of the water table at the location of well MWL-MW3 along the western boundary of the MWL dump. The deep water levels measured in the three new wells MWL-MW7, -MW8 and -MW9 are evidence the three new monitoring wells are unusable and require replacement.

For comparison, Table 2 shows the water levels measured in the new background water quality monitoring well MWL-BW2 that is located 200 feet east of the eastern boundary of the MWL dump. Well BW2 was also installed in 2008. The location of well MWL-BW2 is shown on Figure 8. The water levels measured in October 2008 [33] and October 2009[34] in well MWL-BW2 are close to the expected elevation of the water table at the location of the well. Nevertheless, there is uncertainty in the elevation of the water table measured at well MWL-BW2 because the required care was not taken to accurately determine the elevation of the water table in real time as the borehole for the well was drilled. This issue is discussed below in Sections 3.5.2 and 3.5.3.

Additional evidence that the three new monitoring wells MWL-MW7, -MW8 and -MW9 are defective and require relplacement is the very small decline in the measured water levels from October 2008 to 2009. The expected decline from nearby well MWL-MW3 is approximately 0.62 feet per year. However, Table 3 shows the measured decline in wells MW7, MW8 and MW9 was only 0.11 feet, 0.09 feet and 0.03 feet, respectively. For comparison, the measured decline of the water level at well MWL-BW2 was 0.5 feet per year which is the expected average rate of decline listed on page 3-21 in the DOE/Sandia 20007 LTMMP Report [4].

Table 2. Water table elevations measured in the new monitoring wells MWL-MW7, MW8, MW9 and BW2 in October 2008 compared to the expected water table elevation calculated for monitoring well MWL-MW3 that was plugged and abandoned.

–	Water table elevation [A] (ft asl) [B] Oct. 2008 / Oct. 2009	Change in feet [C]	Difference in feet compared to expected water table elevation [D] in well MWL-MW3
– Well MWL-MW9 (located ~80 feet north of well MW3)	4888.20 / 4888.17	- 0.03	- 22.1 feet
– Well MWL-MW8 (located ~80 feet south of well MW3)	4891.59 / 4891.50	- 0.09	- 18.7 feet
– Well MWL-MW7 (located ~250 feet south of well MW3)	4891.90 / 4891.79	- 0.11	- 18.4 feet
– Well MWL-BW2 (located ~550 feet east of well MW3)	4910.99 / 4910.50	- 0.5	+ 0.7 feet

[A] The water table elevations for wells MWL-MW7, -MW8, -MW9 and -BW2 are for the measurement data in October 2008 and October 2009 posted on the water table contour maps in the DOE/Sandia annual groundwater reports for the MWL dump.
[B] ft asl = elevation in feet above mean sea level
[C] The change in feet is the difference for water levels measured in 2008 and 2009.
[D] The observed rate of decline of the water table is 0.62 foot per year. Therefore, the expected water table elevation at well MWL-MW3 in October 2008 is calculated by subtracting 0,93 feet from the measured elevation of 4911.25 ft asl on April 02, 2007
---.

The assertion of DOE/Sandia and the NMED HWB that the water levels measured in the three new wells MWL-MW7, -MW8 and -MW9 are accurate for the water table elevation below the MWL dump is incorrect and without any technical basis. The NMED HWB issuance of an approval letter on January 15, 2009 [8] for the three new defective monitoring wells MWL-MW7, -MW8 and -MW9 is a violation of the Consent Order [1] Section VIII.A. ***The three new monitoring wells MWL-MW7, -MW8 and -MW9 are not reliable to detect groundwater contamination from the MWL dump. The three new monitoring wells are defective and require replacement. It is not possible to rehabilitate the three wells.***

3.3. Unreliable groundwater samples have been collected on a quarterly schedule from the three new defective monitoring wells MWL-MW7, -MW8 and -MW9 for a large and expensive analytical suite. The analytical results from the unreliable groundwater samples collected from the three new defective and unreliable monitoring wells MWL -MW7, -MW8 and -MW9 can not be used to determine that groundwater at the water table below the Sandia MWL dump is not contaminated. *Nevertheless, DOE/Sandia reports* [33, 34] *provide the unusable analytical water chemistry data and water level data for that purpose.* The excerpt pasted below from the DOE/Sandia June 2010 annual groundwater monitoring report for the MWL dump [34] describes the large number of unreliable groundwater samples that were collected from the three new defective contaminant detection monitoring wells MWL-MW7, -MW8 and -MW9 on a quarterly schedule:

> Groundwater sampling was conducted at a total of seven groundwater monitoring wells at the Sandia National Laboratories, New Mexico (SNL/NM) Mixed Waste Landfill (MWL) in January, April, July, and October 2009. During 2008, four new monitoring wells were installed (MWL-BW2, MWL-MW7, MWL-MW8, and MWL-MW9) and required Consent Order compliant (NMED April 2004) sampling for eight consecutive quarters. In addition, sampling for perchlorate is required at the new wells for at least four consecutive quarters. The MWL monitoring wells were sampled in accordance with appropriate field operating procedures (SNL/NM August 2007a, 2007b, and 2007c) for groundwater sampling activities and minisampling and analysis plans (mini-SAPs) (SNL/NM January 2009, April 2009, July 2009, and October 2009). The results of the groundwater monitoring showed constituent concentrations within historical ranges for the MWL [Emphasis supplied] (p. i).

Garbage compared to garbage yields additional garbage. The above statement – "The results of the groundwater monitoring showed constituent concentrations within historical ranges for the MWL" – is incorrect and misleading for two reasons:

First, the unreliable analytical results from the three new defective monitoring wells MWL-MW7, -MW8 and -MW9 can not be used to determine: 1). the groundwater chemistry at the water table below the MWL dump or 2). the nature and extent of groundwater contamination at the water table. The unreliable analytical data from the three new defective monitoring wells are not usable for comparison to the historical data.

Secondly, there was not a reliable network of monitoring wells properly located and installed for monitoring contamination at the water table below and downgradient of the MWL dump at any time. The extensive analytical data that was collected over a period of 20 years from the defective monitoring wells can not be used for the required knowledge of 1). the groundwater chemistry at the water table below and downgradient of the MWL dump or 2). the nature and extent of groundwater contamination at the water table below and hydraulically downgradient of the MWL dump. For the most part, the large amount of historical data is not usable for comparison to other data.

All of the 9 contaminant detection monitoring wells at the MWL dump were defective and well MWL-MW3 was the only defective monitoring well at an appropriate location downgradient of the MWL dump with a screen installed across the water table. The NMED HWB issued a NOD Report in 1998 [10] that described well MWL-MW3 as the only downgradient monitoring well installed at the water table. The pertinent excerpt from the 1998 NMED NOD Report [10] follows:

> Deficiency #3. Response 37. - - The water-table map indicated that there is only one downgradient monitor well at the Mixed Waste Landfill. Normally, a minimum of three downgradient wells is required for an adequate detection monitoring system (p. 1-2).

A summary of the 1998 NMED NOD report is in Section 5.6. A copy of the 1998 NMED NOD Report is in Appendix A. Well MWL-MW3 was always the only downgradient monitoring well from when the well was installed in 1989 to when the well was plugged and abandoned in 2008. *From when the defective monitoring well MWL-MW3 was plugged and abandoned in 2008 to the present time in 2011, there have been no monitoring wells at the MWL dump with the capability to detect groundwater contamination from the dump at the water table as ordered by the 2007 NMED HWB letter from Chief Bearzi* [25]. *Nevertheless, DOE/Sandia issue reports* [33,34] *that continue to misrepresent that there is a reliable network of five downgradient monitoring wells.*

The reasons well MWL-MW3 did not provide reliable and representative water samples include 1). the bentonite clay contamination from the mud-rotary drilling method, 2). the corrosion of the stainless steel well screen beginning in 1992 [43], and 3). the improper high-flow purging and sampling method that purged the well to dryness and collected water samples for the analytical suite one to many days later from the highly aerated water that refilled the well. These issues are discussed in Sections 1.7.1 and 9 of this report.

In the current network of seven monitoring wells on Figure 8, the six contaminant detection monitoring wells MWL-MW4, -MW5, -MW6, -MW7, -MW8 and -MW9 are not usable 1). to monitor contamination at the water table below and downgradient from the MWL dump or 2). to measure the elevation of the water table below and hydraulically downgradient of the MWL dump. Except for well MW6, the six wells are unusable for any purpose and are required to be plugged and abandoned and replaced.

3.4. DOE/Sandia used the erroneous deep water levels measured in the defective monitoring wells MWL-MW7, -MW8 and -MW9 to construct an incorrect water table contour map for the Sandia MWL dump. The water table contour map in Figure 13 and enlarged view in Figure 13A is incorrect because it is based on the erroneous deep water levels measured in the three new defective monitoring wells MWL-MW7, -MW8 and -MW9 and also the erroneous deep water level measured in well MWL-MW4.

Figures 13 and 13A show the incorrect water table contour map that was published in the 2009 DOE/Sandia annual report [33] for groundwater monitoring at the Sandia MWL dump. A similar incorrect water table map was published in the 2010 DOE/Sandia annual report [34] for groundwater monitoring at the MWL dump. The incorrect water table map in Figures 13 and 13A shows the direction of groundwater flow below the southern half of the MWL dump is to the west and the direction of groundwater flow below the northern half of the dump is to the northwest.

For comparison to Figures 13 and 13A, Figure 14 shows the *southwest* direction of groundwater flow at the water table below the MWL dump based on the water table elevation measured in the new background monitoring well MWL-BW2 in April 2008 and the expected water table elevations in April 2008 for monitoring wells MWL-MW1, -MW2 and -MW3. Wells MWL-MW1, -MW2 and -MW3 were plugged and abandoned in 2008. The expected elevations in the three wells were calculated by subtracting 0.5 foot from the measured elevation of the water table in the three wells in April 2007.

It was a mistake for the NMED HWB and DOE/Sandia to plug and abandon wells MWL-MW1, -MW2 and -MW3 in 2008 [8] because the three wells still provided valuable information on the depth to the water table in the fine-grained alluvial fan sediments. The three wells should not have been plugged and abandoned until a reliable network of monitoring wells was installed to monitor the water table in the fine-grained alluvial fan sediments below and hydraulically downgradient from the MWL dump.

Figure 14 is the most accurate water table contour map on the direction of groundwater flow at the water table below the Sandia MWL dump. Figure 14 shows that the direction of groundwater flow at the water table below the MWL dump is more to the south than to the west. The southward direction of groundwater flow at the water table below the MWL dump was recognized in the NMED 1993 report by Mr. Moats and Ms. Winn [23]. The 1993 report is summarized in Section 6.3. The pertinent excerpt from the report follows:

> The hydrogeologic conditions at the MWL have not been adequately characterized. . . Water level data from July 1992 indicate south-directed or southwest directed flow. However, the gradient and direction of ground-water flow are not known with reasonable certainty (p. 3).

The necessary network of monitoring wells to provide "*reasonable certainty*" on the direction and speed of groundwater flow at the water table below the MWL dump and hydraulically downgradient from the dump was not installed and the three new defective monitoring wells MWL-MW7, -MW8 and -MW9 are *still* not usable for that purpose. The erroneous low water levels measured in the three new wells MWL-MW7, -MW8 and -MW9 are because the three wells were improperly drilled and installed too deep beneath the water table. The mistakes include: 1). the incorrect ARCH drilling method, 2). the improper drilling operations and 3). the 30-foot long well screens compared to the 10 foot screen length requirement by EPA [11] and the Consent Order [1]. The mistakes are because the NMED HWB did not enforce the requirements in the NMED Sandia Consent Order [1] for 1). drilling method, 2). drilling operations, and 3). well design.

3.5. The mistakes in the drilling method, drilling operations and well design for monitoring wells MWL-MW7, -MW8, -MW9 and -BW2. The NMED Sandia Consent Order [1] mandatorily requires the use of drilling methods and drilling operations that determine the elevation of the water table in real time as the borehole is drilled. This was not done for the four new monitoring wells MWL-MW7, -MW8, -MW9 and -BW2. The pertinent excerpts for drilling procedures from Section VIII.A of the Consent Order [1] follow:

> Drilling shall be performed in a manner that minimizes impacts to the natural properties of the subsurface materials (p. 63).
>
> The drilling method shall allow the Respondents to determine when the appropriate location for the screened interval has been encountered (p. 63).

> The drilling method shall allow for the collection of representative groundwater samples and water level data (p. 63).

In addition, the NMED HWB issued a Notice of Disapproval (NOD) letter on June 19, 2007 [35] for the DOE/Sandia work plan to install the new background water quality monitoring well MWL -BW2. Disapproval #5 in the NMED NOD letter follows:

> The Permittees shall log the depth of the first encounter with regional groundwater and any perched groundwater, during drilling. Modify the plan to state that the depth of regional groundwater and the depth of any perched groundwater will be logged during drilling (p. 2).

DOE/Sandia responded on July 8, 2007 [36] to the NMED NOD letter of June 19, 2007. The response of DOE/Sandia to the above NMED Disapproval #5 follows:

> **Response:** (b)y referencing Field Operating Procedure (FOP) 94-05 "Borehole Lithologic Logging" in Table 1 of the plan, DOE/Sandia indicated the intent to describe the depth of regional groundwater and the depth of any perched groundwater encountered during drilling. To clarify our intent, a sentence has been added to the first paragraph of this section that reads: "The depth of the first encounter with regional groundwater and any perched groundwater will be logged during drilling" (p.3).

However, the field records in the DOE/Sandia reports [37, 38] for the installations of the four new monitoring wells MWL-MW7, -MW8, -MW9 and -BW2 show that the drilling operations did not take the necessary care to log the geology of the boreholes during drilling and to accurately locate the depth to the water table during the drilling operations. The field records are in Appendix E. This issue is discussed father in Sections 3.5.2. and 3.5.3.

3.5.1. Use of the Air Rotary Casing Hammer (ARCH) drilling method was a mistake. The ARCH Drilling Method used by DOE/Sandia could not identify the water table elevation or whether perched zones of saturation existed. The ARCH drilling method prevented the identification of perched zones of saturation and the elevation of the water table of the regional zone of saturation because the drill casing sealed off the borehole in real time as part of drilling. The four new monitoring wells MWL-MW7, -MW8. -MW9 and -BW2 were drilled with the ARCH drilling method. The ARCH drilling method is described in Figure 16 which is an advertisement from the drilling company Water Development Corporation (WDC). WDC drilled the boreholes for the four new monitoring wells MWL-MW7, -MW8, -MW9 and -BW2 with the ARCH method.

It was a mistake to use the ARCH drilling method for the boreholes for the four new monitoring wells because the ARCH drilling method drills a borehole with a smaller diameter than the diameter of the drill casing that is forced into the smaller diameter borehole by a powerful casing hammer. The large diameter of the drill casing compressed the fine-grained alluvial fan sediments together and caused irreparable damage to the ability of the fine-grained alluvia fan sediments to produce groundwater to the screened intervals in the completed wells.

In addition, the ARCH drilling method prevented the identification of the water table in the fine-grained alluvial fan sediments *in real time during the drilling of the borehole* because the drill casing immediately sealed off the production of groundwater from the fine-grained alluvial fan sediments. The fact that the ARCH drilling method seals off the production of groundwater as drilling progresses is described in the WDC advertisement in Figure 16 as follows:

> "The flush-threaded drive casing seals off formations in the borehole as drilling progresses, eliminating the potential for cross-contamination of the aquifers."

In summary, because of the following factors, the ARCH Drilling method violated the Consent Order [1] and the June 19, 2007 NMED NOD letter [21] for DOE/Sandia to use appropriate drilling procedures for 1). the requirement to identify perched zones of saturation during drilling the boreholes, 2). the requirement to identify the elevation of the water table of the regional zone of saturation in real time as the borehole was drilled and 3). the requirement to minimize damage to the natural properties of the subsurface materials:

1) The high air pressure of the air-rotary drilling drove groundwater away from the face of the drill bit and back into the geologic sediments.
2) The large diameter of the drill casing compared to the small diameter of the air rotary drill hole compressed the sediments together and reduced the flow of groundwater from the sediments. The physical damage to the fine-grained sediments surrounding the well screen was irreparable.
3) The drill casing was at the same depth as the air-rotary drill bit and immediately sealed the borehole from producing groundwater in real time as part of drilling.

The drilling method that will minimize the damage to the fine-grained alluvial fan sediments is the *air-rotary underreamer casing advance drilling method*. This drilling method is displayed in Figure 17. Figure 17 shows that the underreamer drill bit drills below the drill casing and drills a larger diameter borehole than the diameter of the drill casing. The underreamer drilling method prevents the irreparable damage to the hydraulic properties of the in situ fine-grained alluvial fan sediments that is caused by the large size of the drill casing that is used with the ARCH drilling method.

3.5.2. The careful drilling operations required by the NMED NOD Letter and the NMED Consent Order were not implemented for drilling the borehole for well MWL-BW2. The field notes for the drilling of the borehole for monitoring well MWL-BW2 show that drilling operations did not implement the measures required by the NMED NOD letter on June 19, 2007 [35] for DOE/Sandia to keep a record of any perched zones of saturation and the elevation of the water table of the regional zone of saturation during the drilling operations. The pertinent excerpts from the field notes in Appendix B of the DOE/Sandia summary report for the installation of well MWL-BW2 [37] are below:

MWL-BW2 – "**Anticipated" depth to the water table was ~472 ft bgs.**

– Excerpts from Attachment B Field Notes pages 174 - 179 for drilling the borehole for well MWL-BW2: **[Note. Pages 174-179 from the Field Notes are in Appendix E of this report.]**

- **–**1-14-08
- **–** 0810: Drill string – 1 ft shoe then 20 ft of 113/4 inch drill casing
  1st length of casing 20 ft
- **–** 0830: 2nd 20 ft casing to 40 ft total depth
- **–** 0850: 3rd 20 ft casing to 60 ft total depth

– 0920: 4th 20 ft casing to 80 ft total depth
– 0930: 5th 20 ft casing to 100 ft total depth no grab sample
– 0940: 6th 20 ft casing to 120 ft total depth
– 0945: 7th 20 ft casing to 140 ft total depth 145 ft – no grab sample
– 1003: 8th 20 ft casing to 160 ft total depth sample at 165 ft
– 1021: 9th 20 ft casing to 180 ft total depth
– 1033: 10th 20 ft casing to 200 ft total depth
– 1050: 11th 20 ft casing to 220 ft total depth
– 1105: 12th 20 ft casing to 240 ft total depth
– 1130: 13th 20 ft casing to 260 ft total depth
– 1140: 14th 20 ft casing to 280 ft total depth
– 1201: 15th 20 ft casing to 300 ft total depth
– 1220: Reached 300 ft below ground surface (ft bgs) with 11 ¾ inch drill casing.

– The borehole was drilled with the ARCH method to the depth of 300 ft bgs in 250 minutes at a fast drilling rate of 1.2 feet per minute. The fast rate of drilling with the ARCH method that immediately sealed off the borehole with the large diameter drill casing prevented recognition of perched zones of saturation as part of drilling.

– Continued from the Field Notes for drilling the borehole for well MWL-BW2:

–1-15-08 Resume ARCH drilling with 9 5/8 inch drill casing
– 0740: 1st 20 ft casing to 320 ft total depth
– 0802: 2nd 20 ft casing to 340 ft total depth
– 0818: 3rd 20 ft casing to 360 ft total depth
– 0840: 4th 20 ft casing to 380 ft total depth
– 0902: 5th 20 ft casing to 400 ft total depth
– 0917: 6th 20 ft casing to 420 ft total depth
– 0935: 7th 20 ft casing to 440 ft
– 0950: 8th 20 ft casing to 460 ft
– 1017: 9th 20 ft casing to 480 ft expect WT [water table] at ~472 ft
– 1050: 10th 20 ft casing to 500 ft
– 1100: Cyclone and tube blocked after encountering material below water table.
– 1140: Add 10 ft of casing to total dept of 510 ft.
– 1210: Total Depth at ~ 509 ft.
– 1-16-08 – 0740: water level at 485 ft bgs.
WL [water level] has not reached anticipated ~ 472 ft bgs.
– 1-17-08 – 0730: Tag water level at 498.5 ft bgs
Tag bottom of borehole at ~ 519 ft bgs
Water level has not come up to expected level (~472 ft bgs)
– 1-18-08 – 0820: Water level at 472.5 ft bgs. Yeah!

The water level at 472.5 ft bgs was measured in monitoring well MWL-BW2 ***after*** the well was installed in the borehole. The water level measured in the monitoring well does not meet the requirement in the June 19, 2007 NMED NOD letter [35] and in the NMED Sandia Consent Order [1] to accurately determine the elevation of the water table *in real time as the borehole is drilled*. The 30-foot length of the screen in well MWL-BW2 is a reason the water level measured in the well is expected to be much deeper than the elevation of the water table at the location of the well. The strong downward hydraulic gradient in the fine-grained alluvial fan sediments and the 30-foot length of the well screen are reasons that it was important to accurately measure the elevation of the water table as part of drilling the borehole. This issue is discussed farther in Section 3.6.

3.5.3. The drilling operations for monitoring well MWL-BW2 did not take care to accurately locate the elevation of the water table in the fine-grained alluvial fan sediments as the borehole was drilled. The NMED Consent Order [1] Section VIII.A and the June 19, 2007 NMED NOD letter [35] for well MWL-BW2 required the drilling operations to accurately determine the elevation of the water table in real time as part of drilling. This was not done during the drilling of the borehole for well MWL-BW2. The estimated depth for the water table in the DOE/Sandia work plan for well MWL-BW2 was 472 ft bgs. Drilling should have stopped at a depth of not deeper than 482 ft bgs. The drill casing should have been retracted to a depth of ~465 ft bgs. Over a period of at least several hours the elevation of the water table should have been repeatedly measured in the open borehole and accurately logged. Measurement of the water level should have continued until the water level had stabilized. The activities described here are the standard industry practice for determination of the elevation of the water table in real time as part of drilling operations.

The actual elevation of the water table in the fine-grained alluvial fan sediments at the location of the new well MWL-BW2 is not known. The 30-ft length of the screen in well BW2 also causes uncertainty in the actual elevation of the water table. This mistake in well design is discussed below in Section 3.6.

3.5.4. The careful drilling operations required by the NMED Consent Order were not implemented for drilling the boreholes for wells MWL-MW7, -MW8 and -MW9. The field notes for the drilling of the boreholes for the three new monitoring wells MWL-MW7, -MW8 and -MW9 show that care was not taken to determine the elevation of the water table as the three boreholes were drilled. However, the drilling records for the three defective monitoring wells show that the water table was at the expected elevation based on the elevation of the water table at nearby well MWL-MW3. The pertinent excerpts from the drilling records for wells MWL-MW7, -MW8 and -MW9 from the DOE/Sandia well installation report [38] are below:

Well MWL-MW7 – Predicted depth to the water table was ~467 ft bgs.
– Excerpts from Appendix C Field Notes pages 7 – 8 for drilling the borehole for well MWL-MW7: **[Note. Pages 7-8 from the Field Notes are in Appendix E of this report.]**

– April 28, 2008
–1202 Bit @ ~417 ft bgs, add another joint
–1211 Take lunch break
–1243 Fire up rig. Road crew back on site.
–1259 Bit @ ~437 ft bgs, add another joint
–1325 Bit @ ~457 ft bgs, add another joint. Cuttings are damp to wet, sticking inside discharge line and cyclone, Not adding water (air only).
–1404 Discharge line clogged at cyclone. Disconnect and clean out cuttings.
–1427 Bit @ 477 ft bgs, add another joint. Reattach discharge line to cyclone.
–1456 at 495 ft bgs, discharge line is plugged due to very wet cuttings.

The water table data from well MWL-MW3 predicted the depth to the water table at the location of well MWL-MW7 would be approximately at 467 ft bgs. The field record for drilling operations in the borehole for well MW7 shows damp to wet cuttings at a depth of ~457 ft bgs. The field record shows that care was not taken to accurately determine the location of the water table as part of drilling operations. The drilling should have stopped at a depth of not greater than 10 feet below the depth when wet cuttings were first observed. The drill casing should have been retracted a distance of ~15 feet. Over a period of at least several hours the elevation of the water table should have been repeatedly measured in the open borehole and accurately logged. Measurement of the water level should have continued until the water level had stabilized.

Well MWL-MW8 – **Predicted depth to the water table was ~468** ft bgs.
– Excerpts from Appendix C Field Notes pages 20 – 21 for drilling the borehole for well MWL-MW8: **[Note. Pages 20-21 from the Field Notes are in Appendix E of this report.]**

– May 07, 2008
– 1010: Add 20 ft [of casing] @ ~ 480 ft bgs, expect water table in this next interval (460-480 ft bgs)
– 1035: ~ 465 ft bgs. cyclone line plugs. Cuttings moist (silty sand), same to ~475 ft bgs. Cyclone and [discharge] line plugged.
– 1100: Clear cyclone and discharge line. Resume drilling. Add 20 ft casing to 500 ft bgs

The water table data from well MWL-MW3 predicted the depth to the water table at the location of well MWL-MW8 would be approximately at 468 feet bgs. The field record for drilling operations in the borehole for well MW8 shows that moist cuttings plugged the discharge line from the cyclone at a depth of ~465 ft bgs. The field record shows that care was not taken to accurately determine the location of the water table as part of drilling operations. The drilling should have stopped at a depth of not greater than 475 feet bgs. The drill casing should have been retracted a distance of 15 feet. Over a period of at least several hours the elevation of the water table should have been repeatedly measured in the open borehole and accurately logged. Measurement of the water level should have continued until the water level had stabilized.

Well MWL-MW9 – **Predicted depth to the water table was ~465** ft bgs.
– Excerpts from Appendix C Field Notes page 28 for drilling the borehole for well MWL-MW9: **[Note. Page 28 from the Field Notes are in Appendix E of this report.]**

– May 14, 2008
– 1009 Drive shoe @ ~ 437 ft bgs, add pipe joint.
– 1041 Drive shoe @ ~ 457 ft bgs, clean out cyclone and discharge line.
– 1128 add another joint.
– 1150 Sample @ 468 ft bgs silty sand. Cyclone continues to plug.
– 1200 Add 20 ft of casing to 500 ft on rig.
– 1220 Poor cuttings return 480-500 ft bgs. Cyclone plugged.
– 1345: Add 20 ft of casing to 520 ft bgs on drill rig cobbles @ 505 ft bgs. Injecting water to prevent plugging.
– 1410: Bottom 20 ft of borehole (~ 515 to 535 ft bgs) cobbles, gravels, some clay

The water table data from well MWL-MW3 predicted the depth to the water table at the location of well MWL-MW9 would be approximately at 465 feet bgs. The field record for drilling operations in the borehole for well MW9 shows that moist cuttings began plugging the cyclone and discharge line at the depth of ~457 ft bgs. The field record shows that care was not taken to accurately determine the location of the water table as part of drilling operations. The drilling should have stopped at a depth of not greater than 470 to 475 feet bgs. The drill casing should have been retracted a distance of ~15 feet. Over a period of at least several hours the elevation of the water table should have been repeatedly measured in the open borehole and accurately logged. Measurement of the water level should have continued until the water level had stabilized

The ARCH drilling method prevented the accurate determination of the depth to the water table in real time as the boreholes for the new monitoring wells MWL-MW7, -MW8, -MW9 and -BW2 were drilled. This is because of the large diameter of the drill casing that was driven into the smaller diameter of the borehole drilled by the drill bit. The large diameter drill casing effectively sealed off the production of water from the fine-grained alluvial fan sediments as the drilling progressed (See Figure 16). The ARCH drilling method also caused irreparable damage to the physical properties of the fine-grained alluvial fan sediments because the drill casing compressed and smeared the interlayered clayey, silty and sandy sediments together and reduced the ability of the package of fine-grained alluvial fan sediments to produce groundwater to the screened intervals in the monitoring wells.

The NMED Sandia Consent Order Section VIII.A requires the use of drilling methods that cause minimum damage to the *in situ* properties of the geologic formations. The pertinent excerpt from Section VIII.A. of the Consent Order [1] follows:

> Drilling shall be performed in a manner that minimizes impacts to the natural properties of the subsurface materials (p.63).

The ARCH drilling method did not minimize impacts to the natural properties of the fine-grained alluvial fan sediments. The drilling method that causes much less damage to the natural properties of the fine-grained alluvial fan sediments is Air-Rotary Under-reamer Casing Advance. The underreamer drilling method is described in Section 3.5.1.

3.6. The incorrect well screen length of 30 feet in the four new monitoring wells MWL-MW7, -MW8, -MW9 and -BW2. The length of the well screens installed in the four new monitoring wells MWL-MW7, -MW8, -MW9 and -BW2 is 30 feet. The screen length in the four new wells should not have been greater than 15 feet because of the concern to accurately measure the elevation of the water table and to monitor for groundwater contamination at the water table below the MWL dump. The screen length of 15 feet is with the understanding that the screen will be installed across the water table with approximately the upper 5 feet of the screen above the water table.

Section VIII.A of the Consent Order [1] states the following requirements for the length of well screens in monitoring wells installed at the Sandia MWL dump:

> The design and construction of groundwater monitoring wells <u>shall comply with the guidelines established in EPA guidance</u> [Emphasis supplied], including, but not limited to: U.S. EPA, *RCRA Groundwater*

Monitoring: Draft Technical Guidance, EPA/530-R-93-001, Nov. 1992 [11] (pp. 63-64).

The EPA guidelines in the above EPA RCRA Guidance Manual [11] for the length of screens in monitoring wells are pasted below:

> Generally, screen lengths should not exceed 10 feet (p. 5-7).
>
> For the purpose of measuring total head [i.e., elevation of the water table], wells should have as short a screened interval as possible. Specifically, EPA recommends that the screens in wells that are used to measure head be less than 10 feet long (p.4-40).
>
> The head measured in a well with a long screened interval is a function of all of the different heads over the entire length of the screened interval. Care should be taken when interpreting water levels collected from wells that have long screened intervals (e.g., greater than 10 feet) (p. 4-41).

It is especially important to limit the length of the screens in the monitoring wells installed across the water table at the Sandia MWL dump to not greater than 15 feet because of the large downward hydraulic force that is present in the fine-grained alluvial fan sediments. The downward hydraulic force is displayed on Figure 7 by comparison of the elevation of the water table measured in well MWL-MW3 to the markedly lower piezometric surface measured in well MWL-MW6 that is installed in the ARG Deposits. The water level (i.e., piezometric surface) measured in well MW6 is approximately 25 feet below the elevation of the water table measured in well MW3.

The June 19, 2007 NMED NOD letter [35] recognized that the 30-feet length of the well screen would prevent the new monitoring well MWL-BW2 from providing accurate information on the elevation of the water table at the location of the well. The pertinent excerpt from the NOD letter follows:

> Because of the proposal to use 30 feet of screen, instead of 20 feet, and because of the significant vertical gradient that exists at the MWL site, the water level in MWL-BW2 is expected to be significantly lower than that observed in existing well MWL-BW1. This will need to be considered when generating future water-level maps" (p. 2).

There is no technical basis or method to correct the effect of the 30-foot long screen in well MWL-BW2 on the amount of error in water levels measured in the well to the actual elevation of the water table at the location of the well. The NMED approval of the 30-foot long screens in well MWL-BW2 [7] and also in wells MWL-MW7, -MW8 and -MW9 [8] is a violation of the Consent Order and RCRA for not obtaining representative and reliable water samples and measuring water elevation from a properly screened well..

3.7. Conclusions about the current network of defective monitoring wells at the Sandia MWL dump. The intended purpose of the current network of seven monitoring wells on Figure 8 is to ensure early detection of contamination at the water table below and hydraulically downgradient of the MWL dump. The current network is a failure for this purpose because ***all*** of the six contaminant detection monitoring wells (wells MWL-MW4, -MW5, -MW6, -MW7, -MW8 and -MW9) ***do not*** monitor contamination at the water table or measure the elevation of the water table.

The water levels measured only in monitoring well MWL-BW2 have a semblance to the expected elevation of the water table elevation in the fine-grained alluvial fan sediments. But there is unacceptable uncertainty for the water levels measured in well MWL-BW2 as accurate for the elevation of the water table because of 1). the incorrect ARCH drilling method, 2). the drilling operations were not careful to determine the elevation of the water table in real time during drilling, and 3). the incorrect 30-foot long well screen. In addition, the 30-foot long well screen provides dilution which makes the water quality data collected from well BW2 uncertain for the water quality at the water table.

The water levels measured in the three new defective monitoring wells MWL-MW7, -MW8 and -MW9 are approximately 20 feet too deep for the known elevation of the water table along the western side of the MWL dump. The three new monitoring wells are unable to measure the elevation of the water table or to detect groundwater contamination at the water table. The three new wells are not usable for any purpose. The reasons the three new wells are defective and require replacement are because of 1). the incorrect ARCH drilling method, 2). the mistakes in drilling operations, and 3). the incorrect 30-foot long well screens. The RCRA and the NMED Consent Order require replacement of the three defective monitoring wells MWL-MW7, -MW8 and -MW9.

There is no dispute (1998 NMED NOD Report [10]) that monitoring well MWL-MW4 did not meet the intended purpose to measure the elevation of the water table below the MWL dump and detect groundwater contamination at the water table below the MWL dump. The NMED HWB has a long and ongoing record of violation of duty under the Consent Order [1] and RCRA in the failure to require DOE/Sandia to replace the defective monitoring well MWL-MW4.

There is no dispute (see Figure 7 in this report and Table 4.1-1 below from the DOE/Sandia Annual Groundwater Monitoring Report issued in June 2010 [34]) that monitoring wells MWL-MW5 and -MW6 did not meet the intended purpose to measure the elevation of the water table west of the MWL dump and detect groundwater contamination at the water table west of the MWL dump. Table 4.1-1 describes wells MWL-MW5 and -MW6 as screened below the water table.

Table 4.1-1
Mixed Waste Landfill October 2009 Groundwater Elevation Data

Monitoring Well	Groundwater Elevation	Comments
MWL-BW2	4910.61	Used to contour top of water table
MWL-MW4	--	No measurement, packer not installed
MWL-MW5	4887.07	Not used, well screened below water table
MWL-MW6	4885.84	Not used, well screened below water table
MWL-MW7	4891.79	Used to contour top of water table
MWL-MW8	4891.50	Used to contour top of water table
MWL-MW9	4888.17	Used to contour top of water table

Source: Table 4.1-1 *in* DOE/Sandia Report "Mixed Waste Landfill Annual Groundwater Monitoring Report Calendar Year 2009," June, 2010 [34].

<u>The NMED HWB has a long and continuing record of dereliction of duty in the failure to require DOE/Sandia to replace the defective monitoring wells MWL-MW5 and -MW6 that never met the intended purpose in the NMED 1998 NOD Report [10] to monitor the elevation of the water table.</u> The NMED 1998 NOD Report, the NMED Consent Order [1]

and RCRA require replacement of the defective monitoring wells MWL-MW5 and -MW6 and also the defective monitoring well MWL-MW4.

The NMED HWB violated the Consent Order and RCRA by the October 31, 2008 approval [7] of the DOE/Sandia Completion Report for well MWL-BW2 [37] because the ARCH drilling method and drilling operations did not comply with the requirements in the NMED Notice of Disapproval (NOD) letter issued on June 19, 2007 [35] or in the DOE/Sandia Consent Order [1].

The NMED HWB violated the NMED DOE/Sandia Consent Order [1] and RCRA by the January 15, 2009 approval [8] of the DOE/Sandia Completion Report for wells MWL-MW7, -MW8 and -MW9 [38] because the drilling method, drilling operations and well design did not comply with the requirements in the Consent Order. The three wells were known to be defective and required replacement at the time the well construction was completed.

The NMED HWB made a mistake to allow DOE/Sandia to collect quarterly groundwater samples for an expensive analytical suite from the defective monitoring wells MWL-MW7, -MW8 and -MW9 [33,34]. The three wells do not produce reliable and representative groundwater samples for the detection of groundwater contamination from the MWL dump. The analytical data are not usable for any purpose and must be thrown out.

4.0. The NMED staff and DOE/Sandia staff provided incorrect testimony at the NMED December 2004 Public Hearing and in many reports that there was a reliable network of monitoring wells at the Sandia MWL dump. The reports in the NMED Administrative Record (AR) show that the staff of DOE/Sandia and the NMED HWB were well aware at the time of the NMED December 2004 Public Hearing that the seven monitoring wells at the Sandia MWL dump were all defective and did not produce reliable and representative groundwater samples. The seven monitoring wells are displayed on Figure 6. Six of the reports in the NMED AR are summarized in Section 5. Nevertheless, the NMED and DOE/Sandia staff provided incorrect testimony at the NMED December 2004 Public Hearing that the seven defective monitoring wells were reliable and there was a sufficient network of monitoring wells at the Sandia MWL dump to detect groundwater contamination. The incorrect testimony is described in Section 6.

In addition, the NMED HWB approved a large number of reports from DOE/Sandia up to the present time in 2011 that continued the ***mischaracterization*** that

- 1). the five defective monitoring wells MWL-MW1, -MW2, -MW3, -MW5 and -MW6 were a reliable network of five downgradient monitoring wells,
- 2), the defective monitoring well MWL-MW4 was a reliable monitoring well installed inside the MWL dump,
- 3), the defective monitoring well MWL-BW1 was a reliable monitoring well for accurate knowledge of background groundwater quality and
- 4). the extensive water quality data collected from the seven defective monitoring wells were proof there was no groundwater contamination from the Sandia MWL dump.

All seven monitoring wells were a failure for the intended purpose and required replacement. Examples of the DOE/Sandia and NMED reports that misrepresent there was/is a reliable network of monitoring wells at the MWL dump are described below.

An important example of a report that presented incorrect information that 1). there was a reliable network of monitoring wells at the MWL dump and 2). there was no evidence of groundwater contamination from the MWL dump is the DOE/Sandia 2002 report titled *"Mixed Waste Landfill Groundwater Report, 1990 through 2001, Sandia National Laboratories, Albuquerque, New Mexico"* by Tim J. Goering, Grace M. Haggerty, Dick Van Hart, and Jerry L. Peace, 2002. Report SAND2002-4098, Sandia National Laboratories, Albuquerque, New Mexico (Goering et al., 2002) [9]. The DOE/Sandia report by Goering et al., (2002) ignored the large number of expert reports in the NMED Administrative Record (AR) that described the monitoring well network at the MWL dump as inadequate and all seven of the monitoring wells were defective and required replacement. The summaries of six of the reports in the NMED AR are in Section 5.

The DOE/Sandia report by Goering et al., (2002) [9] provided incorrect information that there was 1). a reliable network of seven monitoring wells at the Sandia MWL dump and 2). an extensive set of water quality data was proof the wastes buried in the MWL dump had not contaminated the groundwater. Pertinent excerpts of the incorrect and misleading information in the Goering et al,. (2002) [9] report are pasted below:

> The MWL monitoring well network consists of one background well, one on-site well, and five downgradient wells (p. 13).

> Groundwater monitoring at the MWL has been conducted since September 1990, with 28 sampling events during the 11-year period through 2001. . . The extensive analytical data collected to date indicate that groundwater beneath the MWL has not been contaminated (p.13).

> Based upon the plethora of analytical data collected, groundwater beneath the MWL is free of contamination (p. 41),

An important fact is that the DOE/Sandia report by Goering et al., (2002) [9] ignored the NMED 1998 Notice of Deficiency (NOD) Report [10] for the DOE/Sandia RCRA Phase 2 Facility Investigation Report for the Sandia Mixed Waste Landfill [69]**.** The deficiencies identified in the NMED 1998 NOD Report included

– 1). Monitoring well MWL-MW3 was the only downgradient monitoring well,

– 2). The on-site monitoring well MWL-MW4 was defective and required replacement,

– 3). The nickel contamination in the water samples collected from monitoring wells MWL-MW1 and -MW3 was evidence of groundwater contamination from the wastes buried in the MWL dump. [The other groundwater contamination detected in the groundwater samples collected from the two wells are cadmium, chromium and nitrate. See Section 9.8.]

– 4). The pumping tests performed in the MWL dump monitoring wells were a failure and did not produce data that could be used to calculate the speed of groundwater travel. Nevertheless, the report by Goering et al., (2002) [9] used the defective data from the pumping tests that were rejected by the NMED 1998 NOD Report [10]**.**

A summary of the issues presented in the NMED 1998 NOD Report [10] about the defective monitoring wells is in Section 5.6. A copy of the NOD report is in Appendix A.

- **The DOE/Sandia report by Goering et al., (2002) [9] ignored the overall failure of the monitoring well network at the Sandia MWL dump and began the pattern and practice in a large number of reports by DOE/Sandia and the NMED HWB that misrepresent that there was a reliable network of monitoring wells at the MWL dump.**

One example of the incorrect reporting for a period of twenty years from 1990 to 2011 that there was a reliable network of monitoring wells at the Sandia MWL dump are the excerpts below from the DOE/Sandia MWL dump annual groundwater monitoring report that was issued on February 21, 2008 [32] for groundwater sampling events in April and June of 2007:

> Annual groundwater sampling was conducted at the MWL located in TA-III at SNL/NM. Six of the seven monitoring wells at the MWL were sampled, including on-site monitoring well MWL-MW4 and downgradient monitoring wells MWL-MW1, MWL-MW2, MWL-MW3, MWL-MW5, and MWL-MW6 [Emphasis supplied] (p. 3-1).

Comment from the authors: The reports in Section 5 show that it was known from the early 1990's that well MWL-MW3 was the only downgradient monitoring well and the groundwater samples collected from this well prevented the detection of groundwater contamination from the MWL dump for many reasons that are described in Sections 1.7.1 and 9 of this report. The 1998 NMED NOD Report [10] also described the need to replace the on-site monitoring well MWL-MW4 because the screen was installed too deep below the water table. The 1998 NMED NOD Report required the installation of wells MWL-MW5 and MW6 to monitor contamination at the water table but the screens in the two wells were installed too deep below the water table. The deep locations of the screens in wells MW4, MW5 and MW6 are shown on Figure 7. The NMED HWB did not enforce the requirement in the 1998 NMED NOD Report [10] or the Consent Order [1] for replacement of the three defective monitoring wells MWL-MW4, -MW5 and -MW6.

Continued from the incorrect and misleading information provided in the DOE/Sandia annual groundwater monitoring report issued on February 21, 2008 [32]**:**

> Groundwater in the area of the MWL has been extensively characterized since 1990 for major ion chemistry, volatile organic compounds (VOCs), nitrate, metals, radionuclides, and perchlorate. <u>Sixteen years of data indicate that groundwater has not been contaminated by releases from the MWL</u> [Emphasis supplied] (Goering et al. 2002; SNL/NM July 2001, November 2001, January 2002, April 2002, July 2002, October 2002, April 2003, September 2003, April 2004; Lyon and Goering April 2005; SNL/NM April 2006) (p. 1-1).

Comment from the authors: Over a period of 18 years, the NMED HWB required DOE/Sandia to collect unreliable groundwater samples from the seven defective monitoring wells at the MWL dump for a very expensive analytical suite. Then, the NNED HWB approved the 12 DOE/Sandia reports listed in the excerpt above knowing that there was not a reliable network of monitoring wells at the Sandia MWL dump capable of detecting groundwater contamination from the wastes buried in the unlined trenches and pits at the MWL dump. As described in this report, only two of the seven defective monitoring wells (i.e., wells MWL-MW1 and -MW3) were at locations that could detect groundwater contamination from the MWL dump. **The RCRA criteria determined that the groundwater contamination repeatedly detected in the two monitoring wells beginning in 1990 included cadmium, chromium, nickel and nitrate. The groundwater contamination repeatedly detected in the two wells is described in Section 9.8.**

4.1. The NMED Hazardous Waste Bureau (HWB) was a partner with DOE/Sandia in the mischaracterization that a reliable network of monitoring wells existed at the Sandia MWL dump. The NMED HWB approved a large number of DOE/Sandia reports over a 20-year period from 1990 to 2011 that presented incorrect information that there was/is a network of reliable monitoring wells at the Sandia MWL dump. In addition, staff of the NMED HWB presented incorrect testimony at the NMED December 2004 Public Hearing that there was a reliable network of monitoring wells at the MWL dump sufficient for the determination that there was no groundwater contamination from the wastes buried in the MWL dump.

In fact, all seven monitoring wells on Figure 6 were known to be defective soon after the date they were installed over the years from 1988 to 2000. None of the defective wells were replaced until 2008 after Citizen Action and Gilkeson filed a complaint with EPA Region 6 in 2007. Figure 8 shows that three of the defective monitoring wells (wells MWL-MW4, -MW5 and -MW6) are in the current network of six defective contaminant detection monitoring wells. The complaint from Citizen Action and Gilkeson resulted in the installation of the new defective and unusable monitoring wells MWL-MW7, -MW8 and -MW9 that also require replacement.

The NMED November 2006 Moats Report [31]report misrepresents that the seven monitoring wells displayed on Figure 6 provide a reliable network of monitoring wells with no evidence of groundwater contamination from the MWL dump. The incorrect information in the 2006 Moats Report and the requirement for NMED to retract the report are discussed in Section 9.

4.2. The NMED has failed to the present time to invalidate the incorrect and unreliable information furnished by DOE/Sandia from the defective monitoring wells at the Sandia MWL dump. This violation of hazardous waste law continues to the present time because 1). New reports are issued that pretend there was always a reliable network of monitoring wells at the Sandia MWL dump [32, 33, 34] and 2). The six contaminant detection monitoring wells in the current network at the MWL dump are also unreliable to detect contamination and require replacement.

In addition, new DOE/Sandia reports [33,34] make incorrect statements that the current network of six defective monitoring wells produce reliable and representative ground-water samples. The current network is displayed on Figure 8. The June 2010 DOE/Sandia report [34] for groundwater samples collected in 2009 from the defective MWL dump monitoring wells continues the mischaracterization that there was always a reliable network of monitoring wells at the MWL dump when the opposite is known to be true. The pertinent excerpts from the June 2010 DOE/Sandia Report follow:

> Groundwater at the MWL has been extensively characterized since 1990 for major ion chemistry, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), nitrate plus nitrite (NPN), metals, radionuclides, and perchlorate. Twenty years of quarterly, semiannual, and annual data indicate that groundwater has not been contaminated by releases from the MWL [emphasis supplied] (Goering et al. 2002; Lyon and Goering January 2006; SNL/NM December 2001, January 2002, March 2002, July 2002, August 2002, October 2002, June 2003, September 2003, July 2004, November 2006, January 2008, and May 2009) (p. 1-1).
>
> The monitoring well network currently consists of one background well (BW) (MWL-BW2), one on-site monitoring well (MW) (MWL-MW4), and five downgradient wells (MWL-MW5, MWL-MW6, MWL-MW7, MWL-MW8, and MWL-MW9) (p.1-1).

Comment from the authors: The twenty years of quarterly, semiannual, and annual data are **all** unreliable because all of the very expensive data (at a total cost of millions of dollars) were collected from a monitoring well network that was known to be defective from the first monitoring well installed in 1988 to the current network of six defective contaminant detection monitoring wells that includes the three new defective monitoring wells installed in 2008. Moreover, RCRA criteria determine that the groundwater below the MWL dump is contaminated with cadmium, chromium, nickel and nitrate beginning with the first groundwater samples collected in 1990. The nature and extent of the groundwater contamination is not known because a reliable network of monitoring wells was not installed. An additional concern is that the DOE/Sandia computer modeling in 1995 [79] and 2007 [2] identified that the highly toxic tetrachloroethene (PCE) wastes buried in the MWL dump have contaminated the groundwater. The PCE groundwater contamination is discussed in Sections 10.4 and 12.

5.0. Examples of documents in the NMED Administrative Record about the unreliable monitoring wells at the Sandia MWL dump. The NMED Administrative Record (AR) shows that the NMED HWB and DOE/Sandia were aware the seven monitoring wells at the Sandia MWL dump on Figure 6 were defective and required replacement. The seven monitoring wells did not produce reliable and representative groundwater samples at any time. Nevertheless, the NMED HWB accepted annual reports from DOE/Sandia up to 2008 [32] that described 1). the five defective monitoring wells MWL-MW1, -MW2, -MW3, -MW5 and -MW6 as a reliable network of five downgradient monitoring wells, 2). the defective monitoring well MWL-MW4 as a reliable monitoring well installed inside the MWL dump and 3). the defective monitoring well MWL-BW1 as a reliable monitoring well for background groundwater quality.

However, there were many reports published between 1991 and 1998 that described the reasons the monitoring well network at the Sandia MWL dump was defective. Most of the reports are in the NMED Administrative Record (AR). The six reports summarized in this section were written by: 1) the DOE Tiger Team (report #1); 2) the Los Alamos National Laboratory (LANL) (report #2); 3) the NMED Hazardous Waste Bureau (HWB) (reports #3 & #6); 4) the NMED DOE Oversight Bureau (report #4), and; 5) the Region 6 of the Environmental Protection Agency (EPA) (report #5).

5.1. Report #1. The 1991 DOE Tiger Team Assessment Report [39] of monitoring activities at the Sandia National Laboratories Albuquerque Facility. The conclusion in the May 1991 report by the DOE Tiger Team for the monitoring well network at the Sandia MWL dump follows:

> The number and placement of wells at the mixed waste landfill is not sufficient to characterize the effect of the mixed waste landfill on groundwater (p. 3-59).

Comment from the authors: At the time of the 1991 DOE Tiger Team Report [39], the monitoring well network at the Sandia MWL dump was the four monitoring wells MWL-MW1, -MW2, -MW3 and -BW1 (see Figure 6). The DOE Tiger Team Report recognized that the monitoring well network was not sufficient to investigate groundwater contamination from the wastes buried in the MWL dump. <u>However, the monitoring well network at the MWL dump was not improved from the inadequate and unreliable network of four monitoring wells that were reviewed in the 1991 DOE Tiger Team Report.</u> The only monitoring wells installed after the 1991 DOE Tiger Team Report were wells MWL-MW4, -MW5 and -MW6 but Figure 7 shows that the screens in the three wells were installed too deep for the intended purpose to monitor at the water table. The NMED HWB did not require replacement of the three defective monitoring wells. Figure 8 shows that the defective monitoring wells MWL-MW4, -MW5 and -MW6 remain in the current network of six defective monitoring wells.

5.2. Report #2. The 1991 Los Alamos National Laboratory Report [40] (NMED AR 003746) about the improperly located monitoring well network. A June 1991 report (K. Rea, 06-28-91) by scientists at the Los Alamos National Laboratory (LANL) determined that the direction of groundwater flow at the water table below the Sandia MWL dump was to the southwest and monitoring well MWL-MW3 was the only downgradient monitoring well. The LANL report [40] was a technical review of the 1991 DOE/Sandia report –*Compliance Activities Workplan for the Mixed Waste Landfill,* Sandia National Laboratories, June 1991.

The 1991 LANL report was written after the first four monitoring wells MWL-MW1, -MW2, -MW3 and -BW1 were installed at the MWL dump. The pertinent excerpts from the LANL report [40] follows:

> It is stated that "three additional wells were installed, two downgradient and one upgradient…" It would be appropriate to mention here that the data from these [four] wells indicated that the network has in fact only one downgradient well [i.e., well MWL-MW3] and no wells that are definitely upgradient (p.3).
>
> <u>The data from the present monitoring well network indicates that there is only one downgradient and no upgradient wells. *This in itself establishes the inadequacy (under RCRA) of the present well network*</u> [Emphasis supplied]. The presence of this additional well [i.e., proposed angle well MWL-MW4 at a location inside the MWL dump] (neither downgradient nor upgradient) will still not meet RCRA monitoring criteria (p. 3).

Comment from the authors: At the time of the 1991 LANL report [40]**,** the monitoring well network at the Sandia MWL dump was the four monitoring wells MWL-MW1, -MW2, -MW3 and –BW1 (see Figure 6). The LANL report recognized that the monitoring well network at the Sandia MWL dump did not meet the RCRA minimum requirement for three downgradient contaminant detection monitoring wells and one upgradient monitoring well for background water quality. However, the necessary monitoring well network for reliable detection of contamination from the MWL dump was not installed from when the LANL report was written in 1991 to the present time in 2011. The monitoring well network presented at the NMED December 2004 Public Hearing was not improved in any way from the inadequate network described in the 1991 LANL report that did not meet RCRA regulations for groundwater monitoring.

5.3. Report #3. The 1993 NMED report by Moats and Winn [23] (NMED AR 006421) addresses the inadequate monitoring well network. The New Mexico Environment Department (NMED) issued a report in 1993 by NMED staff persons Mr. William Moats and Ms. Lee Winn that described 1). the poor knowledge of the groundwater flow direction below and downgradient of the Sandia MWL dump and 2). the improper use of the mud-rotary drilling method to install monitoring wells MWL-MW2, -MW3 and -BW1 at the MWL dump. A copy of the NMED 1993 report by Moats and Winn is in Appendix B. The pertinent excerpts from the 1993 NMED report [23] are pasted below:

> The hydrogeologic conditions at the MWL have not been adequately characterized. . . <u>Water level data from July 1992 indicate south-directed or southwest directed flow</u> [Emphasis supplied]. However, the gradient and direction of ground-water flow are not known with reasonable certainty (p. 3).
>
> The detection monitoring system that currently exists at the MWL is inadequate because the direction and gradient of ground-water flow can not be determined with reasonable certainty (p. 7).
>
> Additional wells installed at the MWL at greater distances from the facility than the existing wells would better define the horizontal gradient and direction of ground-water flow (p. 4).

Comment from the authors: Mr. Moats and Ms. Winn recognized that the local direction of groundwater flow at the water table below the MWL dump was to the south or the southwest and the existing network of monitoring wells was inadequate

- 1). to detect groundwater contamination from the MWL dump and
- 2). to determine the direction and gradient of groundwater flow at the water table.

The NMED 1998 NOD Report [10] ordered DOE/Sandia to install monitoring wells MWL -MW5 and -MW6 at locations west of the MWL dump to better define the horizontal gradient and direction of groundwater flow at the water table below and hydraulically downgradient from the MWL dump. However, Figure 7 shows that the screens in the two wells MWL-MW5 and -MW6 were installed too deep below the water table and the two wells were not usable for the intended purpose to improve knowledge of the direction and speed of groundwater flow at the water table. The NMED HWB did not require replacement of the defective monitoring wells MWL-MW5 and -MW6.

The direction and speed of groundwater flow at the water table below the MWL dump was not known with reasonable certainty from when the Moats and Winn report [23] was written in 1993 to the present time in 2011. However, the water table contour map in Figure 14 shows that the direction of groundwater flow at the water table below the MWL dump is more to the south than to the west. <u>Accordingly, it is necessary to install monitoring wells along the south side of the MWL dump.</u> There were no contaminant detection monitoring wells installed at appropriate locations south of the MWL dump up to the present in 2011 despite the conclusion in the 1993 report by Moats and Winn that groundwater flow was directed to the south. Continued from the 1993 report by Moats and Winn:

> <u>Research by AIP/DOE Oversight staff members has not yet located any site-specific contour maps of the water table at the MWL. An adequate water level map is basic to the understanding of a site's hydrogeologic system</u> [Emphasis supplied]. Water level maps should be prepared by SNLA [i.e., Sandia] on at least a quarterly basis (p, 3).
>
> The EPA recommends that flow nets be constructed to identify and depict potential contaminant migration pathways. No flow nets representative of conditions specific to the MWL have been located by the AIP/DOE Oversight Program. Additional monitor wells would need to be installed at the MWL in order to construct adequate flow nets for the facility (p. 4).

Comment from the authors: The technical staff of NMED understood the importance of accurate contour maps of the water table below and immediately surrounding the MWL dump. In addition, the technical staff of NMED knew the network of monitoring wells installed at the Sandia MWL dump was wholly inadequate for the construction of accurate site-specific contour maps of the water table below and downgradient of the MWL dump or for the construction of flow nets. But the necessary network of monitoring wells was not installed. <u>Instead, the NMED HWB approved of ***many*** DOE/Sandia reports that incorrectly presented the direction of groundwater flow at the MWL dump to be to the northwest.</u> <u>In addition, the NMED staff and the DOE/Sandia staff presented ***identical incorrect testimony*** at the NMED December 24, 2004 Public Hearing that the direction of groundwater flow at the Sandia MWL dump was to the northwest.</u> For example, see the identical incorrect testimony from DOE/Sandia consultant Mr. Tim Goering and NMED staff person Ms. Carolyn Cooper in Section 6.1 of this report.

The monitoring wells at the Sandia MWL dump were installed for the purpose of measuring the elevation of the water table but Figure 7 shows that the screens in the three wells MWL-MW4, -MW5 and -MW6 were installed too deep for this purpose. The monitoring well network at the MWL dump did not resolve the conclusion in Moats and Winn (1993) [23] that ***"The detection monitoring system that currently exists at the MWL is inadequate because the direction and gradient of ground-water flow can not be determined with reasonable certainty."***

The monitoring well network at the MWL dump was inadequate at all time because of the fundamental fact that the network of monitoring wells necessary to 1). accurately determine the direction and speed of groundwater flow at the water table below and downgradient from the MWL dump and 2). monitor groundwater contamination at the water table were not installed. Continued from the 1993 report by Moats and Winn [23]**:**

> The use of mud-rotary drilling methods should be avoided in any future monitor well installations at the MWL. Mud rotary is not a preferred drilling technology due to its potential detrimental impacts to ground-water quality and the hydraulic characteristics of an aquifer (p. 3).

Comment from the authors: The above excerpt from Moats and Winn (1993) [23] shows that the NMED knew the three mud-rotary monitoring wells MWL- MW2, -MW3 and -BW1 at the MWL dump were not reliable 1). for the detection of groundwater contamination from the MWL dump or 2). for the measurement of the hydraulic properties of the fine-grained alluvial fan sediments at the water table. But the NMED didn't order the replacement of the three defective monitoring wells until 2007 [24,25]**.** In addition, the NMED HWB approved of many reports that described the water quality data collected from the three defective mud-rotary wells as reliable for the detection of contamination from the MWL dump. The NMED also allowed DOE/Sandia [9] to use the three unreliable mud-rotary wells to measure the hydraulic properties of the fine-grained alluvial fan sediments.

<u>**A major deficiency and violation of the Consent Order and RCRA is that the required network of monitoring wells was not installed in the ARG Deposits below the MWL Dump.**</u> The ARG Deposits are the highly productive aquifer zone that are the fast pathway for lateral travel of contaminated groundwater. The regulatory requirements in RCRA and the 2004 NMED Consent Order [1] for a network of monitoring wells in the ARG Deposits are discussed in Section 7 of this report.

5.4. Report #4. The 1994 NMED DOE Oversight Bureau Review [41] of the Sandia MWL dump 1993 Phase 2 RCRA RFI Work Plan (NMED AR 006462). The DOE Oversight Bureau reviewed the March 10, 1993 RCRA RFI Phase 2 Work Plan for the Sandia MWL dump. The pertinent excerpts from the NMED DOE Oversight Bureau Memorandum dated October 13, 1994 [41] are pasted below:

> **General Comment #7.** Page 2-31. Section 2.2.5.2. Paragraph 3: **"**….. Current water level data for the four MWL monitor wells suggest that the hydraulic gradient is toward the southwest, approximately 40 degrees counterclockwise to the regional gradient.**"** Regional gradient was determined to be west-northwest. <u>What will be done to better define the local hydraulic gradient?</u> [Emphasis supplied]. (p. 3).

Comment from the authors: Accurate definition was not obtained for the local hydraulic gradient and direction of groundwater flow below and away from the Sandia MWL dump. *The DOE/Sandia reports* [9,32,4] *repeatedly misused the water table maps that displayed the regional groundwater flow direction and not the local flow direction and hydraulic gradient in the immediate vicinity of the MWL dump.* Examples are the regional groundwater flow maps in Figures 11 and 12. The contour maps in Figures 11 and 12 show that the regional direction of groundwater flow is to the northwest.

However, the water table elevations measured in wells MWL-MW1, -MW2 and -MW3 are posted on the regional maps. The water table elevations measured in the three wells show that the local direction of groundwater flow at the water table below and hydraulically downgradient from the MWL dump is to the southwest. This is illustrated by Figure 11A that shows the local southwest direction of groundwater flow below the MWL dump compared to the regional flow to the northwest displayed on Figure 11.

Continued from the 1994 report by the NMED DOE Oversight Bureau [41]:

> **General Comment #8.** Page 2-44. Section 2.3.2, Groundwater monitoring at the MWL, Paragraph 3: **"**Based on the results from six rounds of sampling at the MWL, there is no indication that groundwater beneath the MWL is contaminated. No elevated levels of radionuclides or hazardous waste constituents have been detected to date in groundwater samples from MWL monitor wells.**"** It should be noted that if the local hydraulic gradient is not known the wells may not be able to adequately detect groundwater contamination, and additional groundwater monitoring wells should be proposed and installed [Emphasis supplied]. Location and design of additional wells should be based on evaluation of all reliable data and coordinated with regulatory and oversight personnel (p. 3).

Comment from the authors: The 1994 NMED DOE Oversight Bureau report [41] makes it obvious that the NMED knew the defective monitoring well network at the MWL dump should not be used for the testimony at the NMED December 2004 Public Hearing that 1). there was a reliable network of monitoring wells at the MWL dump and 2). the groundwater below the dump was not contaminated. The 1994 NMED DOE Oversight Bureau Report [41] recognized that additional monitoring wells were needed at the MWL dump and that the network of monitoring wells used at the NMED December 2004 Public Hearing was inadequate to detect groundwater contamination from the wastes buried in the MWL dump. However, the required network of monitoring wells to investigate groundwater contamination from the MWL dump was not installed to the present time in 2011.

Instead, DOE/Sandia and the NMED HWB have used the defective monitoring well network for a large number of reports up to the present time in 2011 [9.31,32,33,34,46] that make the obviously incorrect conclusions that there was/is a reliable network of monitoring wells and the MWL dump has not contaminated the groundwater. In fact, over all time from when the first monitoring well was installed in 1988, to the present time in 2011, only two monitoring wells (i.e., wells MWL-MW1 and -MW3 were installed at locations that could detect groundwater contamination from the Sandia MWL dump. The groundwater contamination from the MWL dump that was detected in the two wells includes cadmium, chromium, nickel and nitrate. The groundwater contamination is discussed in Section 9.8. The reasons wells MWL-MW1 and MW3 were defective for reliable detection of groundwater contamination are described in Sections 1.7.1 and 9.

5.5. Report #5. The 1994 EPA Region 6 Notice of Deficiency (NOD) Report [30] (NMED AR 006433). The Environmental Protection Agency (EPA) Region 6 issued a Notice of Deficiency (NOD) Report on September 22, 1994 for the DOE/Sandia RCRA Facility Investigation (RFI) Work Plan for the Sandia MWL dump, dated March 1993. Pertinent excerpts from the 1994 EPA Region 6 NOD Report [30] follow:

> **Comment no. 11.** On page 2-31 [in the RFI Work Plan], the third paragraph states that regional potentiometric maps indicate that the hydraulic gradient at the MWL is toward the west and northwest. As shown in Figure 2-21, the MWL monitoring well network (i.e., MWL-BW1, MWL-MW1, MWL-MW2, and MWL-MW3) has been installed based on the assumed regional hydraulic gradient. However, the third paragraph further continues to state water level data collected from the MWL monitoring wells suggests the hydraulic gradient is to the southwest (p,5).
>
> <u>Based on the southwest gradient flow of groundwater, the MWL monitoring wells are located cross gradient instead of downgradient from the MWL; therefore, contaminants emanating from the MWL may not be detected in the monitoring wells</u> [Emphasis supplied] (p. 6).

Comment from the authors: The network of monitoring wells at the MWL dump was not improved from the network of four defective and unreliable monitoring wells in the 1994 EPA Region 6 NOD Report. The 1994 EPA Region 6 NOD Report [30] recognized that the direction of groundwater flow below the Sandia MWL dump was to the southwest and the network of four monitoring wells MWL-MW1, -MW2, -MW3 and -BW1 was not adequate to detect contaminants released from the MWL dump.

Continued from the 1994 EPA Region 6 NOD Report:

> **Comment no. 18.** Paragraph 2, on page 2-44, states that the monitoring wells were sampled six times between September 1990 and January 1992 and semiannually thereafter. *Paragraph 3, on page 2-44, concludes that based on the analytical results of these sampling events, there is no evidence of contamination in the groundwater beneath the MWL. The Work Plan does not provide sufficient information to support this conclusion. In fact, as described below, the location of the monitoring wells and the depth of the screened intervals may not be adequate to detect releases of hazardous constituents from the unit to groundwater* (p. 8-9).
>
> As discussed in comment #11 above, the existing monitoring well network was designed in anticipation of a local hydraulic gradient toward the northwest; however, based on water level data, the observed hydraulic gradient is reportedly toward the southwest (p. 9).

Comment from the authors: The EPA Region 6 NOD Report [30] and the DOE Oversight Bureau Report [41] (Report #4 in this section) recognized that the defective monitoring wells at the Sandia MWL dump could not be used for the unsupported conclusion that the wastes buried in the dump had not contaminated groundwater. But this was the pattern and practice in 1). the incorrect identical testimonies by NMED and DOE/Sandia staff at the NMED December 2004 Public Hearing and 2). the large number of reports from DOE/Sandia and the NMED HWB that used the unreliable water quality data from the defective network of monitoring wells at the MWL Dump.

5.6. Report #6. The 1998 NMED Notice of Deficiency (NOD) Report [10] (NMED AR 010983). On October 30, 1998, Mr. Benito Garcia, the Chief of the NMED Hazardous and Radioactive Materials Bureau [now named the Hazardous Waste Bureau (HWB)] issued a Notice of Deficiency (NOD) Report for the ***Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation (RFI), Sandia National Laboratories, Albuquerque, New Mexico.*** A copy of the 1998 NMED NOD Report is in Appendix A.

The 1998 NMED HWB NOD Report [10] is very important because the report identified many major problems with the monitoring well network at the MWL dump that were not subsequently resolved. The reason the important deficiencies in the 1998 NMED NOD Report were not resolved should be investigated. Mr. James Bearzi replaced Mr. Benito Garcia as Chief of the NMED Hazardous Waste Bureau in the spring of 1999.

- **There is only one downgradient monitoring well.** The pertinent excerpt in the 1998 NMED NOD Report [10] about the inadequate monitoring well network installed at the Sandia MWL dump follows:

> Deficiency #3. Response #37 - - "The water-table map indicates that there is only one downgradient monitoring well at the mixed waste landfill [i.e., well MWL-MW3]. Normally, a minimum of three downgradient wells is required for an adequate detection monitoring system. <u>After the two new wells are installed [wells MWL-MW5 and -MW6], and the water table map is revised, the HRMB [now the NMED HWB] will reevaluate the adequacy of the detection monitoring system</u> [Emphasis supplied]. HRMB requests a meeting with DOE/SNL technical and management staff to discuss the location and design of the two new wells" (p. 2-3).

Comment from the authors: Figure 6 shows the locations of wells MWL-MW5 and -MW6 that were installed west of the MWL dump in 2000 to attempt to resolve the deficiency in the 1998 NMED NOD Report that there was only one downgradient monitoring well installed at the water table. However, Figure 7 shows that the screens in wells MWL-MW5 and -MW6 were installed too deep below the water table and the two wells did not resolve Deficiency #3 in the 1998 NMED NOD Report. Deficiency #3 in the 1998 NMED NOD Report was not resolved to the present in 2011.

The water table contour maps in Figures 11 and 12 did not use the deep water levels measured in wells MWL-MW5 and -MW6 (or in well MWL-MW4). The intended purpose of the three monitoring wells was to improve knowledge of the elevation of the water table below and west of the MWL dump. The NMED HWB did not enforce the requirements in the NMED 1998 NOD Report [10] or the NMED Sandia Consent Order [1] for replacement of the defective monitoring wells MWL-MW4, -MW5 and -MW6. **Over all time from 1989 to the present in 2011, the defective monitoring well MWL- MW3 was the <u>only</u> monitoring well that measured the elevation of the water table at a location hydraulically downgradient of the MWL dump.**

It is important to note the other problems with well MWL-MW3 that prevented detection of groundwater contamination from the wastes buried in the MWL dump. The other problems include 1). the mud-rotary drilling method, 2). The corroded stainless steel well screen beginning in 1992 [43] and 3). the high-flow purging and sampling methods that purged the well to dryness and later collected samples of the nonrepresentative water that refilled the well. These issues are discussed in Sections 1.7.1 and 9.

Well MWL-MW3 was plugged and abandoned in 2008 when the three new contaminant detection monitoring wells MWL-MW7, -MW8 and -MW9 were installed along the western boundary of the MWL dump. However, the three new wells MW7, MW8 and MW9 are also defective and require replacement. The mistakes that require the replacement of the three new wells are discussed above in Section 3.

- **Monitoring well MWL-MW4 is defective and requires replacement.** The pertinent excerpts in the NMED 1998 NOD Report [10] about the requirement to replace monitoring well MWL MW4 follow:

> Additional Comment #3. Response #38 - - "The top of the upper screen of MWL-MW4 is located approximately 22 ft below the water table. Because of the vertical gradient and the way the well is constructed, MWL-MW4 is of **no value** for determining the elevation of the water table (and therefore, the horizontal direction of ground-water flow and the horizontal gradient [emphasis supplied] (p.7).
>
> Also, because the top of the upper screen of MWL-MW4 is located 22 ft. below the water table, the well is of little value for detecting any groundwater contamination (if any exists) that may be present in the saturated zone just below the water table [emphasis supplied] (p. 7).

Comment from the authors: Figure 6 shows the location of angle well MWL-MW4 installed in 1993 to monitor contamination at the water table below Trench D. Figure 7 shows the top of the upper screen is 22 feet below the water table. The deep water levels measured in well MW4 were not used to construct the water table contour maps in Figures 9,11 and 12. The 1998 NMED NOD Report [10] recognized the need to replace well MWL-MW4 but the well was not replaced. Instead, the NMED HWB accepts reports from DOE/Sandia that claim well MWL-MW4 provides reliable and representative water samples for the detection of groundwater contamination at the water table below the MWL dump. In fact, NMED staff person Ms. Carolyn Cooper provided incorrect testimony at the December 2004 public hearing that the upper screen in well MWL-MW4 intersects the water table. Ms. Cooper stated:

> Monitoring well MW-4 was installed at an angle of six degrees from vertical and intersects the water table [Emphasis supplied] at a location beneath disposal Trench D (v. III, p. 919, l. 13-16).

- **Core samples collected of sediments below the MWL dump demonstrate that the dump wastes are the source for nickel contamination in the groundwater.** The pertinent excerpts in the NMED 1998 NOD Report [10] about the requirement for DOE/Sandia to investigate the MWL dump as the source for the high concentrations of nickel contamination measured in groundwater samples collected from monitoring wells MWL-MW1 and -MW3 follow:

> **Deficiency #2. Response #23** – – The cross-sections indicate:
>
> D. There is evidence of possible nickel contamination at concentrations ranging from 11.8 – 21.5 mg/kg in soil samples collected at depths of about 70 – 100 ft (Boreholes SB-5 and BH-3).

E. There is a “hot spot” of contamination at a depth of 50 ft. at Borehole BH-3. Contaminants are Ag [silver] (1.46 mg/kg), Cd [cadmium](1.44 mg/kg), Co [cobalt] (105 mg/kg), Cu [copper] (645 mg/kg), Ni [nickel] (97.5 mg/kg), and Zn [zinc] (413 mg/kg).

The presence of metal contaminants at depths which can exceed 100 ft indicate that liquid wastes were disposed of in the landfill. Thus, groundwater monitoring for metals is required.

The Response [42] from DOE/Sandia to Deficiency #2, Response #23 follows:

DOE/Sandia will continue to monitor groundwater at the mixed waste landfill for metals.

Comment from the authors: <u>DOE/Sandia did not install a reliable network of monitoring wells at the MWL dump for the detection of metals or other contaminants from the first four monitoring wells installed in 1988 and 1989 to the present time in 2011.</u>

- **Continued from the NMED 1998 NOD Report [10]:**

Deficiency #5. Response #46 – – The MWL inventory is not complete. Data derived from soil sampling beneath the landfill indicate that nickel is a possible contaminant from the MWL. (See Deficiency No. 2) (p.3).

<u>DOE/SNL must support their position on a technical basis that the elevated nickel levels detected in groundwater samples from monitor well MWL-MW1 (and MWL-MW3) are a result of the corrosion of 304 stainless steel well screen; otherwise, such elevated levels of nickel will be attributed to a release of contaminants from the landfill</u> [Emphasis supplied] (p.3).

The Response [42] from DOE/Sandia to Deficiency #5, Response #46 follows:

Although nickel is a possible contaminant at the MWL, DOE/Sandia believe it is unlikely that nickel has migrated from disposal cells at the MWL through the 500-foot-thick vadose zone. However, DOE/Sandia plans to continue monitoring nickel and other RCRA metals in ground-water at the MWL as part of their long-term monitoring program at the landfill.

Comment from the authors: DOE/Sandia did not support their position on a technical basis that the elevated nickel concentrations measured in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 were not from the wastes buried in the MWL dump. Mr. Benito Garcia was Chief of the NMED Hazardous Waste Bureau (HWB) when the 1998 NMED NOD was issued. Mr. James Bearzi became Chief of the NMED HWB in 1999 and the concern in the 1998 NMED NOD Report for the high nickel concentrations in water samples collected from monitoring wells MWL-MW1 and -MW3 was not resolved.

The concern in the 1998 NMED NOD Report [10] for the high concentrations of nickel measured in monitoring wells MWL-MW1 and -MW3 is unresolved to the present time. The NMED HWB did not require DOE/Sandia to provide technical proof that the corroded well screens were the only source for the high nickel concentrations measured in groundwater samples collected from wells MWL-MW1 and -MW3.

A public hearing was held in December 2004 on the NMED selection of the dirt cover remedy for the Sandia MWL dump. The NMED staff person Ms. Carolyn Cooper testified at the public hearing about the nickel and chromium contamination detected in the water samples collected from monitoring wells MWL-MW1 and -MW3 as follows:

> Elevated levels of nickel and chromium have been detected since 1992 in Monitoring Wells MW-1, 2, 3 and BW-1. Concentrations of nickel that exceed the EPA MCL for drinking water have been detected in Monitor well 1. Concentrations of chromium exceeding the MCL have been detected in Monitor well 1 and 2. Each of these four wells is constructed with a stainless steel well screen (v. III, p. 924, l. 24-25; p. 925 l. 1-7).

Comment from the authors: The NMED HWB should have required replacement of the four defective monitoring wells MWl-MW1, -MW2, -MW3 and -BW1 in 1992 because of the assumption by DOE/Sandia that the high concentrations of nickel and chromium in the groundwater samples were only from the corrosion of the stainless steel well screens. The corroded screens prevented the wells from producing reliable and representative water samples for chromium, nickel, cadmium and other trace metal and organic contaminants buried in the MWL dump. This issue is discussed below in Section 9.

Continued from the testimony of Ms. Carolyn Cooper:

> Elevated levels of nickel and chromium have not been detected in groundwater samples from the three wells that are constructed with PVC screens, which are Monitor Wells 4, 5 and 6. (v. III, p. 925, l. 8-11).

From the testimony of DOE/Sandia consultant Mr. Tim Goering:

> I mentioned earlier that our earliest wells that were installed nearly 15 years ago had stainless steel screens, and a very common problem with wells with stainless steel screens is that there is low-level corrosion of these screens. In effect, they rust, and you see chromium and you see nickel from the corrosion of the screens. So we have detected chromium and nickel, but only in our wells with the stainless steel screens. (v. I, p. 925, l. 2-9).
>
> In fact, in one well, MW-1, which is at the northeast corner of the landfill, there have been several exceedences of the EPA drinking standard for chromium, but this chromium and nickel occurs as a result of the corrosion of the screens. It's a very well-documented problem in the literature, and as I discussed, our recent wells have PVC screens, and we don't see the chromium and nickel. (v. I, p. 925, l. 10-17).

Comment from the authors: The above testimony of Ms. Cooper and Mr. Goering about the monitoring wells constructed with PVC screens has <u>no technical basis</u> to prove the high concentrations of nickel and chromium measured in monitoring wells MWL-MW1 and -MW3 was only from corrosion of the stainless steel screens. One reason the testimony is incorrect and not acceptable is because the NMED 1998 NOD Report [10] described the reason well MWL-MW4 was not reliable to detect contamination from the MWL dump because of the deep location of the upper well screen. In addition, monitoring wells MWL-MW5 and -MW6 are located the great distances of 540 feet and 730 feet, respectively away from well MWL-MW1 (see Figure 6). Moreover, the screens in wells MWL-MW5 and -MW6 were installed too deep for the intended purpose to monitor contamination at the water table (see Figure 7).

A second reason the testimony of Ms. Cooper and Mr. Goering is incorrect and of no scientific value is that in the first three years (i.e., 1990 through 1992) of collecting groundwater samples from the four monitoring wells with stainless steel screens, dissolved chromium and nickel were only detected in the groundwater samples collected from wells MWL-MW1 and MW3 located close to the MWL dump and not in the distant background monitoring well MWL-BW1 or in monitoring well MWL-MW2 that was located north and cross-gradient to the direction of groundwater flow below the MWL dump. The dissolved nickel and chromium data were presented in a DOE/Sandia report by Goering et al., (2002). The water quality tables from Goering et al., 2002 are in Appendix F.

A third reason the testimony of Ms. Cooper and Mr. Goering is incorrect and not explanatory is that in the first three years (i.e., 1990 through 1992), the dissolved concentrations of chromium and nickel measured in monitoring wells MWL-MW1 and MW3, were determined under RCRA Criteria to be evidence of groundwater contamination from the wastes buried in the MWL dump.

Continued from the testimony of Ms. Carolyn Cooper:

> Additionally, elevated levels of nickel and chromium have not been detected in the subsurface soil beneath the mixed waste landfill (v. III, p. 925 l. 12-14). .

Comment from the authors: The above testimony is incorrect because the NMED 1998 NOD Report [10] described the elevated levels of nickel detected in the subsurface sediments beneath the MWL dump (see the excerpts from the 1998 NOD above).

Continued from the testimony of Ms. Carolyn Cooper:

> Sandia attributes the elevated nickel and chromium concentrations in the groundwater to corrosion of the stainless steel well screens (v. III, p. 925, l. 15-17).
>
> In NMED's view, the most likely explanation for the elevated nickel and chromium concentrations in groundwater at the mixed waste landfill is the corrosion of the stainless steel well screens (v. III, p. 925, l. 24-25; p. 926, l. 1-2).

Comment from the authors: At the NMED December 2004 Public Hearing the NMED HWB accepted the **speculation, "the belief"** by DOE/Sandia that the high nickel and chromium concentrations measured in the groundwater samples were only from corrosion of the stainless steel well screens. **Regulatory actions based on mere speculation and belief are not protective of public health and the environment.** The NMED HWB did not enforce the requirement in the 1998 NMED NOD Report [10] for DOE/Sandia to support on a technical basis that the wastes buried in the MWL dump were not the source for the groundwater contamination with nickel and chromium. The pertinent excerpt from the 1998 NMED NOD Report [10] is above in this section.

The Hearing Officer's Proposed Finding of Fact and Conclusions of Law Report [43] for the NMED December 2004 Public Hearing stated that NMED attributed corrosion as the only source for the high concentrations of nickel measured in wells MWL-MW1 and -MW3. The Finding Number 81 in the Hearing Officer's Report [43] follows:

> "81. Elevated levels of nickel and chromium have been detected since 1992 in MWL- MW1, MWL-MW2, MWL-MW3 and MWL-BW1, which wells are all constructed with stainless steel well screen. <u>NMED attributes these elevated levels to corrosion of the stainless steel well screens</u>" [Emphasis supplied] (p. 15)

Comment from the authors: <u>The high concentrations of nickel detected in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 meet RCRA criteria as "statistically significant evidence" of a nickel plume in the groundwater below the MWL dump from the nickel wastes buried in the dump.</u> This issue is discussed in Sections 8 and 9. Well MWL-MW1 was plugged and abandoned in 2008 and not replaced with a new monitoring well installed near the location of well MW1. There is an immediate need to install a new monitoring well on the north side of the MWL dump near the location of plugged and abandoned well MWL-MW1.

- **Continued from the NMED 1998 NOD Report [10]:**

> **Additional comment no. 5. Response 50. - -** The pumping tests for monitor wells MWL-MW1, MWL-MW2, MWL-MW3, and MWL-MW4 appear to have failed because the yield of each well was too small to permit a successful pumping test to be conducted. The pumping test conducted on MWL-MW4 (Lower) also appears to have failed, . . . none of the drawdown curves appears to have a form which matches that of a type curve. <u>Therefore, the reported values for hydraulic conductivity and transmissivity are not considered by the HRMB [now the NMED HWB] to be reliable</u> [Emphasis added](p. 7-8).

Comment from the authors: The unreliable pumping test data that were rejected in the NMED 1998 NOD Report [10] were nevertheless subsequently used by DOE/Sandia to calculate the hydraulic conductivity and lateral speed of groundwater travel away from the MWL dump at the water table in the fine-grained alluvial fan sediments and in the deeper ARG Deposits. The incorrect hydraulic conductivity data and the incorrect lateral speed of groundwater travel were listed in Tables 3-3 and 3-4, respectively, in the December 2002 DOE/Sandia Report by Goering et al., 2002 [9]**.**

- Table 3-4 lists an erroneous very low value of 0.17 feet / year for the average lateral speed of travel for groundwater in the fine-grained alluvial fan sediments below the MWL dump,

- Table 3-4 lists an erroneous low value of 18.5 feet / year for the average lateral speed of travel for groundwater in the ARG Deposits below the MWL dump,

- Both of the above values from Table 3-4 in Goering et al. (2002) [9] do not have any technical basis to represent the actual speed of lateral travel of groundwater in the fine-grained alluvial fan sediments or in the ARG Deposits. The reasons for no technical basis are explained below.

Both of the above incorrect values for the speed of groundwater travel at the MWL dump were in the testimony of DOE/Sandia consultant Mr. Tim Goering at the NMED December 2004 Public Hearing. The testimony of Mr. Goering follows:

> the flow velocities in groundwater, because these materials are so tight, are so - - - the hydraulic conductivity is low of the formation, and our shallowest wells show that the groundwater is flowing approximately 0.17 feet per year toward the west (v. I, p. 93, l. 20-25).
>
> The deeper wells are in a more transmissive zone, with some more sands, and the flow velocity is 18.5 feet per year in that deeper part of the aquifer (v.I, p. 94, l. 1-3).

The "shallowest wells" in the above testimony of Mr. Goering are the wells installed in the fine-grained alluvial fan sediments and include wells MWL-MW1, -MW2, -MW3, upper screen in -MW4, and -BW1. Wells MWL-MW2, -MW3 and -BW1 were drilled with the mud-rotary method with well known properties in the technical literature [11] to reduce the hydraulic properties of the screened intervals. The 1993 report by NMED staff persons William Moats and Lee Winn [23] described the damage caused by the mud-rotary drilling method as follows:

> The use of mud-rotary drilling methods should be avoided in any future monitor well installations at the MWL. Mud rotary is not a preferred drilling technology due to its potential detrimental impacts to ground-water quality and the hydraulic characteristics of an aquifer (p. 3).

Well MWL-MW1 was drilled with the ARCH drilling method which also has well known properties to lower the hydraulic properties of the fine-grained silty and clayey sediments in the screened interval of a monitoring well because the drive casing smears a hole through the interlayered silty and clayey sediments, squeezes the sediments together and seals of the flow of groundwater. See the discussion of the ARCH drilling method in Figure 16.

The very low lateral velocity of 0.17 feet / year in Goering et al., (2002) for groundwater flow at the water table in the fine-grained alluvial fan sediments calculates that the groundwater at the water table travels a lateral distance of only 17 feet over a time period of 100 years. There is no technical basis that this very slow speed for groundwater flow at the water table below the MWL dump is accurate. Accurate knowledge of the lateral speed of groundwater travel below the MWL dump at the water table in the fine-grained alluvial fan sediments and in the deeper ARG Deposits is very important but is not known at the present time.

<u>The Nitrate Groundwater Contamination is from the wastes buried in the MWL dump.</u> The very slow lateral travel of groundwater at the water table is in contradiction to the claim by DOE/Sandia in Goering et al. (2002) [9] and the NMED HWB [31] that the high levels of nitrate repeatedly measured in the ground-water samples collected from wells MWL-MW1 and -MW3 are not from the MWL dump.

DOE/Sandia [9] and the NMED HWB [31] claim that the septic systems in TA-3 are the source of the high nitrate concentrations that are present in the groundwater at the water table below the MWL dump. The TA-3 septic systems can not be the source of the nitrate contamination unless the lateral speed of groundwater travel in the fine-grained alluvial fan sediments is several orders of magnitude greater than 0.17 feet / year.

Low nitrate concentrations are measured in the new background water quality monitoring well MWL-BW2. A new important issue about the high concentrations of nitrate repeatedly measured in the groundwater at the water table below the MWL dump are the low nitrate concentrations measured in the groundwater samples collected from the new hydraulically upgradient background water quality monitoring well MWL-BW2. Well BW2 was installed in 2008 at a location 200 feet east of the eastern boundary of the MWL dump. The location of well MWL-BW2 is shown on Figure 8.

The nitrate concentrations measured in the groundwater samples collected from the background monitoring well MWL-BW2 are listed in the data tables in Appendix G. The nitrate concentrations measured in groundwater samples collected from well MWL-BW2 for seven sampling events in 2008 [33] and 2009 [34] range from 1.86 to 2.34 mg/L with a median concentration of 2.01 mg/L. Markedly higher nitrate concentrations of 5.21 mg/L and 3.75 mg/L were measured in the last groundwater samples collected in April 2007 [32] from monitoring wells MWL-MW1 and -MW3, respectively, at the MWL dump.

The high concentrations of nitrate repeatedly measured in wells MWL-MW1 and -MW3 compared to the low nitrate concentrations measured in the background well MWL-BW2 are an indication of nitrate groundwater contamination from the wastes buried in the MWL dump. Wells MWL-MW1 and -MW3 are also the monitoring wells where the high concentrations of nickel were repeatedly measured in the groundwater below the MWL dump. The nickel contamination in the groundwater below the MWL dump is discussed further in Section 8. In addition, the cadmium, chromium, nickel and nitrate contamination measured in the groundwater below the MWL dump from the wastes buried in the MWL dump is discussed in Section 9.8.

The unresolved nature and extent of the high cadmium, chromium, nickel and nitrate concentrations measured in the water samples collected from monitoring well MWL-MW1 requires the installation of a new monitoring well at a location close to the location of well MWL-MW1. DOE/Sandia and NMED made a serious mistake to plug and abandon well MWL-MW1. The well was usable for ongoing measurement of the elevation of the water table and for the measurement of the nitrate contamination in the groundwater. Important information on the MWL dump as the source for nitrate contamination in the groundwater below the dump could have been acquired by the comparison of nitrate isotopic analyses of water samples collected from wells MWL-MW1 and MWL-BW2. Now that comparison is not possible because well MWL-MW1 was plugged and abandoned in 2008. As stated earlier, there is an immediate need to install a new monitoring well near the location of plugged and abandoned monitoring well MWL-MW1.

The background water quality monitoring well MWL-BW2 is located 200 feet east of the eastern boundary of the MWL dump. For the fine-grained alluvial fan sediments, the speed of 0.17 feet per year for the lateral travel of groundwater at the water table represents that the groundwater at the water table below and surrounding the MWL dump travels a lateral distance of only 17 feet over a period of 100 years. At a lateral speed of 0.17 feet per year, the time for groundwater to travel from the location of well BW-2 to the eastern boundary of the MWL dump would be 1200 years. <u>Therefore, the</u>

distant location in Technical Area 3.

The very slow speed of groundwater travel at the water table below the MWL dump requires the installation of 2 monitoring wells at appropriate locations inside the MWL dump to investigate tritium contamination in the groundwater from the very large inventory of tritium wastes buried in the classified area of the dump. A large inventory of tritium wastes are buried in the pits that are located in the central and southern region of the classified area of the MWL dump. Figure 22 shows that tritium wastes were buried in 12 pits in the central and southern region of the classified area. For example, 822 Curies of tritium were buried in Pit 33 which is greater than 34% of the estimated total inventory of 2400 Curies of tritium [2] buried at the MWL dump.

The distance from Pit 33 to the monitoring wells located along the western boundary of the MWL dump is greater than 260 feet. Accordingly, at a speed of 0.17 feet / year, the time for tritium contaminated groundwater at the water table below Pit 33 to travel to the monitoring wells is greater than 1,500 years. The very slow speed for lateral travel of groundwater below the MWL dump requires installation of two [2] monitoring well inside the MWL dump at appropriate locations to monitor groundwater contamination below the central and southern region of the classified area.

The average lateral speed for the flow of groundwater in the ARG Deposits in the DOE/Sandia report by Goering et al. (2002)[9] and in the testimony of Mr. Tim Goering to the December 2004 public hearing was 18.5 feet / year. The review of the report by Goering et al. (2002) [9] shows that the average value for lateral groundwater flow in the ARG Deposits is unreasonably slow and presents another technically baseless conclusion.

The average lateral speed of 18.5 feet / year for groundwater travel in the ARG Deposits was based on hydraulic tests in only the three MWL monitoring wells listed below:

- MWL- MW6 - one slug test - Average saturated hydraulic conductivity (Ksat) = 5 ft/year
- MWL-MW5 - one slug test - Average Ksat = 0.7 ft/year
- MWL-MW4 (lower screen) - Average Ksat = 1.7 ft/year
  - one slug test - - Ksat = 1.69 – 2.09 ft/year
  - one pumping test - - Ksat = 1.49 ft/year (NOTE: the NMED 1998 NOD Report [10] rejected the pumping test).

Comment from the authors:

- **First,** the use of the two wells MWL-MW4 (lower screen) and MWL-MW5 to determine the speed of lateral flow in the ARG Deposits is <u>improper</u> because most of the screened interval in each well is installed in the fine-grained alluvial fan sediments. Figure 7 shows that only the bottom tips of the two screens are in the ARG Deposits.

- **Second,** The screened interval in well MWL-MW5 was contaminated with a large quantity of bentonite clay/cement grout because of a mistake in construction of the well. The grout contamination lowered the Ksat measured in well MWL-MW5. The lowest Ksat was measured in well MWL-MW5.

- **Third,** a markedly higher lateral speed of groundwater travel of 51.6 ft/year was measured in well MWL-MW6 where the well screen is only installed in the deeper productive ARG Deposits. But the use of a slug test in only one well installed in the ARG Deposits is too sparse a sample for accurate knowledge of the hydraulic properties of the ARG Deposits. RCRA and the NMED Consent Order require a network of monitoring wells installed in the ARG Deposits at the Sandia MWL dump. This requirement is discussed in Section 7. The speed of groundwater travel in the ARG Deposits should be determined in the future from pumping tests performed in the appropriate and required network of monitoring wells that are installed only in the ARG Deposits.

- **Continued from the NMED 1998 NOD Report [10].**

  The 1998 NMED NOD Report required a risk assessment for groundwater contamination from the Sandia MWL dump. The pertinent excerpt from the 1998 NMED NOD Report [10] follows (p.4-5):

> B. Because land located approximately 1 mile west of the MWL could be developed for residential use, DOE/SNL must evaluate the potential for off-site contaminant migration from the landfill. The evaluation should consider ecological and human health impacts from any potential migration.
>
> C. The nature and extent of subsurface contamination indicate that some contaminants are a potential threat to ground-water quality beneath and downgradient (west) of the MWL. A simple screening comparison of contaminant concentrations in subsurface soils against available EPA soil screening levels (SSL's) developed for the protection of ground-water resources demonstrates exceedences for cadmium and nickel (U. S. EPA, 1996, *Soil Screening Guidance: Technical Background Document,* EPA/540/R-95/128. Office of Emergency and Remedial Response, Washington, DC. PB96-963502).
>
> Therefore, the risk assessment for the MWL must evaluate potential impacts of cadmium, nickel, and other contaminants (metals such as cobalt and copper, and radioactive materials such as uranium and tritium, for which SSL's are not available at this time) on local and regional ground-water quality [Emphasis supplied].

Comment from the authors: The risk assessment that was required in the 1998 NMED NOD Report [10] for impacts to groundwater was not performed because the unreliable water quality data from the defective monitoring well network were used for the incorrect conclusion that the groundwater contamination pathway below the MWL dump was "incomplete." This incorrect conclusion was made despite the fact that DOE/Sandia did not provide proof that the MWL dump was not the source for the high concentrations of nickel contamination in the groundwater below the dump. In addition, the available data show that at a minimum the MWL dump has contaminated the groundwater below the dump with cadmium, chromium, nickel and nitrate and probably the highly toxic solvents tetrachloroethene (PCE) and trichloroethene (TCE). The nature and extent of the groundwater contamination from the MWL dump is not known because a reliable network of monitoring wells was not installed.

The new information of the low chromium, nickel, nitrate and cadmium concentrations (cadmium is not detected) in the groundwater samples collected from the new background water quality monitoring well MWL-BW2 is evidence under RCRA criteria that the MWL dump is the source for the cadmium chromium, nickel and nitrate contamination in the groundwater below the dump. The 1998 NMED NOD Report [10] also concluded that the high nickel concentrations measured in the groundwater samples collected from wells MWL-MW1 and -MW3 are evidence of nickel groundwater contamination from the wastes buried in the MWL dump. The best interpretation of all of the available data is that the wastes buried in the MWL dump have contaminated the groundwater below the dump with cadmium, chromium, nickel, nitrate and PCE. The groundwater contamination is discussed in Sections 8 and 9 of this report.

The pertinent excerpt from the testimony at the NMED December 2004 Public Hearing of NMED consultant Ms. Paige Walton on the decision to not perform the required risk assessment for the groundwater pathway follows:

> Both RCRA facility investigations concluded that groundwater had not been impacted by contaminants from the landfill (v. III, p. 1036, l. 18-20).
>
> The first step in identifying constituents of concern [for risk assessment] was to compare detected concentrations to natural pathway of concern. However, extensive groundwater monitoring has shown that groundwater is not contaminated as a result of releases from the landfill. (v. III, p. 1036, l. 18-20).
>
> Therefore, while groundwater was identified as a potential exposure pathway, it is acceptable, in NMED's view, to evaluate groundwater under the current conditions as an incomplete exposure pathway. (v. III, p. 1039, l. 1-7).
>
> In this case, since groundwater has not been found to be contaminated, there is no source, and, therefore, the pathway is incomplete. (v. III, p. 1039, l. 13-15).

Comment from the authors: The testimony by Ms. Walton did not mention the findings in the NMED 1998 NOD Report that included a requirement of a risk assessment for the groundwater pathway. <u>The conclusion in the NMED 1998 NOD Report [10] about the RCRA Facility Investigations was that 1). there was no reliable network of monitoring wells at the MWL dump but 2). the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 were evidence of a nickel plume from the nickel wastes buried in the MWL dump.</u> In addition, the best interpretation now of the badly flawed water quality data is that the wastes buried in unlined trenches and pits have contaminated the groundwater below the dump with cadmium, chromium, nickel, nitrate, PCE and possibly many other contaminants including tritium, beryllium, lead, uranium and other toxic solvents including TCE.

<u>**The 1998 NMED NOD Report [10] demonstrates that the pathway for groundwater contamination from the MWL dump *is complete* in the absence of technical data proving that the nickel contamination is only from corrosion of the stainless steel well screens.**</u> In addition, the comparison of the chemistry of water samples collected from wells MWL-MW1 and -MW3 to the chemistry of water samples collected from the new background water quality monitoring well MWL-BW2 indicates the MWL dump has contaminated the groundwater with cadmium, chromium, nickel and nitrate beginning with the first groundwater samples collected in 1990. This issue is discussed in Section 9.8.

The DOE/Sandia 2007 fate and transport computer modeling report (DOE/Sandia 2007 FTM Report [2]) determined the groundwater below the MWL dump is contaminated presently with the highly toxic solvent tetrachloroethene (PCE) at concentrations above the revised drinking water standard that EPA will promulgate in 2011 [66]. A new concern that requires a risk assessment of the groundwater pathway is the announcement by EPA on March 29, 2010 [66] that the drinking water standards for the highly toxic VOC contaminants PCE and TCE will be set in 2011 at much lower concentrations than the current standards. The discussion in the Federal Register on March 29, 2010 [66] indicates that the EPA DWS for PCE and TCE will be tightened one hundred times from the current MCLs of 5 ug/L to new MCLs of 0.05 ug/L. The large magnitude of the tightening of the EPA standards is because PCE and TCE in drinking water at the current drinking water standards of 5 ug/L are known to cause cancer [66].

PCE and TCE wastes are buried in the MWL dump and PCE and TCE are present as contamination in the soil gas in the vadose zone below the MWL dump [68,69]. The DOE/Sandia 2007 FTM Report [2] determined that the groundwater below the MWL dump is contaminated at the present time with PCE at concentrations much greater than the new DWS MCL that EPA will promulgate for PCE in 2011.

The 100 computer simulations in the DOE/Sandia FTM Report [2] for groundwater contamination from the PCE wastes buried in the MWL dump are displayed in Figure 29.

- Figure 29 shows that 87 of 100 of the Monte Carlo simulations in the 2007 FTM Report [2] predict the groundwater below the MWL dump to be contaminated now with PCE at concentrations greater than 0.05 ug/L.
- Figure 29 shows that 59 of 100 of the Monte Carlo simulations in the 2007 FTM Report [2] predict the groundwater below the MWL dump to be contaminated now with PCE at concentrations greater than 0.5 ug/L.

A reliable network of monitoring wells for the detection of PCE, TCE and other solvents was not installed at the water table or in the ARG Deposits below the MWL dump. The deficiencies in the monitoring wells and the methods used to collect water samples for the detection of VOCs including PCE and TCE are discussed in Sections 9.6 and 9.7 of this report. The DOE/Sandia FTM Report [2] is discussed in Section 12 of this report.

The NMED HWB has not enforced the requirement of RCRA and the NMED Consent Order [1] for reliable networks of monitoring wells to be installed in two separate zones below the MWL dump. The upper zone that requires a network of monitoring wells is the water table in the poorly productive fine-grained alluvial fan sediments. The deeper zone that requires a network of monitoring wells is the highly productive ARG Deposits that are located below the layer of fine-grained alluvial fan sediments. The two zones are displayed on Figure 7. After the two required networks of monitoring wells are installed and sampled for a minimum period of three to five years, a risk assessment shall be performed of the groundwater pathway as required by RCRA and the NMED 1998 NOD Report.

6.0. The staff of the NMED Hazardous Waste Bureau and DOE/Sandia provided incorrect testimony at the December 2004 Public Hearing on the Sandia MWL dump contrary to the facts in the NMED Administrative Record. The public hearing was to present the proposed NMED remedy recommendation to install a dirt cover over the toxic wastes buried in unlined trenches and pits at the Sandia MWL dump. The staff of NMED and DOE/Sandia provided incorrect testimony at the public hearing that there was a reliable network of monitoring wells at the MWL dump and groundwater below the dump was not contaminated. The substantial scientific evidence that contradicted NMED and DOE/Sandia witnesses' statements was omitted.

Excerpts from the testimony from NMED Attorney Ms. Tannis Fox at the NMED December 2004 Public Hearing follow:

> This is a hearing on the New Mexico Environment Department's proposal to modify Sandia National Laboratories hazardous waste permit to require Sandia to take corrective action on its mixed waste landfill. The proposed permit modification [i.e., the dirt cover remedy] is the culmination of many person-hours of complex technical review and evaluation by NMED staff (v. III, p.892, l.11-17).
>
> Staff has reviewed and scrutinized the technical documents prepared by Sandia as part of the corrective action process. Including the Phase 1 and Phase 2 RCRA Facility Investigation Reports, the Corrective Measures Study Report, and volumes of air, soil and groundwater monitoring data, among other information (v. III, p.892, l.18-24).

Comment from the authors: NMED Attorney Fox described the importance of the findings in the Phase 2 RCRA Facility Investigation (RFI) Report to the NMED recommendation to leave the toxic waste in the unlined trenches and pits at the MWL dump below a dirt cover. However, the testimony of Attorney Fox did not inform the public or hearing officer that the NMED 1998 Notice of Deficiency (NOD) Report [10] described major deficiencies for the defective monitoring well network in the RFI Phase 2 Report including that there was "only one downgradient well" and that the onsite monitoring well MWL-MW4 was not usable. In addition, the NMED 1998 NOD Report determined that the Sandia MWL dump was the source for the nickel contamination in the groundwater below the dump. The NMED 1998 NOD Report is summarized in Section 5.6 and a copy of the report is in Appendix A.

In addition, Attorney Fox failed to inform the public hearing that the 1994 EPA NOD Report [30] rejected the RCRA RFI Phase 2 Workplan to make any conclusions that the monitoring well network at the MWL dump could detect groundwater contamination. The defective monitoring well network in the 1994 EPA NOD Report was the same defective network presented at the NMED December 2004 Public Hearing. A summary of the 1994 EPA NOD Report is in Section 5.5 of this report.

NMED Attorney Fox described the testimony of NMED staff person Mr. William Moats as follows:

> Mr. Moats will provide testimony analyzing, from NMED's perspective, the RFIs, the Sandia Corrective Measures Study, or CMS. And potential remedies for the site, and will describe NMED's proposed draft permit and remedy (v. III, p.894, l. 8-12).

Pertinent excerpts from Mr. Moats' testimony at the NMED December 2004 Public Hearing follow:

> I have reviewed the RCRA Facility Investigation and Groundwater Investigation Reports for dozens of solid waste management units, or SWMUs, including the Phase 2 RFI Facility Investigation Report for the mixed waste landfill [Emphasis supplied] (v. III, p. 962, l. 13-17).
>
> However, to ensure that groundwater does not become contaminated, NMED will impose robust soil and groundwater monitoring requirements that will ensure early detection of migration. If additional releases of contaminants are detected, NMED will evaluate all the data and will require Sandia to take whatever action is necessary to ensure that human health and the environment is protected. (v. III, p. 976, l. 1-8).
>
> Following extensive review of the Phase 1 and Phase 2 RCRA Facility Investigation Reports, NMED required Sandia to respond to over 100 questions and comments [Emphasis supplied] (v. III, p. 979, l. 13-16).

Comment from the authors: The DOE/Sandia answers to the 100 questions from NMED prompted NMED to issue the 1998 NMED Notice of Deficiency (NOD) Report [10] for the many problems in the Phase 2 RCRA Facility Investigation Report [69]**.** Mr. Moats was the lead technical person for the review of the DOE/Sandia RFI Reports and for the issuance of the NMED 1998 NOD Report [10]**.** Mr. Moats was the coauthor on the 1993 NMED Report [23] that described the monitoring well network at the MWL dump as "inadequate." Mr. Moats was also the lead person for the April 29, 2004 NMED DOE/Sandia Consent Order [1]**.**

It was a violation of RCRA for Mr. Moats to omit substantive and relevant information at the NMED December 2004 Public Hearing regarding the significant deficiencies that he knew existed in the Sandia MWL dump monitoring well network. The deficiencies were identified by the NMED report written by Mr. Moats and Ms. Winn in 1993 [23], the 1994 EPA NOD Report [30], the 1998 NMED NOD Report [10], the April 29, 2004 Consent Order [1] and many other reports in the NMED Administrative Record (AR). The deficiencies required the replacement of the entire monitoring well network that was described as a reliable network at the NMED December 2004 Public Hearing. See the summary of the NMED AR reports in Section 5.

Continued from the testimony of Mr.Moats:

> Data quality was assessed for completeness, representativeness, precision, and accuracy. In general, data collected during the mixed waste landfill RCRA Facility Investigation were found to be of acceptable quality (v. III, p. 979, l. 17-21).
>
> In general, laboratory data reported in the Phase 1 and Phase 2 RCRA Facility Investigation Reports are considered by NMED to be of high quality (v. III, p. 1001, l. 18-20).

Comment from the authors: The above testimony regarding data quality is contradicted by the NMED Report by Moats and Winn (1993) [23], the 1994 EPA Region 6 NOD Report [30]**,** the 1998 NMED NOD Report [10] and the other three reports in Section 5.

The six reports in Section 5 describe the need to replace the seven monitoring wells at the MWL dump that were presented as a reliable network in the testimony of Mr. Moats. Continued from the testimony of Mr. Moats:

> As discussed in [NMED staff person] Ms. Cooper's testimony, <u>there is no evidence of groundwater contamination at the mixed waste landfill caused by a release from the waste at the mixed waste landfill</u> (Emphasis supplied] (v. III, p. 986, l. 5-8).
>
> The mixed waste landfill is a low-risk facility because there are no releases that pose unacceptable risk - - that is, the environmental problems are relatively small and the releases present minimal exposure concerns (v. III, p. 1019, l. 20-24).

Comment from the authors: <u>In fact, the 1998 NMED NOD Report [10] (and also RCRA criteria) identified the high nickel concentrations measured in water samples collected from wells MWL-MW1 and -MW3 as groundwater contamination from the MWL dump.</u> Moreover, the water quality data from monitoring wells MWL-MW1 and MW3 are evidence the wastes buried in the MWL dump have contaminated the groundwater with cadmium, chromium, nickel and nitrate. The groundwater contamination is determined to be present by RCRA Criteria. The overall evidence of the groundwater contamination is described in Section 9.8 and specifically for nickel in Section 8.

The above testimony by Mr. Moats is incorrect and offers no explanation for the several reports in the NMED AR including 1). the 1993 NMED report by Moats and Winn [23] that described the monitoring well network as "inadequate," 2). the 1994 EPA Region 6 NOD Report [30] that concluded the monitoring well network could not determine that the MWL dump had not contaminated the groundwater below the dump, and 3). the many deficiencies for the defective monitoring well network in the 1998 NMED NOD Report [10]**.** <u>Absent reliable monitoring data no valid risk assessment can be made.</u>

Continued from the testimony of Mr. Moats:

> NMED disagrees with Mr. Baskaran's assertion that Sandia data for the mixed waste landfill are substandard quality. The quality of the Sandia data is adequate for comparing the analytical results of samples of environmental media to corresponding background levels, which is the normal method to determine whether contaminants have been released from a site (v. III, p. 1078, l. 16-22).

Comment from the authors: The above testimony by Mr. Moats is incorrect because all of the monitoring wells at the MWL dump were defective for many reasons known to Mr. Moats [10, 23, 30]. There was no scientific basis to compare the unreliable and unrepresentative groundwater samples collected from the defective monitoring wells to <u>**questionable and uncertain**</u> regional background concentrations from a NMED background report [44]**.**

The "normal method" and the method required by RCRA is comparison of water quality data from a reliable network of contaminant detection monitoring wells to water quality data from a reliable hydraulically upgradient background monitoring well but there were no reliable monitoring wells at the Sandia MWL dump at the time of the NMED December 2004 Public Hearing to detect groundwater contamination or to measure

background groundwater chemistry. The conclusion of Mr. Baskaran that the Sandia data for the MWL dump are of substandard quality was correct.
It is important to note that the water quality data from the new background monitoring well MWL-BW2 [33,34] are evidence that the water quality data in the NMED regional background groundwater quality report [44] are of substandard quality and should not be used in place of water quality data from a reliable hydraulically upgradient background monitoring well.

Continued from the testimony of Mr. Moats:

- The groundwater and soil monitoring data demonstrate that nonnatural uranium, plutonium, and strontium-90 have not contaminated groundwater and soil (v. III, p. 1079, l. 15-17).
- Concentrations of uranium detected in wells at the mixed waste landfill are consistent with the approved background level of 2.5 micrograms per liter (v. III, p. 1079, l. 21-24).
- Uranium concentrations detected in water samples from the downgradient wells do not differ from those found in water samples from the upgradient well (v. III, p. 1080, l. 6-8).
- Plutonium is not present in the groundwater, as demonstrated by the data in the NMED's Compilation of Groundwater Monitoring Data, NMED Exhibit 18 (v. III, p. 1080, l. 17-19).

Comment from the authors: The above testimony by Mr. Moats is incorrect because the defective monitoring well network [10, 23,24,25 30, 39,40,41] at the MWL dump can not be used for any conclusions that the groundwater below the MWL dump is not contaminated with any of the above contaminants that are present in the wastes buried in the unlined pits and trenches at the MWL dump. ***The above testimony by Mr. Moats omitted his knowledge for the public hearing that there was no hydraulically upgradient background water quality monitoring well at the MWL dump, that well MWL-MW3 was the only downgradient monitoring well, and that the onsite monitoring well MWL-MW4 was unusable for any purpose.***

Continued from the testimony of Mr. Moats:

- Here's the NMED analysis [of the WERC Report]. NMED agrees with the WERC peer review team with respect to the following conclusions: Characterization data are of high quality and that the general approach taken by Sandia to conduct the mixed waste landfill RCRA Facility Investigation was adequate (v. III, p. 1094, l. 7-13).
- WERC agrees with the NMED that there have been no past releases of chemicals or radionuclides that currently pose an unacceptable risk to human health or the environment (v. III, p. 1095, l. 25, p. 1096, l. 1-3).

Comment from the authors: The above testimony by Mr. Moats is contradicted by the NMED 1998 NOD Report [10] and the 1993 NMED Report authored by Mr. Moats [23] that found many deficiencies with the groundwater monitoring well network in the Phase 2 RCRA facility investigation. The two NMED Reports [10, 23] along with the other 4 reports in Section 5 show that NMED was acutely aware that the DOE/Sandia characterization data for the MWL dump were **not of high quality** and that the general approach taken by DOE/Sandia to conduct the mixed waste landfill RCRA Facility Investigation was **not adequate** and did not protect public health and the environment.

The WERC Study [45] of the Sandia MWL dump was commissioned by Congress. The two WERC reports issued in 2001 [45] and 2003 [76] contain appendices that list the documents pertaining to the MWL dump that were provided to the WERC expert staff for review. Appendix D in the 2001 WERC Repot [45] lists 113 documents provided to the WERC expert staff and Appendix D in the 2003 Final WERC Report [76] lists 124 documents provided to the WERC expert staff. However, the document appendices in the two WERC Reports [45, 76] do not contain *any* of the six reports summarized in Section 5 that describe the reasons all of the seven monitoring wells at the MWL dump in the review by the WERC expert staff were defective and required replacement. The appendices show that the WERC staff were not provided the important reports in the NMED Administrative Record (AR) that proved the monitoring well network presented to the NMED December 2004 Public Hearing was defective and required replacement.

There were no monitoring wells that provided "high quality" and accurate data about groundwater contamination from the wastes buried in unlined trenches and pits at the MWL dump. The WERC Final Report [45] about the MWL dump is of substandard quality because the WERC peer review team was not informed about the important documents in the NMED AR that described the defective monitoring well network at the MWL dump.

Under RCRA there is a duty to provide full and complete information. For example, the above testimony by Mr. Moats shows that the WERC staff were not provided the 1993 report by Moats and Winn [23], the 1994 EPA Region 6 NOD Report [30] or the NMED 1998 NOD Report [10] that described the many deficiencies in the Phase 2 RCRA Facility Investigation Report for the Sandia MWL dump. The WERC staff apparently were not informed about the defective monitoring well network at the MWL dump during meetings with staff of DOE/Sandia and NMED on March 22 and 23, 2001 and on May 11, 2001. The WERC staff relied on information in reports and presentations provided by the staff of DOE/Sandia and NMED. This reliance is shown by the following statement in the 2001 WERC Final Report [45]**:**

> The review conducted was a high-level analysis, focused on determining the reasonableness of conclusions reached by DOE. The intent of the review was not to reproduce the calculations and results of the reports used to evaluate the MWL (p.1).

In addition, the following excerpt from the 2003 WERC Final Report shows the scant attention paid by the WERC expert staff to the 124 documents listed in Appendix D:

> High professional standards and extraordinary technical knowledge demonstrated by the SNL staff during public hearings and in the preparation of the Draft CMS document helped the [WERC] Panel substantially in learning, understanding, and accepting information related to the MWL history, design, and operation. <u>The limited time factor for this review, however, did not allow the Panel to perform a complete review of all documents pertaining to the site (see Appendix D). The principal documents reviewed were the Draft CMS, the *Mixed Waste Landfill Phase 2 RCRA Facility Investigation*, and documentation provided by presenters</u> [Emphasis supplied].

Comment from the authors: The two above excerpts from the two WERC Final Reports [45, 76] show that the WERC expert staff were not provided the NMED 1998 NOD

Report [10] or the other five reports in Section 5 that described many important deficiencies with the groundwater monitoring wells in the *Mixed Waste Landfill Phase 2 RCRA Facility Investigation*. Moreover, the text of the 2003 WERC Final Report [76] on pages 7 to 8 described the MWL dump monitoring well network as follows:

> To monitor for groundwater contamination, 7 monitoring wells were drilled around the perimeter of the landfill, one of which was in a generally upgradient location. Additionally, one monitoring well was placed inside the unclassified area of the landfill. Monitoring well locations are presented in Figure 11 and penetrate the underlying aquifer a minimum of 110 feet to a maximum of 160 feet.

<u>The above statement in the WERC 2003 Final Report [76] is entirely incorrect as shown by the six reports in Section 5.</u> The deficiencies in the NMED 1998 NOD Report [10] included the findings that 1). there was only one downgradient monitoring well, 2). the onsite monitoring well was defective and required replacement and 3). the MWL dump was the source of the nickel contamination in the groundwater below the dump. The set of six reports in Section 5 presented findings that there was no background water quality monitoring well at a hydraulically upgradient location and all seven monitoring wells at the MWL dump were defective and required replacement.

In addition, Figure 6 shows that only two of the monitoring wells (i.e., wells MWL-MW1 and -MW3) were at locations drilled “around the perimeter” of the MWL dump and there was no hydraulically upgradient monitoring well for background. Moreover, there is also no technical basis for the incorrect statement in the above excerpt from the WERC 2003 Final Report [76] that the monitoring wells “penetrate the underlying aquifer a minimum of 110 feet to a maximum of 160 feet” for the following reasons:

The NMED required all seven monitoring wells to be installed not in the aquifer below the MWL dump but instead in the fine-grained alluvial fan sediments at the water table below the MWL dump. The hydrogeologic setting below the MWL dump is displayed in the geologic cross-section in Figure 7. The fine-grained alluvial fan sediments have very low permeability (saturated hydraulic conductivity) and are not an aquifer but are instead, a low permeability confining bed above the productive aquifer strata which are the Ancestral Rio Grande “A” Deposits (ARG Deposits) on Figure 7.

Figure 7 shows that monitoring well MWL-MW6 is the only monitoring well installed in the ARG Deposits. The installation of well MWL-MW6 in the ARG Deposits was because of a mistake in the drilling methods that were used to install the well.

In addition, Figure 7 shows that there is no technical basis for the incorrect statement in the WERC 2003 Final Report [76] that the monitoring wells penetrate the underlying aquifer a minimum of 110 feet to a maximum of 160 feet. Figure 7 shows that the screen length in all of the seven monitoring wells is 20 feet. Figure 7 shows that the four wells MWL-MW3, -MW2, -MW1, and -BW1 penetrate the fine-grained alluvial fan sediments a distance ranging from approximately 5 to 10 feet. Recall that the NMED required all seven monitoring wells to monitor contamination at the water table. However, Figure 7 shows that the screens in wells MWL-MW4, -MW5 and -MW6 were installed too deep below the water table for the intended purpose.

Comment from the authors: Our review of the two WERC reports [45,76] shows that the WERC staff lacked basic knowledge about the hydrogeologic setting below the MWL dump and did not understand that there were two zones of saturation that required networks of monitoring wells: The upper zone was the water table in the fine-grained alluvial fan sediments that produced only small amounts of groundwater and were a confining bed above the underlying aquifer known as the ARG Deposits. The ARG Deposits are the important regionally extensive aquifer that provides large supplies of groundwater to the very productive drinking water supply wells for Albuquerque.

The discussion in the Risk Assessment Section of the Final 2001 WERC Report [45] is another example that the WERC peer review team was not aware that there was not a reliable network of monitoring wells at the MWL dump. The pertinent excerpt from the WERC Report follows:

> It should be noted that this risk assessment is strictly based on the levels of contaminants that were detected in soil and groundwater sampling [Emphasis supplied].The assessment did not consider risks posed by other chemicals that are present in the MWL, based on the inventory, that have not been released into the environment (p. 48).

The above statement shows that the WERC peer review team incorrectly believed there was a reliable network of seven monitoring wells at the MWL dump. In fact, none of the seven monitoring wells were reliable to detect groundwater contamination from the wastes buried in the MWL dump. The process for how the expert staff on the WERC study that was commissioned by Congress were misinformed about the groundwater protection practices at the Sandia MWL dump and the role of the NMED staff and the DOE/Sandia staff in controlling and omitting important information provided to the WERC study [45] should be investigated.

6.1. The staff of DOE/Sandia and NMED provided identical false testimony to the NMED December 2004 Public Hearing. The testimony is shown to be knowingly untrue by the six reports in Section 5 and also by the July 2, 2007 letter from the NMED HWB Chief James Bearzi [25] that is summarized below in this section. The July 2, 2007 letter from HWB Chief Bearzi ordered DOE/Sandia to replace the two defective monitoring wells MWL-MW1 and MWL-MW3 with new monitoring wells located west of the MWL dump. The Bearzi letter on July 2, 2007 confirms the six earlier reports in Section 5 that the direction of groundwater flow at the water table below the MWL dump is not to the northwest but to the southwest. The two defective monitoring wells were replaced in 2008 with the two new monitoring wells MWL-MW7 and -MW8 that are also defective and require replacement.

The staff of NMED and DOE/Sandia presented ***identical incorrect testimony*** at the NMED December 2004 Public Hearing that 1). the direction of groundwater flow at the water table below the Sandia MWL dump was to the ***northwest*** and that 2). there was a reliable network of five downgradient monitoring wells (i.e., wells MWL-MW1, -MW2, -MW3, -MW5 and -MW6) and 3). one reliable on-site monitoring well existed (i.e., well MWL-MW4). The pertinent excerpts from the identical incorrect testimonies of DOE staff person Mr. John Gould, DOE/Sandia consultant, Mr. Tim Goering and NMED staff persons Mr. Will Moats, Mr. William McDonald and Ms. Carolyn Cooper are pasted below:

- Testimony of DOE staff person Mr. John Gould:

> We have seven groundwater monitoring wells right now which we think are sufficient. We put in two recently at the request of NMED. Currently, we feel that NMED thinks the system we have in place is right now is [sic] sufficient. If we're ever required to put in additional wells, we'll do so (v. I, p. 202, l.19-24).

Comment from the authors: The seven groundwater monitoring wells described as "sufficient" in the testimony of Mr. Gould are the seven monitoring wells on Figure 6. The seven wells were all known to be unreliable and required replacement in the reports in the NMED Administrative Record (AR). See the summary of six reports written over the years 1991 to 1998 in Section 5. The NMED 1998 NOD Report [10] (report #6 in Section 5) identified many deficiencies with the monitoring well network including 1). well MWL-MW3 was the only downgradient monitoring well, no upgradient background well existed 2). the need to replace the defective onsite well MWL-MW4 and 3). the NMED HWB considered the high nickel concentrations measured in groundwater samples collected from wells MWL-MW1 and -MW3 to be groundwater contamination from the wastes buried In the MWL dump.

The two recently installed wells in Mr. Gould's testimony are monitoring wells MWL-MW5 and -MW6. Figure 7 shows the screens in the two wells are installed too deep for the intended purpose to monitor the water table at locations downgradient of the MWL dump. In addition, Figure 7 shows the mistake in installing the screened interval in well MWL-MW5 across two zones of saturation. Well MWL-MW5 was not usable for any purpose. The defective monitoring well <u>**prevented**</u> the detection of groundwater contamination from the MWL dump.

The testimony by Mr. Gould that DOE will install additional monitoring wells at the MWL dump if required to do so was incorrect and misleading because the NMED Consent Order issued on April 29, 2004 [1] required replacement of the entire network of seven defective monitoring wells that were presented as reliable monitoring wells in the testimony of Mr. Gould and others at the NMED December 2004 Public Hearing. The requirements in the Consent Order are discussed in Section 7 of this report. DOE was a signatory on the Consent Order.

- Testimony of DOE/Sandia consultant Mr. Tim Goering:

> The groundwater flow direction at the site is towards the west, with a slight north component of flow (v. I, p. 93, l. 18-19).
>
> We have been monitoring groundwater at the site since 1990, and we've conducted more than 36 sampling events (v. I, p. 94, l. 15-17).
>
> We're currently monitoring at the landfill on an annual basis for a wide suite of parameters. These reductions in monitoring frequency was done in coordination with the New Mexico Environment Department, where we were in agreement to reduce the frequency, based on the fact that we were not seeing evidence of contamination and groundwater was well-characterized (v. I, p. 94, l. 22-25; p. 95, l. 1-3).

> So, in summary, I can state that there is no evidence that there is groundwater contamination from the mixed waste landfill (v. I, p. 100, l. 22-24).

Comment from the authors: Mr. Goering provided incorrect testimony that the direction of groundwater flow below the MWL dump was to the northwest. The reports in the NMED AR (six of the reports are summarized in Section 5) show that it was known from the early 1990's that the direction of groundwater flow was to the southwest and <u>well MWL-MW3 was the only downgradient monitoring well.</u> DOE/Sandia and NMED collected more than 36 sampling events from the defective monitoring well network at the MWL dump for a very expensive analytical suite. The unreliable water quality data collected from the defective monitoring well network at the Sandia MWL dump could not be used to conclude by Mr. Goering that <u>*"there is no evidence that there is groundwater contamination from the mixed waste landfill."*</u> Instead, the water quality data in the DOE/Sandia report by Goering et al (2002) are evidence under RCRA criteria that the wastes buried in the MWL dump have contaminated the groundwater below the dump with cadmium, chromium, nickel, and nitrate. The nature and extent of the groundwater contamination is not known because reliable monitoring wells were not installed.

The 1994 EPA Region 6 NOD Report [30] (report #5 in Section 5) informed DOE/Sandia that the unreliable monitoring well network could not be used for the conclusion in the testimony of Mr. Goering that the MWL dump had not contaminated the groundwater. The pertinent excerpt from the 1994 EPA Region 6 NOD Report follows:

> Based on the southwest gradient flow of groundwater, the MWL monitoring wells are located cross gradient instead of downgradient from the MWL; therefore, <u>contaminants emanating from the MWL may not be detected in the monitoring wells</u> [Emphasis supplied] (p. 6).

In addition, Mr. Goering's testimony did not mention that the 1998 NMED NOD Report [10] (report #6 in Section 5) considered the high levels of nickel measured in the groundwater samples collected from wells MWL-MW1 and MW3 as evidence of groundwater contamination from the MWL dump.

- Testimony of NMED staff person Mr. William McDonald:

> At the time of the [RCRA] Phase 2 RFI, the groundwater monitoring well network at the mixed waste landfill consisted of five wells. No evidence of groundwater contamination as a result of a release from waste was found at the mixed waste landfill (v. III, p. 958, l. 11-17).

Comment from the authors: Mr. McDonald's testimony was identical to the above testimony from Mr. Goering that there was a reliable network of monitoring wells and no evidence of groundwater contamination from the MWL dump. Mr. McDonald's testimony did not mention the conclusions in the 1994 EPA Region 6 NOD Report [30] and the 1994 NMED Oversight Bureau Report [41] that the network of monitoring wells was inadequate to detect contaminants from the MWL dump.

In addition, also identical to the testimony from Mr. Goering, Mr. McDonald's testimony did not mention the NMED 1998 NOD Report [10] that was issued for the many deficiencies in the groundwater monitoring network in the RCRA Phase 2 RFI Report for the Sandia MWL dump. The 1998 NMED NOD Report recognized 1). there was only one downgradient monitoring well (i.e., well MWL-MW3), no upgradient background well 2). the monitoring well installed inside the dump (well MWL-MW4) was defective and required replacement and 3). the high levels of nickel contamination measured in the groundwater samples collected from wells MWL-MW1 and -MW3 were evidence of groundwater contamination from the wastes buried in the MWL dump. DOE/Sandia did not prove the nickel groundwater contamination was not from the MWL dump.

The NMED 1998 NOD Report required the installation of the monitoring wells MWL-MW5 and -MW6. But the two wells were also defective and did not meet the requirements in the NMED 1998 NOD Report. This issue is discussed above in our comments on the testimony of Mr. John Gould. The issues presented in the NMED 1998 NOD Report were not resolved. Pertinent excerpts from the NMED 1998 NOD Report are pasted below in this section. Section 5.6 of this report summarizes the NMED 1998 NOD Report. A copy of the NMED 1998 NOD Report is in Appendix A.

- Testimony of NMED staff person Ms. Carolyn Cooper:

> Currently, groundwater at the mixed waste landfill flows west, with a slight northwest component of flow (v. III, p. 918, l. 25, p. 919, l. 1-2)
>
> Downgradient monitoring wells MW-1 and MW-2 are located north of the landfill, and MW-3 is situated to the west of the landfill (v. III, p. 919, l. 11-13).
>
> The groundwater monitoring data, as a whole, shows there has been no contamination of groundwater beneath and surrounding the mixed waste landfill. This finding is critical to NMED's determination that a vegetative cover, with a biointrusion barrier, and long-term monitoring, represent an adequate remedy for the site and that excavation of the landfill is not necessary to protect human health and the environment (v. III, p. 920, l. 14-21).

Comment from the authors: DOE/Sandia consultant Mr. Tim Goering and NMED staff person Ms. Carolyn Cooper presented <u>identical incorrect testimony</u> at the NMED December 2004 Public Hearing that the direction of groundwater flow at the MWL dump was to the west with a slight northwest component of flow. <u>This incorrect testimony was necessary so that the three incorrectly located monitoring wells MWL-MW1, -MW2 and -MW6 could be described as downgradient monitoring wells</u>.

Ms. Cooper also provided incorrect testimony that the upper screen in well MWL-MW4 intersects the water table as follows:

> Monitoring well MW-4 was installed at an angle of six degrees from vertical and <u>intersects the water table</u> [Emphasis supplied] at a location beneath disposal Trench D (v. III, p. 919, l. 13-16).

Figure 7 shows the water level measured in the upper screen in well MWL-MW4 is ~ 25 feet below the water table. The NMED 1998 NOD Report [10] recognized well MWL-MW4 required replacement. The requirement to replace well MWL-MW4 is described further in Section 2.3.

The NMED Group Manager Mr. William Moats testimony at the December 2004 public hearing supported the incorrect testimony of NMED staff person Ms. Cooper. The pertinent excerpt from Mr. Moats testimony follows:

> As discussed in Ms. Cooper's testimony, there is no evidence of groundwater contamination at the mixed waste landfill caused by a release from the waste at the mixed waste landfill (v. III, p. 986, l. 5-8).

Comment from the authors: In fact, there is evidence under RCRA criteria that the MWL dump has contaminated the groundwater with cadmium, chromium, nickel and nitrate. The reports in the NMED AR (see Section 5) show that Mr. Moats was well aware that the seven monitoring wells were defective and unreliable for detection of contamination from the MWL dump. The seven monitoring wells required replacement.

- Mr. Moats was a coauthor on the 1993 NMED Report [23] (see report #3 in Section 5) that described the groundwater flow below the dump is to the south or southwest and there was only one downgradient monitoring well. The conclusion in the 1993 NMED report [23] by Mr. Moats and Ms. Winn follows;

  > The detection monitoring system that currently exists at the MWL is inadequate because the direction and speed of ground-water flow can not be determined with reasonable certainty (p. 7).

- Mr. Moats was listed as the person to contact on the cover letter by NMED Bureau Chief Mr. Benito Garcia for the 1998 NMED NOD Report [10] for the Phase 2 RCRA Facility Investigation Report. The cover letter and a copy of the 1998 NOD Report are in Appendix A. The 1998 NMED NOD Report listed the following deficiencies: 1). there was only one downgradient monitoring well, 2). the onsite monitoring well MWL-MW4 was defective and required replacement and 3). the NMED HWB considered the high levels of nickel measured in the groundwater samples collected from well MWL- MW1 and MW3 to be contamination from the MWL dump. None of the issues in the 1998 NMED NOD Report were resolved at the time of the NMED December 2004 Public Hearing or to the present in 2011.

There are many documents in the NMED AR from 1993 to 2007 that demonstrate the NMED HWB and DOE/Sandia knew at the time of the NMED December 2004 Public Hearing and up to the present time in 2011 that the direction of groundwater flow at the water table below the Sandia MWL dump is to the *south or southwest* and the defective monitoring well MWL-MW3 was the only downgradient monitoring well installed at the water table. <u>Figure 14 is a contour map that shows the direction of groundwater flow at the water table below and away from the MWL dump is to the southwest on a direction that is more to the south than to the west.</u> Figure 14 uses the best available data from monitoring wells installed close to the MWL dump including the water table elevation measured in the new background water quality monitoring well MWL-BW2 that was installed in 2008.

The water quality data collected from the substandard monitoring well network did not support the identical testimony of DOE staff person Mr. John Gould, DOE/Sandia consultant Mr. Goering and NMED staff persons Mr. McDonald, Ms. Cooper and Mr. Moats that there was no groundwater contamination from the MWL dump. In fact, the Intercomparison of the water quality data collected over the years 1990 to 1993 was evidence the wastes buried in the MWL dump had contaminated the groundwater with cadmium, chromium and nickel. This contamination and also nitrate groundwater contamination for the MWL dump was confirmed by the background water quality data from the new hydraulically upgradient background monitoring well MWL-BW2 that was installed in 2008.

In addition, the NMED 1998 NOD Report [10] stated that the NMED considered the high concentrations of nickel measured in the groundwater samples collected from wells MWL-MW1 and -MW3 as groundwater contamination from the MWL dump. DOE/Sandia did not prove the MWL dump was not the source of the nickel contamination. See the summary of the NMED 1998 NOD report in Section 5.6. A copy of the NOD report is in Appendix A.

The source of the nickel contamination in the groundwater samples from the Sandia MWL dump monitoring wells MWL-MW1 and -MW3 went unresolved. The resolution of this issue only required the replacement of the two wells MWL-MW1 and -MW3 with new monitoring wells with PVC screens. The wells should have been replaced in 1992 because DOE/Sandia assumed beginning in 1992 [43] that the high concentrations of nickel and chromium measured in the two wells was only from corrosion of the stainless steel well screens. The assumed corroded stainless steel screens masked the detection of nickel, chromium and other contaminants buried at the MWL dump. This issue is discussed in Section 9.6. **NMED accepted fifteen years of unreliable data from the corroded well screens.**

Six of the documents about the defective monitoring well network at the MWL dump are summarized in Section 5 of this report. The pertinent excerpts from three of the NMED documents in the MMED Administrative Record (AR) are pasted below:

- The July 2, 2007 Letter by NMED HWB Chief James Bearzi [25] ordered DOE/Sandia to replace the defective contaminant detection monitoring wells MWL-MW1 and -MW3:

> In accordance with Section VIII.A of the Order on Consent (April 24, 2004), if a well is any way unusable for its intended purpose, it must be replaced. The U. S. Department of Energy and Sandia Corporation (the Permittees) shall therefore replace wells MWL-MW1 and MWL-MW3 (p. 1).
>
> Each [replacement] well shall be installed to monitor groundwater at the water table. 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. This change in well locations, particularly for MWL-MW1, is based on better preparing the MWL for long-term monitoring of the groundwater which flows west-southwest [emphasis supplied] (p.2).

- The 1993 NMED Report by William Moats and Lee Winn [23] (NMED AR 006421)

> Water level data from 1992 indicate south directed or south-west directed flow. However, the gradient and direction of ground-water flow are not known with reasonable certainty (p. 3).

> The detection monitoring system that currently exists at the MWL is inadequate because the direction and speed of ground-water flow can not be determined with reasonable certainty (p. 7).

- The 1998 NMED Notice of Deficiency (NOD) Report for the Phase 2 Mixed Waste Landfill RFI Report [10] (NMED AR 010983).

> Deficiency #3. Response #37 - - "The water-table map [i.e., the water table map in Figure 9 in this report] indicates that there is only one downgradient monitoring well at the mixed waste landfill [i.e., well MWL-MW3]. Normally, a minimum of three downgradient wells is required for an adequate detection monitoring system (p. 2-3).

Comment from the authors: Figure 9 is a water table contour map (NMED AR 010278) that shows the direction of groundwater flow at the water table below the MWL dump is to the *southwest* for water level measurements collected on July 16, 1997. Figure 11A is a water table contour map that shows the direction of groundwater flow at the water table below the MWL dump is to the *southwest* for water level measurements collected in April 2000. Figure 14 is a water table contour map that shows the direction of groundwater flow at the water table below the MWL dump is to the *southwest* for the elevation of the water table in April 2008. **Nevertheless, the actual direction and speed of groundwater flow at the water table below and downgradient of the MWL dump *still* is not accurately determined as required by RCRA.** The best information is the water table map in Figure 14 that shows the direction of groundwater flow is more to the south than the earlier maps.

- Continued from Deficiency #3 in the 1998 NMED NOD Report [10]:

> After the two new wells are installed [i.e., wells MWL-MW5 and -MW6], and the water table map is revised, the HRMB [now the NMED HWB] will reevaluate the adequacy of the detection monitoring system. HRMB requests a meeting with DOE/SNL technical and management staff to discuss the location and design of the two new wells" (p. 2-3).

Comment from the authors: There was no mention at the NMED December 2004 Public Hearing that the NMED HWB issued a Notice of Deficiency (NOD) Report on October 30, 1998 [10] that recognized the direction of groundwater flow at the water table below the MWL dump was to the southwest and well MWL-MW3 was the only down-gradient monitoring well. Figure 6 shows the locations of the two wells MWL-MW5 and -MW6 that were installed west of the MWL dump in 2000 to resolve the deficiency in the 1998 NMED NOD Report that there was only one downgradient monitoring well installed at the water table. However, Figure 7 shows that the screens in wells MW5 and MW6 were installed too deep below the water table and the wells did not resolve Deficiency #3 in the 1998 NMED NOD Report .

Additional evidence that wells MWL-MW5 and -MW6 did not resolve Deficiency #3 in the NMED 1998 NOD Report is that the water table contour maps in Figures 11 and 12 do not use the water levels measured in wells MWL-MW5 and -MW6. Moreover, Table 4.1-1 in the DOE/Sandia 2010 annual groundwater monitoring report [34] describes wells MWL-MW5 and MWL-MW6 as not used for the water table contour map because the wells are screened below the water table. Table 4.1-1 is included as part of the discussion in Section 3.7 of this report.

The NMED HWB has not required replacement of the defective and unusable monitoring wells MWL-MW5 and -MW6 that did not meet the intended purpose in the 1998 NMED NOD Report to provide two additional downgradient monitoring wells at the water table to 1). detect groundwater contamination and 2). accurately determine the speed and direction of groundwater flow at the water table below and downgradient from the Sandia MWL dump. NMED has not required retraction or revision of the many DOE/Sandia reports containing unreliable data and incorrect conclusions from the defective monitoring wells.

The staff of NMED and DOE/Sandia did not inform the NMED December 2004 Public Hearing that the two monitoring wells MWL-MW5 and -MW6 were defective and required replacement to meet the requirements in the 1998 NMED NOD Report [10] and also to meet the requirement in Section VIII.A of the Compliance Order on Consent (Consent Order) that was issued on April 24, 2004 [1]**.** The pertinent excerpt from Section VIII.A. of the Consent Order [1] follows:

> ”if a well or piezometer is any way unusable for its intended purpose, it must be replaced with an equivalent well or piezometer” (p. 63).

An important fact is that the NMED Sandia Consent Order [1] was signed into law on April 29, 2004 more than seven months ***before*** the NMED December 2004 Public Hearing. Section VIII.A of the Consent Order titled, GROUNDWATER MONITORING WELLS, **would** require replacement of the entire network of seven defective monitoring wells at the MWL dump beginning from the date the Consent Order was signed into law. The requirements in the Consent Order for drilling and construction of monitoring wells are additional proof that the defective monitoring well network at the Sandia MWL dump did not provide the knowledge that was necessary for the NMED to select the dirt cover remedy. The requirements in the Consent Order are discussed in Section 7 of this report.

A principal conclusion in the 1993 NMED report by Moats and Winn [23] is:

> The detection monitoring system that currently exists at the MWL is inadequate because the direction and speed of ground-water flow can not be determined with reasonable certainty (p.7).

The required network of reliable monitoring wells was not installed at the MWL dump from the conclusion above in the NMED report by Moats and Winn in 1993 to the present in 2011.

The current network of seven monitoring wells at the MWL dump is displayed on Figure 8 and includes the six defective contaminant detection monitoring wells MWL-MW4, -MW5, -MW6, -MW7, -MW8 and -MW9 and the background water quality monitoring well MWL-BW2. None of the six contaminant detection monitoring wells in the current network meet the intended purpose to monitor contamination at the water table in the fine-grained alluvial fan sediments at locations below and hydraulically downgradient from the MWL dump. All of the six contaminant detection monitoring wells in the current network require replacement. The NMED HWB has not enforced the mandatory requirement in the NMED Sandia Consent Order [1] for replacement of the defective monitoring wells.

At this time, the only monitoring well that may provide accurate measurement of the elevation of the water table in the fine-grained alluvial fan sediments is the new background water quality well MWL-BW2 located 200 feet east of the eastern boundary of the MWL dump. However, the accuracy of the water table elevation measured in well MWL-BW2 is uncertain because the drilling and design of the well did not follow the requirements in the Consent Order [1] or in the NMED NOD letter [35] that was issued on June 19, 2007. This issue is discussed in Section 3.5.

6.2. The NMED December 2004 Public Hearing and the NMED Final Order for the dirt cover remedy relied on the unusable water quality data from the defective monitoring well network at the Sandia MWL dump. The NMED December 2004 Public Hearing was held for the NMED recommendation to leave the toxic wastes buried in the unlined trenches and pits at the Sandia MWL dump below a dirt cover. **The <u>incorrect water quality data</u> from the seven defective monitoring wells on Figure 6 were relied upon for approval of the dirt cover remedy by NMED Secretary Ron Curry in his Final Order issued on May 26, 2005 [46].**

In the May 26, 2005 Final Order [46], Secretary Curry assured the public that his decision to leave the toxic wastes buried below a dirt cover was made after a careful consideration of the NMED Administrative Record. The pertinent excerpt from the Final Order follows:

> ***<u>Having considered the administrative record in its entirety</u> [Emphasis supplied], including the Hearing Officer's Report; and being otherwise fully advised regarding this matter: (p. 1).***

In stark contrast to Secretary Curry's statement of "*<u>Having considered the administrative record in its entirety</u>*," the NMED Administrative Record is replete with evidence from expert reports that

- 1). described the monitoring well network as unable to detect groundwater contamination from the toxic wastes buried in the unlined trenches and pits at the MWL dump and

- 2). described the reasons all seven monitoring wells were defective and required replacement. The contradictions between the NMED Administrative Record and the NMED and Sandia witnesses are irreconcilable differences and show omission of substantive scientific information and failure to verify and validate information.

Reports subsequent to the 2005 Final Order [46], including, but not limited to, a 2006 TechLaw, Inc. report [47], held secret from the public by NMED until late 2009, cast further doubt on the NMED decision for the dirt cover remedy. The TechLaw Report identified issues with

- 1). the incorrect design of the dirt cover,

- 2). the poor long term viability of the dirt cover, and

- 3). the deficiencies in the DOE/Sandia computer model [2] used for contaminant movement modeling.

<u>NMED went so far as to sue Citizen Action to keep the 2006 TechLaw, Inc. report [47] secret.</u>

A $275,000 April 14, 2010 Environmental Protection Agency Office of Inspector General (IG) Audit Report [48] found that EPA Region 6 staffers had concerns similar to Citizen Action and Mr. Gilkeson about the lack of effective groundwater monitoring at the Sandia MWL dump. The EPA IG also found that the oversight report of the EPA Region 6 staff's for MWL dump groundwater monitoring concerns are still being withheld from Citizen Action and the public. The EPA IG found further that NMED and EPA Region 6 agreed that discussions about concerns for the monitoring well network at the MWL dump would not be documented in writing to avoid discovery of the documents by Citizen Action under the FOIA.

7.0. Violations of environmental laws at the Sandia/DOE MWL dump have resulted from failure to enforce the April 29, 2004 Compliance Order on Consent (Consent Order) [1] and regulations adopted under the Resource Conservation and Recovery Act (RCRA). The NMED HWB has not enforced the ongoing regulatory requirements in the NMED April 29, 2004 Consent Order [1] or in RCRA for the installation of a reliable monitoring well network at the Sandia MWL dump for protection of public health and the environment. RCRA and the Consent Order require groundwater monitoring well networks that provide reliable and representative samples to detect contamination in two distinct zones of saturation below and immediately surrounding the MWL dump:

- 1). at the water table in the fine-grained alluvial fan sediments and
- 2).in the productive Ancient Rio Grande Deposits (ARG Deposits).
- **The required monitoring well networks are not installed in either zone.**

The Sandia MWL dump hazardous and radioactive wastes were disposed of in unlined trenches and pits making accurate groundwater monitoring highly important for protection of the public drinking water resource. The MWL dump has not met EPA regulations that would define and qualify its operation as a "landfill" for disposal of mixed or hazardous wastes. Importantly, the MWL dump lacks the protections that RCRA requires for landfill design: liners, installation of a leak detection system and a reliable network of groundwater monitoring wells. 40 CFR 270.1(b). The NMED HWB did not enforce the monitoring well network requirements of RCRA under either 40 CFR 264 and 265 Subpart F or RCRA Corrective Action for groundwater monitoring at the MWL dump.

A summary of groundwater monitoring provisions under the Consent Order:
Section III.A "Groundwater" definition
Section VIII Groundwater Monitoring Wells provides for Drilling, Design and Construction (VIII.A); Well Development (VIII.B); Well Abandonment (VIII.C); Documentation (VIII.D).
Section IX Groundwater provides for Sampling (Section IX.A) and Well Purging (Section IX.B).
Section XI Compliance Schedule Tables are not being met.

7.1. The NMED HWB has not enforced the requirement in RCRA and the NMED 2004 Sandia Consent Order for a network of monitoring wells to be installed in the ARG Deposits below and downgradient of the Sandia MWL dump. Figure 7 shows the layer of ARG Deposits below the fine-grained alluvial fan sediments. The ARG Deposits are regionally extensive and produce large supplies of groundwater for drinking water wells for Albuquerque and the surrounding region. The ARG Deposits provide the fast pathway for groundwater contamination from the MWL dump wastes to reach Albuquerque's municipal drinking water wells. Unfortunately, under the direction of Chief James Bearzi, the NMED HWB has not enforced the requirements in the Sandia Consent Order or in RCRA 40 CFR 264 Subpart F Corrective Action for the installation of a network of monitoring wells in the ARG deposits below and away from the Sandia MWL dump.

The NMED 2004 Consent Order [1] and Federal RCRA Corrective Action Regulations require that a network of monitoring wells be installed in the highly productive ARG Deposits that are present below the Sandia MWL dump.

As will be set forth, the application of the terms “aquifer” and “uppermost aquifer,” as defined by RCRA (40 CFR 260.10) and “groundwater” as defined by the Consent Order (Section III.B), require that a network of groundwater monitoring wells be installed in the ARG Deposits located below the fine-grained alluvial fan sediments.

7.2. Requirements in the NMED Sandia Consent Order and RCRA that apply for installation of a Groundwater Monitoring Network in the ARG Deposits. The Consent Order, by incorporation of EPA technical publications, provides for <u>mandatory compliance with</u> groundwater monitoring requirements of 40 CFR 264 Subpart F. The Consent Order [1] requires installation of Groundwater Monitoring wells (Section VIII and VIII.A) that “will yield high quality, representative samples.” The Consent Order requires that groundwater monitoring wells “shall comply” with RCRA groundwater monitoring requirements set forth in various EPA technical publications.

The Consent Order provides accord between Consent Order and RCRA definitions (Section III.B, p. 14):

> “Unless otherwise expressly provided herein, the terms used in this Consent Order shall have the meaning set forth in HWA [Hazardous Waste Act], RCRA, and their implementing regulations.”

The Consent Order does not have the RCRA definitions for “aquifer” or “uppermost aquifer” but does have the definition for “groundwater” that follows:

> “Groundwater” means interstitial water which occurs in saturated earth material and which is capable of entering a well in sufficient amounts to be utilized as a water supply (Section III.B, p.15).

<u>The RCRA definitions of “aquifer” and “uppermost aquifer”</u> are listed in 40 CFR § 260.10 Definitions as follows:

> “Aquifer means a geologic formation, group of formations, or part of a formation capable of yielding a significant amount of ground water to wells or springs.
>
> “Uppermost aquifer means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility’s property boundary.”

By these equivalent definitions, both the Consent Order and RCRA require that a groundwater monitoring well network be installed in the ARG Deposits.

The Consent Order requires (p.63-64):

> The design and construction of groundwater monitoring wells and piezometers <u>shall comply</u> with the guidelines established in EPA guidance, including, but not limited to:
>
> > U.S. EPA, *RCRA Groundwater Monitoring: Draft Technical Guidance* (November 1992) (Emphasis supplied).

The RCRA Ground-Water Monitoring: Draft Technical Guidance Report at Section 4.3.2 provides that "Aquifer" is defined as the geologic formation, group of formations, or part of a formation that is capable of yielding a significant amount of ground water to wells or springs. (40 CFR §260.10).

The pertinent excerpt from the DOE/Sandia annual report entitled *Mixed Waste Landfill Ground- water Monitoring Report Calendar Year 2009* [34] for regulatory criteria in the NMED Sandia Consent Order [1] follows:

> The NMED issued the Compliance Order on Consent (the Consent Order) in April 2004, which transferred the regulatory requirements for groundwater sampling at the MWL to the Consent Order (NMED April 2004) (p. 2-1).

The definition of "groundwater" in the Consent Order has the same meaning as the "uppermost aquifer" defined by RCRA regulations at 40 CFR 260.10. The fine-grained alluvial fan sediments do not produce sufficient amounts of groundwater to be utilized as a water supply. However, the layer of ARG Deposits located below the fine-grained alluvial fan deposits (see Figure 7) do produce sufficient amounts of groundwater to be utilized as a water supply and must have a groundwater monitoring network. In fact, the ARG deposits are regionally extensive and are the important groundwater resource for Albuquerque and the surrounding region.

7.3. Corrective Action Requirements for Groundwater Monitoring of the ARG Deposits are not being met for protection of public health and the environment. 40 CFR 264.101 and the *RCRA Handbook for Groundwater Protection* [49].

- Because The ARG Deposits are the highly productive aquifer zone that is the fast pathway for lateral travel of contaminated groundwater to Albuquerque's municipal drinking water wells, groundwater monitoring is essential as a part of Corrective Action.

- Because the ARG Deposits are unmonitored, the direction and speed of groundwater travel in the ARG deposits below and away from the Sandia MWL dump is not known.

- The direction of groundwater flow in the ARG Deposits may be very different from the direction of groundwater travel at the water table below the dump in the fine-grained alluvial fan sediments which is also not known after 22 years of study by DOE/Sandia and the NMED HWB.

- The nature and extent of groundwater contamination in the ARG Deposits below and away from the MWL dump is not known.

- The nature and extent of groundwater contamination at the water table in the fine-grained alluvial fan sediments below and away from the MWL dump is not known after 22 years of study by DOE/Sandia and the NMED HWB.

<u>The NMED has approved closure of the Sandia MWL dump with waste left in place, and therefore, under the provisions for RCRA Corrective Action (40 CFR 264.101), described below, the following is required</u>:

- a network of contaminant detection monitoring wells installed in the ARG Deposits at appropriate locations, i.e., "point of compliance," close to the boundary of the Sandia MWL dump and
- a background water quality well installed in the ARG Deposits at an appropriate location hydraulically upgradient of the dump.

The regulatory criteria for groundwater monitoring at the Sandia MWL dump are described in the DOE/Sandia annual report entitled *Mixed Waste Landfill Groundwater Monitoring Report Calendar Year 2009* [34]**.** The report describes applicable groundwater monitoring requirements of RCRA Corrective Action and of the NMED 2004 Sandia

Consent Order. The pertinent excerpt from Section 2.0 of the DOE/Sandia annual groundwater report [34] that describes the requirements for RCRA Corrective Action follows:

> **2.0 REGULATORY CRITERIA**
> Historically, the NMED Hazardous Waste Bureau has provided regulatory oversight of the MWL as Solid Waste Management Unit (SWMU) 76 under the Hazardous and Solid Waste Amendments module of the facility Resource Conservation and Recovery Act [RCRA] permit. The NMED confirmed that the MWL is properly designated as a SWMU (Dinwiddie June 1998) and, as such, must comply with the corrective action program defined in Title 20, New Mexico Administrative Code, Section 4.1.500, incorporating Title 40, Code of Federal Regulations, Section 264.101. The requirements for corrective action at the MWL, including those for groundwater monitoring, are established through the corrective measures process (p. 2-1).

The RCRA provides for corrective action to include groundwater monitoring and clean up requirements in 40 CFR § 264.90-100 (Subpart F). RCRA Subpart F requires that networks of monitoring wells be installed in the "uppermost aquifer." The RCRA definitions of "aquifer" and "uppermost aquifer" are provided above and apply to the ARG Deposits at the MWL dump. In addition, as described above, the Consent Order provides for "groundwater" monitoring that is applicable to the ARG Deposits at the MWL dump under Corrective Action.

In April 2004 the EPA issued the *EPA Handbook of Ground-water Protection and Cleanup Policies for RCRA Corrective Action* (The EPA RCRA Handbook) [49]**.** The *EPA RCRA Handbook* is for Facilities such as Sandia National Laboratories Albuquerque Facility (including the Sandia MWL dump) that are subject to Corrective Action under Subtitle C of the Resource Conservation and Recovery Act. The Consent Order mandates compliance with the *EPA RCRA Handbook*. (Consent Order Section VIII.A).

<u>The "point of compliance" requirement</u> for Correction Action is provided for in the EPA RCRA Handbook as follows:

> **Topic 6. Point of Compliance.** As a general definition, the point of compliance for groundwater is where a facility [i.e., the Sandia MWL dump] should monitor groundwater quality and/or achieve specified cleanup levels to meet facility-specific goals[1] (p, 6.1).
>
> > [1] Progress toward meeting a particular cleanup goal is typically measured at the point of compliance using groundwater monitoring wells. The locations of these monitoring wells may change during different stages of a groundwater cleanup action.
>
> For final cleanups selected to return groundwater to its maximum beneficial use, EPA recommends regulators set the point of compliance throughout the area of contaminated groundwater, <u>or when waste is left in place[6], at and beyond the boundary of the waste management area encompassing the original source(s) of groundwater contamination</u> [emphasis supplied] (p. 6.3).

[6] In the context of RCRA corrective action, “waste in place” typically refers to the waste management area encompassing the original source(s) of a release that the regulator determined is acceptable to leave in place as part of a final remedy. For example, a properly closed landfill represents a waste management area commonly allowed to stay in place as part of a final remedial action.

No network of monitoring wells exists at the Sandia MWL dump in the ARG Deposits to meet the Corrective Action requirements that RCRA imposes through Subpart F. <u>The Consent Order incorporates the Subpart F requirements for monitoring the uppermost aquifer through mandatory compliance with *EPA Handbook of Ground-water Protection and Cleanup Policies for RCRA Corrective Action.*</u>

Figure 7 shows that monitoring well MWL-MW6 is the only monitoring well installed in the ARG Deposits. However, Figure 6 shows that well MW6 is located more than 500 feet west of the western boundary of the MWL dump. Well MW6 does not meet the “point of compliance” monitoring well requirements for RCRA Corrective Action.

The corrective action requirements for solid waste management units follow:

> **40 CFR § 264.101. Corrective action for solid waste management units.**
>
> (a) The owner or operator of a facility seeking a permit for the treatment, storage or disposal of hazardous waste must institute corrective action as necessary to protect human health and the environment for all releases of hazardous waste or constituents from any solid waste management unit at the facility, regardless of the time at which waste was placed in such unit.
>
> (b) Corrective action will be specified in the permit in accordance with this section and subpart S of this part. The permit will contain schedules of compliance for such corrective action (where such corrective action cannot be completed prior to issuance of the permit) and assurances of financial responsibility for completing such corrective action.
>
> (c) The owner or operator must implement corrective actions beyond the facility property boundary, where necessary to protect human health and the environment, unless the owner or operator demonstrates to the satisfaction of the Regional Administrator that, despite the owner's or operator's best efforts, the owner or operator was unable to obtain the necessary permission to undertake such actions. The owner/operator is not relieved of all responsibility to clean up a release that has migrated beyond the facility boundary where off-site access is denied. On-site measures to address such releases will be determined on a case-by-case basis. Assurances of financial responsibility for such corrective action must be provided.

The Sandia MWL dump does not have monitoring wells that are using sampling methods for the groundwater as defined by the Consent Order and RCRA. Since there is no sampling of the ARG Deposits there is no compliance with the Consent Order Section IX.A. Sampling (p.66) states that “Groundwater samples shall initially be obtained from monitoring wells between 10 to 30 days after completion of well development.” Other than MWL-MW6 that is located over 500 ft beyond the point of compliance and may be cross-gradient to the flow of groundwater there is no monitoring well for the ARG Deposits at the point of compliance. Failure to install a reliable network of monitoring wells in the ARG Deposits at the Sandia MWL dump is an ongoing violation of the Consent Order and RCRA.

7.4. A reliable network of monitoring wells was not installed at the water table below and downgradient from the Sandia MWL dump. A reliable network of monitoring wells installed in the fine-grained alluvial fan sediments at the water table is important for early detection of contamination and, as described throughout this report, has yet to be accomplished. The NMED 2005 Final Order remedy decision to install a dirt cover at the MWL was based on the unreliable water quality data from the defective monitoring wells MWL-BW1, -MW1, -MW2 and -MW3, -MW4, -MW5 and -MW6.

The first four monitoring wells (wells MWL-BW1, -MW1, -MW2 and -MW3) were installed in 1988 and 1989 with the mistaken assumption that groundwater flow was to the northwest. Water level measurements beginning in 1990 determined that 1). groundwater flow was to the southwest and 2). that well MWL-MW3 was the only downgradient monitoring well. Well MWL-MW1 was also useful for the detection of groundwater contamination because it was located 50 feet north of the MWL dump. Wells MWL-BW1 and -MW2 were not usable for the detection of groundwater contamination but they were inaccurately presented as useful for that purpose over the years from 1990 to the present and at the NMED December 2004 Public Hearing.

The monitoring wells installed between1988 and 1989 were defective and did not provide reliable and representative water samples because all four wells: 1). had corroded stainless steel screens recognized in 1992 [43] and 2). the groundwater samples were collected with improper high-flow purge-to-dry sampling methods. The three wells MWL-MW2, -MW3, and -BW1 were also prevented from providing reliable and representative water samples because the screened intervals were contaminated with bentonite clay drilling muds from the mud-rotary drilling method.

Well MWL-MW4 was installed inside the MWL dump in 1993 to monitor groundwater contamination at the water table below Trench D where 271,500 gallons of reactor coolant water were dumped in1967 [2]**.** Figure 7 shows the upper screen in well MW4 was installed too deep to monitor contamination at the water table. There is also a history of leakage over more than five years between the upper and lower screen. The 1998 NMED NOD Report [10] recognized that well MWL-MW4 should be plugged and abandoned and replaced. But well MWL-MW4 was not replaced. Instead, groundwater samples are still collected from well MW4 with the incorrect conclusion in many DOE/Sandia reports [2,4,5,9,32,33,34,61] that the unreliable water quality data show there is no groundwater contamination.

In 2000, wells MWL-MW5 and -MW6 were installed 200 feet and 500 feet west of the MWL dump, respectively, to 1). monitor groundwater contamination at the water table, and 2) measure the elevation of the water table Figure 7 and Table 4.1-1 in Section 3.7 of this report shows that the two wells MWL-MW5 and –MW6 were installed too deep below the water table for the intended purpose. The NMED HWB has not required replacement of the two wells. Instead, up to the present time [33, 34], the NMED HWB has accepted the unreliable groundwater quality data from the two defective monitoring wells MWL-MW5 and –MW6 as part of a reliable monitoring well network.

In 2008, the four defective monitoring wells MWL-BW1, -MW1, -MW2 and -MW3 were replaced with the new background water quality monitoring well MWL-BW2 and the three new <u>defective</u> contaminant detection monitoring wells MWL-MW7, -MW8 and -MW9. The reasons wells MWL-MW7, MW8 and MW9 are defective are described in Section 3 of this report.

The NMED HWB required DOE/Sandia to install all eleven monitoring wells over the period from 1988 to the present in 2011 to monitor contamination at the water table at the MWL dump in the fine-grained alluvial fan sediments. However, many reports in the NMED Administrative Record (See Section 5) describe the overall failure of DOE/Sandia to install a reliable network of monitoring wells at the water table. From 1990 to 2007, the defective monitoring wells MWL-MW1 and -MW3 were the only two monitoring wells installed at locations that could detect contamination from the Sandia MWL dump. The two wells did detect nickel, chromium, cadmium and nitrate groundwater contamination from the wastes buried in the MWL dump. The two wells were plugged and abandoned in 2008 without installation of new reliable monitoring wells at close locations to the defective monitoring wells to determine the nature and extent of groundwater contamination from the wastes buried in the MWL dump.

The many problems with the network of seven monitoring wells installed between 1988 and 2000 were recognized by NMED, DOE/Sandia and the EPA from the early 1990s but the problems were not corrected.

7.5. The Continued Acceptance and Failure to Invalidate the Flawed Data from the Defective Monitoring Wells for NMED Decision Making Violate Both the Consent Order and RCRA. The monitoring well network at the Sandia MWL dump was/is not capable of providing reliable and representative water quality data. Both NMED and DOE/Sandia have a duty to verify whether information is incorrect and to promptly submit correct information. Nevertheless, there is an ongoing continuing pattern and practice of unreliable data submission by Sandia/DOE and acceptance of unreliable data for decision making by the NMED. The incorrect information has not been corrected. (40 CFR 270.30 (l)(11) and 20.4.1.900 NMAC -- Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, it shall promptly submit such facts or information. Also, 270.41-270.43, 270.43(2) -- The permittee's failure in the application or during the permit issuance process to disclose fully all relevant facts, or the permittee's misrepresentation of any relevant facts at any time).

NMED made a decision to place a soil cover over the MWL dump wastes based on the incorrect and unreliable data from a monitoring well network known to be defective. NMED obtained a favorable outcome of the WERC investigation and the 2004 public hearing by omission and misrepresentation of relevant facts. The close similarity in incorrect testimony between NMED and DOE/Sandia witnesses at the 2004 public hearing is indicative of a plan to omit and withhold relevant facts from the decision maker and the public to obtain the dirt cover remedy to leave the MWL dump wastes in place. NMED and DOE/Sandia had the knowledge that the MWL dump <u>did not have a monitoring well network capable of detecting contamination.</u> Despite this knowledge, NMED and DOE/Sandia witnesses provided incorrect testimony at the NMED December 2004 Public Hearing for the dirt cover remedy that there was a reliable monitoring well network and no evidence of contamination to the groundwater.

Additionally, the incorrect testimony and continuing failure to promptly submit relevant information and provide accurate information constitutes an ongoing violation of the public participation requirements of RCRA to 1). provide meaningful opportunity for public comment and review and 2). denies the public the opportunity to request modification, termination or reissuance of the permit by furnishing misinformation and withholding relevant facts. 40 CFR 124.5; 63 FR 56710 et seq.

The staff of NMED and DOE/Sandia provided incorrect testimony at the NMED December 2004 Public Hearing that the direction of groundwater flow at the water table was to the northwest. In 2007, a letter [25] from NMED Hazardous Waste Bureau (HWB) Chief James Bearzi acknowledges that the flow of groundwater at the water table is to the southwest. This crucial fact was realized in 1991 and reported numerous times in reports in the NMED Administrative Record. There is an administrative history of knowledge since 1991 in NMED, DOE and EPA documents that the groundwater flow was to the southwest at the water table below and away from the MWL dump. The August 26, 1991 RCRA Work Plan states:

> "According to the regional water level contour maps, the hydraulic gradient at the MWL should be toward the west and northwest. However, current water level elevation information for the four MWL monitor wells (Appendix A) indicate that the hydraulic gradient is toward the southwest, approximately 40 degrees counter-clockwise to the regional gradient." (Emphasis supplied).

Thus, NMED, EPA and Sandia/DOE all knew: No background well existed and there were not three downgradient wells to monitor the groundwater because the wells were positioned with the assumption that the flow direction was to the northwest.

Two letters in 2007 [24,25] from James Bearzi, the Chief of the NMED Hazardous Waste Bureau (HWB), acknowledge that groundwater flow is to the southwest by requiring a repositioning of the new background monitoring well MWL-BW2, http://www.nmenv.state.nm.us/hwb/SNL/SNL_3-23-2007_Replacement_of_MWL_Mon_Well_BW1.pdf and replacement for wells MW1 and MW3. http://www.nmenv.state.nm.us/hwb/documents/7-2-2007_NMED_SNL_Require_Replacement_MWL_Wells_MW1_and_MW3.pdf. However, no steps have been taken to correct two decades of misinformation from monitoring wells that were not in appropriate locations.

DOE/Sandia is violating its duty not to submit incorrect information (40 CFR 270.30(l)(11)) and is also failing to report its noncompliance with monitoring requirements under RCRA and the Consent Order (40 CFR 270.30(l)(10)). NMED is violating its duty to verify the accuracy of information for monitoring data, verify the adequacy of sampling, monitoring and whether Sandia/DOE is properly developing such information. (40 CFR 270.15).

These still uncorrected violations throughout this entire Gilkeson/Citizen Action report have been brought to the attention of NMED on numerous occasions by both Registered Geologist Robert H. Gilkeson and Citizen Action New Mexico. (40 CFR 270.15 (b)(4)). NMED is failing to exercise control over Sandia/DOE groundwater monitoring at the MWL dump (40 CFR 271.22 (a)(2)(i)); failing to comply with public participation requirements (40 CFR 271.22 (a)(2)(iii)); failing to act on violations of permits and other program requirements contained in the Consent Order and RCRA (40 CFR 271.22

(a)(3)(i)), and; failing to inspect and monitor activities subject to regulation (40 CFR 271.22 (a)(3)(iii)).

7.6. The NMED admission that groundwater flow at the water table is to the southwest requires the installation of a reliable network of monitoring wells along the southern and western boundary of the MWL dump. (40 CFR 264.95). Monitoring along the southern boundary has not heretofore been provided at the MWL dump. The current network of the six contaminant detection monitoring wells MWL -MW4, -MW5, -MW6, -MW7, -MW8 and -MW9 is displayed on Figure 8. The purpose of the current network is monitoring groundwater contamination at the water table below and to the west of the MWL dump. However, the six contaminant detection monitoring wells on Figure 8 fail for this purpose. The NMED HWB has not enforced the requirement in the Consent Order for replacement of the six defective monitoring wells. Instead, the NMED HWB has issued an approval letter [8] for the three new defective monitoring wells MWL-MW7, -MW8 and -MW9 and accepts the DOE/Sandia annual groundwater monitoring reports [33, 34] that use the unreliable groundwater quality data from the current network of seven defective monitoring wells.

The Sandia September 2007 Long Term Monitoring and Maintenance Plan (LTMMP)[4]**,** which has not been approved by the NMED, blurs the distinction between the meaning of the ARG Deposits as an aquifer that requires monitoring and the fine-grained alluvial fan sediments that are not an aquifer. The LTMMP Section 2.1.2 states:

> "Groundwater occurs approximately 500 feet bgs within Santa Fe Group deposits (basin fill), in either fine-grained alluvial fan deposits or coarse-grained Ancestral Rio Grande deposits."

This above LTMMP statement does not identify and mandatorily apply the definition of "groundwater" which all parties agreed to in signing the Consent Order.

7.7. The violation of public participation requirements. The work plans and the installation of the new groundwater monitoring wells MWL-BW2 and MWL-MW7, -MW8 and -MW9 as new upgradient and downgradient monitoring wells were not presented to the public prior to approval and installation. Public participation for work plans and monitoring well installation is required by RCRA public participation requirements. 40 CFR 270.42 and Appendix I – Classification of Permit Modification-- section C. *Ground-Water Protection,* sections 1-8 thereto, provides that "changes in the number, location, depth, or design of upgradient or downgradient wells of permitted groundwater monitoring systems," "changes in point of compliance" are Class 2 Modification. "Replacement of an existing well that has been damaged or rendered inoperable, without change to location, design or depth of well" is a Class 1 Modification requiring public notification, review and comment. The changes to the MWL well monitoring network also constitute Class 2 modifications. For Class 2 Modifications, the permittee must submit a Modification request to the Director, notify persons, provide a comment period, provide a public meeting and other requirements.

63 Federal Register 56710, 56720 (October 22, 1998) sets out the requirements for public comment *throughout the cleanup process* including site characterization: "For example, the affected community should be notified and given the opportunity to comment prior to the initiation of any activity to assess contamination." Public participation is to take place "very early in the process" and "<u>prior to the initiation of any activity to assess contamination</u> or <u>prior to the implementation</u> of any interim measure."

270.42. Appendix I, Section J.3, provides that addition or modification of a final cover constitutes a level 3 modification. Modifications for the well monitoring system were not included prior to the issuance of the LTMMP. These requirements for permit modification have not been followed.

NMED violated public participation requirements by withholding and omitting information crucial to the decision making process for the remedy selection. NMED omitted information that showed the inadequacy of the defective groundwater monitoring wells. NMED failed to submit several major documents for public review and comment as required by the Final Order. NMED deliberately kept a key 2006 TechLaw, Inc. document secret for three years regarding fate and transport of contaminants benath the dump.

NMED made an agreement with the technical staff at EPA Region 6 to not document conversations between NMED and EPA Region 6 regarding the MWL dump monitoring network. The agreement was made so that Citizen Action could not obtain documentation regarding the discussions. Concerns in the EPA Region 6 Oversight Report for the groundwater monitoring network were orally conveyed to NMED so that Citizen Action could not see the Oversight Report and know the EPA concerns. (http://www.epa.gov/oig/reports/2010/20100414-10-P-0100.pdf, at p.3). Thus, EPA and NMED colluded to prevent public participation and to withhold relevant facts from the public during the RCRA process for corrective measures. Withholding relevant facts and reports allowed NMED and DOE/Sandia to proceed with constructing the dirt cover without opposition from an informed public with full access to the facts.

NMED failed to submit the Moats report to the public for review and comment, as required by the Final Order for major documents, prior to its release for the purpose of putting out of sight the serious deficiencies of the groundwater monitoring network. The Moats report was repeatedly used in the NMED Responses to Public Comments to set aside technical concerns of Citizen Action and Mr. Gilkeson that new wells should be installed at the MWL dump. (See Response to R29, p. 35 described below in section 9.10). Concerns for the Fate and Transport Model were dismissed without reporting the technical concerns contained in the TechLaw report that the Sandia computer model was a “black box” that NMED should not use. The Moats report nevertheless relied on the FTM and did not disclose the contrary conclusions in the TechLaw report.

The 2006 TechLaw, Inc. report was withheld from the public until late 2009 during the period when consideration of the Fate and Transport Model were under consideration. NMED withheld the TechLaw report from the public because it contained information that **cast further doubt on the NMED decision for the dirt cover remedy. The TechLaw Report identified issues with 1). the incorrect design of the dirt cover, 2). the poor long term viability of the dirt cover, and 3). the deficiencies in the DOE/Sandia computer model [2] used for contaminant movement modeling. The Moats Report and the Responses to Public Comment withheld the information contained in the TechLaw report from the public.**

NMED failed to provide either version 1 or version 2 of the DOE/Sandia 2007 FTM Report to the public for review and comment as required for major documents by the May 26, 2005 Final Order [46]**.** The FTM Report was a major document because it was required by the Final Order. (See Sections 12.0 and 12.1 below).’

There are numerous, obvious inaccuracies and contradictions between the data and the textual conclusions contained in the 2008 Vadose Zone Report [68]**.** The discrepancies further deny the public complete and accurate information for contamination beneath the MWL dump. (See section 10.6)

7.8. The improper classification of the MWL dump as a "SWMU" and failure to provide a Post-Closure Plan. 40 CFR 264.118. The MWL dump is a "regulated unit" by definition. (40 CFR 264.90(a). The MWL dump has been improperly classified as a Solid Waste Management Unit (SWMU) for closure under Corrective Action. No post closure permit has been submitted for the MWL dump that is leaving wastes in place. 40 CFR 270.1 (c) requires that owners and operators of landfills that received waste after July 26, 1982 must have post-closure permits, unless they demonstrate closure by removal or decontamination or obtain an enforceable document in lieu of a post-closure permit. If a post-closure permit is required, the permit must address groundwater monitoring, unsaturated zone monitoring, corrective action and post closure care requirements.

Mixed Waste Landfill dump wastes. The MWL dump has large amounts of hazardous, mixed waste and radioactive waste placed in shallow (up to 25 ft deep) unlined pits and trenches. The wastes are being left in place without liners, leachate detection and leachate collection. The amount of the hazardous and radioactive wastes have been estimated from 100,000 cu ft (DOE/Sandia Fate and Transport Report[2] and NMED Fact Sheet [3]**),** 720,000 cu ft (EPA RCRA Facility Assessment Report [50]), and up to 1,500,000 cu ft (DOE/Sandia Corrective Measures Study Report [5]**).** Many of these wastes, which include volatile organic compounds (VOCs), PCBs, ignitable wastes, heavy metals, 271,500 gallons of reactor waste water, tritium, depleted uranium and transuranics such as Plutonium and Americium, were placed in 55-gallon drums and other flimsy containers such as glass bottles, plastic bottles, plastic bags and cardboard cartons. The wastes were not accurately characterized, inventoried as to amounts, locations of burial in the discrete pits and trenches, or for compatibility of the wastes.

The best interpretation of available data is that Nickel, Chromium, Cadmium and Nitrate wastes from the Sandia MWL dump have contaminated the groundwater beneath the MWL dump. The nature and extent of groundwater contamination from the wastes buried in the MWL dump is not known because the NMED HWB has not required DOE/Sandia to install a reliable network of monitoring wells.

7.9. The Continuing Failure to Require Replacement of Defective Monitoring Wells MWL-MW4, -MW5, and -MW6 violates the Consent Order Section VIII.A and 40 CFR 264 Subpart F. Consent Order Section VIII.A Design and Construction of Monitoring Wells requires replacement of wells that fail for any reason to meet their intended purpose as follows:

> In the event of a well or piezometer failure, or if a well or piezometer is any way no longer usable for its intended purpose, it must be replaced with an equivalent well or piezometer (p. 63).

The Consent Order Section VIII.A.6 (p.63) requires "The design and construction of groundwater monitoring wells and piezometers shall comply with the guidelines established in EPA guidance, including, but not limited to: U.S. EPA, *RCRA Groundwater Monitoring: Draft Technical Guidance*, EPA/530-R-93-001, Nov. 1992."

The EPA guidance identifies RCRA 264 Subpart F as the requirements for the groundwater monitoring at the MWL dump.

The defective MWL dump monitoring well network does not comply with 40 CFR 264.91-100 (Subpart F) requirements to obtain reliable and representative water samples and the same Consent Order requirement to obtain high quality, representative groundwater samples. For numerous other reasons, including, but not limited to those below, a RCRA compliant well monitoring system is not in place at the MWL dump:

- There are **two distinct flow systems** at the MWL dump and neither system is monitored in accord with RCRA 40 CFR 264.91-100 requirements.
  – The upper flow system is at the water table in the fine-grained alluvial fan sediments. The direction of groundwater flow in the fine-grained alluvial fan sediments is to the southwest.
  – The deeper flow system is in the Ancestral Rio Grande (ARG) Deposits that are located stratigraphically below the fine-grained alluvial fan sediments. The ARG Deposits are the important groundwater resource in the region of Albuquerque and are recognized under RCRA as the "uppermost aquifer." The direction of groundwater flow in the ARG strata is poorly characterized at the location of the MWL dump. The best available information indicates groundwater flow in the ARG Deposits is to the northwest.

- **Monitoring well MWL-MW4**. Well MW4 is a multiple-screen angle well with two screened intervals that was installed to investigate groundwater contamination below Trench D because of the disposal of 271,500 gallons of reactor coolant water in the trench. The purpose of well MW4 was to investigate contamination at the water table beneath Trench D. However, the top screen in well MW4 was installed too deep below the water table, and the well has not met its important purpose to investigate contamination at the water table. The bottom screen in well MW4 is installed across the contact of the AF sediments with the ARG strata. The position of NMED is that well screens shall not be installed across formations with contrasting hydraulic properties or markedly different hydraulic head but this is the setting for the bottom screen in well MW4. In addition, the available information indicates that well MW4 is allowing cross-contamination between the top and bottom screen. There is an immediate need to plug and abandon well MW4, and install a new monitoring well to characterize groundwater contamination at the water table beneath Trench D.
  The multiple screen of MW4 is leaking between the upper and lower screen. The Consent Order requires replacement because:
- Upper screen installed too deep below the water table to detect contamination below Trench D.
- There is leakage between the well screens that can cross contaminate the two different strata as a fast pathway for contamination to enter from beneath the dump.
- The plan to leave the well in place without monitoring it will result in unnoticed contamination entering the productive aquifer strata.

NMED knew in 1993 that well MWL-MW4 could not monitor at the water table beneath Trench D and that cross contamination between different zones of saturation could result. Moats et al. (March 1993) stated several concerns for the MWL-MW4 (AR 006424):

1. … "[T]he installation of MWL-MW4 will not adequately address the stated objectives."

The stated objectives for drilling MWL-MW4 that could not be adequately addressed included: "1.) direction and gradient of ground-water flow, 2.) extent of contamination beneath the likeliest source area (Trench D), 3.) ground-water quality directly beneath the landfill, and 4.) aquifer and vadose zone characteristics." (AR 006424).

"Thus it is doubtful that the horizontal direction and gradient of groundwater flow can be reliably determined using the existing monitor well network, even with the addition of MWL-MW4. Additional monitor wells will have to be installed at the MWL which are located at greater distances form the landfill to adequately resolve this problem.

"2. If ground-water contamination is not detected in MWL-MW4, this fact in itself does not disprove the existence of ground-water contamination at the MWL. Other characterization work may be required. Because of the layered heterogeneity of the sediments comprising the relatively thick vadose zone, contaminant plumes may not necessarily develop in ground water lying immediately below Trench D or any other trench at the MWL.

"3. In Anonymous (1991), there is no mention of any mechanism in the design of MWL-MW4 to separate the lower screen from the upper screened intervals. The two intervals must be isolated at all times to prevent cross-contamination between shallow and deeper ground water.

"5. MWL-MW4, by itself, will not adequately address the issue of vertical ground-water flow at the MWL…

"6. As designed, MWL-MW4 is an unconventional monitor well and does not meet strict RCRA well construction guidance criteria."

Moats and Winn (1993) [23] concluded (p.7): "The detection monitoring system that currently exists at the MWL is inadequate because the direction and gradient of ground-water flow can not be determined with reasonable certainty. If ground-water contamination is not found directly beneath Trench D (in well MWL-MW4), this fact in itself, does not definitely disprove the existence of ground-water contamination at the MWL. … In conclusion, there exists a need for more detailed hydrogeologic information for the MWL."

Monitoring well MWL-MW4 Consent Order Violations

- MW4 was not designed and constructed to meet its intended purpose for monitoring at the water table beneath Trench D.
- MW4 cannot yield high quality, representative samples.
- MW4 has not lasted the duration of the planned monitoring need.
- MW4 cannot determine if a release from Trench D will impact groundwater.
- MW4 cannot establish concentration trends for Contaminants or potential Contaminants at the ground water table.
- MW4 was not usable for its intended purpose and cannot be rehabilitated.
- MW4 serves as a conduit for Contaminants to migrate between the different zones of saturation.

Monitoring well MWL-MW5. Well MW5 is located west of the MWL dump, but the well screen is installed across the contact of the fine-grained alluvial fan sediments with the ARG Deposits which, as explained above, is in violation of NMED requirements for monitoring wells. Well MWL-MW5 clearly violates the Consent Order Section VIII.A because Sandia/DOE installed MW5 across both the fine-grained alluvial fan sediments and the ARG Deposits which can "serve as a conduit for Contaminants to migrate between different zones of saturation." In addition, a mistake in well construction contaminated the screened interval with the bentonite clay grout that was used for back-filling and sealing the annular space between the well casing and the borehole wall. The grout flowed into the filter pack sediments surrounding the well screen and into the well through the well screen. Field notes show the grout filled the well sump and the lower 4 feet of the well screen. There is an immediate need to plug and abandon well MWL-MW5. The failure to do so is a violation of the Consent Order. Replacement of well MW5 is required because MW5 1) did not meet its intended purpose to monitor at the water table and 2). monitoring well MW5 can serve as a conduit for cross contamination between different zones of saturation.

The unreliable water quality data from the defective monitoring well MWL-MW5 continues to be submitted by Sandia/DOE and accepted by NMED as part of the decision making process for the MWL dump including the DOE/Sandia proposed long-term monitoring and maintenance plan (LTMMP) [4]**.**

Consent Order Section VIII.A. Well construction is to be done to not allow contamination to migrate between different zones of saturation. The MWL dump monitoring well MWL-MW4 and -MW5 allow cross contamination across different zones of saturation. The fine-grained alluvial fan sediments are a different zone from the saturated zone beneath in the ARG Deposits and well screens were across both zones. The NMED HWB has not enforced the requirement in the Consent Order for plugging and abandonment of wells MWL-MW4 and -MW5.

Monitoring well MWL-MW5 Consent Order Violations

- **MW5 does not meet its intended purpose to monitor groundwater contamination at the water table downgradient of the MWL dump.**
- **MW5 does not meet its intended purpose to measure the elevation of the water table downgradient of the MWL dump.**
- MW5 has not lasted the duration of the planned monitoring need.
- MW5 cannot yield high quality, representative samples. The mistakes in the installation of well MW5 include installation of the screen across strata with a large contrast in hydraulic conductivity and water levels (*i.e.,* hydraulic head), and contamination of the screened interval with a large amount of bentonite/cement grout because of a mistake in constructing the well.
- MW5 cannot establish concentration trends for Contaminants or potential Contaminants for either the fine-grained alluvial fan sediments zone or the ARG Deposits zone.
- MW5 was not usable for its intended purpose and cannot be rehabilitated.
- MW5 serves as a conduit for Contaminants to migrate between the different zones of saturation. The well screen is installed across the contact of the AF sediments with the ARG Deposits.
- The NMED HWB has not enforced the requirement in the Consent Order that well MWL-MW5 must be plugged and abandoned and replaced with a new

There is an immediate need to plug and abandon defective well MWL-MW5 and install a reliable monitoring well. The failure to do so is a violation of the Consent Order.

Monitoring well MWL-MW6. Well MW6 is in the productive groundwater strata but is 500 ft distant to the northwest corner from the dump. No monitoring well network is located at the point of compliance to monitor the "groundwater" as defined by the Consent Order.

Monitoring well MWL-MW6 Consent Order Violations

- **MW6 does not meet its intended purpose to monitor groundwater contamination at the water table downgradient of the MWL dump.**
- **MW6 does not meet its intended purpose to measure the elevation of the water table downgradient of the MWL dump.**
- MW6 cannot yield high quality, representative samples because of its great distance from the MWL dump.
- MW6 does not meet its intended purpose to monitor releases from the MWL dump and groundwater as defined by the Consent Order.
- MW6 does not meet the intended purpose to determine the direction of groundwater travel at the water table west of the MWL dump.
- MW6 has not lasted the duration of the planned monitoring need.
- MW6 cannot establish concentration trends for Contaminants or potential Contaminants in the groundwater.
- MW6 was not usable for its intended purpose and cannot be rehabilitated because the screen was not installed at the water table.

7.10. The NMED has violated the Consent Order Section VIII.A by not requiring replacement of monitoring wells MWL-MW7, -MW8 and -MW9. The new wells MWL-MW7, -MW8 and -MW9 and -BW-2 were drilled without identifying the elevation of the water table as part of drilling operations as was required by the NMED Consent Order [1]**.** The water levels measured in the three new wells MWL-MW7, -MW8 and -MW9 are approximately 20 feet too deep for the known elevation of the water table. The three new wells do not meet the intended purpose to 1). monitor groundwater contamination at the point-of-compliance and 2) measure the elevation of the water table at the point-of-compliance. The NMED HWB has not enforced the requirement in the Consent Order for plugging and abandonment of the three defective monitoring wells MWL-MW7, -MW8 and -MW9 and replacement with three reliable monitoring wells that meet the intended purpose.

7.11. RCRA requires the Compliance Monitoring Program at the Sandia MWL dump. The high concentrations of nickel contamination measured repeatedly in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 requires the Compliance Monitoring Program under RCRA 264 Subpart F. There is also evidence of Chromium, Cadmium, and Nitrate contamination of the groundwater below the Sandia MWL dump. A RCRA Program of Compliance Monitoring is required for installation of many monitoring wells within and surrounding the MWL dump to define the dimensions of the nickel plume and the other groundwater contamination in both the fine-grained alluvial fan sediments and the ARG Deposits and to investigate groundwater contamination from other metals and solvents and “hot spot” sources within the MWL dump. RCRA and the NMED Sandia Consent Order require monitoring wells to be installed in both the fine-grained alluvial fan sediments and the ARG Deposits at appropriate locations to investigate the tritium hot spots, the trace metal hot spots, and the VOC hot spots that were identified in the RCRA facility investigation.

7.12. Contamination in the groundwater from the wastes buried in the Sandia MWL dump. A letter was sent to NMED from Sandia informing of Chromium contamination exceedences at the MWL. Table 3 in Section 8 presents the nickel concentrations measured in wells MWL-MW1, -MW2, -MW3, and -BW1. There is a history of measurement of anomalously high levels of nickel in water samples from well MW1 beginning with the first water sample collected in 1990 with total and dissolved levels of 46 and 43 ug/L, respectively. For comparison, the NMED approved background for total and dissolved nickel in groundwater is 28 ug/L [44].

The Nickel concentrations measured in groundwater samples collected from monitoring wells MWL-MW1 and -MW3 were consistently high compared to the NMED approved background water quality value (see Table 3 in Section 8). The high nickel levels are evidence of contamination released from the dump. The measured concentrations of dissolved nickel in the groundwater samples collected from well MWL-MW1 are often above 400 ug/L – that is 4 times higher than the EPA standard that was set. The World Health Organization has a health advisory for groundwater concentrations to not exceed 30 ug/L and the nickel concentrations measured in groundwater samples collected from well MWL-MW1 were more than ten times higher. The nickel levels are above the New Mexico Water Quality Control Commission (WQCC) standard of 200 ug/L[52].

The nickel groundwater data from the new background water quality monitoring well MWL–BW2 is evidence that the nickel wastes buried in the Sandia MWL dump have contaminated the groundwater. For the seven sampling events in 2008 [33] and 2009 [34], the nickel concentrations measured in the filtered and unfiltered groundwater samples collected from the new background monitoring well MWL-BW2 were all less than 2 ug/L. The very low nickel concentrations measured in the background groundwater is important evidence that the high nickel concentrations measured in the groundwater samples collected from well MWL-MW1 beginning with the first sampling event in 1990 is groundwater contamination from the nickel wastes buried in the MWL dump.

The NMED HWB ordered plugging and abandoning MWL-MW1 without replacement with a new monitoring well. The action taken by the NMED HWB does not comply with the Consent Order or RCRA because the nature and extent of contamination is not investigated. The Consent Order requires that an equivalent well replacement be made for well MW1 close to the location of plugged and abandoned well MW1.

7.13. Consent Order Section IX.A Sampling of Groundwater. The sampling is to be at a period approved by the Department. Section IX.A requires the following:

> The Respondents shall sample all saturated zones screened to allow entry of groundwater into a monitoring well during each sampling event unless otherwise approved in writing by the Department.

"Groundwater" as defined by the Consent Order is groundwater in the ARG Deposits. The NMED HWB has not enforced the requirement in the Consent Order for a network of monitoring wells at the MWL dump in the ARG Deposits.

7.14. Well Purging Consent Order Section IX.B (p. 67). The NMED HWB requirement for the improper high-flow purge-to-dry well purging has caused collapse of the fine-grained alluvial fan sediments surrounding the well screens. Purging rates that dry out the wells were/are not avoided and hydraulic forces resulted that compressed the fine-grained alluvial fan sediments and prevent productive flow of water. The MWL dump monitoring wells installed in the fine-grained alluvial fan sediments were purged at a rate that was too high (see Section 10.7). The wells were not rehabilitated and sampling of the wells was made up to a week later from water that had trickled into the wells.

7.15. The NMED has not required vadose zone monitoring beneath the MWL dump. The NMED HWB has not required vadose zone monitoring beneath the unlined trenches and pits at the MWL dump. The vadose zone monitoring proposed in the DOE/Sandia Long-Term Monitoring and Maintenance Plan [4] is inadequate because there are only three vadose zone monitoring wells and they are located distant from the MWL dump beyond the toe of the dirt cover. A network of vadose zone monitoring wells are required that monitor the release of contamination **below** the unlined trenches and pits.

7.16. The DOE/Sandia Fate and Transport Model [2] which currently relies on assumed values rather than hard data from vadose zone and other characterization should be abandoned. SNL/DOE admits the computer models [2] lack of quality assurance: "We agree, however, that additional work and materials are needed to provide quality assurance for the models and software used in this particular study." (MWL CMI Plan NOD Comment Response Set 2, p.14).

7.17. Requirements to be met for Compliance with the Consent Order for the Sandia MWL dump:

1. Replace, plug and abandon well MWL-MW4.
2. Replace, plug and abandon well MWL-MW5
3. Install a new monitoring well at the water table close to the location of plugged and abandoned monitoring well MWL-MW1.
4. Well MWl-MW6 – leave in place, but must be replaced due its distant location. Install new well at the point of compliance in the productive zone of groundwater as defined by the Consent Order to be the ARG Deposits.
5. Replace, plug and abandon the defective monitoring wells MWL-MW7, -MW8 and -MW9
6. Locate monitoring wells to the south side of the MWL dump at the water table.
7. Two flow systems exist; the fine grained alluvium fan sediments and the ARG Deposits. Both zones of saturation are required to be monitored.
8. Monitoring Wells must be installed at the water table at the hot spots for tritium and Volatile Organic Compounds (VOCs) beneath the MWL dump. NMED proposed such monitoring but DOE has not met that demand. Those wells are important for verifying the DOE/Sandia Fate &Transport Model [2] and for early detection of the arrival of contamination below the MWL dump to the water table in the fine-grained alluvial fan sediments.
9. New wells may only be drilled with air rotary casing advanced under-reamer technique or sonic drilling method. No organic drilling fluids or clay muds are

10. Drilling operations shall take special care to identify any perched zones of saturation and the elevation of the water table in the fine-grained alluvial fan sediments.
11. NMED must require vadose zone well monitoring beneath the MWL dump with special emphasis on vadose zone monitoring below the unlined trenches and pits that are known hot spots.

8.0. RCRA criteria identify that the nickel contamination measured in the ground-water samples collected from the Sandia MWL dump monitoring wells MWL-MW1 and -MW3 are from the nickel wastes buried in the Sandia MWL dump. The 1998 NMED Notice of Deficiency (NOD) Report [10] determined that the nickel wastes buried in the MWL dump were responsible for the high concentrations of nickel that were measured in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3. The pertinent excerpts in **Deficiency No. 2** and **Deficiency No. 5** from the 1998 NMED NOD Report [10] are pasted below along with the response from DOE/Sandia [42]**:**

> **Deficiency #2. Response #23** – – The cross-sections indicate:
>
> D. There is evidence of possible nickel contamination at concentrations ranging from 11.8 – 21.5 mg/kg in soil samples collected at depths of about 70 – 100 ft (Boreholes SB-5 and BH-3).
>
> E. There is a “hot spot” of contamination at a depth of 50 ft. at Borehole BH-3. Contaminants are Ag [silver] (1.46 mg/kg), Cd [cadmium](1.44 mg/kg), Co [cobalt] (105 mg/kg), Cu [copper] (645 mg/kg), Ni [nickel] (97.5 mg/kg), and Zn [zinc] (413 mg/kg).
>
> The presence of metal contaminants at depths which can exceed 100 ft indicate that liquid wastes were disposed of in the landfill. Thus, groundwater monitoring for metals is required.

The response [42] from DOE/Sandia to Deficiency #2, Response #23 follows:

> DOE/Sandia will continue to monitor groundwater at the mixed waste landfill for metals.

Continued from the 1998 NMED NOD Report [10]:

> **Deficiency #5. Response #46** – – The MWL inventory is not complete. Data derived from soil sampling beneath the landfill indicate that nickel is a possible contaminant from the MWL. (See Deficiency No. 2).
>
> <u>DOE/SNL must support their position on a technical basis that the elevated nickel levels detected in groundwater samples from monitor well MWL-MW1 (and MWL-MW3) are a result of the corrosion of 305 stainless steel well screen; otherwise, such elevated levels of nickel will be attributed to a release of contaminants from the landfill</u> [emphasis supplied].

The response [42] from DOE/Sandia to Deficiency #5, Response #46 follows:

> Although nickel is a possible contaminant at the MWL, DOE/Sandia believe it is unlikely that nickel has migrated from disposal cells at the MWL through the 500-foot-thick vadose zone. However, DOE/Sandia plans to continue monitoring nickel and other RCRA metals in ground-water at the MWL as part of their long-term monitoring program at the landfill.

Comment from the authors: DOE/Sandia acknowledged that nickel is a possible contaminant in the wastes buried in the MWL dump but DOE/Sandia did not support their position on a technical basis that the elevated nickel concentrations measured in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 were not from the wastes buried in the MWL dump. Mr. Benito Garcia was Chief of the NMED Hazardous Waste Bureau (HWB) when the 1998 NMED NOD Report [10] was issued. Mr. James Bearzi became Chief of the NMED HWB in 1999 and the concern in the 1998 NMED NOD Report for the high nickel concentrations in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 was never resolved.

Under Chief Bearzi, the NMED HWB did not require DOE/SNL to support their position on a technical basis that the high nickel concentrations detected in groundwater samples from monitoring well MWL-MW1 (and MWL-MW3) were only a result of the corrosion of the Type 304 stainless steel well screens. <u>Instead, the NMED HWB accepted the **unreasonable assumption** of DOE/Sandia that the high nickel concentrations measured in wells MWL-MW1 and -MW3 were caused only by corrosion.</u>

The concern in the 1998 NMED NOD Report [10] that the nickel groundwater contamination was from the wastes buried in the MWL dump was not resolved at the NMED December 2004 Public Hearing [43]**,** in the NMED 2006 Moats Report [31]**,** or to the present in 2011. The NMED HWB did not require DOE/Sandia to support their position on a technical basis that the high concentrations of nickel measured in the groundwater samples collected from the two monitoring wells MWL-MW1 and -MW3 was not a plume of groundwater contamination from the wastes buried in the MWL dump. Instead, the testimony of the NMED HWB technical staff at the NMED December 2004 Public Hearing was <u>**speculation**</u> that the source of the nickel contamination was only corrosion of the stainless steel well screens. The pertinent testimony of NMED staff person Ms. Carolyn Cooper is pasted below:

> In NMED's view, the most likely explanation for the elevated nickel and chromium concentrations in groundwater at the mixed waste landfill is the corrosion of the stainless steel well screens (v. III, p. 925, l. 24-25; p. 926, l. 1-2).

In addition, the NMED November 2006 Moats Report [31] also <u>**speculated**</u> that the corrosion of the stainless steel well screen was the only source for the high concentrations of nickel measured in the two monitoring well MWL-MW1 as follows:

> (t)he concentration of total nickel in MW1 groundwater samples has shown a marked increase over time (see Figure 6 [Figure 18 in this report]). <u>This is inferred to Indicate progressive corrosion of the stainless steel well screen in this well</u> [Emphasis supplied] (p. 7).

The <u>speculation</u> by the NMED HWB that corrosion is the only source for the high levels of nickel measured in the groundwater samples from monitoring wells MWL-MW1 and -MW3 violates RCRA, the NMED 1998 NOD Report [10] and the NMED Consent Order [1]**.**

The regulations require monitoring wells that produce reliable and representative groundwater samples for the detection of nickel contamination from the wastes that are buried in the MWL dump. Monitoring wells with corroded stainless steel screens do not provide reliable and representative groundwater samples for the detection of many contaminants of concern for the wastes buried in the MWL dump including the trace metals nickel, beryllium, cadmium, chromium, uranium and lead and the solvents tetrachloroethene (PCE) and trichloroethene (TCE).

The well-known properties of corroded stainless steel screens to prevent the detection of groundwater contamination are described in Section 9.4 of this report. The NMED staff person Ms. Carolyn Cooper testified at the NMED December 2004 Public Hearing about the nickel and chromium contamination detected in the groundwater samples collected from monitoring wells MWL-MW1 and MW3 as follows:

> Elevated levels of nickel and chromium have been detected since 1992 in Monitoring Wells MW-1, 2, 3 and BW-1. Concentrations of nickel that exceed the EPA MCL for drinking water have been detected in Monitor well 1. Concentrations of chromium exceeding the MCL have been detected in Monitor well 1 and 2. Each of these four wells is constructed with a stainless steel well screen (v. III, p. 924, l. 24-25; p. 925 l. 1-7).

Comment from the authors. The NMED HWB should have required replacement of the four monitoring wells with corroded stainless steel screens in 1992. Replacement of monitoring wells MWL-MW1 and -MW3 by 1994 was a requirement of RCRA because nickel and/or chromium were detected in the groundwater samples at concentrations above the EPA Drinking Water Standard. In addition, replacement of the two monitoring wells MWL-MW2 and -BW1 was also a requirement of RCRA and the NMED Consent Order [1] because the wells were not at locations that could detect groundwater contamination from the MWL dump. However, the NMED HWB did not require DOE/Sandia to replace the four defective monitoring wells MWL-MW1, -MW2, -MW3 and -BW1 until 2008 [24,25].

8.1. The anomalous high concentrations of nickel measured in the groundwater samples collected from monitoring wells MWL-MW1 and MW3 are evidence of groundwater contamination from the nickel wastes buried in the MWL dump. Monitoring well MWL-MW1 was installed in 1988 and the three monitoring wells MWL -MW2, -MW3 and -BW1 were installed in 1989. The position of the NMED HWB is that the Type 304 stainless steel screens in the four monitoring wells became corroded beginning in 1992 [43]. Figure 18 and Table 3 below on the next page display the very high concentrations of nickel measured in the groundwater samples collected from monitoring well MWL-MW1 compared to the low nickel concentrations measured in the groundwater samples collected from the three other monitoring wells with corroded stainless steel screens.

Figure 6 shows the close locations of wells MWL-MW1 and -MW3 to the MWL dump and the distant locations of wells MWL-MW2 and -BW1 100 feet north and 500 feet south from the MWL dump, respectively. Figure 7 is a geologic cross-section that shows that the corroded screens in the four wells were installed across the water table in the fine-grained alluvial fan sediments.

The corrosion of the stainless steel screens in the four wells should have resulted in similar concentrations of nickel in the groundwater samples collected from the four monitoring wells but this is not the case. The high nickel concentrations measured in the groundwater samples collected over all time from well MWL-MW1 compared to the low nickel concentrations measured in the two monitoring wells MWL-MW2 and -BW1 that are at locations that do not detect contamination from the MWL dump is evidence that the nickel wastes buried in the MWL dump are the source for the nickel contamination in the groundwater at the water table below the dump.

Table 3. Total and Dissolved Nickel Measured in the Water Samples Produced From Monitoring Well MWL-MW1, -MW-3, -BW1 and - MW2 at the Sandia Mixed Waste Landfill. The four wells have stainless steel screens.

- Date	- Well MW1 Nickel (ug/L) [A] T [B] / D [C]	- Well MW3 Nickel (ug/L) T / D	- Well BW1 Nickel (ug/L) T / D	- Well MW2 Nickel (ug/L) T / D
- 09 - 90	46 / 43	ND [D] <40 / ND < 40	ND <40 / ND <40	ND <40 / ND <40
- 01 - 91	NA [E] / NA	NA / NA	NA / NA	NA / NA
- 04 - 91	NA / NA	NA / NA	NA / NA	NA / NA
- 10 - 91	NA / NA	NA / NA	NA / NA	NA / NA
- 07 - 92	150 / 63	66 / 43	ND <40 / ND <40	ND <40 / ND <40
- 01 - 93	78 / NA	26 (j) [F] / NA	ND <40 / NA	ND <40 / NA
- 04 - 93	97 / 94	37 (j) / 33 (j)	7.5 / 16	14 (j) / 13 (j)
- 11 - 93	95 / NA	ND < 40 / NA	ND < 40 / NA	ND < 40 / NA
- 05 - 94	110 / NA	ND <40 / NA	NA / NA	ND <40 / NA
- 10 - 94	130 / NA	ND <40 / NA	9.8 (j) / NA	ND <40 / NA
- 04 - 95	120 / NA	NA / NA	9.3 (j) / NA	7.5 (j) / NA
- 10 - 95	107 / NA	7.99 (j) / NA	1.96 (j) / NA	NA / NA
- 04 - 96	145 / NA	3.67 (j) / NA	ND < 0.81 / NA	3.42 (j) / NA
- 04 - 97	NA / NA	NA / NA	NA / NA	NA / NA
- 10 - 97	NA / NA	NA / NA	NA / NA	NA / NA
- 04 - 98	398 / 538	36.2 / 28.5	2.9 (j) / NA	5 (j) / 4
- 11 - 98	490 / 467	18 / 18.3	7.19 / 9.47	4.49 / 3.42
- 04 - 99	266 / 313	31 / 31.3	12.8 / 14.3	5.31 / 4.37
- 04 - 00	279 / 281	25.1 / NA	16.5 / NA	124 / NA
- 04 - 01	252 / NA	14.1 / NA	191 / NA	88.2 / NA
- 04 - 02	265 / NA	96.1 / NA	13.6 / NA	89.7 / NA
- 04 - 03	374 / NA	NA / 69.4	26.6 / NA	52 / NA
- 04 - 04	401 / NA	56 / NA	33.2 / NA	10.5 / NA
- 04 - 05	424 / 405	17.3 / 11.5	35.5 / NA	8.02 / 7.11
- 04 - 06	477 / NA	157 / NA	68 / NA	6. 76 / NA
- 04 - 07	436 / 284	84.8 / 120	NA / NA	7.34 / 5.41

[A] **ug/L = micrograms per liter or parts per billion**
[B] **T = Concentration of total nickel measured in an unfiltered water sample**
[C] **D = Concentration of dissolved nickel measured in a filtered water sample**
[D] **ND = nickel was not detected at the listed minimum detection level**
[E] **NA = nickel was not analyzed in samples collected on this date**
[F] **(j) = the listed value is an estimated value**

- A median dissolved nickel concentration of 1.22 ug/L was measured in water samples collected on seven dates in 2008 and 2009 from the new background water quality monitoring well MWL-BW2 with a range from 0.82 to 1.7 ug/L.

- The NMED proposed trigger concentration for total and dissolved nickel in groundwater below the Sandia MWL dump is 50 ug/L.

- The EPA recommends for nickel concentrations in drinking water to not exceed 100 ug/L.

- <u>Sources for Nickel Data</u>: Data from 1990 – 2001 are from Table 4-2 in Goering et al., 2002 [9] (see Appendix F); Data from 2002 – 2007 - Sandia Annual Reports for groundwater monitoring at the Sandia MWL Dump.

Additional evidence of a nickel plume in the groundwater at the water table below the MWL dump is the marked increase in the nickel concentrations in the groundwater samples collected from monitoring well MWL-MW3 beginning in 1998 and continuing to increase to the last water sample collected from well MW3 in 2007.

There is a history of measurement of high concentrations of nickel in the groundwater samples collected from well MWL-MW1 beginning with the first water sample collected in 1990 with total and dissolved levels of 46 and 43 ug/L, respectively. For comparison, the NMED approved background concentration for total and dissolved nickel in groundwater is 28 ug/L [44]**.** However, the range of dissolved nickel in the groundwater samples collected from the new background monitoring well MWL-BW2 were the low values from 0.815 ug/L to 1.71 ug/L with a median concentration of 1.22 ug/L (The data tables for background water quality are in Appendix G). The very low background concentrations for dissolved nickel measured in well MWL-BW2 compared to the markedly higher nickel concentration measured beginning with the first groundwater samples collected from well MWL-MW1 meet RCRA Criteria that the nickel wastes buried in the MWL dump have contaminated the groundwater.

Table 3 shows that the nickel concentrations in the groundwater samples collected from well MWL-MW1 increased over time to near 100 ug/L for dissolved nickel in 1993 and above 400 ug/L for dissolved nickel beginning in 1998. The very high concentrations of nickel were measured in well MWL-MW1 until the well was plugged and abandoned in 2008. A new monitoring well was not installed at the location of defective monitoring well MWL-MW1 to investigate the nature and extent of the groundwater contamination from the MWL dump.

There is also a history of measurement of high concentrations of nickel in the ground-water samples collected from monitoring well MWL-MW3 beginning in 1998 with the repeated measurement of dissolved nickel concentrations greater than the NMED approved background concentration of 28 ug/L. Table 3 shows that the concentrations of nickel increased over time and a dissolved concentration of 120 ug/L was measured in the last groundwater sample collected from well MWL-MW3 in 2007. Well MWL-MW3 was plugged and abandoned in 2008. A new monitoring well was not installed at the location of defective monitoring well MWL-MW3 to investigate the nature and extent of the groundwater contamination from the MWL dump.

For comparison, in Table 3 the low concentrations of dissolved nickel measured in the two monitoring wells MWL-MW2 and -BW1 that are located away from the Sandia MWL dump are important evidence that the high concentrations of dissolved nickel measured in wells MWL -MW1 and -MW3 are from the nickel wastes buried in the MWL dump. Table 3 shows that the dissolved nickel concentrations measured in the groundwater samples collected from wells MWL-MW2 and -BW1 were always less than 20 ug/L and commonly less than 10 ug/L.

Additional evidence of a plume of groundwater contamination from the MWL dump is the other contamination detected in the groundwater samples collected from the two monitoring wells MWL-MW1 and -MW3 including cadmium, chromium and nitrate. The groundwater contamination from the MWL dump that was detected in the two defective monitoring wells is described in Section 9.8 of this report.

EPA remanded the nickel 100 ug/L Drinking Water Standard (DWS) on February 9, 1995 and a new DWS has not been set. However, EPA recommends that drinking water levels for nickel should not be greater than 100 ug/L [51]**.**

The New Mexico Water Quality Control Commission (WQCC) Water Quality Standard is for nickel in water to not exceed 200 ug/L [52]**.** Accordingly, the NMED HWB [53] set 50 ug/L (25% of 200 ug/L) as the corrective action trigger level for nickel contamination in the groundwater below the MWL dump. The 50 ug/L "trigger level" requires the NMED HWB to order DOE/Sandia to install new monitoring wells at the locations of plugged and abandoned monitoring wells MWL-MW1 and -MW3 to investigate the nature and extent of the nickel groundwater contamination from the MWL dump.

9.0. The methodology and conclusions of the NMED November 2006 Moats Report lack scientific basis, are known to be incorrect and the Moats Report requires retraction. In November of 2006 the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) published the report titled *Evaluation of the Representativeness and Reliability of Groundwater Monitoring Well Data, Mixed Waste Landfill, Sandia National Laboratories* by William P. Moats, David L. Mayerson and Brian L. Salem [31] (referred to as the 2006 Moats Report or the Moats Report). The 2006 Moats Report makes the incorrect conclusion that all of the seven defective monitoring wells displayed on Figure 6 provided reliable and representative water quality data.

However, the incorrect conclusion in the NMED 2006 Moats Report was based on the evaluation of the unreliable water quality data from **only four of the seven MWL dump monitoring wells** (i.e., wells MWL-MW2, -MW3, -MW5 and -BW1) that were known to be defective for many factors that are described in this section.

- ***ONLY ONE OF THE FOUR MONITORING WELLS EVALUATED IN THE NMED 2006 MOATS REPORT (i.e., WELL MWL-MW3) WAS AT A LOCATION THAT COULD DETECT GROUNDWATER CONTAMINATION FROM THE SANDIA MWL DUMP.***

- ***Only two of the seven defective monitoring wells at the MWL dump (i.e., wells MWL-MW1 and -MW3) were at locations that could detect groundwater contamination from the dump.***

- ***In addition, the evaluation methodology used in the NMED 2006 Moats Report was previously rejected numerous times by the Environmental Protection Agency (EPA) and the National Research Council (NRC). The reports from the EPA and the NRC are discussed in Section 9.2.***

The two incorrect and totally unsupported conclusions in the NMED 2006 Moats Report that are discussed below were used by the NMED HWB to justify leaving the dangerous radioactive and hazardous wastes buried in unlined pits and trenches under a dirt cover above Albuquerque's drinking water aquifer:

– 1). **The NMED 2006 Moats Report makes the incorrect conclusion that there was a reliable network of seven monitoring wells at the Sandia MWL dump.**

> **–** A large number of expert reports in the NMED Administrative Record (AR) contradict this conclusion in the NMED 2006 Moats Report. Six of the reports are summarized in Section 5. The six reports written over the years 1991 to 1998 determined that the seven monitoring wells described as "reliable" in the 2006 Moats Report to be defective and require replacement. NMED staff person William P. Moats was the lead author on a 1993 report [23] that described the "reliable" monitoring well network in the NMED 2006 Moats Report [31] as 'inadequate" and requiring installation of additional monitoring wells. The monitoring well network was inadequate to the present time in 2011 for the reasons described in the 1993 report by Moats and Winn [23]**.** A summary of Moats and Winn (1993) is in Section 5.3. A copy of the report is in Appendix B.
>
> Mr. Moats was also the lead person on the 1998 NMED Notice of Deficiency (NOD) Report [10] that recognized there was only one downgradient monitoring well (well MWL-MW3) and the onsite monitoring well MWL-MW4 was defective and required replacement. The 1998 NMED NOD Report ordered the installation of two additional monitoring wells but the two wells (i.e., wells MWL-MW5 and

- MW6) are also defective and require replacement. The NMED 2006 Moats Report describes the two defective wells MW5 and MW6 as reliable monitoring wells for the detection of groundwater contamination from the MWL dump. The 1998 NMED NOD Report [10] is summarized in Section 5.6. A copy of the report is in Appendix A.

– 2). The NMED 2006 Moats Report makes the incorrect conclusion that there was no evidence of groundwater contamination from the wastes buried at the MWL dump.

– The NMED 1998 NOD Report [10] considered the high levels of nickel measured in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 to be evidence of groundwater contamination from the wastes buried in the MWL dump. Of the seven monitoring wells considered to be reliable in the 2006 Moats Report, wells MWL-MW1 and -MW3 are the only monitoring wells at locations that can detect groundwater contamination from the MWL dump. The groundwater contamination repeatedly detected in the two defective monitoring wells by RCRA Criteria include cadmium, chromium, nickel and nitrate. Other contaminants may be present in the groundwater below the MWL dump. The groundwater contamination from the wastes buried in the MWL dump are described below in Section 9.8. The monitoring wells MWL-MW1 and -MW3 are defective with factors that prevent the detection of groundwater contamination. Two factors in both wells are 1). the corroded stainless steel screens beginning in 1992 [43] and 2). the high-flow pumping systems that purged the wells to dryness and collected water samples a week later from the highly aerated water that refilled the wells. An additional factor that prevented the detection of groundwater contamination in the water samples collected from well MWL-MW3 was the bentonite clay contamination in the screened interval from the mud-rotary drilling method.

An important reason the NMED 2006 Moats Report [31] is without any value and the NMED must retract the report is that the evaluation methodology only studied the impact of the bentonite clay contamination on the ability of the four monitoring wells MWL-BW1, -MW2, -MW3 and -MW5 to produce reliable and representative water samples**.** **Of the four monitoring wells evaluated in the 2006 Moats Report, only well MWL-MW3 was at a location that could detect groundwater contamination from the MWL dump.** In addition, the evaluation methodology used in the 2006 Moats Report for the bentonite clay contamination in well MWL-MW3 was rejected by the scientific community including the EPA Kerr Lab and the National Research Council (NRC). The reports by the EPA and NRC are summarized below in Section 9.2. Moreover, the 2006 Moats Report did not recognize the other factors listed below that prevented well MWL-MW3 (and the other six defective monitoring wells at the MWL dump) from producing reliable and representative groundwater samples.

The NMED relied upon the unreliable data from the seven defective monitoring wells in the NMED Final Order issued on May 26, 2005 [46] for DOE/Sandia to leave the commingled hazardous and radioactive waste buried in unlined trenches and pits at the Sandia MWL dump below a dirt cover. The NMED 2006 Moats Report [31] was written to suppress the public comments submitted to the NMED in June 2006 about the defective monitoring well network at the Sandia MWL dump. The public comments were for the DOE/Sandia Corrective Measures Implementation Plan [54] for the Sandia MWL dump .

– **The NMED did not provide the public with opportunity to comment on the NMED November 2006 Moats Report.** The Final Order [46] issued by NMED Secretary Ron Curry on May 26, 2005 required NMED to provide the public with opportunity to review and comment on major documents such as the NMED 2006 Moats Report. The Final Order required NMED to review, consider and respond to the public comments prior to the approval of the 2006 Moats Report. The formal requirement in Secretary Ron Curry's Final Order was not followed for the NMED 2006 Moats Report. Instead, the NMED November 2006 Moats Report [31] was issued without opportunity for public comment and without the outside peer review repeatedly requested by the public..

The NMED November 2006 Moats Report [31] continued the knowingly incorrect testimony about the defective monitoring well network at the Sandia MWL dump that was provided by the staff of the NMED HWB and DOE/Sandia at the NMED December 2004 Public Hearing on the NMED recommendation to leave the buried wastes below a dirt cover. The incorrect testimony at the NMED December 2004 public hearing is described in Section 6 of this report. The NMED 2006 Moats Report continued the misrepresentation that a reliable network of monitoring wells was installed at the Sandia MWL dump. Section 7 of this report describes the violations of RCRA for providing incorrect information and failing to correct it.

The seven defective and unreliable monitoring wells that were used as reliable monitoring wells at the NMED December 2004 Public Hearing [43] and in the NMED November 2006 Moats Report [31] include the six defective contaminant detection monitoring wells MWL-MW1, -MW2, -MW3, -MW4, -MW5 and -MW6 and the defective background water quality monitoring well MWL-BW1. The locations of the seven defective monitoring wells are displayed on Figure 6. The seven monitoring wells were installed to monitor groundwater contamination at the water table in the fine-grained alluvial fan sediments below and hydraulically downgradient of the MWL dump. The seven monitoring wells were an overall failure for this purpose.

The only two monitoring wells that could detect groundwater contamination from the MWL dump were wells MWL-MW1 and -MW3. The groundwater contamination from the MWL dump that was detected in the two monitoring wells included cadmium, chromium, nickel and nitrate. The groundwater contamination detected in the two wells is described in Section 9.8. The nickel groundwater contamination detected in monitoring wells MWL-MW1 and -MW3 is also discussed in Section 8. The NMED HWB ordered DOE/Sandia to plug and abandon the two defective monitoring wells MWL-MW1 and -MW3 in July 2007 [25]. The two defective monitoring wells were not replaced with reliable monitoring wells to characterize the nature and extent of the groundwater contamination that was repeatedly detected at the location of the two defective monitoring wells.

The NMED December 2004 Public Hearing [43] and the NMED 2006 Moats Report [31] did not consider the many deficiencies for the MWL dump monitoring wells that were described in the NMED 1998 Notice of Deficiency (NOD) Report [10]. A summary of the NMED NOD Report is in Section 5.6 and a copy of the NOD Report is in Appendix A. The deficiencies in the 1998 NMED NOD Report include the following:

- Monitoring well MWL-MW3 was the only downgradient monitoring well. The 1998 NOD Report ordered the installation of monitoring wells MWL-MW5 and MW6 to provide three downgradient monitoring wells installed at the water table. However,

- The upper screen in monitoring well MWL-MW4 was installed too deep below the water table to measure the elevation of the water table and detect contamination at the water table. Figure 7 shows the deep location of the upper screen in well MWL -MW4. The NMED HWB did not require replacement of the defective monitoring well MWL-MW4. The defective monitoring well is in the current monitoring well network on Figure 8.

- The high levels of nickel repeatedly measured in the water samples collected from monitoring wells MWL-MW1 and -MW3 were considered to be groundwater contamination from the wastes buried in the MWL dump. This issue was not resolved. At the December 2004 Public Hearing[43] and in the 2006 Moats Report [31]**,** the NMED HWB ***speculated*** that the high nickel levels were only from corrosion of the stainless steel well screens. The nickel groundwater contamination from the wastes buried in the MWL dump is discussed in Section 9.8 and in Section 8.

The deficiencies in the 1998 NMED NOD Report [10] were not resolved at the time of the NMED December 2004 Public Hearing [43], at the time of the NMED November 2006 Moats Report [31] or to the present time in 2011. The NMED and DOE/Sandia staff presented identical incorrect testimony at the NMED December 2004 Public Hearing purporting that there was a reliable network of monitoring wells at the Sandia MWL dump and no evidence of groundwater contamination. The incorrect and misleading testimony by Mr. Moats and other NMED staff at the NMED December 2004 Public Hearing that there was a reliable network of monitoring wells at the Sandia MWL dump is summarized in Section 6.

NMED staff person Mr. William Moats was the lead author on the 1993 NMED Report [23] and also the lead staff person on the 1998 NMED NOD Report [10] that identified the monitoring well network at the MWL dump as inadequate. The NMED November 2006 Moats Report [31] is contradicted by Mr. Moats earlier investigations [23,10] as well as several other expert reports in the NMED Administrative Record (AR). Six of the reports in the NMED AR are summarized in Section 5. The pertinent excerpts from the 1993 NMED Report [23] by Mr. Moats and Ms. Winn follow:

> Water level data from July 1992 indicate south-directed or southwest-directed flow. However, the gradient and direction of groundwater flow are not known with reasonable certainty (p. 3).
>
> The horizontal gradient and direction of groundwater flow are not known with reasonable certainty. Additional wells installed at the MWL at greater distances from the facility than the existing wells would better define the horizontal gradient and direction of groundwater flow (p. 4).
>
> The detection monitoring system that currently exists at the MWL is inadequate because the direction and gradient of groundwater flow can not be determined with reasonable certainty (p.9).

The NMED November 2006 Moats Report [31] ignored without explanation the conclusions in the 1993 report by Moats and Winn [23] and the findings in the NMED 1998 NOD Report [10] that described the MWL monitoring well network to be inadequate. The issues in the 1993 NMED Report [23] and in the NMED1998 NOD Report [10] were not resolved at any time including at the NMED December 25, 2004 Public Hearing, when the NMED Moats Report was issued in November of 2006 or to the present time in 2011.

The NMED November 2006 Moats Report [31] is an unscientific evaluation of only the chemistry of the groundwater samples collected from four monitoring wells at the MWL dump that could not provide reliable and representative groundwater samples for many other factors. In addition, the scientific community including the Environmental Protection Agency (EPA) and the National Research Council (NRC) has rejected the methodology of using only the chemistry of groundwater samples to evaluate the ability of monitoring wells contaminated with bentonite clay to provide reliable and representative water samples for the detection of groundwater contamination from the wastes buried in the Sandia MWL dump. The screened intervals in the three mud-rotary monitoring wells MWL-BW1, -MW2 and -MW3 were contaminated with bentonite clay from the mud-rotary drilling method. The screened interval in monitoring well MWL-MW5 was contaminated with bentonite clay/cement grout because of a mistake in the construction of the well. The reports by the EPA and the NRC are discussed below in Section 9.2

An important fact is that only one of the four monitoring wells evaluated in the NMED November 2006 Moats Report (i.e., well MWL-MW3) was at a location that could detect groundwater contamination from the Sandia MWL dump. Figure 9 is a water table contour map that shows the direction of groundwater flow at the water table below the MWL dump is to the southwest and well MWL-MW3 was the only downgradient monitoring well. The 2006 Moats Report evaluation of the chemistry of the groundwater samples from the two mud-rotary monitoring wells MWL-MW2 and -BW1 was meaningless because of the incorrect locations and great distances of the two wells from the MWL dump.

Figure 9 shows that the background water quality monitoring well MWL-BW1 was not at a required location that was hydraulically upgradient of the MWL dump. Instead, well MWL-BW1 was at an unusable location that was 500 feet south of the southern boundary of the MWL dump and cross-gradient to the southwest direction of ground-water flow below the MWL dump. The NMED HWB did not require replacement of the defective and unusable background water quality monitoring well MWL-BW1 until 2008. At the time of the NMED 2004 Public Hearing and at the time of the NMED 2006 Moats Report, the defective background monitoring well MWL-BW1 was described as a reliable monitoring well for background water quality.

Figure 9 shows that the contaminant detection monitoring well MWL-MW2 was located 100 feet north of the northern boundary of trenches at the MWL dump and cross-gradient to the southwest direction of groundwater flow below the MWL dump. The well MWL-MW2 was not usable as a contaminant detection monitoring well because of 1). the location 100 feet north of the northern boundary of trenches at the dump; 2). the mud-rotary drilling method; 3). the corrosion of the stainless steel well screen beginning in 1992 [43]**;** and 4). the high-flow pumping method that purged the well to dryness with collection of water samples up to a week later. The NMED HWB did not require replacement of the defective and unusable contaminant detection monitoring well MWL-MW2 until 2008. At the time of the NMED December 2004 Public Hearing and at the time of the NMED 2006 Moats Report, the defective monitoring wells MWL-MW2 was described as a reliable hydraulically downgradient monitoring well for the detection of groundwater contamination from the MWL dump.

The NMED 2006 Moats Report evaluation of the water quality data from monitoring well MWL-MW5 was also meaningless because the screen was installed too deep below the water table to monitor groundwater contamination at the water table. The deep location of the screen in well MWL-MW5 is displayed on Figure 7. Well MWL-MW5 is unusable for any purpose because the well screen is installed in two zones of saturation and the screened interval is contaminated with bentonite clay/cement grout. The NMED HWB has not enforced the requirement in the NMED 1998 NOD Report [10] and the 2004 NMED Sandia Consent Order [1] for replacement of the defective monitoring well MWL-MW5. This bentonite clay/cement grout contamination in well MWL-MW5 is discussed below in Section 9.2.

The NMED 2006 Moats Report [31] violated RCRA by omission of the other substantive factors for why the seven defective monitoring wells at the MWL dump were not usable as a network of monitoring wells for the May 26, 2005 Final Order [46] by NMED Secretary Ron Curry for DOE/Sandia to leave the toxic commingled hazardous and radioactive wastes in the Sandia MWL dump below a dirt cover. Six reports in the NMED Administrative Record (AR) contradict the conclusion in the 2006 Moats Report that there was a reliable network of monitoring wells at the MWL dump for the NMED decision to install the dirt cover over the MWL dump. The six reports were written over the years from 1991 to 1998 and describe the extensive defects and requirement to replace the seven monitoring wells that were used for the NMED Final Order to install the dirt cover over the MWL dump. The six reports are summarized in Section 5.

9.1. The NMED 2006 Moats Report did not consider many important factors for why the seven monitoring wells at the Sandia MWL dump were defective and required replacement. The many factors known to the NMED staff who wrote the NMED November 2006 Moats Report [31] for why the network of seven monitoring wells at the Sandia MWL dump were defective and required replacement are summarized as follows:

- Incorrect monitoring well locations; the four monitoring wells MWL-MW2, -MW5, -MW6 and -BW1.

- Incorrect well screen locations; the three monitoring wells MWL-MW4, -MW5 and -MW6.

- Corrosion of the stainless steel well screens beginning in 1992 [43]**;** the four monitoring wells MWL-MW1, -MW2, -MW3 and -BW1.

- Absence of an upgradient background water quality monitoring well; monitoring well MWL-BW1 was located 500 feet south of the MWL dump and cross-gradient to the southwest direction of groundwater flow.

- Existence of only one downgradient monitoring well; monitoring well MWL-MW3.

- Well screens allowed cross-contamination between different zones of saturation and did not monitor contamination at the water table; monitoring wells MWL -MW4 and -MW5.

- The use of improper high-flow purge to dry sampling methods; the five monitoring wells MWL-MW1, -MW2, -MW3, -MW4 and -BW1.

- Screened intervals contaminated with bentonite clay drilling muds from the mud-rotary drilling method; the three monitoring wells MWL-MW2, -MW3 and -BW1.

- Screened interval contaminated with bentonite clay/cement grout because of a mistake in constructing the well; monitoring well MWL-MW5.

Failure to consider the factors listed above demonstrates lack of regulatory and scientific basis for the NMED November 2006 Moats Report [31] and requires NMED retraction of the Moats Report for the serious omissions. <u>The conclusions in the NMED 2006 Moats Report are no more rigorous than an evaluation based only on **smelling** the groundwater samples from the Sandia MWL dump monitoring wells.</u>

9.2. The NMED 2006 Moats Report evaluation methodology was rejected by the Environmental Protection Agency and the National Research Council. For the four monitoring wells evaluated in the 2006 Moats Report, the mud-rotary monitoring well MWL-MW3 was the only well at a location that could detect groundwater contamination from the MWL dump. In addition, the study of only the chemistry of groundwater samples collected from well MWL-MW3 could not determine that the water quality data were reliable and representative and not impacted by the bentonite clay and organic additives in the drilling muds. The assessment methodology in the Moats Report to determine water quality impacts from the bentonite clay was without merit and rejected by the scientific community including the Environmental Protection Agency (EPA) National Risk Management Research Laboratory **–** Ground-water Restoration Division (the EPA Kerr Lab) and the National Research Council (NRC).

The methodology used in the NMED November 2006 Moats Report [31] was modeled after the methodology used in similar studies at the Los Alamos National Laboratory (LANL). The pertinent excerpt from the Moats Report follows:

> **Data analysis method.** For this study, NMED has modified an effective method utilized by LANL in a similar investigation of the quality of LANL groundwater monitoring data (LANL, 11/2005 [i.e., The November 2005 LANL *Well Screen Analysis Report* (WSAR)]) (p. 2)..

The NMED November 2006 Moats Report [31] ignored the fact that the EPA Kerr Lab previously issued one report in September of 2005 [19] and two reports in February of 2006 [20, 21] that rejected the assessment method in the November 2005 LANL WSAR Report [55]**.** The assessment method used in the LANL WSAR Reports was also rejected in the 2007 Final Report [56] by the National Research Council (NRC) on the LANL groundwater protection practices. In addition, an April 2009 Report [22] from the EPA Kerr Lab also rejected the assessment method in the revised version of the LANL WSAR report that was issued in May of 2007 [57]**.**

The pertinent excerpt from the EPA Kerr Lab Report of September 30, 2005 [19] follows:

> Due to uncertainties in the utility of aqueous chemistry assessments for the determination of whether [groundwater] samples are fully representative of aquifer conditions, it is recommended that field studies be designed to validate these or similar criteria (p. 7).

The NMED 2006 Moats Report did not include any field studies. The report was solely based on an unscientific study of the chemistry of the water samples collected from the four defective monitoring wells MWL-MW2, -MW3, -MW5 and -BW1.

Prior to the issuance of the November 2006 Moats Report, the EPA Kerr Lab Report issued on February 10, 2006 [20] compared the suitability of using water quality data alone to the futility of trying to determine the temperature of a glass of water by looking at it:

> Relative to addressing the question of whether ground-water samples are representative of the undisturbed aquifer chemistry, water quality data alone provide an unreliable indication of whether there is sustained impact to sediment sorption characteristics. The margin of error of determining, through measurements of water chemistry, what sediment minerals exist at any given point in time at a well screen is comparable to the level of uncertainty in estimating the temperature of a glass of water solely through visual observations (p. 4).

The EPA Kerr Lab Report of February 10, 2006 stated further:

> With respect to screens where bentonite-based additives were used, it is possible that even trace amounts of residual bentonite that remain following development may render ground-water samples non-representative for highly sorbing constituents [Emphasis supplied]. This situation would be difficult to accurately characterize. Therefore, the quality of samples for constituents such as isotopes of americium, cerium, plutonium, and radium obtained from these screens will likely remain uncertain even after re-development (p.7).

The conclusion in the 2007 Report [56] by the National Research Council (NRC) – "*Plans and Practices for Groundwater Protection at the Los Alamos National Laboratory, Final Report*" was also that the study only of water chemistry data could not determine that monitoring wells contaminated with bentonite clay provide reliable groundwater samples. Like the EPA Kerr Lab, The NRC also recommended additional laboratory and field investigations to better determine the nature and evolution of the interactions between the drilling additives such as bentonite clay, well construction, and aquifer materials; quantify sorption parameters; and to validate the accuracy of the conclusions developed only from the study of only the water quality data.

The NMED did not require DOE/Sandia to perform the additional laboratory and field studies recommended by both the NRC and the EPA Kerr Lab. Such field studies would include 1. installation of a new monitoring well with a nonmetallic PVC well screen close to the location of well MWL-MW1 for comparison of water quality data from the PVC screen to the water quality data from the corroded stainless steel screen in well MWL-MW1 and 2). comparison of water quality data from a new monitoring well located close to the mud-rotary well MWL-MW3 which also had a corroded stainless steel well screen.

The borehole for the new well would be drilled without bentonite clay or organic drilling additives. The new well would be installed with a PVC screen and groundwater samples would be collected with low-flow purging and sampling methods.

The incorrect conclusion in the NMED November 2006 Moats Report [31] was that the three mud-rotary monitoring wells MWL-BW1, -MW2 and -MW3 produced reliable and representative groundwater samples for the detection of groundwater contamination from the MWL dump. The pertinent excerpt from the Moats report follows;

> Evaluation of groundwater analytical data from MWL mud rotary well samples confirms that these data are not compromised. Therefore, none of the data examined is assigned a qualifying data flag. This study further shows that there are no bentonite drilling mud components that adversely affect sample chemistry in groundwater samples from the mud rotary wells, that there is no evidence of adsorption of groundwater contaminants (p. 10).

In addition, the incorrect conclusion in the NMED 2006 Moats Report was that the monitoring well MWL-MW5 produced reliable and representative groundwater samples for the detection of groundwater contamination from the MWL dump. The pertinent excerpt from the Moats report follows;

> This study further shows that . . . . . . [the bentonite clay/cement] grout contamination was adequately removed from ARCH well MW5 before the well was placed into service (p. 10).

However, read against the conclusions in the EPA Kerr Laboratory Reports and the Final Report from the NRC, the staff of NMED knew the conclusions in the NMED November 2006 Moats Report [31] had no scientific validity when issued to the public.

The other factors for why the conclusions in the 2006 Moats Report about the three mud-rotary monitoring wells MWL-MW2, -MW3 and -BW1 are incorrect are that

– 1). the two mud-rotary wells MWL-MW2 and -BW1 were not usable as monitoring wells because they were at locations in the wrong direction and too great a lateral distance from the dump,

– 2). all three mud-rotary wells did not produce reliable and representative water samples because the stainless steel well screens were corroded beginning in 1992 [43] (the properties of corroded screens to prevent the detection of groundwater contamination are discussed in Section 9.6), and

– 3). all three mud-rotary monitoring wells did not produce reliable and representative groundwater samples because of the improper high-flow purge-to-dry sampling methods. The properties of the high-flow sampling methods to prevent the detection of groundwater contamination are discussed in Section 9.7.

– The NMED 2006 Moats Report did not recognize or evaluate the effects of the three above factors to prevent the three mud-rotary monitoring wells from being able to detect the groundwater contamination from the wastes buried in the MWL dump.

The conclusion in the NMED November 2006 Moats Report [31] that well MWL-MW5 was a reliable monitoring well for detection of groundwater contamination below the MWL dump is incorrect because 1). well MWL-MW5 was installed to monitor contamination at the water table but the screen was installed too deep below the water table and 2). the screen allowed cross-flow of ground-water across two zones of saturation; the fine-grained alluvial fan sediments and the deeper ARG Deposits. The deep location of the screen in well MW5 and across the two zones of saturation is displayed on Figure 7. The large amount of bentonite clay/cement grout that contaminated the screened interval is an additional reason well MWL-MW5 is not usable as a monitoring well.

The NMED Sandia Consent Order issued on April 29, 2004 [1] requires replacement of monitoring wells such as well MWL-MW5 that are installed across two zones of saturation. The pertinent excerpt from Section VIII.A of the Consent Order follows:

> Groundwater monitoring wells and piezometers must be designed and constructed in a manner that will yield high quality, representative samples. Each well or piezometer must be constructed such that it will last the duration of the planned monitoring need (i.e., last long enough to gather enough samples for purposes of establishing concentration trends for Contaminants or potential Contaminants; determining if releases from SWMUs or AOCs will impact groundwater; monitoring post VCA, VCM, or corrective measure activities to ensure efficacy; and monitoring for post-closure care). <u>In the event of a well or piezometer failure, or if a well or piezometer is any way no longer usable for its intended purpose, it must be replaced with an equivalent well or piezometer</u> [Emphasis supplied]. In constructing a well or piezometer, Respondents shall ensure that the well or piezometer will not serve as a conduit for Contaminants to migrate between different zones of saturation (p. 63).

The NMED HWB is not enforcing the NMED Sandia Consent Order [1]. Monitoring well MWL-MW5 violates the requirements in the NMED Consent Order. The Consent Order requires replacement of the defective monitoring well. The NMED November 2006 Moats Report did not describe the requirement in the 2005 Consent Order for replacement of the defective monitoring well MWL-MW5.

Instead, Figure 8 shows that the defective monitoring well MWL-MW5 remains in the current network of six defective monitoring wells continuing to provide unreliable data in DOE/Sandia reports that are accepted by NMED in violation of the Consent Order and RCRA. The DOE/Sandia 2007 proposed Long-Term Monitoring and Maintenance Plan Report [4] shows that DOE/Sandia intend to use the defective monitoring well MWL-MW5 as a long-term monitoring well.

<u>After all factors are considered, the evaluation and conclusions in the NMED November 2006 Moats Report [31] for the chemistry of the water samples taken from the improperly located monitoring wells MWL-MW2 and -BW1 and from the improperly placed screen in well MWL-MW5 are as irrelevant as if the water samples were taken from monitoring wells on the moon.</u>

9.3. The NMED November 2006 Moats Report studied the median concentrations of the water quality data. The NMED HWB made the unscientific claim that the assessment methodology in the NMED November 2006 Moats Report [31] was a **"<u>major enhancement</u>"** of the methodology used in the LANL WSAR Reports because the Moats Report assessment was based on the median concentration values for the entire data set from each well for any specific analyte. The pertinent excerpt from the NMED 2006 Moats Report follows:

> An additional modification to the LANL process is the use of the median concentration values from the entire data set for any specific analyte where possible. This is a major enhancement of the LANL process, as use of median values allows for assessment of the reliability and representativeness of the *entire* data set for the subject wells, while discounting the effects of extreme (*i.e.*, very high or low) data values (p. 5).

The use of the median concentrations was a mistake because the study of median concentrations prevented the detection of groundwater contamination. The study of the entire range of the water quality data is essential. Careful attention to the high and low data values is very important. The best study of water quality data is a study of the range over time from the first to the most recent sampling events of measured dissolved concentrations of a given analyte in all of the water samples collected from each monitoring well. But this standard industry practice was not followed in the badly flawed unscientific NMED November 2006 Moats Report [31].

9.4. The NMED 2006 Moats Report did not study the dissolved constituents in the groundwater samples collected from the MWL dump monitoring wells. Another major problem that prevented the study of the water samples collected from the defective monitoring wells at the Sandia MWL dump from being of any use is that only a small number of the water quality data were from groundwater samples that were filtered to determine the dissolved concentrations of the analytes. The NMED November 2006 Moats Report [31] was for unfiltered water samples (i.e., total concentrations) and the Moats Report did not consider the turbidity of the unfiltered water samples. The pertinent excerpt from the 2006 Moats Report follows:

> The NMED further modified the LANL process by evaluating total, rather than dissolved metal concentrations. With the exception of dissolved zinc, generally no more than four analyses for any dissolved metals analyte exist. Use of total metal concentrations could overestimate the effect of desorption and Fe/Mn reducing conditions, thus producing overly conservative assessments. On the other hand, use of the total metal concentrations could under-estimate the effect of adsorption if the turbidity of a sample appreciably exceeds 5 NTU (p. 6+7).

The sparse data available for dissolved concentrations in the groundwater samples collected from the MWL dump monitoring wells was another important reason that the NMED HWB should not have performed the evaluation of the water quality data that was published in the NMED November 2006 Moats Report [31]. Lack of data on dissolved constituents is another factor that renders the conclusions in the Moats Report as useless.

9.5. The NMED November 2006 Moats Report used unreliable and inaccurate background water quality data. The reports from the EPA Kerr Lab described the importance for the assessment of water quality data from reliable downgradient contaminant detection monitoring wells to be compared to accurate water quality data from a reliable background monitoring well that was installed at the water table at an appropriate location hydraulically upgradient of the Sandia MWL dump. Reliable water quality data from background monitoring wells is a requirement of RCRA. The pertinent excerpt from the February 16, 2006 EPA Kerr Lab Report [21] follows:

> **Issues regarding the strong reliance on uncertain background conditions.** Actual background values at the locations of the individual characterization well screens may be significantly different from the proposed values [in the regional background report]. Therefore, the strong reliance on these uncertain background conditions for the evaluation of the impacts of residual drilling additives increases the uncertainty in these assessments (p. 3).

The March 30, 2009 report from the EPA Kerr Lab [22] described the important need for background groundwater chemistry data from a monitoring well installed at an appropriate location upgradient of the Sandia MWL dump as follows:

> **Upgradient Well Installations.** Install wells immediately upgradient of the regulated units [i.e., Sandia MWL dump] of most concern, screening intervals equivalent to those of monitoring wells located downgradient of the regulated units. If such wells were installed without the use of harmful drilling additives in the screened zone, the data should be useful in better defining pre-drilling conditions within the particular hydrostratigraphic units of interest (p. 5).

No reliable background water quality monitoring well was installed at the Sandia MWL dump until 2008 [37]**.** Because no background monitoring well was installed immediately upgradient of the MWL dump, the NMED 2006 Moats Report [31] used the water quality data in two regional reports for distant monitoring wells and supply wells at Kirtland Air Force Base. The pertinent excerpt from the 2006 Moats Report follows:

> Background hydrochemistry, which is used for comparison purposes with corresponding data from the monitoring wells, is taken from a comprehensive study of background groundwater quality throughout the area encompassed chiefly by Kirtland Air Force Base (KAFB), which includes the SNL research facilities (Moats and Winn, 01/1995). Only uranium concentration data are taken from a separate background study (IT Corporation, 03/1996). (p. 5).

The NMED November 2006 Moats Report [31] also used the water quality data from the defective monitoring well MWL-MW1 as representative of background water quality. Well MW1 was not installed at an appropriate location for background water quality monitoring. The use of the water quality data for well MWL-MW1 to represent background water quality is unacceptable because the corroded well screen and the high flow purge-to-dry water sampling method prevented the well from producing reliable and representative groundwater samples. In addition, the groundwater samples collected from the well indicate that the groundwater at the location of well MWL-MW1 is contaminated with cadmium, chromium, nickel and nitrate from the wastes buried in the MWL dump. The groundwater contamination is discussed in Section 9.8.

The use of unreliable and unrepresentative background information in the NMED November 2006 Moats Report [31] is caused because no background monitoring well was installed upgradient of the MWL dump until 2008. The reliance on incorrect background water quality data is another reason the conclusions in the NMED 2006 Moats Report are incorrect and the NMED is required to retract the report. The background water quality data used in the Moats Report are now known to be incorrect because of the background water quality data from the new upgradient background monitoring well MWL-BW2 that was installed in 2008.

9.6. Four of the monitoring wells at the Sandia MWL dump had corroded stainless steel screens. The corroded screens prevented the detection of groundwater contamination. The NMED November 2006 Moats Report [31] acknowledged that the stainless steel screen in the MWL dump monitoring well MWL-MW1 was corroded. The 2006 Moats Report made a mistake to conclude that the four wells with corroded screens (i.e., wells MWL-MW1, -MW2, -MW3, and -BW1 produced reliable and representative groundwater samples. It is well known in the technical literature that corrosion prevents monitoring wells from producing water samples that are reliable for detection of many contaminants of concern for the wastes buried in the MWL dump. The properties of corroded stainless steel well screens to prevent the detection of groundwater contamination are described below in this section.

The September 18, 2006 NMED NOD Letter [58] for the 2005 LANL WSAR Report [55] shows that the staff in the NMED HWB were aware of the need to replace monitoring wells that had corroded stainless steel well screens. The pertinent excerpt from the NMED LANL NOD letter [58] is pasted below:

> The Permittees must evaluate physical damage to, and corrosion of, all well screens. This evaluation is also an important part of the well screen analysis to determine whether a screen can produce water samples representative of formation water (p. 3).

The corroded stainless steel well screens in monitoring wells at LANL and at the Sandia MWL dump are an example of the arbitrary and inconsistent regulatory practice by the NMED HWB at LANL and at Sandia. The position of DOE/LANL was that corrosion of the stainless steel screens was responsible for the high concentrations of chromium and nickel that were measured in the water samples produced from screens #1 and #2 in the LANL multiple-screen monitoring well R-25. However, in a Letter dated April 5, 2007 [59], the NMED HWB described the claim of DOE/LANL that screen corrosion was responsible for the high levels of chromium and nickel as "speculation". In the NMED letter dated April 5, 2007, the NMED HWB ordered installation of two new single-screen monitoring wells at locations close to well R-25 with the screens targeting equivalent intervals to the corroded screens #1 and #2 in the defective LANL monitoring well R-25.

The corroded stainless steel screens in monitoring wells MWL-MW1, -MW2, -MW3 and -BW1 were not identified by the NMED HWB at the NMED December 2004 Public Hearing [43] or in the NMED November 2006 Moats Report [31] as a reason the four wells did not produce reliable and representative water samples. The NMED HWB did not require DOE/Sandia to replace the four defective monitoring wells with corroded stainless steel screens at the Sandia MWL dump until 2008.

The NMED 2006 Moats Report erroneously reported water quality data from monitoring well MWL-MW1 as being representative of background water quality. Table 3 and Figure 18 show the very high nickel concentrations measured in the groundwater samples collected from well MWL-MW1. The other contaminants detected in the groundwater samples collected from well MWL-MW1 include cadmium, chromium and nitrate, The groundwater contamination from the MWL dump is discussed below in Section 9.8, The 2006 Moats Report did not consider the well known properties of corroded stainless steel well screens to mask the detection of groundwater contamination from many of the contaminants of concern that were known to be buried in the MWL dump including beryllium, cadmium, chromium, lead, nickel and the organic solvents PCE and TCE.

The conclusion in the NMED November 2006 Moats Report that the high nickel concentrations measured in the water samples collected from wells MWL-MW1 and -MW3 were only from the corrosion of the stainless steel well screens is unverifiable and a violation of RCRA and the NMED Sandia Consent Order [1]**.** The pertinent excerpt from the NMED 2006 Moats Report [31] is pasted below:

> In addition, the concentration of total nickel in MW1 groundwater samples has shown a marked increase over time (see Figure 6) [see Figure 18 and Table 3 in this report]. <u>This is inferred to indicate progressive corrosion of the stainless steel well screen in this well</u> [Emphasis supplied] (p. 7),

The NMED November 2006 Moats Report [31] ignored the conclusion in the 1998 NMED NOD Report[10] that the high nickel concentrations measured in the water samples collected from wells MWL-MW1 and -MW3 were from the nickel wastes buried in the MWL dump. The unsupported speculation in the Moats Report that the high nickel concentrations in the groundwater samples were only from the corrosion of the stainless steel screens is contradicted by the 1998 NMED NOD Report of which Moats was well aware. The pertinent excerpt from the 1998 NMED NOD Report [10] follows:

> DOE/SNL must support their position on a technical basis that the elevated nickel levels detected in groundwater samples from monitor well MWL-MW1 (and MWL-MW3) are a result of the corrosion of 304 stainless steel well screen; otherwise, such elevated levels of nickel will be attributed to a release of contaminants from the landfill (p. 3).

The best interpretation of the available data is that the nickel, cadmium, chromium and nitrate wastes in the MWL dump have contaminated the groundwater below the dump. The NMED 1998 NOD Report [10] described the fact that the core samples collected from below the MWL dump identified the release of nickel and cadmium from the wastes buried in the MWL dump . The nickel groundwater contamination issue is discussed below in Section 9.8 and also in Section 8. The nature and extent of the groundwater contamination from the MWL dump is not known because the required reliable networks of monitoring wells in the two zones of saturation were not installed at the MWL dump.

Monitoring well MWL-MW3 was the only downgradient monitoring well and one reason this well did not produce reliable and representative groundwater samples was because the stainless steel well screen was known to be corroded beginning in 1992. The corroded screens in wells MWL-MW1, -MW2, -MW3 and -BW1 were described in the

Hearing Officer's Report for the December 2004 Public Hearing [43]. The Finding Number 81 in the Hearing Officer's Report is pasted below:

> "81. Elevated levels of nickel and chromium have been detected since 1992 in MWL- MW1, MWL-MW2, MWL-MW3 and MWL-BW1, which wells are all constructed with stainless steel well screen. <u>NMED attributes these elevated levels to corrosion of the stainless steel well screens</u>" [Emphasis supplied].

The assumption that the elevated levels of nickel and chromium detected in the MWL dump monitoring wells are only from well screen corrosion is groundless speculation by the NMED HWB. As identified by the 1998 NMED NOD Report [10] and other DOE/Sandia Reports [2], nickel, chromium and cadmium are in the wastes buried in the MWL dump. The MWL dump is the most probable source for the nickel, chromium and cadmium groundwater contamination in the groundwater samples from monitoring wells MWL-MW1 and -MW3. DOE/Sandia reports [2] identify that 271,500 gallons of reactor coolant water containing hexavalent chromium was dumped in Trench D in the unclassified area of the MWL dump.

NMED should have required replacement of the four monitoring wells MWL-MW1, -MW2, -MW3, and -BW1 in the early 1990's because the corroded screens did not provide reliable and representative groundwater samples. In addition, as described above, the NMED HWB was well aware in the early 1990's of the requirement to replace wells MWL-MW2 and -BW1 because they were not at appropriate locations. The failure of the NMED to replace the four defective monitoring wells and to continue acceptance and reliance on the unreliable water quality data for more than a decade and then knowingly present the bogus data to support the dirt cover remedy was not protective of public health and the precious groundwater resource.

The NMED Sandia Consent Order [1] (p.63-64) requires that "The design and construction of groundwater monitoring wells and piezometers <u>shall comply</u> with the guidelines established in EPA guidance, including, but not limited to:

- U.S. EPA, *RCRA Groundwater Monitoring: Draft Technical Guidance*, EPA/530-R-93-001, Nov. 1992. [The EPA RCRA Manual].

The EPA RCRA Manual [11] presents findings that stainless steel screens are inappropriate for the contaminants of concern at the MWL dump as follow:

> "The presence of corrosion products represents a high potential for the alteration of ground-water sample chemical quality. The surfaces where corrosion occurs also present potential sites for a variety of chemical reactions and adsorption. <u>These surface interactions can cause significant changes in dissolved metal or organic compounds in ground-water samples</u>" [emphasis supplied] (p. 6-30).

> "Monitoring well casing and screen materials should not chemically alter ground-water samples as a result of their sorbing, desorbing, or leaching analytes, especially with respect to the analytes of concern. <u>If a casing [or well screen] material sorbs selected constituents from the ground water, those constituents either will not be present in any water quality sample or the concentration of constituents will be reduced</u>" [Emphasis supplied]. (p. 6-24).

The contaminants of concern at the MWL dump include metals and organics. The EPA RCRA Manual describes the importance to avoid corroded stainless steel well screens when monitoring for metals and organics.

The measurement of cadmium in soil cores and groundwater below the Sandia MWL dump is proof of a release of cadmium from the buried wastes. The repeated detection of cadmium in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 is evidence of groundwater contamination from the cadmium wastes released from the MWL dump. The cadmium contamination repeatedly measured in the groundwater samples collected from the monitoring wells MWL-MW1 and -MW3 is discussed in Section 9.8.3. The corroded stainless steel screens in wells MWL-MW1 and -MW3 had strong properties to mask the detection of the cadmium contamination in the in situ groundwater in the unreliable groundwater samples collected from the defective monitoring wells.

The sorption of cadmium by corroded stainless steel well screens is described in the journal article by Hewitt (1994) [60]**.** The pertinent excerpt from the Hewitt paper is pasted below:

> "Common stainless steel well screens significantly affect solution metal concentrations under dynamic conditions consistent with typical groundwater sampling protocol. The magnitude of the influence appears directly correlated with the presence of corrosion products on stainless steel screens, and concentrations of Nickel (and perhaps chromium) could approach those that would affect regulatory compliance. <u>Along with leaching, surface corrosion also causes significant sorption losses for metals such as lead and cadmium</u> [emphasis supplied] (p. 94).

The nature and extent of cadmium (and lead) contamination in the groundwater at the water table below the Sandia MWL dump is not known because monitoring wells MWL-MW1 and MW3 are the only monitoring wells at locations that can detect groundwater contamination at the water table and the stainless steel screens in the two wells became corroded beginning in 1992 [43]**.** The NMED November 2006 Moats Report [31] did not evaluate the ability of the corroded screens to provide accurate water quality data for trace metal contaminants from the MWL dump including cadmium and lead. <u>Instead, the NMED 2006 Moats Report made the unscientific and incorrect conclusion that the cadmium repeatedly measured in the groundwater samples produced from the two wells indicated the wells produced reliable and representative water samples.</u>

The NMED November 2006 Moats Report [31] made a mistake to consider the trace metal cadmium as a natural background constituent in the *in situ* groundwater. In fact, cadmium is not detected in the *in situ* groundwater as shown by the groundwater samples collected from the new background water quality monitoring well MWL-BW2 (see Section 9.8.3). The NMED 2006 Moats Report did not recognize that the repeated measurement of cadmium in the groundwater samples produced from the two monitoring wells MWL-MW1 and -MW3 was evidence of groundwater contamination from the MWL dump. The corroded screens in the two wells and the high-flow purge-to-dry sampling method prevented accurate knowledge of the nature and extent of the cadmium groundwater contamination at the location of the two monitoring wells. An additional factor that prevented the detection of cadmium in the groundwater samples collected from well MWL-MW3 was the bentonite clay contamination from the mud-rotary drilling method.

Because there was no upgradient background monitoring well at the Sandia MWL dump until 2008, the NMED 2006 Moats Report relied on the Kirtland AFB regional background value for cadmium [44] of 0.47 ug/L and the cadmium concentrations measured in the MWL dump monitoring well MWL-MW1. Those "background values" are now known to be unreliable because the water quality data from the hydraulically upgradient background monitoring well MWL-BW2 shows non-detection for cadmium in the groundwater at the water table in the fine-grained alluvial fan sediments. Cadmium was not detected in seven groundwater samples collected from well MWL-BW2 at a very low limit of detection of 0.1 ug/L. This is evidence under RCRA criteria that the cadmium measured repeatedly in the groundwater samples collected from wells MWL-MW1 and -MW3 is cadmium contamination from the MWL dump. The cadmium groundwater contamination from the MWL dump is described farther below in Section 9.8.3.

9.7. The use of high-flow purging and sampling methods to collect groundwater samples several days later from the Sandia MWL dump monitoring wells prevented the detection of groundwater contamination from the wastes buried in the dump. The high-flow purging and sampling methods that were used to produce water samples from the five MWL dump monitoring wells MWL- BW1, -MW1, -MW2, -MW3 and the upper screen in well MWL-MW4 are another factor that prevented the collection of reliable and representative water samples. These sampling methods are well known to strip contaminants of concern, especially volatile organic solvents and trace metals from the collected groundwater samples.

– The NMED December 2004 Public Hearing and the NMED 2006 Moats Report did not describe or evaluate the well known effects of the improper high-flow purging and sampling methods to prevent the MWL dump monitoring wells from producing reliable and representative groundwater samples. Table 4 below lists the rate at which groundwater was purged from the MWL dump monitoring wells with the high-flow Bennett[R] pumping system. The high-flow pumping rate varied from 1.55 to 4.01 liters per minute.

The improper and unnecessary high-flow purging and sampling methods that were used over all time to sample the MWL dump monitoring wells are described in the DOE/Sandia 2006 annual report [61] for groundwater sampling activities at the MWL dump in 2005 . The pertinent excerpt from the report is pasted below:

> Prior to sample collection, each monitoring well was purged to remove stagnant well casing water. Most MWL monitoring wells recharge slowly, and multiple days were required to purge and sample these wells. <u>The monitoring wells were purged to dryness, allowed to recover, and then sampled to collect the most representative groundwater sample possible, given the low yields of these wells</u> [Emphasis supplied] (p.15).

The low yields of the monitoring wells that were installed in the fine-grained alluvial fan sediments is because of factors that include the effects of the mud-rotary and air-rotary casing hammer (ARCH) drilling methods to lower the yield of groundwater from the wells and the effects of the repeated use of high-flow pumping methods to lower the yield of groundwater from the wells.

Table 4. Pumping data for the four monitoring wells at the SNL MWL dump with screens across the water table in the fine-grained alluvial fan sediments.

Well No.	Date Purged	Date Sampled	Pumping Rate (liter/min)	Pumping Period (minutes)	Volume Pumped (gallons)	Volume in Screen (gallons)	Was Well Pumped Dry?
- BW1	01/24/91	Same	3.71	56	55	16.5	No
- BW1	05/07/91	Same	2.91	107	82	16.5	No
- BW1	08/06/91	Same	2.42	134	86	16.4	No
- BW1	10/16/91	Same	1.74	163	75	16	No
- BW1	04/28/94	?	1.74	78	36	< 16	Yes
- BW1	04/08/05	04/15/05	?	?	12.5	?	Yes
- BW1	04/04/06	04/18/06	?	?	8	?	Yes
- MW1	01/24/91	Same	3.89	68	70	20.2	No
- MW1	05/07/91	Same	2.42	119	76	20.3	No
- MW1	07/31/91	Same	3.60	77	73	18.8	No
- MW1	10/15/91	Same	1.97	163	84	19	No
- MW1	05/31/94	?	1.78	88	41	< 19	Yes
- MW1	04/04/05	04/11/05	?	?	33	?	Yes
- MW1	04/05/06	04/12/06	?	?	34	?	Yes
- MW1	04/04/07	04/05/07	?	?	16	?	Yes
- MW2	01/28/91	Same	3.63	54	52	23.8	No
- MW2	05/02/91	Same	3.29	90	78	23.8	No
- MW2	08/01/91	Same	1.67	123	54	21.9	No
- MW2	10/14/91	Same	2.57	80	54	22	No
- MW2	04/29/94	?	2.54	52	35	< 22	Yes
- MW2	04/05/05	04/12/05	?	?	23	?	Yes
- MW2	04/03/06	04/10/06	?	?	20	?	Yes
- MW2	04/02/07	04/06/07	?	?	12	?	Yes
- MW3	01/28/91	Same	4.01	33	35	18.3	No
- MW3	05/02/91	Same	2.91	58	45	19.1	No
- MW3	08/05/91	Same	3.79	63	63	17.6	No
- MW3	10/15/91	Same	2.23	61	36	20	No
- MW3	04/29/94	?	2.20	40	23.2	< 20	Yes
- MW3	04/07/05	04/13/05	?	?	14	?	Yes
- MW3	04/07/06	04/13/06	?	?	13	?	Yes
- MW3	04/03/07	04/11/07	?	?	9	?	Yes
- BW2	03/13/08	Same	1.55	360 (6 hours)	150	42	No
- BW2	10/06/09	Same	?	?	39	?	No

* All data are from the New Mexico Environment Department Administrative Record or DOE/Sandia Reports.

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Table 4 shows that during the high-flow pumping events in 1991, all four monitoring wells installed at the water table in the fine-grained alluvial fan sediments produced a sufficient flow of groundwater for water samples to be collected without purging the wells to dryness. The high-flow pumping rates used for sampling the four wells in 1991 ranged from 3.63 to 4.01 liters per minute for the January 1991 sampling event. However, the high-flow pumping rates were markedly lower for the four wells for the October 1991 sampling event and ranged from 1.74 to 2.97 liters per minute.

- The progressive decline in the flow rates of groundwater from the four wells over time for the sampling events in 1991 is evidence of the damage caused by the unnecessary high-flow pumping and sampling methods.

- The high-flow pumping methods were unnecessary because the pumping was performed with Bennett[R] air-piston submersible pumps that can be operated at flow rates as low as 0.1 L/min (liters per minute) [29]. The low-flow capability of the Bennett[R] sampling pumps is described in Appendix C.

The EPA RCRA Draft Technical Enforcement Guidance Document (the EPA RCRA Manual) [11] describes the importance for monitoring wells to be purged at low flow rates between 0.2 to 0.3 liters per minute. The pertinent excerpts from the EPA RCRA Manual follow:

> The owner/operator should ensure that purging does not cause formation water to cascade down the sides of the well screen. At no time should a well be purged to dryness if recharge causes the formation water to cascade down the sides of the screen, as this will cause an accelerated loss of volatiles. This problem should be anticipated; water should be purged from the well at a rate that does not cause recharge water to be excessively agitated. <u>Laboratory experiments have shown that unless cascading is prevented, up to 70 percent of the volatiles present could be lost before sampling</u> [emphasis supplied] (p. 7-8).
>
> Purging should be accomplished by removing ground water from the well at low flow rates using a pump. The rate at which ground water is removed from the well during purging ideally should be less than approximately <u>0.2 to 0.3 liters per minute</u> [emphasis supplied] (p. 7-8).

Table 4 shows the high-flow pumping rates that were used to purge the monitoring wells dry and collect groundwater samples from one day to a week later of the highly aerated groundwater that refilled the wells. The high-flow pumping rates range from 1.55 to 4.01 liters per minute and are from 5 to 20 times above the low-flow pumping rates recommended in the EPA RCRA Manual.

The large and regular decline in the rate of high-flow pumping for the four sampling events for the four monitoring wells in Table 4 is evidence of the damage caused by the high-flow pumping to reduce the yield of groundwater in all four monitoring wells. The damage caused by high-flow pumping with excessive drawdown of water levels in monitoring wells is described in a position paper [62] published by the NMED HWB in 2001. The pertinent excerpts from the position paper are pasted below:

> **High Flow Rate Sampling:** Evacuation of water from the screened interval of a monitoring well at a rate that significantly exceeds natural flow through the screen (Barcelona, Wehrman, and Varljen, 1994) or the groundwater flow velocity for which the well was designed. High pumping rates of groundwater from the monitoring well may cause undue stress on the well screen or sand pack, shorten the usability and life span of the well, cause excessive turbidity, or may cause other damage to well construction (p. 3).

> Low-flow purging and sampling rates generally range from 0.1 to 1.0 liter per minute (**L/min**) using a pump. Steady-state drawdown in the casing should occur if the pumping rate is sufficiently slow. Drawdown should be kept to a minimum [Emphasis supplied]. For wells that recharge at a rate insufficient for the use of low-flow purging and sampling, another method must be used. Employing a lower pumping rate is an attempt to approach natural flow conditions in the formation surrounding the well and produce a less turbid and more representative groundwater sample (p. 4).

Care was not taken to keep drawdown to a minimum during the groundwater sampling events in the MWL dump monitoring wells. The Bennett[R] sampling pumps could have been adjusted with a simple flow valve [29] to achieve the required low-flow purging and sampling of groundwater from the MWL dump monitoring wells in order to keep the drawdown of water levels to a minimum and avoid purging the wells to dryness.

Volatile organic contaminants (VOCs) including tetrachloroethene(PCE) and trichloroethene (TCE) are contaminants of concern for the wastes buried in the MWL dump. The high-flow pumping system that was used to collect groundwater samples from the MWL dump monitoring wells is an important reason for why the wells were pumped to dryness with water samples collected a week later from the highly aerated groundwater that slowly refilled the wells. Table 4 shows the common practice of purging the wells to dryness with collection of groundwater samples a week later. This routine sampling practice prevented the collection of reliable and representative groundwater samples for the highly toxic VOCs PCE and TCE that are contaminants of concern that are measured in the vadose zone below the MWL dump.

A 2003 Sandia report by Collins et al.[63] compared the analytical data for groundwater samples collected from four of the Sandia Facility monitoring wells for sampling events with high-flow and low-flow purging and sampling methods. None of the four wells were located at the MWL dump. The high-flow samples were collected with the Bennett[R] pump and the low-flow samples were collected with a bladder pump. Collins et al. (2003) [63] reported that for two of the wells, the measured concentrations of the solvents TCE and PCE dropped by more than an order of magnitude for water samples collected with the high-flow Bennett[R] pump compared to the samples collected with the low-flow bladder pump. As expected, the high-flow pumping was stripping solvents from the groundwater samples produced from the two wells. The pertinent excerpts from Collins et al. (2003) [63] are pasted below:

> PCE has been detected in Well TAV-MW7 at 5 – 7.5 micrograms/liter, except when the high-volume [Bennett[R] pump] system was used. TCE has been detected in Well TAV-MW7 at 4.4 – 6.1 micrograms/liter except when the high-volume [Bennett[R] pump] system was used. Thus, volatile organic compounds in groundwater at Wells TAV-MW7 and TAV-MW8 appear to be sensitive to the sampling system used (p. 7-8).
>
> PCE and TCE concentrations dropped an order of magnitude when the high-volume [Bennett[R] pump] system was used at Wells TAV-MW7 and TAV-MW8 respectively (p. 12).

The findings in the Sandia report by Collins et al (2003) [63] of the order of magnitude reduction in the measured concentrations of PCE and TCE in the groundwater samples for the two wells when the Bennett[R] high-flow pump was used to collect groundwater illustrates the improper use of the Bennett high-flow pump to collect water samples from the seven monitoring wells at the MWL dump. The defective monitoring well network at the MWL dump has provided no reliable information on the presence or absence of PCE and TCE groundwater contamination from the TCE and PCE wastes that are buried in the MWL dump.

The current EPA drinking water standard (DWS) maximum contaminant level (MCL) for PCE and TCE is 5 ug/L (5 micrograms/liter or 5 parts per billion). Concentrations of PCE and TCE above the current EPA DWS MCL may be in the groundwater below the MWL dump but have not been detected because of the unreliable network of monitoring wells. One factor is the high-flow Bennett[R] sampling system has reduced the solvent contamination by an order of magnitude or more in the high flow purge-to-dry and collect water samples a week later routine that was used to collect the groundwater samples from the monitoring wells. As described in Section 9.6, the corroded stainless steel well screens also had properties to reduce the amount of PCE and TCE in the groundwater samples collected from wells MWL-MW1 and -MW3.

- <u>The combination of the high-flow purge-to-dry sampling routine and the corroded stainless steel screens created a synergism that efficiently prevented the detection of the volatile solvent contaminants PCE and TCE in the groundwater samples collected from the only two MWL dump monitoring wells that were installed at locations that could detect groundwater contamination from the MWL dump (i.e., monitoring wells MWL-MW1 and -MW3).</u>

The Sandia report – *Probabilistic Performance-Assessment Modeling of the Mixed Waste Landfill at Sandia National Laboratories* (January 2007) (DOE/Sandia 2007 FTM Report [2]) identified that groundwater below the MWL dump is contaminated at the present time with the highly toxic solvent tetrachloroethene (PCE). There was great uncertainty in the assumptions used in the computer model and it is possible that the groundwater below the MWL dump is contaminated presently with PCE and TCE at concentrations above the EPA DWS MCLs of 5 ug/L. The required networks of monitoring wells that produce reliable and representative groundwater for the accurate detection of VOCs including PCE and TCE were not installed at the MWL dump.

A new concern is that USEPA announced plans in the **Federal Register** on March 29, 2010 [66] to revise the Federal Drinking Water Standards (DWS) for the carcinogens PCE and TCE. EPA plans to initiate a rulemaking in 2011 to revise the PCE and TCE DWS maximum contaminant levels (MCLs) to much lower concentrations than the current DWS MCLs of 5 ug/L. EPA indicates the DWS MCLs for PCE and TCE in groundwater may be set at 0.05 ug/L [66] – a reduction of 100 times from the current DWS MCLs of 5 ug/L for each VOC contaminant. EPA believes the revision of the DWS MCLs to the much lower concentrations will reduce public health risks from the two carcinogens PCE and TCE [66]**.**

The DOE/Sandia 2007 FTM Report [2] determined that the groundwater below the MWL dump is contaminated at this time with PCE at concentrations above 0.05 ug/L as follows:

- Figure 29 shows that 87% of the Monte Carlo simulations in the 2007 FTM Report [2] predict the groundwater below the MWL dump to be contaminated now with PCE at concentrations greater than 0.05 ug/L.
- Figure 29 shows that 59% of the Monte Carlo simulations in the 2007 FTM Report [2] predict the groundwater below the MWL dump to be contaminated now with PCE at concentrations greater than 0.5 ug/L.

– **The DOE/Sandia 2007 proposed Long-Term Monitoring and Maintenance Plan (LTMMP) [4] shows that DOE/Sandia understand the importance to use low-flow purging and sampling techniques for the collection of groundwater samples from the MWL dump monitoring wells.** The proposal to use low-flow purging and sampling methods in the LTMMP [4] is an important concession by DOE/Sandia because it is an admission that the routine use of the high-flow purge-to-dry sampling methods over the 20-year period from 1990 to 2011 were unnecessary and did not produce reliable and representative groundwater samples from the MWL dump monitoring wells. The importance to use low-flow purging and sampling techniques is described in Section 3.5.5 in the DOE/Sandia September 2007 LTMMP [4] as follows:

> 3.5.5 Transition to Low-Flow Purging and Sampling Techniques
> In order to obtain the most representative samples possible, the DOE/Sandia will use dedicated low-flow pumps and sampling techniques in MWL wells during long-term monitoring. Low-flow purging and sampling techniques are recommended for all MWL wells because the hydrogeologic environment is well suited for this type of groundwater sampling. In the past, low-flow sampling techniques have been successful at other sites across SNL/NM. However, on October 23, 2003, the NMED requested that all DOE/Sandia low-flow sampling (which the NMED termed “micropurging”) be ceased for all RCRA-compliant groundwater monitoring at SNL/NM (NMED October 2003).
>
> The low-flow purging method has been approved by the EPA (Puls and Barcelona 1996) and offers the following advantages over conventional sampling methods currently used at the MWL:
>
> - Low-flow sampling causes less well disturbance, minimizing the disturbance of the fine-grained sediments that have collected in the wells. As a result, samples collected using low-flow purging and sampling methods typically have lower sample turbidity and variability of sampling results.
> - Low-flow sampling minimizes the required purge volume by up to 95 percent, reducing the time and labor required for purging and sampling and minimizing waste.
> - Low-flow purging reduces problems related to excessive drawdown and pumped volumes.
> - Dedicated equipment for low-flow sampling saves field time and eliminates contamination from other wells and equipment handling.
>
> The NMED has issued a position paper, “Use of Low-Flow and Other Non-Traditional Sampling Techniques for RCRA Compliant Groundwater Monitoring” (NMED October 2001), which allows low-flow purging and

> sampling techniques to be used if the monitoring wells meet the Low-Flow Well Selection Criteria (described in the position paper).
>
> Low-flow purging and sampling techniques will be performed in accordance with the approach outlined in the NMED Position Paper and presented by the EPA (Puls and Barcelona 1996) (p. 3-29).

The EPA guidance paper (Puls and Barcelona 1996) [64] describes the importance to determine the appropriate low-flow purging and sampling rate at each monitoring well in order to minimize the drawdown in water level that occurs during the purging and sampling event. The pertinent excerpt from the 1996 paper by Puls and Barcelona is pasted below:

> Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. . . . Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min (p. 5).

<u>The improper and unnecessary "purge to dry" sampling methods that were routinely used in the MWL dump monitoring wells MWL-BW1, -MW1, -MW2, -MW3, and the upper screen in well MWL-MW4 are another factor that prevented the five wells from producing reliable and representative water samples for solvents, RCRA trace metals and the nuclear weapons radionuclide contaminants that are trace metals.</u> The poor reliability of the water quality data from five of the seven monitoring wells at the Sandia MWL dump because of the high-flow purging and sampling methods was not described at the NMED December 2004 Public Hearing or evaluated in the NMED 2006 Moats Report.

9.8. The groundwater contamination from the wastes buried in the Sandia MWL dump. The wastes buried in the unlined trenches and pits at the Sandia MWL dump have contaminated the groundwater at the water table below the dump with cadmium, chromium, nickel and nitrate. The groundwater contamination is based on RCRA criteria. In addition, the DOE/Sandia 2007 FTM Report [2] identified that the groundwater is contaminated with the highly toxic solvent tetrachloroethene (PCE) from the wastes buried in the MWL dump.

The analytical data on the groundwater samples collected from the new background water quality monitoring well MWL-BW2 installed in 2008 satisfy RCRA criteria that the MWL dump is the source for the cadmium, chromium, nickel and nitrate contamination that was repeatedly detected in the defective monitoring wells MWL-MW1 and -MW3. Other contaminants may be present in the groundwater but are prevented from detection by the defective monitoring well network and the improper purge-to-dry methods that were used to collect the groundwater samples.

9.8.1. The nickel groundwater contamination from the Sandia MWL dump.
The1998 NMED NOD Report [10] considered the Sandia MWL dump to be the source of the nickel contamination in the groundwater below the dump as follows:

> **Deficiency #5. Response #46** – – The MWL inventory is not complete. Data derived from soil sampling beneath the landfill indicate that nickel is a possible contaminant from the MWL. (See Deficiency No. 2). <u>DOE/SNL must support their position on a technical basis that the elevated nickel levels detected in groundwater samples from monitor well MWL-MW1 (and MWL-MW3) are a result of the corrosion of 305 stainless steel well screen; **otherwise,** such elevated levels of nickel will be attributed to a release of contaminants from the landfill</u> [Emphasis supplied] (p. 3).

DOE/Sandia did not ever support their position on a technical basis that the elevated nickel levels detected in the groundwater samples from monitoring wells MWL-MW1 and -MW3 were only from corrosion of the stainless steel well screens. Under RCRA criteria, the high concentrations of nickel measured in the groundwater samples collected from the two monitoring wells MWL-MW1 and -MW3 are evidence of nickel contamination in the groundwater from the wastes buried in the MWL dump. The concentrations of nickel that are measured in the groundwater samples collected from the two monitoring wells MWL-MW1 and -MW3 are above the EPA recommendation for nickel in groundwater to not exceed 100 ug/L [51]**.** The nickel contamination in the groundwater below the Sandia MWL dump is summarized in this section and described in greater detail in Section 8.

The NMED November 2006 Moats Report [31] made the <u>unacceptable assumption</u> that the high concentrations of nickel contamination repeatedly measured in the groundwater samples collected from monitoring well MWL-MW1 was only from "<u>progressive corrosion</u>" of the stainless steel screen as follows:

> Although MW1 should provide sample data that are representative of background hydrochemistry in the AF facies, the concentration of total nickel in MW1 groundwater samples has shown a marked increase over time (see Figure 6 [Figure 18 in this report]). <u>This is inferred to indicate **_progressive corrosion_** of the stainless steel well screen in this well</u> [emphasis supplied] (p. 7).

The corrosion prevented monitoring well MWL-MW1 from producing reliable and representative groundwater samples. In addition, there was no scientific basis for the NMED 2006 Moats Report to <u>assume</u> that the high nickel concentrations measured in well MWL-MW1 were only because of "<u>progressive corrosion</u>" of the stainless steel screen. Figure 18 and Table 3 show the very high nickel concentrations repeatedly measured in well MWL-MW1 compared to the very much lower concentrations measured in the other three wells that also have corroded stainless steel well screens according to the NMED testimony at the NMED December 2004 Public Hearing [43]**.**

> Finding of Fact 81 in the Hearing Officer's Report [43]**.** Elevated levels of nickel and chromium have been detected since 1992 in [monitoring wells] MWL-MW1, MWL-MW2, MWL-MW3 and MWL-BW1, which wells are all constructed with stainless steel well screen. NMED attributes these elevated levels to corrosion of the stainless steel well screens.

The “progressive corrosion” with high levels of dissolved nickel should have occurred in all four monitoring wells but the water quality data show it only occurred in monitoring wells MWL-MW1 and -MW3 that are located close to the MWL dump. Table 3 and Figure 14 show that high nickel concentrations were not measured in the groundwater samples collected from monitoring wells MWL-MW2 and -BW1 that are at distant locations from the MWL dump. The nickel data from the DOE/Sandia Report by Goering et al., (2002) are in Appendix F and are summarized below for the groundwater samples collected from the four monitoring wells with stainless steel screens over the years 1990 through 1996.

- Date	- Well MW1 Nickel (ug/L) [A] T [B] / D [C]	- Well MW3 Nickel (ug/L) T / D	- Well BW1 Nickel (ug/L) T / D	- Well MW2 Nickel (ug/L) T / D
- 09 - 90	46 / 43	ND [D] <40 / ND < 40	ND <40 / ND <40	ND <40 / ND <40
- 01 - 91	NA [E] / NA	NA / NA	NA / NA	NA / NA
- 04 - 91	NA / NA	NA / NA	NA / NA	NA / NA
- 10 - 91	NA / NA	NA / NA	NA / NA	NA / NA
- 07 - 92	150 / 63	66 / 43	ND <40 / ND <40	ND <40 / ND <40
- 01 - 93	78 / NA	26 (j) [F] / NA	ND <40 / NA	ND <40 / NA
- 04 - 93	97 / 94	37 (j) / 33 (j)	7.5 / 16	14 (j) / 13 (j)
- 11 - 93	95 / NA	ND < 40 / NA	ND < 40 / NA	ND < 40 / NA
- 05 - 94	110 / NA	ND <40 / NA	NA / NA	ND <40 / NA
- 10 - 94	130 / NA	ND <40 / NA	9.8 (j) / NA	ND <40 / NA
- 04 - 95	120 / NA	NA / NA	9.3 (j) / NA	7.5 (j) / NA
- 10 - 95	107 / NA	7.99 (j) / NA	1.96 (j) / NA	NA / NA
- 04 - 96	145 / NA	3.67 (j) / NA	ND < 0.81 / NA	3.42 (j) / NA

[A] ug/L = micrograms per liter or parts per billion
[B] T = Concentration of total nickel measured in an unfiltered water sample
[C] D = Concentration of dissolved nickel measured in a filtered water sample
[D] ND = nickel was not detected at the listed minimum detection level
[E] NA = nickel was not analyzed in samples collected on this date
[F] (j) = the listed value is an estimated value

The analytical data from Goering et al., (2002) over the period 1990 through 1996 show that the high concentrations of nickel were only repeatedly measured in the groundwater samples collected from monitoring well MWL-MW1. Nickel was not detected in the groundwater samples collected from monitoring well MWL-MW2 at a distant location north of the MWL dump or in the background monitoring well MWL-BW1 located 500 feet south of the MWL dump over the period from September 1990 through January 1993. <u>The high concentrations of nickel repeatedly measured in the groundwater samples collected from monitoring well MWL-MW1 compared to nickel was not detected in the groundwater samples collected from the background monitoring well MWL-BW1 are determined through RCRA criteria to be evidence of groundwater contamination from the nickel wastes buried in the MWL dump.</u>

The very low nickel concentrations measured in the new background monitoring well MWL-BW2 is new evidence that satisfy RCRA criteria that the high nickel concentrations measured in the groundwater samples collected from the monitoring well MWL-MW1 beginning in 1990 and also in monitoring well MWL-MW3 beginning in 1998 is a nickel plume from the wastes buried in the Sandia MWL dump. A low median dissolved nickel concentration of 1.22 ug/L was measured in the groundwater samples collected on seven dates in 2008 and 2009 from the new background water quality monitoring well MWL-BW2 with a range from 0.82 to 1.7 ug/L.

The nickel concentrations measured in the groundwater samples collected from the four monitoring wells with stainless steel screens over the period from April 1998 through April 2007 are listed below. The analytical data are from DOE/Sandia reports.

	- Well MW1	**- Well MW3**	**- Well BW1**	**- Well MW2**
	Nickel (ug/L) [A]	**Nickel (ug/L)**	**Nickel (ug/L)**	**Nickel (ug/L)**
- Date	**T [B] / D [C]**	**T / D**	**T / D**	**T / D**
- 04 - 98	**398 / 538**	**36.2 / 28.5**	**2.9 (j) / NA**	**5 (j) / 4**
- 11 - 98	**490 / 467**	**18 / 18.3**	**7.19 / 9.47**	**4.49 / 3.42**
- 04 - 99	**266 / 313**	**31 / 31.3**	**12.8 / 14.3**	**5.31 / 4.37**
- 04 - 00	**279 / 281**	**25.1 / NA**	**16.5 / NA**	**124 / NA**
- 04 - 01	**252 / NA**	**14.1 / NA**	**191 / NA**	**88.2 / NA**
- 04 - 02	**265 / NA**	**96.1 / NA**	**13.6 / NA**	**89.7 / NA**
- 04 - 03	**374 / NA**	**NA / 69.4**	**26.6 / NA**	**52 / NA**
- 04 - 04	**401 / NA**	**56 / NA**	**33.2 / NA**	**10.5 / NA**
- 04 - 05	**424 / 405**	**17.3 / 11.5**	**35.5 / NA**	**8.02 / 7.11**
- 04 - 06	**477 / NA**	**157 / NA**	**68 / NA**	**6. 76 / NA**
- 04 - 07	**436 / 284**	**84.8 / 120**	**NA / NA**	**7.34 / 5.41**

The high concentrations of nickel were repeatedly measured in the groundwater samples collected only from monitoring well MWL-MW1. Only low concentrations of dissolved nickel were measured in the groundwater samples collected from the two monitoring wells MWL-BW1 and MWL-BW2. The dissolved nickel concentrations increased over the period from 1998 through 2007 in the groundwater samples collected from monitoring well MWL-MW3 at a location close to the MWL dump.

<u>Accordingly, under RCRA criteria, the high levels of nickel measured in well MWL-MW1 and also in well MWL-MW3 are evidence of a nickel plume in the groundwater below the MWL dump from the nickel wastes buried in the Sandia MWL dump.</u>

The low dissolved nickel concentrations measured in the new background monitoring well MWL-BW2 of 1.2 ug/L are another example along with the low dissolved cadmium data from well MWL-BW2 that show the unreliable water quality data in the NMED regional background report [44]. The nickel concentration value in the background report is the high value of 28 ug/L; a "background concentration" that is 23 times higher than the median dissolved nickel concentration measured in the new background monitoring well MWL-BW2 of 1.22 ug/L.

9.8.2. The chromium groundwater contamination from the Sandia MWL dump. The NMED staff person Ms. Carolyn Cooper testified at the NMED December 2004 Public Hearing about the chromium contamination detected in the water samples collected from monitoring wells MWL-MW1 and MW3 as follows:

> Elevated levels of nickel and chromium have been detected since 1992 in Monitoring Wells MW-1, 2, 3 and BW-1. Concentrations of nickel that exceed the EPA MCL for drinking water have been detected in Monitor

> well 1. Concentrations of chromium exceeding the MCL have been detected in Monitor well 1 and 2. Each of these four wells is constructed with a stainless steel well screen (v. III, p. 924, l. 24-25; p. 925 l. 1-7).
>
> Sandia attributes the elevated nickel and chromium concentrations in the groundwater to corrosion of the stainless steel well screens (v. III, p. 925, l. 15-17).
>
> In NMED's view, the most likely explanation for the elevated nickel and chromium concentrations in groundwater at the mixed waste landfill is the corrosion of the stainless steel well screens (v. III, p. 925, l. 24-25; p. 926, l. 1-2).

Chromium wastes were disposed of in the Sandia MWL dump. Therefore, the NMED decision that corrosion of the stainless steel well screens is the only source for the elevated chromium concentrations measured in the groundwater is not protective of public health and the environment. In addition, the above testimony is incorrect to the water quality data presented in the DOE/Sandia 2002 report by Goering et al. that show the chromium wastes buried in the MWL dump have contaminated the groundwater.

The chromium contamination in the groundwater is based on the groundwater samples collected in 1990 and 1991 before the stainless steel well screens were <u>assumed</u> to be corroded [43]**.** The chromium water quality data from Goering et al., (2002) are in Appendix F. The evidence of the groundwater contamination is the dissolved concentrations of chromium measured in the groundwater samples collected from monitoring wells MWL-MW1 and MWL-MW3 that are at locations close to the MWL dump. For comparison, dissolved chromium was not detected in the groundwater samples collected from monitoring wells MWL-MW2 and MWL-BW2 that are at locations away from the dump. The locations of the four wells are displayed on Figure 6. Figure 7 shows that the stainless steel screens in the four wells are installed across the water table in the fine-grained alluvial fan sediments. The dissolved chromium concentrations measured in the groundwater samples collected from the four wells for the years 1990 to 1992 are as follows:

- **Dissolved chromium was detected in the groundwater samples collected from the two monitoring wells MWL-MW1 and MWL-MW3 located close to the MWL dump as follows:**

- Monitoring well MWL-MW1 – Dissolved chromium concentrations (ug/L)

-1. September 1990 [ND (10 ug/L)], **-**2. January 1991 [21 ug/L],

-3. May 1991 [15 ug/L], **-**4. July 1991 [11 ug/L], **-**5. October 1991 [19 ug/L]

-6. April 2007 [3.81 ug/L (j)]

The dissolved chromium measured in groundwater samples collected from well MWL-MW1 in the first two years of sampling range from Not Detected at a method detection limit of 10 ug/L to a maximum dissolved concentration of 21 ug/L. Dissolved chromium was detected in 4 of the 5 sampling events in the first two years of sampling the well.

- Monitoring well MWL-MW3 – Dissolved chromium concentrations (ug/L)

-1. September 1990 [13 ug/L], **-**2. January 1991 [16 ug/L],

-3. March 1991 [ND (10 ug/L)], **-**4. August 1991 [15 ug/L],

-5. October 1991 [ND (10 ug/L)] **-**6. April 2007 [4.52 ug/L]

The dissolved chromium measured in groundwater samples collected from well MWL-MW3 in the first two years of sampling range from Not Detected at a method detection limit of 10 ug/L to a maximum dissolved concentration of 16 ug/L. Dissolved chromium was detected in 3 of the 5 sampling events in the first two years of sampling the well.

- **Dissolved chromium was not detected in the groundwater samples collected from the two monitoring wells MWL-MW2 and MWL-BW1 that were at distant locations from the MWL dump as follows:**

- Monitoring well MWL-MW2 – Dissolved chromium concentrations (ug/L)

-1. September 1990 [ND (10 ug/L)] **-**2. January 1991 [ND (10 ug/L)]

-3. March 1991 [ND (10 ug/L)] **-**4. August 1991 [ND (10 ug/L)]

-5. October 1991 [ND (10 ug/L)] **-6.** July 1992 [ND (10 ug/L)]

- Monitoring well MWL-BW1 – Dissolved chromium concentrations (ug/L)

-1. September 1990 [ND (10 ug/L)] **-**2. January 1991 [ND (10 ug/L)]

-3. May 1991 [ND (10 ug/L)] **-**4. August 1991 [ND (10 ug/L)]

-5. October 1991 [ND (10 ug/L)] **-6.** July 1992 [ND (10 ug/L)]

The above dissolved chromium water quality data from the four monitoring wells with stainless steel screens is evidence under RCRA criteria of chromium contamination in the groundwater below the MWL dump from the chromium wastes that are buried in the dump. Dissolved chromium was only detected in the two monitoring wells that are located close to the MWL dump.

The very low dissolved chromium concentrations that are measured in the new background monitoring well MWL-BW2 that was installed in 2008 at a location hydraulically upgradient of the MWL dump provide additional evidence under RCRA criteria that the chromium wastes buried in the MWL dump have contaminated the groundwater below the dump. The dissolved chromium concentrations for well MWL-BW2 are as follows:

- Monitoring well MWL-BW2 – Dissolved chromium concentrations (ug/L)

-1. April 2008 [2.54 ug/L(j)*****] **-**2. July 2008 [1.86 ug/L(j)]

-3a. October 2008 [ND (1.5 ug/L)] **-**3b. October 2008 (duplicate) [ND (1.5 ug/L)]

-4. January 2009 [ND (1.5 ug/L)] **-** 5. April 2009 [ND (1.5 ug/L)]

-6. July 2009 [ND (2.5 ug/L)] **-**7a. October 2009 [ND (2.5 ug/L)]

-7b. October 2009 (duplicate) [ND (2.5 ug/L)]

***** (j) indicates estimated concentration. ND indicates chromium was Not Detected at the listed limit of detection of 2.5 ug/L.

Note: The median concentration for dissolved chromium in the background ground-water is the low value of 1.25 ug/L using the convention in the NMED November 2006 Moats Report [31] to assign a detected concentration as 50% of the not detected value.

The comparison of the very low dissolved chromium concentrations measured in the groundwater samples collected from the new background monitoring well MWL-BW2 **(a median concentration of 1.25 ug/L)** to the dissolved chromium concentrations measured in monitoring wells MWL-MW1 and MWL-MW3 in 1990 and 1991 are evidence under RCRA criteria of chromium contamination in the groundwater below the MWL dump. The dissolved chromium concentrations measured in the first two years of sampling monitoring wells MWL-MW1 and -MW3 are approximately 10 times greater than the dissolved concentrations measured in the new background monitoring well MWL-BW2 and are evidence of chromium groundwater contamination from the wastes buried in the MWL dump. DOE/Sandia and the NMED did not recognize that the water quality data in the DOE/Sandia Report by Goering et al (2002) was evidence under RCRA criteria that the wastes buried in the Sandia MWL dump had contaminated the groundwater beginning in 1990.

The dissolved chromium data for the two monitoring wells MWL-MW1 and –MW3 and also well MWL-MW2 in 2007 before the three wells were plugged and abandoned follow:

- **Monitoring well MWL-MW1 –** April 2007 [3.81 ug/L (j)]
- **Monitoring well MWL-MW3 –** April 2007 [4.52 ug/L]
- **Monitoring well MWL-MW2 –** April 2007 [1.74 ug/L(j), 1.89 ug/L(j) duplicate]

The dissolved chromium concentrations measured in wells MWL-MW1 and -MW3 are markedly higher than the very low median dissolved chromium concentration of 1.25 ug/L measured in the background monitoring well MWL-BW2. Also note that very low dissolved chromium concentrations of 1.74 ug/L(j) and 1.89 ug/L(j) (duplicate) were measured in the last groundwater sample collected from monitoring well MWL-MW2 in 2007.

In summary, the anomalously high dissolved chromium concentrations measured in the groundwater samples collected from monitoring wells MWL-MW1 and MWL-MW3 compared to the consistent low values measured in monitoring wells MWL-BW1, MWL-MW2 and MWL-BW2 are evidence under RCRA criteria that the chromium wastes buried in the Sandia MWL dump have contaminated the groundwater below the MWL dump. The low dissolved chromium concentrations measured in the new background monitoring well MWL-BW2 are additional evidence that the wastes buried in the MWL dump have contaminated the groundwater with chromium. The nature and extent of the chromium contamination in the groundwater is not known because a reliable network of monitoring wells was not installed at the MWL dump.

The very low dissolved chromium concentrations measured in the new background monitoring well MWL-BW2 are another example of the mistake by the NMED HWB to accept the unreliable background water quality data in the regional background groundwater quality report for KAFB [44]. The NMED approved background concentration for dissolved chromium in groundwater is 43 ug/L [44] but the water quality data from the new background monitoring well MWL-BW2 shows that the background dissolved chromium concentration is the very low median concentration of 1.25 ug/L.

The **assumption** by NMED at the December 2004 Public Hearing that the corroded screens were the source of the elevated chromium concentrations measured in the groundwater samples collected from wells MWL-MW1 and -MW3 is a violation of RCRA and the NMED Sandia Consent Order. There are chromium wastes in the MWL dump. The NMED HWB must require DOE/Sandia to install reliable networks of monitoring wells to investigate chromium contamination and other contamination 1). at the water table in the fine-grained alluvial fan sediments and 2). In the highly productive ARG Deposits below the layer of poorly productive fine-grained alluvial fan sediments

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9.8.3. The cadmium groundwater contamination from the Sandia MWL dump.
Cadmium wastes are buried in the MWL dump [10] and elevated levels of cadmium were measured in the soil borings below the dump [10]**.** The repeated detection of cadmium in the groundwater samples collected from the MWL dump monitoring wells is Finding Number 82 in the Hearing Officer's Report [43] for the NMED December 2004 Public Hearing. Finding 82 is below:

> "82. Low levels of cadmium have been detected in approximately one-third of all groundwater samples collected since 1990, some above the EPA Maximum Contaminant Level ("MCL"). NMED attribute these elevated levels to laboratory error, due to evidence of quality control issues and subsequent sampling at lower levels."

The detection of cadmium in the groundwater samples collected from the MWL dump monitoring wells is described as follows in the DOE/Sandia 2007 computer modeling report (DOE/Sandia 2007 FTM Report) [2] for the danger of the MWL dump to contaminate groundwater:

> <u>Cadmium has occasionally been detected in MWL groundwater at concentrations above the EPA MCL, although these detections are sporadic and unpredictable</u> [Emphasis supplied]. Because the cadmium detections above the MCL are inconsistent, it is believed that these detections do not indicate contamination from the MWL. Nevertheless, cadmium is considered a contaminant of concern, and the fate and transport of cadmium was modeled (p. 14).

The primary reason the detection of cadmium in the MWL dump monitoring wells is "<u>sporadic and unpredictable</u>" is because DOE/Sandia and the NMED HWB did not recognize that the defective monitoring wells MWL-MW1 and -MW3 were the only monitoring wells at locations that could detect cadmium contamination from the MWL dump. However, the two defective monitoring wells prevented the reliable detection of cadmium for the reasons described above in Sections 9.6 and 9.7.

A contradiction is that the 2007 DOE/Sandia 2007 FTM Report [2] and the Hearing Officer's report [43] acknowledge cadmium is repeatedly detected in the groundwater below the MWL dump and occasionally at concentrations above the EPA Drinking Water Standard of 5 ug/L. But the unsupported conclusion arrived at from the flawed computer modeling [2] is that no cadmium from the wastes buried in the MWL dump will reach the groundwater for a period longer than 10,000 years as follows:

> Neither lead nor cadmium were simulated to reach the groundwater in 1,000 years (or extended periods past 10,000 years) (p. 75).

In fact, the available data satisfy RCRA criteria that the groundwater at the water table below the MWL dump is contaminated with cadmium beginning with the first groundwater samples collected in 1990 to the present. However, the nature and extent of the groundwater contamination is not known because a reliable network of monitoring wells was not installed at the MWL dump. At the Sandia MWL dump, the NMED HWB has allowed DOE/Sandia to use incorrect computer modeling results [2] that were fabricated from preferred assumptions instead of using accurate water quality data from a reliable network of monitoring wells.

Cadmium is not detected in the groundwater samples collected from the new MWL dump background water quality monitoring well MWL-BW2. The water quality data from the new background water quality monitoring well MWL-BW2 installed in 2008 at a location hydraulically upgradient from the MWL dump show that cadmium is not detected [0.11 ug/L = limit of detection] in the *in situ* groundwater at the water table in the fine-grained alluvial fan sediments. Therefore, the large number of detections of cadmium in the monitoring wells MWL-MW1 and -MW3 is evidence under RCRA criteria of cadmium groundwater contamination from the wastes buried in the MWL dump. The cadmium contamination in the groundwater from the MWL dump requires the NMED to order DOE/Sandia to

- 1). retract the incorrect conclusions in the DOE/Sandia 2007 FTM Report [2], and
- 2). install the required networks of reliable monitoring wells in the two zones of saturation below the Sandia MWL dump.

Cadmium is not detected [0.11 ug/L = limit of detection] in any of the dissolved (filtered) or the total concentration (unfiltered) groundwater samples collected from the new background water quality monitoring well MWL-BW2 for seven sampling events in 2008[33] and 2009 [34]. Background water quality monitoring well MWL-BW2 was installed in 2008 at a location 200 feet east of the eastern boundary of the MWL dump. The location of well MWL-BW2 is shown on Figure 8. The screen in well BW2 was installed across the water table in the fine-grained alluvial fan sediments.

The fact that cadmium is not detected in the groundwater samples collected from the new background monitoring well MWL-BW2 [33,34] indicates that the repeated detection of cadmium reported in Appendix A in the NMED November 2006 Moats Report [31] is evidence of groundwater contamination from the cadmium wastes buried in the Sandia MWL dump. Appendix A in the 2006 Moats Report lists the following data for the median concentration of total cadmium for groundwater samples collected from monitoring wells MWL-MW1 and MW3 over the 15 year period from 1990 to 2004:

> Well MWL-MW1: – Cadmium was detected in 31 sampling events
> – Median concentration for total cadmium = 1.2 ug/L: Examples of total cadmium concentrations measured in well MWL-MW1 are the following: 46 ug/L on 08-27-90; 8.6 ug/L on 01-19-93; 2.5 ug/L on nine sampling dates; 2.22 ug/L on 04/21/03; and 1.68 ug/L on 09-09-03.
>
> Well MWL-MW3: – Cadmium was detected in 26 sampling events
> – Median concentration for total cadmium = 1.9 ug/L: Examples of total cadmium concentrations measured in well MWL-MW3 are the following: 29 ug/L on 01-19-93; 2.5 ug/L on 11 sampling dates; 2.4 ug/L on 07-28-92; 1.4 ug/L on 04-27-93; and 1.11 ug/L on 05-08-02.

The repeated detection of cadmium at the median concentrations of 1.2 ug/L for well MWL-MW1 and 1.9 ug/L for well MWL-MW3 in Appendix A in the NMED November 2006 Moats Report [31] is direct evidence under RCRA criteria of groundwater contamination from the cadmium wastes buried in the MWL dump because cadmium is not detected at the low detection limit of 0.11 ug/L in the groundwater in the fine-grained alluvial fan sediments at the location of the new hydraulically upgradient background water quality monitoring well MWL-BW2.

In addition, cadmium contamination from the wastes buried in the MWL dump were detected in the groundwater samples collected from the two defective monitoring wells MWL-MW1 and MWL-MW3 for the 2007 [32] and 2006 [65] sampling events. The analytical results for the groundwater sample collected from monitoring well MWL-MW1 on April 05, 2007 are as follows:

- April 05, 2007 / Total cadmium, 0.576 ug/L **(j)*** [limit of detection = 0.1 ug/L]
- April 05, 2007 / Dissolved cadmium, 0.244 ug/L **(j)*** [limit of detection = 0.1 ug/L]

The analytical results for the groundwater sample collected from monitoring well MWL-MW3 on April 11, 2007 are as follows:

- April 11, 2007 / total cadmium, 0.115 ug/L **(j)*** [limit of detection = 0.1 ug/L]
- April 11, 2007 / dissolved cadmium, not detected [limit of detection = 0.1 ug/L]

The analytical results for the groundwater sample collected from monitoring well MWL-MW3 on April 13, 2006 are as follows:

- April 13, 2006 / total cadmium, 0.569 ug/L **(j)*** [limit of detection = 0.1 ug/L]
- April 13, 2006 / dissolved cadmium, not analyzed

(j)* denotes estimated concentration

The actual amount of cadmium contamination in the groundwater below the Sandia MWL dump is not known because the defective monitoring wells MWL-MW1 and -MW3 are the only two monitoring wells at locations that could detect groundwater contamination from the MWL dump. The corroded stainless steel screens in the two wells and the purge-to-dry sampling methods have well known properties to <u>*reduce*</u> the concentrations of cadmium in the groundwater samples collected from the two defective monitoring wells. The corroded screens and purge-to-dry sampling methods also prevented the detection of other groundwater contamination from the MWL dump from other trace metals and solvents. <u>The NMED November 2006 Moats Report [31] did not recognize or evaluate the impacts of the corroded well screens and the purge-to-dry sampling methods to prevent wells MWL-MW1 and -MW3 from producing reliable and representative groundwater samples for cadmium or any other contaminants.</u>

9.8.4. The nitrate groundwater contamination from the Sandia MWL dump. The NMED November 2006 Moats Report [31] <u>***assumed***</u> that the high concentrations of nitrate repeatedly measured in the groundwater samples collected from monitoring wells MWL-MW1 and MW3 were from the TA-3 septic systems. The TA-3 septic systems, however are at locations far away from the MWL dump so as to preclude travel to the dump. The pertinent excerpt from the NMED 2006 Moats Report [31] is pasted below:

> The presence of nitrate in the shallower facies groundwater [i.e., the fine-grained alluvial fan sediments] is attributed to contamination from septic

systems within the vicinity of Tech Area 3 (IT, 04/1999, cited in Goering et al., 12/2002), as no significant nitrate sources from the MWL are known to exist (p. 3).

The NMED November 2006 Moats Report did not consider that the calculated speed of lateral groundwater travel in the fine-grained alluvial fan sediments is too slow for the TA-3 septic systems to be the source for the nitrate contamination in the groundwater below the Sandia MWL dump. The slow speed of lateral groundwater travel of only 0.17 feet per year (17 feet in one hundred years) [9] indicates that the MWL dump is the source for the high levels of nitrate contamination measured repeatedly in the groundwater samples collected from the two monitoring wells MWL-MW1 and -MW3.

A new important issue about the high concentrations of nitrate repeatedly measured in the groundwater at the water table below the MWL dump are the low nitrate concentrations measured in the groundwater samples collected from the new hydraulically upgradient background water quality monitoring well MWL-BW2. Well BW2 was installed in 2008 at a location 200 feet east of the eastern boundary of the MWL dump. The location of well MWL-BW2 is shown on Figure 8.

The nitrate concentrations measured in groundwater samples collected from well MWL -BW2 for seven sampling events in 2008 [33] and 2009 [34] range from 1.86 to 2.34 mg/L for a median concentration of 2.01 mg/L. Markedly higher nitrate concentrations of 5.21 mg/L and 3.75 mg/L were measured in the last groundwater samples collected in April 2007 [32] from monitoring wells MWL-MW1 and -MW3, respectively. The high concentrations of nitrate measured in wells MWL-MW1 and -MW3 compared to the low nitrate concentrations measured in the background well MWL-BW2 is an indication of nitrate groundwater contamination from the wastes buried in the Sandia MWL dump.

9.9. The NMED November 2006 Moats Report's conclusions are incorrect and ignore the many reasons that the groundwater monitoring wells at the Sandia MWL dump were unreliable and required replacement. The NMED November 2006 Moats Report [31] did not prove:

– 1). There was a reliable network of seven monitoring wells at the Sandia MWL dump and

– 2). There was no groundwater contamination from the wastes buried in the MWL dump.

The Moats Report ignored the large number of reports in the NMED Administrative Record that prove all seven monitoring wells at the MWL dump were defective and required replacement. Six of the reports are summarized in Section 5. Only two of the seven defective monitoring wells (wells MWL-MW1 and -MW3) were at locations that could detect groundwater contamination from the MWL dump. The groundwater contamination from the MWL dump that was repeatedly detected in wells MWL-MW1 and -MW3 include cadmium, chromium, nickel and nitrate.

Monitoring wells MWL-MW1 and -MW3 were unable to accurately determine the nature and extent of groundwater contamination because of factors that include the corroded stainless steel well screens and the practice of purging the wells dry with collection of groundwater samples up to a week later from the highly aerated groundwater that refilled the wells. The groundwater samples collected from well MWL-MW3 were also unreliable because of the bentonite clay contamination from the mud-rotary drilling method.

The NMED November 2006 Moats Report [31] **<u>represented itself-- without peer review--</u>** to be a comprehensive evaluation of the seven defective monitoring wells at the MWL dump. In fact, the Moats Report was a badly flawed unscientific study of the water quality data from the four monitoring wells that were impacted by bentonite clay and only one of the four wells (i.e., well MWL-MW3) was at a location that could detect groundwater contamination from the MWL dump. In addition, the Environmental Protection Agency [19,20,21,22] and the National Research Council [56] rejected the methodology that was used in the NMED November 2006 Moats Report [31] to evaluate the impacts from the bentonite clay.

9.10. The NMED should retract the NMED November 2006 Moats Report without opportunity for revision. The NMED November 2006 Moats Report [31] presents no scientific basis for acceptance of its conclusions because of the following factors:

- 1. The NMED 2006 Moats Report did not recognize that only two of the seven monitoring wells at the MWL dump (wells MWL-MW1 and -MW3) were installed at locations that could detect groundwater contamination from the MWL dump.

- 2. The “comprehensive” NMED Moats Report was a study of only four of the seven defective monitoring wells at the MWL dump. Of the four wells, only well MWL-MW3 was at a location that could detect groundwater contamination from the MWL dump.

- 3. The NMED Moats Report was only a study of the chemistry of the groundwater samples produced from well MWL-MW3 but the assessment methodology used in the Moats Report was rejected by the scientific community including the EPA Kerr Research Laboratory and the National Research Council.

- 4. The NMED Moats Report did not recognize the well-known properties of corroded stainless steel screens to prevent monitoring wells MWL-MW1 and -MW3 from detection of the groundwater contamination from the wastes buried in the MWL dump.

- 5. The NMED Moats Report did not recognize the well-known properties of the high-flow purge-to-dry sampling methods used for the collection of groundwater samples to prevent the detection of the solvent and trace metal contamination in the wastes buried in the MWL dump.

- 6. The NMED Moats Report used unreliable background water quality data for comparison to the water quality data from the defective monitoring wells.

- 7. The NMED Moats Report did not recognize the many factors that prevented the on-site monitoring well MWL-MW4 from being usable as a reliable monitoring well including a). installation of the upper screen too far below the water table, b). leakage of groundwater between the upper and lower screen was allowed to occur for many years, and c). the groundwater samples were collected with high-flow purge-to-dry methods.

- 8. The NMED Moats Report did not recognize that the high concentrations of nickel measured in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 are evidence of a nickel plume from the wastes buried in the MWL dump.

- 9. The NMED Moats Report did not recognize that the high concentrations of chromium measured in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 are evidence of chromium groundwater contamination from the wastes buried in the MWL dump.

- 10. The NMED Moats Report did not recognize that the repeated detection of cadmium in the groundwater samples collected from monitoring wells MWL-MW1 and MW3 are evidence of cadmium groundwater contamination from the wastes buried in the MWL dump.

- 11. The NMED Moats Report did not recognize that the repeated detection of high concentrations of nitrate in the groundwater samples collected from wells MWL-MW1 and MW3 are evidence of nitrate groundwater contamination from the wastes buried in the MWL dump.

<u>RCRA requires the NMED to retract the NMED November 2006 Moats Report [31] due to the misrepresentations, incorrect information and the failure to fully disclose all relevant facts.</u> No scientific reasons would justify revision of the Moats Report.

The NMED used the November 2006 Moats Report to discredit accurate public comment on the many deficiencies with the groundwater protection practices at the Sandia MWL dump. The public comment was for the DOE/Sandia Corrective Measures Implementation Plan.

One example in the NMED Response to Comments Report [75] where the NMED used the badly flawed and factually incorrect NMED Moats Report to respond to the comment from Registered Geologist Robert H. Gilkeson and the former Citizen Action Executive Director Sue Dayton that the monitoring well network at the Sandia MWL dump was not reliable and required replacement. Mr. Gilkeson was the first technical expert to inform Ms. Dayton of the need to replace all of the monitoring wells at the MWL dump that are displayed on Figure 6. The NMED response on page 35 of the November 21, 2006 NMED Response Report to the comment from Mr. Gilkeson and Ms. Dayton about the need to replace the monitoring wells follows:

> **NMED Response Number R29.** The NMED disagrees with this comment and believes that groundwater data obtained from the monitoring wells at the Mixed Waste Landfill (MWL) are generally representative of formation water <u>(see also NMED report by Moats, Mayerson, and Salem, 2006, entitled *Evaluation of the Representativeness and Reliability of Groundwater Monitoring Well Data, Mixed Waste Landfill, Sandia National Laboratories*)</u> [Emphasis supplied].

<u>In fact, there are many reports in the NMED Administrative Record (AR) written over the years 1990 to 1998 that prove Mr. Gilkeson and Ms. Dayton were correct that all of the monitoring wells at the Sandia MWL dump required replacement. Six of the reports in the NMED AR are summarized in Section 5.</u>

The NMED HWB written response [75] to the comments of Mr. Gilkeson on the DOE/Sandia Corrective Measures Implementation Plan cited the NMED November 2006 Moats Report [31] for <u>eleven</u> of the NMED responses.

The Final Order of Secretary Curry on May 26, 2005 [46] required the NMED HWB to provide the NMED November 2006 Moats Report [31] to the public for comment as follows:

> 3. NMED and Sandia shall provide a convenient method for the public to review Sandia's Corrective Measures Implementation Plan, Corrective Measures Implementation Report, progress reports, long-term monitoring and maintenance plan, and <u>any other major documents developed by NMED or Sandia for the MWL ("the documents"), including but not limited to, posting the documents on a publicly-accessible website</u> [Emphasis supplied].
>
> 4. NMED and Sandia shall provide a method and schedule that allows interested members of the public to review and comment on the documents, and <u>NMED shall review, consider and respond to these public comments prior to approving any of these documents (with the exception of any documents</u> [Emphasis supplied],such as progress reports, that NMED does not approve in the normal course of permit review and oversight).

The NMED November 2006 Moats Report [31] is a "<u>major document</u>" that the May 26, 2005 Final Order required NMED to provide for public comment and response by NMED ***<u>before</u>*** the NMED HWB used the Moats Report to discredit comments from the public. However, the NMED November 2006 Moats Report was not provided to the public for comment and response by NMED. Instead, the NMED November 2006 Moats Report was used unfairly, without technical or regulatory basis, to discredit the correct public comment from Mr. Gilkeson and Ms. Dayton about the important deficiencies in the groundwater protection practices at the Sandia MWL dump.

The Final Order of Secretary Curry on May 26, 2005 [46] supports that the NMED HWB should retract the November 2006 Moats Report [31] because the report is a <u>major document</u> and was not provided to the public for comment and response as required by the Final Order**.**

10.0. The 2008 discovery of a large release of contamination to the vadose zone below the unlined trenches and pits at the Sandia MWL dump was not investigated and is contrary to expectations. The New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) issued a Notice of Disapproval (NOD) letter on November 20, 2006 [67] for the MWL dump Corrective Measures Implementation Work Plan (CMIP). The NMED NOD [67] required DOE/Sandia to collect samples from new boreholes to determine if there were new releases of contamination from the wastes buried at the Sandia MWL dump. DOE/Sandia performed a limited and incorrectly designed field investigation in 2008 that

- 1). failed to meet the investigation requirements in the NMED NOD [67] but that nevertheless
- 2). discovered a new large release of tritium contamination in the vadose zone below the unlined pits and trenches in the MWL dump.

In August of 2008, DOE/Sandia issued a Final Report [68] for the 2008 field investigation in which <u>the written conclusions do not acknowledge the new large release of tritium contamination that was discovered in the 2008 field investigation.</u> The report was titled *Investigation Report on the Soil-Vapor Volatile Organic Compounds, Tritium, and Radon Sampling at the Mixed Waste Landfill, August 2008* (referred to as the DOE/Sandia 2008 Vadose Zone Report [68] in this report).

The text of the DOE/Sandia 2008 Vadose Zone Report [68] presented incorrect conclusions that cannot be made or inferred from the analytical data presented in the report. An important example of an incorrect conclusion in the report follows:

> Because the findings of this investigation are consistent with the conceptual model of the MWL, the [dirt] cover should be constructed (p. ii).

The findings of the 2008 field investigation were <u>**not**</u> consistent with the conceptual model of the MWL dump and the dirt cover should not have been constructed until the nature and extent of the new contamination in the vadose zone below the MWL dump was fully understood. The conceptual model was that the high concentrations of tritium measured in the vadose zone below the MWL dump were evidence that <u>**the unlined pits and trenches are *still* releasing contamination**</u> which may include other contaminants in addition to tritium.

The dirt cover should not have been installed over the MWL dump without a careful field investigation to characterize the nature and extent of the new contamination in the vadose zone below the dump but this was not done. Instead, the NMED approved the DOE/Sandia 2008 Vadose Zone Report in a letter dated September 26, 2008 [72] as follows:

> The New Mexico Environment Department (NMED) has reviewed the subject report and finds the levels and distributions of tritium, radon, and volatile organic compounds (VOC) vapors detected in the investigation are consistent with earlier data used to develop the conceptual model for the MWL. As demonstrated in the risk assessment that is included in the MWL Corrective Measures Study Report, similar levels detected in the past for these constituents were found not to pose unacceptable risk to human health and the environment based on an industrial land-use scenario (p.1).

First, the high concentrations of tritium that were measured in the 2008 field investigation were <u>**not**</u> consistent with the earlier tritium data that were collected in 1995 as part of the Phase 2 RCRA Field Investigation. Figure 19 shows that the DOE/Sandia 2008 field investigation found tritium concentrations that measured more than ten times higher than the tritium concentrations expected to be present based on the tritium concentrations measured in the previous DOE/Sandia 1995 RCRA RFI field investigation [69]**.** The maximum tritium contamination measured in the 2008 field investigation was 39,500,000 pCi/L and more than ten times higher than the expected maximum concentration of 3,900,000 pCi/L.

Secondly, the 2008 field investigation only collected samples from six new boreholes at locations inside the MWL dump. Six boreholes were not an adequate number. In addition, the locations of the new boreholes did not meet the requirements in the NMED NOD letter of November 20, 2006 [67] as follows:

> As the Permittees are aware, most site characterization data for the MWL (other than groundwater data) dates before the mid 1990's. Because the rupturing of containers and the leaking of their contents could have occurred since the mid 1990's the NMED requires more current soil-gas data to help resolve this issue. <u>The Permittees shall therefore collect and analyze active soil-gas samples taken at depth of 10 and 30 feet at a minimum of three locations within the landfill where previous sampling has detected the highest soil-gas concentrations in the past</u> [Emphasis supplied]. The soil gas samples shall be analyzed for volatile organic compounds, tritium, and radon (p. 8).

A NMED HWB letter dated February 14, 2008 [70] disregarded the above NMED November 20, 2006 NOD letter [67] and provided specific instructions for DOE/Sandia to collect and analyze samples from six new boreholes at locations inside the MWL dump. <u>The six borehole locations selected by the NMED HWB did not comply with the requirement in the November 20, 2006 NMED NOD letter [67] for the boreholes to be at locations within the MWL dump where previous sampling detected the highest concentrations.</u>

The DOE/Sandia 2008 Vadose Zone Report [68] describes the incapability of the borehole locations selected by the NMED HWB to provide data comparison as follows:

> Because none of the 2008 tritium samples were collected from the same locations that were sampled in 1995, a direct comparison of 1995 and 2008 tritium concentrations was not possible (p, 6-2),

The evidence of the new large release of contamination to the vadose zone below the MWL dump requires that:

- the incorrect conclusions in the text of the 2008 DOE/Sandia Vadose Zone Report [68] be withdrawn and
- a new comprehensive investigation of contamination in the vadose zone below the Sandia MWL dump be performed to protect public health and the environment.

- **A new comprehensive investigation is essential because the toxic wastes buried in unlined pits and trenches were left below a dirt cover without the required knowledge that the dirt cover would protect the groundwater below the dump from contamination.**

The high tritium concentrations measured in the limited 2008 field investigation required a comprehensive investigation of the nature and extent of contamination in the vadose zone below the MWL dump before installation of the dirt cover, but this investigation was not performed. The dirt cover was installed and DOE/Sandia issued the Corrective Measures Implementation Report for the completion of the installation of the dirt Cover in January 2010 [73].

The vertical and lateral extent of the tritium contamination, VOC contamination and other contamination in the vadose zone below the Sandia MWL dump is not known because the 2008 field investigation collected soil samples from only six boreholes at locations inside the MWL dump. None of the six boreholes were

- 1). located close to the previous boreholes in the 1995 RCRA RFI investigation where high tritium contamination was measured,
- 2). located close to Trench A and the twelve pits where the large inventory of tritium wastes are buried, or
- 3). drilled to a sufficient depth to characterize the vertical extent of the tritium and VOC contamination.

Figure 2 shows the location of Trench A in the unclassified area and Figure 3 shows the locations of the pits in the classified area. The inventory of tritium wastes buried in the 12 pits in the classified area are shown on Figure 22.

The six boreholes in the incorrectly designed 2008 field investigation were named DP1 to DP6. The six boreholes are shown on Figure 20 at locations inside the MWL dump which are from north to south DP6, DP1, DP5, DP4, DP3 and DP2. Core and soil gas samples were collected from all of the six boreholes at depths of 10 feet and 30 feet below ground surface (ft bgs). However, only the three boreholes DP2, DP3 and DP5 were sampled at depths of 50 ft bgs.

The discovery of the high tritium contamination should have resulted in a larger field investigation in 2008. The field investigation should have included more than six boreholes and all of the boreholes should have been drilled and sampled to a minimum depth of 250 ft bgs. The larger field investigation is required because an adequate study of the nature and extent of the contamination in the vadose zone below the MWL dump was not accomplished including for the incorrectly designed RCRA Facility Investigations in the 1990s. For example, Figure 26 shows that the maximum depth of investigation in the previous 1994 RCRA RFI investigations for volatile organic compounds (VOCs) was only 30 feet below ground surface (ft bgs). However, Figure 26 shows increasing concentrations of Total VOC contamination from the 10 ft to the 30 ft depth for 41 of the 43 boreholes. The contamination measured in the 43 boreholes is summarized in Table 5 in Section 10.4.

The need to characterize contamination to a minimum depth of 250 ft bgs at the MWL dump is shown by the vertical profile of Total VOC contamination in the vadose zone below the Sandia Chemical Waste Landfill (CWL dump) that is displayed on Figure 30. Figure 30 shows that the maximum Total VOC contamination in the soil-gas plume below the CWL dump was present at a depth of greater than 200 ft bgs. Figure 30 shows that the characterization of VOC and tritium contamination in the vadose zone below the MWL dump to only a depth of 50 ft bgs was not to a sufficient depth for either the RCRA RFI Investigations in the 1990s or the new DOE/Sandia field investigation performed in 2008.

The installation of the dirt cover over the MWL dump does not eliminate the requirement for DOE/Sandia to perform a new comprehensive investigation of the new and poorly characterized large release of contamination in the vadose zone below the MWL dump. In addition to tritium, the new contamination may include other contaminants from the wastes buried in the MWL dump including VOCs, trace metals and radionuclides. The 2008 field investigation was performed after the subgrade layer of the dirt cover was installed over the MWL dump. The heavy construction equipment used to install the subgrade layer may have caused the release of tritium contamination from the buried waste. Additional unknown contamination may have been released by the heavy construction equipment. The release of contamination from the activities to construct the dirt cover was a concern in the January 31, 2003 Final WERC Report [76] as follows:

> Uncertainties remain regarding the disposal of liquid hazardous and radioactive wastes in the early years of the landfill due to data gaps in documents before 1964. Areas of concern to the Peer Panel include the potential leakage of radioactive sealed sources (documented and possibly undocumented) and the possible leakage of unstabilized hazardous liquids; in particular those that are not documented because they may have been disposed during the first years of operation. The presence of trace concentrations of VOCs within and in areas surrounding the landfill may be an indication that unaccounted sources may be starting to migrate out of their respective containers into the core of the landfill (p. 32).
>
> It is also possible that additional liquid containers may, under the present environmental conditions in the landfill, leak their contents into the bulk of the landfill in the future. Additionally, there is the possibility that one or more of the radioactive sealed sources may have their seals compromised and expose their contents to the surrounding environment prior to the natural radioactive decay of the source to safe levels. The increase of overburden and the construction activities of cap placement could exasperate these potential problems. Therefore, presence of heavy equipment on the landfill surface and an increase in overburden should be carefully evaluated for their potential impact to prevent possible damage to the stability of contained radioactive and possible liquid and semisolidified wastes (p.33),

The necessary comprehensive investigation of the new release of contamination from the wastes buried in unlined pits and trenches at the MWL dump should be done as part of installing the required network of monitoring wells in the vadose zone below the MWL dump for early detection of new releases of contamination from the unlined pits and trenches. The network of monitoring wells required in the vadose zone below the unlined pits and trenches for long-term monitoring of the MWL dump is discussed in Section 11 of this report.

10.1. The conceptual model recognized that the high tritium concentrations measured in the 2008 field investigation results were evidence of a new large release of tritium contamination from the wastes buried in the Sandia MWL dump. The conceptual model of the NMED HWB [3]**,** DOE/Sandia [5] and the WERC independent peer review [45] was that the tritium concentrations measured in the vadose zone would decline over time if the MWL dump did not release new contamination. The expected decline in the measured tritium concentrations was because of the 12.3 year half-life of tritium. Instead of the expected decline, a tenfold increase in tritium contamination was measured in the soil samples collected from the six boreholes in the DOE/Sandia 2008 field investigation.

The conceptual model in reports by the NMED HWB [3], DOE/Sandia [5] and WERC [45] recognized that the large increase in the tritium concentrations measured in the 2008 field investigation were because of a new large release of tritium contamination from the wastes buried in the MWL dump. The pertinent excerpt from the NMED August 11, 2004 Fact Sheet [3] follows:

> Tritium activities at the MWL will decrease steadily with time due to its relatively short half-life of 12.3 years (p. 4).

The pertinent excerpt from the August 31, 2001 WERC Report [45] follows:

> Future concentrations of tritium are not expected to increase but rather are expected to decrease over the next 10 years based on the natural decay of the tritium radionuclide (p.29).

The pertinent excerpt from the DOE/Sandia Final Corrective Measures Study (CMS) Report [5] follows:

> Tritium activities at the MWL will decrease steadily with time due to the relatively short half-life of 12.3 years (p. 21).

In addition, the conceptual model presented by DOE/Sandia staff at public meetings and to the WERC expert panel [45] is the following:

> "It is a well-behaved landfill with no apparent risk to people or the environment" (p.43 in WERC 2001 Final Report [45].

However, Figure 19 shows that the maximum concentration of tritium contamination measured in the sparse number of samples collected from the inappropriate locations in the 2008 field investigation was 39,500,000 pCi/L. The measured maximum concentration was more than ten times greater than the maximum concentration of 3,900,000 pCi/L allowed by the DOE/Sandia conceptual model that "It is a well-behaved landfill with no apparent risk to people or the environment."

Figure 19 shows that the maximum concentration of tritium measured in the vadose zone below the MWL dump in the 1995 field investigation was 7,800,000 pCi/L. Figure 20 shows the maximum tritium concentration in the 1995 investigation was for a sample collected at 30 feet below ground surface (ft bgs) in angle borehole BH-12. The location of angle borehole BH-12 below the pits in the southern region of the classified area of the MWL dump is shown on Figure 21. The NMED November 20, 2006 NOD [67] for the DOE/Sandia CMIP required a new angle borehole close to the location of angle borehole BH-12, but this was not performed by the 2008 field investigation.

The time between the 1995 and the 2008 field investigations was13 years and longer than the 12.3 year half-life of tritium. Therefore, the maximum tritium concentration expected in the samples collected in the vadose zone below the MWL dump in 2008 was less than 50% of 7,800,000 pCi/L (i.e., less than 3,900,000 pCi/L). The highest measured tritium concentration in the samples collected in the 2008 field investigation was 39,500,000 pCi/L which is more than ten times greater than the expected maximum concentration based on the conceptual model in the NMED Fact Sheet [3], the WERC Report [45], and the DOE/Sandia CMS Report [5] for no new release of contamination from the unlined pits and trenches at the MWL dump.

The large new release of tritium from the unlined pits and trenches at the MWL dump is illustrated by the tritium concentrations that are displayed on Figure 19 from the DOE/Sandia 2008 Vadose Zone Report [68]. Figure 19 shows that the tritium concentrations measured in 18 of the 24 samples collected from the 8 boreholes in the 2008 field investigation are higher than the concentrations measured in the 1995 RCRA RFI field investigation [69].

Figure 19 shows that six of the analytical results for samples collected in the 2008 investigation were lower concentrations for tritium than measured in the samples collected in 1995. The lower concentrations measured in four of the six samples with the lower tritium concentrations were expected because the four samples were collected from the two background boreholes DP7 and DP8. The two background boreholes were located at distances greater than 500 feet southwest of the southwest corner of the MWL dump. The remaining two tritium concentrations on Figure 19 that are lower than the concentrations measured in 1995 are for the two samples collected at the depth of 30 ft bgs from borehole DP6.

Figure 20 shows the location of borehole DP6 and the low measured tritium concentrations of 165 pCi//L and 189 pCi/L for the two samples collected at the depth of 30 ft bgs. Figure 20 shows that borehole DP6 was located in the northwest corner of the MWL dump and not close to Trench A where a large inventory of tritium wastes are buried nor close to any of the previous boreholes where large concentrations of tritium were measured. In fact, Figure 20 shows that tritium was not detected in the soil sample collected at the 30 ft bgs depth in the 1995 angle borehole BH-5 that was located between borehole DP6 and the northern boundary of Trench A. The trajectory of the angle borehole BH-5 across the northern boundary of Trench A and south of borehole DP6 is displayed on Figure 21. The low tritium concentrations measured in borehole BH-5 show the mistake by the NMED HWB to locate borehole DP6 where low concentrations of tritium were expected to be present.

Borehole DP2 is another example of where the NMED HWB made a mistake to locate a borehole where low concentrations of tritium and VOCs were expected in the vadose zone below the MWL dump. Figure 20 shows that the NMED HWB located borehole DP2 in the southern part of the unclassified area close to the western side of Trench G. However, Figure 20 shows the low tritium concentrations that were measured in nearby angle boreholes BH-1 and BH-2 that were drilled and sampled in 1995. Figure 21 shows that borehole BH-1 was an angle borehole drilled below Trench G and Figure 20 shows that tritium was not detected in the sediment sample collected in 1995 at the 50 foot depth below Trench G.

In addition, Figures 26, 27 and 28 show the low concentrations of Total VOCs, PCE and TCE, respectively, measured in the soil gas samples collected from the boreholes 5, 6 and 7 that were located along the southern boundary of the MWL dump south of Trench G in the 1994 RCRA RFI field investigations. Moreover, the WERC Report [45] describes the wastes buried in Trench G as follows:

> Trench G was the last operational disposal trench. It contained very little waste, as indicated by the geophysics in the MWL Phase 2 RFI Report, when the MWL was closed in December 1988 (p. 78).

In summary, boreholes DP2 and DP6 are two examples of the NMED HWB inappropriate selection for the locations of the six boreholes that were required by the NMED NOD of November 20, 2006 [67] to be at locations close to where the previous boreholes measured high concentrations of tritium and VOCs.

The large increase in tritium concentrations measured in 2008 for 18 of the 24 samples in Figure 19 is direct evidence of a new large release of tritium contamination and possibly VOC contamination from the wastes buried in the unlined pits and trenches at the MWL dump. The actual increase in tritium and VOC concentrations below the MWL dump is not known because of the sparse number of boreholes in the 2008 field investigation. None of the 6 boreholes were

- 1). located close to the previous boreholes where high tritium concentrations were measured,
- 2). located close to Trench A in the unclassified area and the 12 pits in the classified area where the large inventory of tritium wastes are buried or
- 3). drilled to a sufficient depth to characterize the vertical extent of tritium and VOC contamination.

10.2. The DOE/Sandia 2008 Vadose Zone Report [68] incorrectly states that no boreholes in the 1995 RCRA RFI Investigation were located inside the MWL dump.
The 2008 DOE/Sandia Vadose Zone Report [68] incorrectly states that the higher tritium concentrations measured in the 2008 field investigation were "expected" because the eight boreholes for the 2008 investigation were located inside the MWL dump whereas the boreholes for the 1995 RCRA RFI investigation were located outside the dump. In fact, the boreholes for the 1995 RCRA RFI investigation were angled beneath the unlined pits and trenches at the MWL dump. The 2008 DOE/Sandia Vadose Zone Report [68] incorrectly stated as follows:

> All of the 1995 tritium samples were collected from boreholes around the perimeter of the MWL, whereas 20 out of 24 of the 2008 samples were collected from the interior of the MWL. The overall higher tritium concentrations found in the 2008 samples were expected because most of these samples were collected in close proximity to waste pits and trenches in the landfill (p. 1).

First, the above statement is incorrect because none of the six boreholes in the 2008 investigation were in close proximity to the 12 waste pits in the classified area of the MWL dump or Trench A in the unclassified area of the dump where the large inventory of tritium wastes are buried.

Secondly, 13 of the 15 boreholes located around the perimeter of the MWL dump in the 1995 RCRA RFI Investigation collected samples from inside the MWL dump because the boreholes were drilled at an angle to collect samples from below the unlined trenches and pits. Figure 21 shows the lateral distances drilled below the MWL dump pits and trenches for the 13 angle boreholes in the 1995 RCRA RFI field investigation. The minimum lateral distance drilled below the MWL dump was 90 feet for borehole BH-9. The lateral distances drilled for the other 12 boreholes ranged from 119 to 130 feet with 10 of the 11 boreholes drilled a lateral distance below the dump of 120 feet or greater. The DOE/Sandia 2008 Vadose Zone Report [68] contradicts its own above statement for the incorrect description of the location of the 1995 RCRA RFI boreholes outside the MWL dump as follows:

> Soil samples were collected from 15 boreholes drilled with a resonant sonic drill rig around the perimeter of the MWL from April through June 1995. ***Boreholes 1 to 13 were drilled adjacent to the MWL fence at a 30-degree angle*** **[Emphasis supplied]**, and Boreholes 14 and 15 were drilled vertically 60 feet east of the classified area fence (p. 2-1),

The thirteen boreholes in the 1995 field investigation were drilled at a 30-degree angle below the unlined trenches and pits as show on Figure 21.

The analytical data collected in the limited 2008 field investigation is evidence of a new large release of tritium contamination and possibly other contamination from the wastes buried in the MWL dump. The new large release is obscured by the incorrect statements and conclusions described previously and other incorrect statements in the 2008 DOE/Sandia Vadose Zone Report [68] such as the following excerpts (p. 6-3):

> As shown in Figure 5-2 [Figure 20 in this report], 1995 tritium samples were collected from 15 boreholes that were located around the perimeter of the MWL, and none of the 1995 samples were collected in the MWL [Emphasis supplied]. In 2008, tritium samples were collected from six borehole locations in the landfill.
>
> The 2008 borehole location DP5, where the highest tritium concentrations were found, is located between, and close to, the edges of two waste disposal trenches in the northwestern portion of the MWL. The overall higher tritium concentrations detected in the 2008 samples were expected because most of these samples were collected in close proximity to waste pits and trenches in the landfill.

Again, for reasons stated above, there is no basis for comparing the 1995 and 2008 tritium contamination data:

- 1). 13 of the 15 boreholes in the 1995 field investigation were drilled at an angle with the sonic drilling method to collect samples from below the unlined trenches and pits,
- 2). None of the six boreholes in the 2008 field investigation were in close proximity to the previous angle boreholes where high contamination was measured,
- 3). None of the 6 boreholes in the 2008 field investigation including borehole DP5 were located in close proximity to the 12 pits or Trench A where the large inventory of tritium wastes are buried,
- 4). Borehole DP5, where the highest tritium contamination was measured in the 2008 field investigation, is located 50 feet east of the Trench A and 140 feet west of the nearest pit in the classified area where tritium wastes are buried, and
- 5). The conceptual model of the NMED [3], DOE/Sandia [5] and the WERC expert panel Final Reports [45,76] recognized that the higher tritium concentrations measured in the limited 2008 field investigation were evidence of a new large release of tritium contamination from the unlined pits and trenches at the MWL dump.

The DOE/Sandia Fate and Transport Computer Modeling Report (DOE/Sandia 2007 FTM Report) [2] estimates the total inventory of tritium wastes buried in the MWL dump to be 2400 Curies. The independent study by WERC [45] listed 1451.3 Curies of the tritium wastes (60% of the total inventory) to be buried in 12 disposal pits located in the central and southern region of the classified area of the MWL dump with 822 Curies of tritium wastes buried in Pit 33 (34% of the total inventory). The large inventory of tritium wastes buried in the 12 pits in the classified area of the MWL dump including Pit 33 is displayed on Figure 22.

Figure 23 shows the large amount of tritium contamination measured in soil samples collected in 1993 at land surface above the disposal pits in the classified area of the MWL dump where the large inventory of tritium wastes are buried. Figure 23 is evidence of a large release of tritium wastes from the 12 pits in the classified area. However, the nature and extent of the tritium contamination and other contamination in the vadose zone below the classified area of the MWL dump was not accomplished including for the inadequate RCRA Facility Investigations in the 1990s and the inadequate DOE/Sandia 2008 field investigation.

Comparison of Figures 20 and 22 shows that none of the six boreholes in the 2008 field investigation were located close to the pits in the classified area of the MWL dump where the large inventory of tritium wastes are buried. Pit 33 holds the highest inventory of tritium. The three closest boreholes and distances away from Pit 33 in the classified area are as follows:

- Borehole DP1 was located 75 feet northwest of Pit 33;
- Borehole DP5 was located 175 feet west of Pit 33; and
- Borehole DP3 was located 225 feet south of Pit 33.
- Figure 22 shows that a borehole could have been located in close proximity to the northern side of Pit 33 but this was not done in the DOE/Sandia 2008 field investigation or in the previous DOE/Sandia RCRA RFI investigations in the 1990s.

The 2008 borehole DP1 was the closest borehole to Pit 33 and the tritium concentrations measured in this borehole show a large and greater than 16.8 times increase for the sample collected at 30 ft bgs (1,270,000 pCi/L) compared to the sample collected at 10 ft bgs (75,400 pCi/L). The nature and extent of the tritium contamination at the location of borehole DP1 is not known because the borehole was sampled only to a maximum depth of 30 ft bgs. A new vertical borehole drilled with the sonic method is required between the location of borehole DP1 and Pit 33 in the classified area of the MWL dump to characterize the depth of tritium and other contamination in the vadose zone below the classified area of the MWL dump.

The nature and extent of the new large release of tritium contamination below the classified area of the MWL dump where a large inventory of tritium wastes are buried (see Figure 22) should have been thoroughly characterized before the dirt cover was installed over the MWL dump, but this was not done. A new borehole to investigate the tritium and other contamination including VOCs, trace metals and radionuclides must be drilled with the sonic method through the soil cover. NMED assured the public in the NMED November 2006 Response to Comments [75] on the MWL dump Corrective Measures Implementation Plan that drilling through the cover was not an issue as follows:

> Replacement wells can be installed through a vegetative soil cover without risking damage to the cover, as such covers are by nature of simple design (p.22).

The new vertical borehole is required at a location close to the north side of Pit 33 and to be drilled with a method and design for 1). measurement of soil gas concentrations for a selected set of solvent contaminants as part of drilling; 2). collection of reliable soil gas samples to be sent to an analytical laboratory for tritium and solvent contamination as part of drilling; 3). collection of core samples as part of drilling; 4). installation of a permanent multiple-port sampling monitoring well for long-term use to monitor contamination in the vadose zone below the MWL dump to a minimum depth of 400 feet bgs; and 5). installation of a well screen at the water table below the MWL dump for long-term use to monitor groundwater contamination.

Of the six trenches in the unclassified area of the MWL dump, the DOE/Sandia RFI Work Plan [71] only lists a large inventory of tritium wastes buried in Trench A. The location of Trench A is shown on Figure 2. However, comparison of Figure 2 to Figure 20 shows that none of the six boreholes in the 2008 field investigation were at locations in close proximity to Trench A. The three closest boreholes to Trench A and distances away from the trench are as follows:

- Borehole DP6 was located 50 feet north of the northern boundary of Trench A;
- Borehole DP 5 was located 50 feet east of the central region of Trench A; and
- Borehole DP4 was located 50 feet east of the southern boundary of Trench A.

<u>None of the six boreholes in the 2008 field investigation met the NMED HWB requirement [67] to locate boreholes where previous boreholes measured the highest tritium and VOC concentrations.</u> The NMED HWB Notice of Deficiency (NOD) letter of November 20, 2006 [67] required an angle borehole below Trench A in the 2008 field investigation to be in close proximity to the 1995 angle borehole BH-4 and the 1994 vertical borehole #4 where high tritium concentrations and total VOC concentrations were measured below Trench A. See the tritium concentrations measured in the angle borehole BH-4 west of Trench A on Figure 20. In addition, see the total VOC concentrations and the PCE concentrations measured in the vertical borehole #4 west of Trench A on Figures 26 and 27, respectively. The 2008 field investigation was required by the NMED November 20, 2006 NOD letter [67] to locate a new angle borehole in close proximity to angle borehole BH-4 on Figure 21, but this was not done.

In addition, the NMED HWB NOD of November 20, 2006 [67] required an angle borehole in the 2008 field investigation to be in close proximity to the 1995 angle borehole BH-12 where the highest tritium concentrations were measured in the 1995 field investigation, but this was not done by the 2008 field investigation. Figure 20 shows the location of angle borehole BH-12 below pits in the southwestern region of the classified area of the MWL dump. To correct the overall inadequacy of the 2008 field investigation, NMED should enforce the requirement for DOE/Sandia to install the boreholes to comply with the NMED NOD letter of November 20, 2006 [67] that stated:

> <u>The Permittees shall therefore collect and analyze active soil-gas samples taken at depth of 10 and 30 feet at a minimum of three locations within the landfill where previous sampling has detected the highest soil-gas concentrations in the past</u> [Emphasis supplied]. The soil gas samples shall be analyzed for volatile organic compounds, tritium, and radon (p. 8).

DOE/Sandia should still be required by the NMED NOD of November 20, 2006 [67] to install new angle boreholes at the locations of the five 1995 RCRA RFI field investigation angle boreholes BH-4, BH-12, BH-10, BH-9 and BH-8 because of 1). the high concentrations of tritium that were measured in the five angle boreholes and 2). the new release of a large amount of tritium contamination that was discovered in the limited and incorrectly designed 2008 field investigation. Figure 20 shows that none of the six boreholes in the 2008 field investigation were located close to the four angle boreholes in the 1995 RCRA RFI field investigation where the high tritium concentrations were measured.

The new large release of tritium contamination that was discovered in the limited 2008 field investigation requires a new comprehensive investigation of the nature and extent of contamination in the vadose zone below the unlined pits and trenches at the MWL dump. The new investigation is necessary to ensure the necessary number of multiple-port monitoring wells are installed in the vadose zone below the MWL dump for the long-term monitoring program to protect public health and the environment. An important reason a new comprehensive field study is necessary is that the previous RCRA RFI field investigations in the 1990s and the 2008 field investigation were not adequate to characterize the nature and extent of contamination in the vadose zone below the dump.

In summary, a new comprehensive field investigation of contamination in the vadose zone below the MWL dump is required with a large number of boreholes for the following reasons:

- 1). The deficiencies in the field investigations in the 1990s and in 2008.
- 2). The discovery of a new large release of tritium contamination in 2008.
- 3). The present and long-term danger for the wastes buried in unlined pits and trenches to contaminate groundwater.

10.3. The isopleth contour maps in the DOE/Sandia 2008 Vadose Zone Report [68] are not representative of the tritium contamination in the vadose zone below the Sandia MWL dump. The isopleth maps in the DOE/Sandia 2008 Vadose Zone Report minimize and provide an inaccurate depiction of the tritium contamination in the vadose zone below the Sandia MWL dump. The NMED HWB should order DOE/Sandia to 1). retract the report and 2). perform the necessary comprehensive field investigation of the nature and extent of tritium contamination, VOC contamination and possibly other contamination in the vadose zone below the unlined pits and trenches at the 2.6-acre MWL dump. Two examples of the highly inaccurate isopleth maps for tritium contamination in the DOE/Sandia Vadose Zone Report [68] are in Figures 24, 24A and 25.

Figure 24 is an isopleth map for the tritium contamination in the vadose zone below the MWL dump at the depth of 30 feet below ground surface (ft bgs). Figure 24A is an enlarged view of Figure 24. The isopleth map in Figure 24 and 24A provides the tritium concentration contours for the 2.6 acre MWL dump based on samples collected from only the six incorrectly located boreholes in the badly flawed 2008 field investigation. None of the six boreholes were located close to Trench A or the pits in the classified area of the MWL dump where the large inventory of tritium wastes are buried. Figure 24 shows that the highest tritium contamination in the vadose zone at 30 ft bgs was measured at the location of borehole DP5 but the borehole is located 50 feet east of Trench A and 175 feet west of Pit 33 where large inventories of tritium wastes are buried. Figure 24 shows that there are no tritium contamination data close to Trench A, Pit 33 and the other pits in the classified area of the MWL dump where the large inventory of tritium wastes are buried. The large inventory of tritium wastes buried in the unlined pits in the classified area of the MWL dump are shown on Figure 22.

The large new release of tritium that has occurred from the unlined disposal pits in the classified area is illustrated by the tritium contamination displayed on Figure 23 for soil samples collected in 1993 at many land surface locations above the pits in the classified area. The highest tritium concentrations on Figure 23 are above Pit 33 where 822 Curies of tritium wastes are buried. The high tritium concentrations measured in 1993 in the surface soils above Pit 33 are evidence of a release of a large amount of tritium into the vadose zone below Pit 33 but a borehole was not located near Pit 33 in the incorrectly designed 2008 field investigation. The nature and extent of tritium contamination in the vadose zone below Pit 33 and the other pits in the classified area was not characterized in the 2008 field investigation or in the previous 1995 RCRA RFI field investigation despite the high tritium contamination shown in Figure 23 for the soil samples collected in 1993 at land surface above the pits in the classified area where the large inventory of tritium wastes are buried.

Figure 25 shows that there are no tritium contamination data close to Trench A, Pit 33 and the other pits in the classified area of the MWL dump where the large inventory of tritium wastes are buried. Figure 25 is an isopleth map from the DOE/Sandia 2008 Vadose Zone Report [68] for the tritium contamination in the vadose zone below the MWL dump at the depth of 50 feet below ground surface (ft bgs). The map is unrepresentative because the tritium concentration contours for the 2.6 acre MWL dump are based on samples collected from only three boreholes for the 2008 field investigation. None of the three boreholes were located close to Trench A in the unclassified area or the pits in the classified area of the MWL dump where the large inventory of tritium wastes are buried. Figure 25 shows that the highest tritium contamination in the vadose zone at 50 ft bgs was measured at the location of borehole DP5 but as described above, the borehole is located 50 feet east of the center of Trench A and 175 feet west of Pit 33 where large inventories of tritium wastes are buried.

<u>In summary, the isopleth maps in the DOE/Sandia 2008 Vadose Zone Report [68] do not represent the nature and extent of tritium contamination in the vadose zone below the 2.6-acre MWL dump.</u> The isopleth maps in the DOE/Sandia 2008 Vadose Zone Report [68] for tritium contamination in the vadose zone below the MWL dump are based on too little data with no data collected from boreholes located close to the unlined Trench A and the 12 pits in the classified area where the large inventory of tritium wastes are buried. The set of isopleth maps in the DOE/Sandia 2008 Vadose Zone Report [68] do not offer a common sense or technical basis to accurately characterize and monitor environmental contamination for the protection of public health and the environment.

10.4. The 1994 and 2008 field investigations did not characterize the nature and vertical extent of Volatile Organic Compound (VOC) contamination in the vadose zone beneath the unlined trenches and pits at the Sandia MWL dump. An adequate characterization of the VOC contamination in the vadose zone below the discrete pits and trenches at Sandia MWL dump was not performed by either the RCRA Facility Investigations in 1994 or the DOE/Sandia 2008 field investigation. The 1994 and 2008 field investigations did not adequately investigate the vertical extent of the VOC contamination The locations of the boreholes for the 1994 RCRA Facility Investigations and the DOE/Sandia 2008 field investigation are displayed on Figures 26, 27 and 28.

Major deficiencies in the 1994 RCRA investigations are that 35 of the 43 vertical boreholes that were installed to investigate contamination in the vadose zone below the MWL dump were at locations outside the perimeter of the MWL dump. In addition, no boreholes were drilled to a depth greater than 30 feet below ground surface (ft bgs). Practically all of the boreholes measured a large increase in contamination for the samples collected at 30 ft bgs compared to the samples collected at 10 ft bgs. Sampling to greater depths should have been accomplished given the increasing level of contamination from 10 to 30 ft bgs.

For example, Figures 26, 27 and 28 show that the 1994 RCRA Facility Investigations limited sampling of the vadose zone below the MWL dump to 8 vertical boreholes only at locations inside the northern part of the unclassified area (i.e., borehole nos. 5, 6, 7, 8, 9, 10, 11 and 12). There were no boreholes located inside the southern part of the unclassified area or inside the classified area of the MWL dump as part of the 1994 RCRA Facility Investigations.

The VOC contamination data is summarized in Table 5 beginning on the next page. The data in Table 5 show that all of the soil-gas samples in the 43 boreholes drilled for the 1994 RCRA RFI Investigation were only collected to a maximum depth of 30 feet below ground surface. For comparison, the vertical profile in Figure 30 shows the great depth of the soil-gas VOC plume below the Sandia Chemical Waste Landfill (CWL dump) with the highest contamination present at a depth greater than 200 feet below ground surface (ft bgs). The thickness of the vadose zone below the CWL dump is approximately 400 feet and the thickness of the vadose zone below the MWL dump is greater than 450 feet. The great depth of the VOC plume below the CWL dump is evidence that drilling boreholes to a depth greater than 250 ft bgs for collection of soil-gas samples below the MWL dump is required.

The maximum borehole depths of 30 ft bgs for the 1994 RCRA RFI Investigation and to 50 ft bgs in the DOE/Sandia 2008 Field Investigation were not sufficient. Table 5 shows that there was an increase in the Total VOC soil-gas concentrations measured at 30 ft bgs compared to 10 ft bgs for 41 of the 43 boreholes. The increase was more than double at 34 boreholes and more than triple at 20 boreholes. The increase in VOC contamination required drilling the boreholes to depths much greater than 30 ft bgs but this was not done in the 1994 RCRA RFI investigations. <u>Both the 1994 and 2008 field investigations failed to determine the nature and vertical extent of contamination in the vadose zone below the Sandia MWL dump.</u>

For example, Figures 26, 27 and 28 show that the DOE/Sandia 2008 field investigation only collected samples from three incorrectly located boreholes in the northern part of the unclassified area, one incorrectly located borehole in the southern part of the unclassified area, and two incorrectly located boreholes in the classified area of the MWL dump. The incorrect locations for the six boreholes were selected by the NMED HWB in a letter dated February 14, 2008 [70]**.** The NMED letter disregarded the Notice of Disapproval (NOD) issued by the NMED HWB on November 20, 2006 [67] that required DOE/Sandia to locate the boreholes in the 2008 field investigation in close proximity to where the boreholes in the previous 1994 field investigations measured the highest concentrations of VOC contamination. <u>The six boreholes in the badly flawed DOE/Sandia 2008 field investigation were 1). too few, 2). at incorrect locations, and 3). taken to an insufficient depth to characterize the nature and extent of the VOC contamination in the vadose zone below the unlined pits and trenches at the 2.6-acre MWL dump.</u>

Table 5. The Total VOC, PCE and TCE contamination measured in the 1994 RCRA RFI soil-gas boreholes located at the Sandia MWL dump.

- **35 of the 43 boreholes are located outside the boundary of the MWL dump.**
- **All of the soil-gas samples were collected only to a maximum depth of 30 feet below ground surface (ft bgs). At 41 of the 43 boreholes, there was an increase in the Total VOC soil-gas concentrations measured at 30 ft bgs compared to 10 ft bgs. The increase was more than double at 34 boreholes.**
- **The borehole locations are displayed on Figures 26, 27 and 28. The Trench names are displayed on Figure 2 and the Pit names are displayed on Figure 3.**

- **Boreholes for the northern part of the unclassified area of the MWL dump 12 of the 20 boreholes are located outside the boundary of the MWL dump**

1. Eight boreholes located inside the northern part of the unclassified area.

Borehole #5	Total VOCs [A] (ppbv) [B]		PCE [C] (ppbv)		TCE [D] (ppbv)	
	10 ft bgs [E]	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	340	1,130	240	520	100	270
Change	3.3 X increase [F]		2.2 X increase		2.7 X increase	

Borehole #6	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	410	1,690	240	720	ND [G]	280
Change	4.1 X increase		3 X increase		~5 X increase	

Borehole #7	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	810	3,710	310	1,100	100	540
Change	4.6 X increase		3.5 X increase		5.4 X increase	

Borehole #8	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	630	3,210	200	790	110	520
Change	5.1 X increase		4 X increase		4.7 X increase	

Borehole #9	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	2,460	4,630	380	690	180	370
Change	1.9 X increase		1.8 X increase		2.1 X increase	

Borehole #10	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	30,700	27,700	1,700	2,500	ND	600
Change	10% decrease		1.5 X increase		~12 X increase?	

Borehole #11	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	8,020	9,500	5,200	5,900	540	ND
Change	1.2 X increase		1.1 X increase		~ 90% decrease?	

Borehole #12	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	1,990	3,010	1,700	1,600	290	570
Change	1.5 X increase		5% decrease		1.96 X increase	

Table 5 continued

2. <u>Five boreholes outside the western boundary of the northern part of the MWL dump along a north-south line 30 feet west of the center of Trench A.</u>

<u>Borehole #2</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	754	**2,510**	**521**	**1,200**	**210**	**450**
Change	**3.3 X increase**		**2.3 X increase**		**2.1 X increase**	

<u>Borehole #3</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	1,510	**3,960**	**1,080**	**1,700**	**310**	**530**
Change	**2.6 X increase**		**1.6 X increase**		**1.7 X increase**	

<u>Borehole #4</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	1,170	**4,510**	**627**	**1,300**	**279**	**490**
Change	**3.9 X increase**		**2.1 X increase**		**1.8 X increase**	

<u>Borehole #5</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	596	**1,000**	**339**	**240**	**185**	**120**
Change	**1.7 X increase**		**30% decrease**		**35% decrease**	

<u>Borehole #6</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	358	**2,420**	**186**	**670**	**114**	**330**
Change	**6.76 X increase**		**3.6 X increase**		**2.9 X increase**	

3. <u>Three boreholes outside the western boundary of the northern part of the MWL dump along a north-south line 75 feet west of the center of Trench A.</u>

<u>Borehole #1</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	110	**1,010**	**110**	**450**	**ND**	**230**
Change	**9.2 X increase**		**4.1 X increase**		**~ 4 X increase**	

<u>Borehole #2</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	160	**830**	**160**	**360**	**ND**	**190**
Change	**5.2 X increase**		**2.25 X increase**		**~ 4 X increase**	

<u>Borehole #3</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	239	**880**	**84**	**280**	**54**	**210**
Change	**3.7 X increase**		**3.3 X increase**		**3.9 X increase**	

Table 5 continued

4. <u>Four boreholes located outside the northern boundary of the unclassified area of the MWL dump on a west-east line greater than 50 feet north of Trenches A, B, C and D.</u>

	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
Borehole #1	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	472	980	251	450	131	230
Change	2.1 X increase		1.8 X increase		1.76 X increase	

	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
Borehole #7	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	371	1,930	247	1,000	124	460
Change	5.2 X increase		4 X increase		3.7 X increase	

	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
Borehole #8	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	340	1,610	205	800	123	400
Change	4.7 X increase		3.9 X increase		3.25 X increase	

	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
Borehole #9	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	541	1,140	279	465	210	330
Change	2.1 X increase		1.7 X increase		1.6 X increase	

- **Boreholes for the southern part of the unclassified area of the MWL dump All of the 14 boreholes are located outside the boundary of the MWL dump**

5. <u>Four boreholes located outside the western boundary of the southern part of the unclassified area of the MWL dump along a north-south line 30 feet west of the center of Trench F</u>

	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
Borehole #2	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	754	2,510	521	1,200	210	450
Change	3.33 X increase		2.3 X increase		2.1 X increase	

	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
Borehole #3	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	1,510	3,960	1,080	1,700	310	530
Change	2.6 X increase		1.6 X increase		1.7 X increase	

	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
Borehole #4	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	1,170	4,510	627	1,300	279	490
Change	3.9 X increase		2.1 X increase		1.76 X increase	

	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
Borehole #5	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	596	1,000	339	240	185	120
Change	1.68 X increase		30% decrease		36% decrease	

Table 5 continued

6. <u>Three boreholes located outside the eastern boundary of the southern part of the unclassified area of the MWL dump along a north-south line 30 feet east of the center of Trench E.</u>

<u>Borehole #19</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	477	**2,400**	**69**	**260**	**220**	**630**
Change	**5 X increase**		**3.8 X increase**		**2.9 X increase**	

<u>Borehole #10</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	479	**929**	**260**	**280**	**120**	**250**
Change	**1.3 X increase**		**1.1 X increase**		**2.1 X increase**	

<u>Borehole #9</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	335	**555**	**83**	**120**	**98**	**250**
Change	**1.64 X increase**		**1.45 X increase**		**2.6 X increase**	

7. <u>Two boreholes located outside the eastern boundary of the southern part of the unclassified area of the MWL dump along a north-south line 50 feet east of the center of Trench E</u>

<u>Borehole #12</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	476	**1,055**	**76**	**140**	**230**	**405**
Change	**2.2 X increase**		**1.84 X increase**		**1.76 X increase**	

<u>Borehole #11</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	310	**1,230**	**ND**	**140**	**120**	**270**
Change	**3.97 X increase**		**~3 X increase**		**2.25 X increase**	

8. <u>Five boreholes located outside the southern boundary of the unclassified area of the MWL dump along a west-east line 15 feet south of the southern boundary</u>

<u>Borehole #4</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	476	**1,055**	**76**	**140**	**230**	**405**
Change	**2.2 X increase**		**1.84 X increase**		**1.76 X increase**	

<u>Borehole #5</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	310	**1,230**	**ND**	**140**	**120**	**270**
Change	**3.97 X increase**		**~3 X increase**		**2.25 X increase**	

<u>Borehole #6</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	754	**2,510**	**521**	**1,200**	**210**	**450**
Change	**3.33 X increase**		**2.3 X increase**		**2.14 X increase**	

Table 5 continued

Borehole #7	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	1,510	**3,960**	**1,080**	**1,700**	**310**	**530**
Change	**2.62 X increase**		**1.6 X increase**		**1.71 X increase**	

Borehole #8	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	1,170	**4,510**	**627**	**1,300**	**279**	**490**
Change	**3.85 X increase**		**2.07 X increase**		**1.76 X increase**	

- **Boreholes for the classified area of the MWL dump**
  All of the 10 boreholes are located outside the boundary of the classified area

9. Three boreholes located outside the northern boundary of the classified area of the MWL dump along a west-east line 15 feet north of the classified area

Borehole #10	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	275	**810**	**130**	**280**	**126**	**250**
Change	**2.9 X increase**		**2.15 X increase**		**2 X increase**	

Borehole #11	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	173	**490**	**87**	**150**	**86**	**160**
Change	**2.8 X increase**		**1.7 X increase**		**1.9 X increase**	

Borehole #12	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	282	**260**	**43**	**ND**	**53**	**120**
Change	**8% decrease**		**decrease?**		**2.26 X increase**	

10. Four boreholes located outside the eastern boundary of the classified area of the MWL dump along a north-south line 15 feet east of the classified area

Borehole #13	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	115	**140**	**30**	**ND**	**72**	**140**
Change	**1.2 X increase**		**decrease?**		**1.9 X increase**	

Borehole #14	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	177	**370**	**48**	**ND**	**113**	**240**
Change	**2.1 X increase**		**decrease?**		**2.1 X increase**	

Borehole #15	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	135	**540**	**33**	**ND**	**93**	**250**
Change	**4 X increase**		**decrease?**		**2.7 X increase**	

Borehole #16	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	142	**310**	**34**	**ND**	**84**	**210**
Change	**2.2 X increase**		**decrease?**		**2.5 X increase**	

Table 5 continued

11. <u>Three boreholes located outside the southern boundary of the classified area of the MWL dump along an east-west line 15 feet south of the classified area</u>

Borehole #17	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	125	**330**	**32**	**ND**	**76**	**230**
Change	**2.6 X increase**		**decrease?**		**3 X increase**	

Borehole #18	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	542	**1,310**	**56**	**150**	**435**	**630**
Change	**2.4 X increase**		**2.7 X increase**		**1.5 X increase**	

Borehole #19	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	477	**2,400**	**69**	**260**	**220**	**630**
Change	**5 X increase**		**3.77 X increase**		**2.86 X increase**	

12. <u>2008 Borehole DP3 located along the southern boundary of the classified area approximately 15 feet north-east of 1994 borehole #18 shown above in category 10.</u>

Probehole DP3	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**50 ft bgs**	**10 ft bgs**	**50 ft bgs**	**10 ft bgs**	**50 ft bgs**
	658	**1,330**	**53**	**120**	**39**	**140**
Change	**2 X increase**		**2.26 X increase**		**3.6 X increase**	

[A] **Total VOCs = Total Volatile Organic Compounds – The borehole locations and Total VOCs soil-gas concentrations are shown on Figure 26**.
[B] **(ppbv) = parts per billion volume**
[C] **PCE = the solvent tetrachloroethene – The borehole locations and PCE soil-gas Concentrations are shown on Figure 27.**
[D] **TCE = the solvent trichloroethene – The borehole locations and TCE soil-gas Concentrations are shown on Figure 27**.
[E] **ft bgs = feet below ground surface**
[F] **3.3 X increase means the soil-gas concentration measured at 30 ft bgs is 3.3 times Greater than the soil-gas concentration measured at 10 ft bgs**.
[G] **ND = the constituent was not detected in the soil-gas sample.**

The six boreholes in the 2008 field investigation were sampled for VOC contamination in soil gas at depths of 10 ft bgs and 30 ft bgs. Only the three boreholes DP2, DP3 and DP5 were sampled for VOC soil gas contamination at a maximum depth of 50 ft bgs. The 50 ft depth is not sufficient for any of the six boreholes and especially not sufficient where the contaminant levels are seen to increase with greater depth. In addition, the overall failure of the 1994 RCRA RFI investigations to adequately characterize the vertical extent of VOC soil gas contamination in the vadose zone below the MWL dump required the 2008 field investigation to drill a sufficient number of boreholes to a minimum depth of 250 feet bgs, but this was not done.

<u>EPA will promulgate new more protective drinking water standards for PCE and TCE in 2011.</u> A new concern that requires accurate knowledge of the VOC contamination in the vadose zone below the MWL dump is the announcement by EPA [66] that the drinking water standards for the VOC contaminants tetrachloroethene (PCE) and trichloroethene (TCE) will be set at much lower concentrations in 2011. PCE and TCE are present in the vadose zone below the MWL dump. The DOE/Sandia 2007 Fate and Transport computer modeling report (DOE/Sandia 2007 FTM Report [2]) predicts that the groundwater below the MWL dump is contaminated ***<u>now</u>*** with PCE as follows:

> Simulations showed that PCE reached the groundwater, but only 1% of the realizations yielded aquifer concentrations that exceeded the regulatory metric of 5 ug/L (p. 4).

The ***"5 ug/L regulatory metric"*** in the above excerpt from the DOE/Sandia FTM Report is the current EPA Drinking Water Standard (DWS) Maximum Contaminant Level (MCL) allowed for PCE and TCE in groundwater.

EPA will tighten the Drinking Water Standard (DWS) Maximum Contaminant Level (MCL) for PCE and TCE in groundwater in 2011 [66]. The discussion in the Federal Register on March 29, 2010 [66] indicates that the EPA DWS MCL for PCE and TCE will be tightened one hundred times from the current MCLs of 5 ug/L to new MCLs of 0.05 ug/L. The large magnitude of the tightening of the EPA standards is because PCE and TCE in drinking water at the current standard of 5 ug/L are known to cause cancer [66]. The tightening of the EPA drinking water standards increases concern for accurate characterization of the nature and extent of PCE and TCE contamination in the vadose zone and in the groundwater below the Sandia MWL dump.

The 100 computer simulations in the DOE/Sandia 2007 FTM Report [2] for groundwater contamination from the PCE wastes buried in the MWL dump are displayed in Figure 29.
- Figure 29 shows that 87% of the simulations predict the groundwater below the MWL dump to be contaminated now with PCE at concentrations greater than 0.05 ug/L.
- Figure 29 shows that 59% of the simulations predict the groundwater below the MWL dump to be contaminated now with PCE at concentrations greater than 0.5 ug/L.

The computer simulations in the DOE/Sandia FTM Report [2] predict that the groundwater below the MWL dump is contaminated now with PCE at concentrations above where EPA will set the new DWS MCL for PCE in 2011. A reliable network of monitoring wells for the detection of PCE and other solvents was not installed at the water table below the MWL dump. The deficiencies in the monitoring wells for the detection of VOCs including PCE and TCE are discussed in Sections 9.6 and 9.7 of this report. The DOE/Sandia FTM Report [2] is discussed in Section 12 of this report.

10.5. The inadequate knowledge from historic measurement of solvent contamination below the Sandia MWL dump in the 1994 RCRA RFI Investigations. The Total VOC, PCE and TCE contamination data collected in the 1994 investigations are presented on Figures 26, 27 and 28, respectively. The contamination data on the three figures are summarized above in Table 5. The three figures show that no soil gas samples were collected for solvent contamination from boreholes located inside the classified area or inside the southern part of the unclassified area during the 1994 field investigations. The figures show that only 8 boreholes were located inside the northern part of the unclassified area and soil gas measurements were only at depths of 10 ft bgs and 30 ft bgs. The inadequate characterization of solvent contamination in the vadose zone below the MWL dump in both the 1994 and 2008 field investigations requires that new characterization boreholes be drilled deep into the vadose zone at locations inside the MWL dump.

10.5.1 The characterization of VOC contamination in the vadose zone below the northern part of the unclassified area of the MWL dump is inadequate. Figure 26 shows that the highest concentrations of Total VOC contamination in the 1994 investigations were measured in the three vertical boreholes 9, 10 and 11 at locations between Trenches B and C in the northern part of the unclassified area of the MWL dump. However, the VOC contamination in the vadose zone below the trenches in the northern part of the unclassified area of the MWL dump or any other part of the MWL dump was not adequately characterized to protect public health and the environment because boreholes were not drilled to the required depth of 250 ft bgs.

Proper characterization requires drilling a minimum of 8 new vertical boreholes at locations close to the previous boreholes 5, 6, 7, 8, 9, 10, 11 and 12 in the northern part of the unclassified area. Figure 26 and Table 5 show the general case of a large increase in Total VOC contamination in the samples collected from 30 ft bgs compared to 10 ft bgs for the 8 boreholes in the 1994 RCRA RFI field investigation. The boreholes in a new field investigation should be drilled to a minimum depth of 250 feet bgs with soil gas and core samples collected at the depth intervals of 10 ft bgs, 30 ft bgs, 60 ft bgs, 100 ft bgs, 150 ft bgs, 200 ft bgs and 250 ft bgs. The actual depth required for drilling each borehole should be based on monitoring of solvent contamination with a field portable instrument that provides accurate measurement of discrete solvent contaminants in real time during the drilling of the boreholes.

At a minimum the collected soil gas and core samples should be analyzed for total VOCs, and a complete suite of solvents including PCE and TCE, a suite of appropriate trace metals, Tritium and a suite of appropriate radionuclides. The findings from the 8 new boreholes should be used to select the locations for a minimum of two (and possibly more) permanent multiple-port monitoring wells installed at locations inside the northwestern part of the unclassified area of the MWL dump for long-term monitoring of contamination in the vadose zone below the unlined trenches to a depth of 400 feet below ground surface (ft bgs). The long-term monitoring well network also should include a minimum of two multiport monitoring wells drilled at an angle below Trench A and B in the northwestern part of the MWL dump. The angle wells that are important to install below Trench A and B for the long-term monitoring of tritium contamination are discussed in Section 10.2.

10.5.2. The characterization of VOC contamination in the vadose zone below the southern part of the unclassified area of the MWL dump is inadequate. Figures 26, 27 and 28 and Table 5 show the general large increase in the Total VOC, PCE and TCE contamination for samples collected at 30 ft bgs compared to the samples collected at 10 ft bgs for the 14 boreholes drilled in 1994 around the perimeter of the southern part of the unclassified area of the MWL dump. The 14 boreholes include borehole 19 drilled in the “first round.” borehole 4 drilled in the “second round” and the boreholes 1 through 12 drilled in the “third round” of the 1994 RCRA RFI boreholes. Figures 26, 27 and 28 show that **no boreholes** were located inside the southern part of the unclassified area of the MWL dump for the RCRA RFI Investigations in the 1990s. In addition, Figures 26, 27 and 28 show that borehole DP2 was the only borehole located in the southern part of the MWL dump for the DOE/Sandia 2008 field investigation. Borehole DP2 was located close to the western boundary of Trench G but far from Trench E and F. The historical records [45] show there is more concern for solvent and tritium wastes buried in Trench E and F than in Trench G.

The inadequate knowledge of VOC contamination in the vadose zone below Trench E in the southern part of the unclassified area of the MWL dump. Figures 26, 27 and 28 show that no boreholes were located close to or below Trench E in the 1994 RCRA RFI field investigation or in the DOE/Sandia 2008 field investigation. Figure 26 shows the five vertical boreholes 9, 10, 11,12 and 19 drilled to a maximum depth of only 30 ft bgs at locations east of the MWL dump. Borehole 9 was located approximately 30 feet east of the center of Trench E at the southern boundary of the trench. Borehole 10 was located approximately 30 feet east of the center of Trench E away from the southern part of the trench. Borehole 11 was located approximately 50 feet east of the center of Trench E away from the central part of the trench. Borehole 12 was located approximately 50 feet east of the center of Trench E away from the northern part of the trench. Borehole 19 was located approximately 30 feet east of the center of Trench E away from the northern boundary of the trench. Category 6 and 7 in Table 5 show the large increase in Total VOC, PCE and TCE contamination collected in the soil-gas samples at 30 ft bgs for the five vertical boreholes drilled at locations east of Trench E. Much higher Total VOC, PCE, and TCE contamination is expected in the vadose zone at locations below Trench E.

There is a need to locate a minimum of two new angle boreholes close to the eastern side of the MWL dump to investigate the nature and extent of contamination in the vadose zone below Trench E. The new boreholes should be completed as multiple-port vadose zone monitoring wells for long-term monitoring of contamination.

The inadequate knowledge of VOC contamination in the vadose zone below Trench F in the southern part of the unclassified area of the MWL dump. Figures 26, 27 and 28 show that no boreholes were located close to or below Trench F in the 1994 RCRA RFI field investigation or in the DOE/Sandia 2008 field investigation. Figure 26 shows the vertical boreholes 4, 1, 2 and 3 drilled to a maximum depth of only 30 ft bgs at locations along a north-south line approximately 15 feet east of the MWL dump. Category 5 in Table 5 shows the large increase in Total VOC, PCE and TCE contamination collected in the soil-gas samples at 30 ft bgs for the four vertical boreholes drilled at locations west of Trench F. Much higher Total VOC, PCE, and TCE contamination is expected in the vadose zone at locations below Trench F.

There is a need to locate a minimum of two new angle boreholes close to the western side of the MWL dump to investigate the nature and extent of contamination in the vadose zone below Trench F. The new boreholes should be completed as multiple-port vadose zone monitoring wells for long-term monitoring.

10.5.3. The inadequate knowledge of VOC contamination in the vadose zone below the classified area of the MWL dump. Figures 26, 27 and 28 show that no boreholes were located inside the classified area of the MWL dump for the collection of soil-gas samples as part of the RCRA Phase 2 RFI Investigations. However, Figure 26 shows that the contaminant data for the boreholes drilled in 1994 on the northern, eastern and southern perimeter of the classified area show an increase at the 30-ft depth for Total VOC contamination for all ten boreholes. The contaminant data are summarized in Categories 9, 10 and 11 in Table 5. There is a special concern for the high contaminant levels measured in the two 1994 boreholes #18 and #19 located along the southern perimeter of the classified area and also the high concentrations of contaminants measured in soil gas samples collected in the 2008 borehole DP3 at a location east of the two 1994 boreholes #18 and #19. For example, the increase in Total VOCs for the soil-gas samples collected at the depth of 30 ft bgs to 10 ft bgs for the 1994 boreholes #18 and #19 and at the depth of 50 ft bgs to 10 ft bgs for the 2008 borehole DP3 was as follows:

- **#18 Total VOCs: 10 ft bgs (542 ppbv), 30 ft bgs (1,310 ppbv) = increase of 2.4 times**
- **#19 Total VOCs: 10 ft bgs (477 ppbv), 30 ft bgs (2,400 ppbv) = increase of 5 times**
- **DP3 Total VOCs: 10 ft bgs (658 ppbv), 50 ft bgs (1,330 ppbv) = increase of 2 times**

Borehole DP3 is located 20 feet west of the southwestern corner of Pit SP-1 where a large and unknown inventory of chemical wastes including liquid wastes were disposed of over the 4-year period from 1959 to 1962. The Sandia Chemical Waste Landfill (CWL) dump was not opened until 1962. The pertinent Finding of Fact in the Hearing Officer's Report for the NMED December 2004 Public Hearing is as follows:

> Finding of Fact #33: Between 1959 and 1962, chemical wastes were disposed of in Pit 1, which is located in the southeast corner of the classified area (p. 6).

The location of Pit SP-1 (i.e., Pit 1 in the Hearing Officer's report) is shown on Figure 3.

The WERC 2003 Final Report [76] also had a concern for the incomplete knowledge of the hazardous wastes disposed of at the MWL dump as follows from page 23:

- MWL inventory data for the period 1958-1964 were destroyed as part of normal record keeping protocol. This is particularly disconcerting information because the site operational history (Section 1.0 of the Draft CMS) does not indicate this situation for the MWL inventory data and does not report that in the early years of operation the MWL was probably used as the chemical dump prior to the opening of the Chemical Waste Landfill.

- Amount of hazardous waste is not well understood – the inventory does not match the characterization of Pit 35, Trenches B and C. For instance, the inventory provides no plausible explanation for the levels of solvents (TCE, PCE, TCA, CFCs) found by the *Phase 2 RCRA Facility Investigation*.

The historical record indicates a large volume of chemical wastes disposed of in Pit SP-1 and other pits in the southern region of the classified area in the early years of waste dumping. The marked increase in Total VOCs, PCE and TCE measured in the soil gas samples collected from borehole DP3 requires a minimum of two new deep boreholes on the southern perimeter of the classified area. One borehole should be located between borehole DP3 and Pit SP-1 to fully characterize the nature and extent of contamination in the vadose zone below Pit SP-1. The second borehole should be located in close proximity to the 1994 borehole #19. The new borehole should be drilled at an appropriate angle below the pits in the classified area and to the water table of the regional zone of saturation. The drilling method and borehole design should provide for collection of soil gas samples and core as part of drilling. The borehole diameters should allow for the construction of a single-screen monitoring well at the water table and multiple sampling ports throughout the vadose zone. The well design should provide for long-term monitoring of groundwater contamination at the water table and the long-term monitoring of contamination in soil gas samples at several depth intervals in the vadose zone.

The need for new angle boreholes in close proximity to the three 1995 angle boreholes BH-8, BH-9 and BH-10 was described above in Section 10.2 for characterization of the new release of tritium contamination to the vadose zone below the pits in the classified area. The three angle boreholes should also be sampled for VOCs. In addition, the new angle boreholes should be completed as long-term monitoring wells.

10.6. The missing inventory of the wastes buried in four of the disposal pits in the classified area of the Sandia MWL dump. The study of Figure 3 and Figure 20 shows that there are four disposal pits in the classified area of the MWL dump with no knowledge of the waste inventory on record. Figure 3 shows the names of the pits with a waste inventory provided in the WERC 2003 Final Report [76] and in the Final Phase 2 RCRA RFI Investigation Report. However, Figure 3 shows 2 circular pits with hachure symbols (symbols that resemble a bicycle wheel with cutoff spokes) for which an inventory is not provided in any DOE/Sandia document. The diameters of the two unnamed circular pits are 10 feet. On Figure 3, one of the circular pits is located in the central part of the classified area immediately north of Pit 32. The second circular pit with no inventory on record is located in the southeastern part of the classified area immediately north of Pit SP-1. The conventional meaning of the hachure symbols on the two circular pits is a depression on the land surface. This suggests the two unnamed circular pits were impoundments used for the disposal of liquid wastes. The issue of possible disposal in the unnamed circular pits must be resolved.

In addition, Figure 20 shows a large square-shaped pit with a size of 15 feet on each side in the northwestern corner of the classified area with no listed name and no waste inventory. The square-shaped pit does not appear on Figure 3. Similarly, Figure 20 shows a small circular unnamed pit located immediately northwest of the pit no. 14 on Figure 3. The small circular pit is not shown on Figure 3 and there is no record of the waste inventory buried in this pit.

DOE/Sandia should provide the waste inventory for the four pits or acknowledge the inventory is missing. In addition, a borehole should be located on the north side of the MWL dump and drilled at an appropriate angle below the unnamed large square-shaped pit that is displayed on Figure 20 at a location in the northwest corner of the classified area. It will also be necessary to drill angle boreholes below the two unnamed circular pits dependent on the knowledge of the waste inventory buried in the two pits.

Conclusion. The NMED HWB should order a competent and thorough field investigation of the contamination in the vadose zone below the Sandia MWL dump. The evidence from the limited and incorrectly designed 2008 field investigation shows a new large release of tritium contamination from the unlined pits and trenches. The nature and extent of the new release of tritium and other contamination is not known. The historic record shows the nature and extent of tritium and solvent contamination beneath the MWL dump was not adequately characterized. The MWL dump contaminants are of increased concern given new more restrictive EPA standards for the highly toxic solvent wastes buried in the dump. The design of the 2008 study and the earlier RCRA RFI investigations in the 1990s were inadequate to determine the full extent of solvent and tritium contamination beneath the MWL dump. There are numerous, obvious inaccuracies and contradictions between the data and the textual conclusions contained in the 2008 Vadose Zone Report [68]**.** DOE/Sandia should discontinue ongoing public meeting statements "that the MWL dump is well-behaved."

Given the ten times higher tritium concentrations measured in the 2008 field investigation, the DOE/Sandia conceptual model demands 1). a competent and thorough field investigation of the contamination in the vadose zone below the Sandia MWL dump 2). competent long-term monitoring of the vadose zone below the unlined pits and trenches at the MWL dump and 3). competent long-term monitoring of the groundwater contamination that is known to be present from the Sandia MWL dump. Clean up of the dumps wastes may be required to protect the precious groundwater resource.

11.0. The DOE/Sandia proposed *Long-Term Monitoring and Maintenance Plan* does not provide protection to the groundwater below the Sandia MWL dump. DOE/Sandia submitted the proposed *Long-Term Monitoring and Maintenance Plan* (LTMMP) in November of 2007 [4] on a schedule that did not comply with the Final Order issued by NMED Secretary Ron Curry on May 25, 2005 [46]**.** The Final Order and also the Class 3 Permit Modification [74] required submittal of the LTMMP *after* the NMED's *approval* of the DOE/Sandia Corrective Measures Implementation Report [73] (CMI Report) for the installation of the dirt cover over the Sandia MWL dump. The LTMMP was submitted before the approval of the CMI Report.

The DOE/Sandia November 2007 LTMMP [4] states that the early submittal of the report was at the request of the NMED as follows:

> Although the Class 3 Permit Modification requires the Permittees (DOE/Sandia) to submit this document to the NMED within 180 days after the NMED's approval of the CMI Report, the schedule for this document has been accelerated at the NMED's request (p, 1-2).

The May 25, 2005 Final Order [46] and the Class 3 Permit Modification [74] issued by the NMED in August 2005 do not allow NMED to change the schedule for submittal of the DOE/Sandia LTMMP without public notice. The public was not notified of the schedule change. Compliance with the Final Order and the Class 3 Permit modification requires DOE/Sandia to retract the November 2007 proposed LTMMP and submit a new proposed LTMMP within 180 days after the NMED's approval of the CMI Report. The new proposed LTMMP is required to be provided to the public for review and comment. In addition, the NMED is required to provide a written response to the comments from the public. The required public comment process is described below for the CMI Report.

DOE/Sandia submitted the CMI Report [73] to NMED in January 2010. The NMED took formal action to notice the CMI Report on November 30, 2010. The May 26, 2005 Final Order [46] requires that the DOE/Sandia CMI Report be provided to the public for review and comment as follows:

> 3. *NMED and Sandia shall provide a convenient method for the public to review Sandia's Corrective Measures Implementation Plan, Corrective Measures Implementation Report* [Emphasis supplied], progress reports, long-term monitoring and maintenance plan, and any other major documents developed by NMED or Sandia for the MWL ("the documents"), including but not limited to, posting the documents on a publicly-accessible website.
>
> 4. NMED and Sandia shall provide a method and schedule that allows interested members of the public to review and comment on the documents, and NMED shall review, consider and respond to these public comments ***prior to approving*** any of these documents [Emphasis supplied].

The new information presented by NMED at the December 14, 2010 public meeting on the DOE/Sandia CMIR Report is that NMED will require DOE/Sandia to revise the Long-Term Monitoring and Maintenance Plan (LTMMP) that was submitted to NMED in 2007. Submission of the revised LTMMP will be required within 180 days after the NMED approval of the CMIR Report.

The resubmission of the proposed LTMMP must correct the many deficiencies in the November 2007 proposed LTMMP [4]**.** The proposed LTMMP is not protective of human health and the environment with regard to the protection of the groundwater below the Sandia MWL dump for all long-term monitoring activities including the following:

- 1). The existing defective groundwater monitoring well network. The overall failure of the groundwater monitoring well network below and downgradient from the MWL dump is discussed extensively in other Sections of this report and is summarized below in Section 11.1. <u>Six of the seven monitoring wells in the current network require replacement.</u>
- 2). The existing defective dirt cover installed over the wastes buried in the MWL dump. The existing dirt cover is defective because it is not the required design and does not have the required instrumentation to detect and measure the travel of water through the dirt cover and into the buried wastes.
- 3). The existing defective dirt cover does not accomplish the intended purpose to protect groundwater from contamination from the wastes buried in unlined pits and trenches because the buried wastes had contaminated the groundwater beginning more than 20 years before the dirt cover was installed.
- 4). The proposed soil gas monitoring well network in the vadose zone is inadequate because it does not monitor below the unlined pits and trenches.
- 5). The existing soil moisture probe holes below the MWL dump are inadequate because a). they only monitor below a small number of the unlined pits and trenches; b). they do not monitor continuously; and c). they do not monitor the breakthrough of moisture at the base of the dirt cover.
- 6). The existing inaccurate and unreliable DOE/Sandia Fate and Transport Computer Model (DOE/Sandia 2007 FTM Report [2]) does not protect groundwater from contamination from the wastes buried in the MWL dump. This issue is discussed in Section 12.

The Sandia MWL dump was not designed and operated as an engineered landfill. During the 30-years of waste disposal operations (from March 1959 through December 1988), the MWL dump was named the "<u>TA-3 low-level radioactive waste dump</u>" [3]**.** There is much uncertainty in the volume and type of commingled hazardous and radioactive wastes that were buried in the Sandia MWL dump [76]**.** The wastes are buried in unlined pits and trenches without the protection provided in engineered landfills that are constructed with liners and leachate collection systems for each discrete disposal trench or pit.

The lack of liners and leachate collection systems at the MWL dump places special requirements on the network of monitoring wells that are installed to provide detection of contamination released from the unlined pits and trenches to the vadose zone. The need for installation of monitoring wells in the vadose zone <u>below</u> the unlined trenches and pits is essential because of the new large release of contamination from the dump to the vadose zone that was discovered in the limited 2008 field investigation [68]**.** The new large release of contamination to the vadose zone below the MWL dump is discussed in Section 10. DOE/Sandia must provide the special requirements for the long-term monitoring and maintenance plan to provide protection of the public health and the environment from the wastes buried in the unlined pits and trenches at the <u>*Sandia MWL dump*</u> that does not provide the protection of an engineered landfill.

The relationship between the DOE/Sandia proposed November 2007 LTMMP [4], the April 2004 Consent Order[1], the May 26, 2005 Final Order [46] and the August 2, 2005 Class 3 Permit Modification [74] are described as follows on page 1-2 in the proposed LTMMP [4]:

> A requirement to develop an LTMMP was presented in the NMED Final Order on the MWL (Curry May 2005) and the Class 3 Permit Modification (NMED August 2005). Although the Consent Order (NMED April 2004) governs the remedy selection process for the MWL, it does not contain any requirements related to long-term monitoring, other than requirements for monitoring well replacement. Rather, the Consent Order defers to the RCRA Part B Permit (as revised by the August 2005 Class 3 Permit Modification for the MWL) for implementation of long-term controls for SWMUs.
>
> The Class 3 Permit Modification provides the framework for the LTMMP and states the following in Section V(6):
>
>> A long-term monitoring and maintenance plan, which includes all necessary physical and institutional controls to be implemented in the future shall be submitted by the Permittees to the Administrative Authority for approval within 180 days after the Administrative Authority's approval of the CMI Report. The Administrative Authority may require monitoring, maintenance, and physical and institutional controls different than those specified in the Corrective Measures Study report referenced in V.1 of this section. The plan shall also include contingency procedures that must be implemented by the Permittees if the remedy set forth in Section V.2 above fails to be protective of human health and the environment.

The NMED should order DOE/Sandia to retract the DOE/Sandia 2007 FTM Report. The reasons that require the retraction of the DOE/Sandia 2007 Fate and Transport Computer Model Report [2] (DOE/Sandia 2007 FTM Report) are described in Section 12 of this report and summarized here. The DOE/Sandia 2007 FTM Report [2] does not recognize the groundwater contamination that has been present for more than the past 20 years from the wastes buried in the MWL dump. The conclusions in the DOE/Sandia 2007 FTM Report are unsupportable due to omission of the knowledge of the groundwater contamination from the MWL dump. The evidence that the wastes buried in the MWL dump have contaminated the groundwater with cadmium, chromium, nickel and nitrate is presented in Section 9.8.

The available groundwater analytical data from 1990 to the present time show that the groundwater below the Sandia MWL dump is contaminated with cadmium, chromium, nickel and nitrate wastes released from the unlined pits and trenches in the dump. The scientific basis for the groundwater contamination is from the comparison of analytical results for groundwater samples collected from monitoring wells MWL-MW1 and -MW3 to analytical results from the new background monitoring well MWL-BW2 that was installed in 2008. Previous to 2008, the MWL dump had no upgradient groundwater monitoring well for assessment of background water quality. The cadmium, chromium, nickel and nitrate groundwater contamination was present in the groundwater samples collected from the two monitoring wells MWL-MW1 and -MW3 beginning with the first water samples collected in 1990. The water quality data satisfy RCRA criteria as evidence of groundwater contamination from the wastes buried in the MWL dump.

11.1. The proposed groundwater monitoring well network in the DOE/Sandia *Long-Term Monitoring and Maintenance Plan* is inadequate*.* The Federal Resource Conservation and Recovery Act (RCRA) and the NMED DOE/Sandia Consent Order [1] require two networks of monitoring wells at the Sandia MWL dump for long-term monitoring. The regulatory requirements are described in Section 7. The two zones of saturation where the monitoring well networks are required are displayed on the geologic cross-section in Figure 7 and are 1). a network of monitoring wells at the water table in the poorly productive fine-grained alluvial fan sediments and 2). a network of monitoring wells in the highly productive ARG deposits that are located below the fine-grained alluvial fan sediments.

- A network of monitoring wells is required at the water table below the Sandia MWL dump. A network of monitoring wells is required at the water table in the fine-grained alluvial fans sediments for the early detection of groundwater contamination from the unlined pits and trenches at the MWL dump. The fine-grained alluvial fan sediments have very low permeability (i.e., saturated hydraulic conductivity) and are unable to provide sufficient amounts of groundwater to be used as a water supply [9]**.**

- A network of monitoring wells is required in the ARG Deposits – the productive aquifer below the Sandia MWL dump . The Consent Order and RCRA require a network of monitoring wells in the uppermost layer of productive aquifer strata that can provide a sufficient amount of groundwater for a water supply. Below the MWL dump, the uppermost layer of productive aquifer strata is the Ancestral Rio Grande “A” Deposits (the ARG Deposits) that are located below the fine-grained alluvial fan sediments. Figure 7 is a geologic cross-section that displays the ARG Deposits below the fine-grained alluvial fan sediments.

The NMED Consent Order and RCRA require the appropriate number of monitoring wells to be located close to the downgradient boundary of the MWL dump for the direction of groundwater flow at the water table in the fine-grained alluvial fan sediments and in the deeper ARG Deposits. In addition, monitoring wells are required at locations inside the MWL dump and at locations away from the dump as necessary to identify groundwater contamination from the wastes buried in the unlined trenches and pits

- The required network to monitor groundwater at the water table in the poorly productive fine-grained alluvial fan sediments has not been installed. Monitoring wells are required below the MWL dump and at locations surrounding the perimeter of the MWL dump. A reliable network of monitoring wells is not installed *at the water table* for long-term monitoring of contamination from the MWL dump. The Consent Order and RCRA requirements for a reliable network of monitoring wells at the water table below and away from the MWL dump have not been met.

- A reliable network of monitoring wells is required in the ARG Deposits for long-term monitoring of groundwater contamination from the MWL dump. The Consent Order and RCRA requirements for a monitoring well network in the ARG Deposits have not been met. The requirements are described in Section 7 of this report.

11.1.1. The current network of monitoring wells is defective to monitor at the water table and requires replacement. A network of monitoring wells is required at the water table in the fine-grained alluvial fan sediments for the early detection of groundwater contamination from the MWL dump Figure 8 shows the locations of the seven monitoring wells in the current network including the six defective contaminant detection monitoring wells MWL-MW4, -MW5, -MW6, -MW7, -MW8 and -MW9 and the background water quality monitoring well MWL-BW2.

Section 3 of this report describes the reasons why the six contaminant detection monitoring wells on Figure 8 are defective and require replacement. The basic reason is that none of the six monitoring wells are located at the water table 1). below the MWL dump, 2). along the southern and western boundary of the MWL dump , and 3). at locations immediately surrounding and downgradient of the MWL dump.

The proposed LTMMP [4] requires the long-term groundwater monitoring network to include the five unreliable contaminant detection monitoring wells MWL-MW5, -MW6, -MW7, -MW8 and -MW9 and the background water quality monitoring well MWL-BW2. DOE/Sandia do not include monitoring well MWL-MW4 for collection of groundwater samples in the LTMMP. The plan for well MWL-MW4 is as follows in the November 2007 LTMMP [4]**:**

> The DOE/Sandia intend to leave MWL-MW4 in place but not include it in annual sampling because it is not a point-of-compliance well. The packer pressure will be maintained and the well will be available for discretionary sampling (p. 3-26).

The proposed plan of DOE/Sandia for the defective monitoring well MWL-MW4 is contrary to the requirement of the Consent Order for plugging and abandonment and replacement of wells that do not meet their intended purpose. The 1998 NMED NOD Report [10] described the fact that the upper screen in well MWL-MW4 was installed too deep below the water table for the well to be usable for the intended purpose to measure contamination or water elevation at the water table below the Sandia MWL dump. The 1998 NMED NOD Report [10] is summarized in Section 5.6 and a copy of the NOD Report is in Appendix A. Figure 7 shows that the upper screen in well MWL-MW4 was installed too deep below the water table.

Monitoring well MWL-MW4 was installed in an angle borehole drilled below Trench D to investigate groundwater contamination at the water table from the 270,500 gallons of liquid wastes [2] dumped into the trench. A replacement well for well MWL-MW4 requires that a new angle borehole is drilled through the soil cover at an appropriate location to characterize and monitor groundwater contamination at the water table below Trench D.. The NMED assured the public in the NMED November 2006 Response to Comments [74] on the MWL dump Corrective Measures Implementation Plan that drilling through the cover was not an issue as follows:

> Replacement wells can be installed through a vegetative soil cover without risking damage to the cover, as such covers are by nature of simple design (p.22).

Monitoring well MWL-MW4 should have been replaced soon after the NMED 1998 NOD Report [10] recognized the well required replacement. The need to replace well MWL-MW4 was recognized by the NMED HWB in 1998 and more than eight years before the dirt cover was installed over the MWL dump. The NMED Consent Order [1] issued in May 2005 requires DOE/Sandia to plug and abandon the defective monitoring well MWL-MW4 and install a new reliable monitoring well to investigate groundwater contamination at the water table below Trench D as follows:

> In the event of a well or piezometer failure, or if a well or piezometer is any way no longer usable for its intended purpose, it must be replaced with an equivalent well or piezometer (p. 63).

The above requirement from page 63 in the Consent Order [1] for DOE/Sandia to replace the defective monitoring well MWL-MW4 is also applicable to the five defective contaminant detection monitoring wells MWL-MW5, -MW6, -MW7, -MW8 and -MW9. The five monitoring wells are installed too deep below the water table to meet the intended purpose to monitor contamination at the water table. Figure 7 shows that the screens in wells MWL-MW5 and -MW6 are screened below the water table. The DOE/Sandia MWL annual groundwater monitoring report issued in June 2010 describes wells MWL-MW5 and -MW6 as not used to monitor elevation of the water table. (See Table 4.1-1 from the DOE/Sandia annual report in Section 3.7 of this report.

Section 3 of this report describes the factors that prevent the new monitoring wells MWL-MW7, -MW8 and -MW9 from being usable for the intended purpose as RCRA point-of-compliance monitoring wells installed at the water table. The deep water levels measured in the three monitoring wells show that the three wells do not monitor contamination at the water table or the elevation of the water table along the western boundary of the MWL dump.

The five monitoring wells MWL-MW4, -MW5, -MW7, -MW8 and -MW9 should be plugged and abandoned because the five wells are not usable for any purpose. Monitoring well MWL-MW6 has continued value for the measurement of water levels in the ARG Deposits and should not be plugged and abandoned. The long-term value of well MWL-MW6 is not known at this time because the direction and speed of travel of groundwater in the ARG Deposits at the location of the Sandia MWL dump is not known.

11.1.2. A reliable network of monitoring wells is required at the water table below the Sandia MWL dump but was not installed. The direction of ground-water flow at the water table below the Sandia MWL dump is not accurately known but is to the south or southwest. The best contour map for the direction of groundwater flow at the water table below the MWL dump is displayed in Figure 14. The contour map shows the direction of groundwater flow at the water table is to the southwest but is more to the south than to the west.

Given the south/southwest flow of groundwater at the water table, monitoring wells at the water table are required at locations close to the southern and western side of the MWL dump. Three new monitoring wells are required along the western boundary of the MWL dump to replace the three defective monitoring wells MWL-MW7, -MW8 and -MW9. In addition, four new monitoring wells are necessary with two of the wells located along the southern boundary of the unclassified area and two of the wells located along the southern boundary of the classified area.

The two monitoring wells along the southern boundary of the classified area of the MWL dump are necessary because of the long history of waste disposal operations in the classified area beginning in 1959 [43] and the very slow speed of lateral groundwater travel at the water table of only 17 feet in 100 years [9]. With reference to Figure 3, one of the monitoring wells along the southern boundary of the classified area should be located south of Pit SP-1 where a large and unknown inventory of chemical wastes including liquid wastes were disposed of over the 4-year period from 1959 to 1962 [43]. An appropriate location for the second monitoring well along the southern side of the classified area is in close proximity to Pit 10 in the southwestern corner of the classified area. The location of Pit 10 is displayed on Figure 3.

The water table in the fine-grained alluvial fan sediments is located at a distance greater than 460 feet below ground surface. The contamination released from the unlined trenches and pits may move laterally an unknown distance during the downward travel to contaminate the groundwater below the MWL dump. The cadmium, chromium, nickel and nitrate contamination detected in monitoring well MWL-MW1 is evidence of the lateral travel in the vadose zone of the contamination released from the unlined trenches and pits in the MWL dump. Figure 6 shows the location of monitoring well MWL-MW1 50 feet north of the northern boundary of the MWL dump.

The unknown direction and distance of lateral travel of contamination downward below the unlined pits and trenches at the MWL dump requires the monitoring well network at the water table to also include monitoring wells installed at locations north and east of the MWL dump . The 1998 NMED NOD Report [10] and the Consent Order [1] require a new monitoring well in close proximity to the former location of monitoring well MWL-MW1 to resolve the source for the high nickel concentrations measured in groundwater samples collected from the well. Well MWL-MW1 was plugged and abandoned in 2008 and not replaced with a new monitoring well at that location.

In addition, because of the unknown lateral travel of contamination in the vadose zone on pathways down to the water table, a new monitoring well should be installed at an appropriate location north of the unclassified area of the MWL dump; one new monitoring wells should be installed east of the classified area of the MWL dump; and one new monitoring well should be installed east of the unclassified area of the MWL dump.

An additional important reason to install new monitoring wells at the water table east of the MWL dump is to resolve the uncertainty in the elevation of the water table at the location of the new background water quality monitoring well MWL-BW2 that is located 200 feet east of the southeast corner of the classified area. There is uncertainty in the elevation of the water table at the location of well MWL-BW2 because of 1). the use of an incorrect drilling method; 2). the improper drilling operations; and 3). the 30-ft length of the well screen. These issues are discussed in Sections 3.5 and 3.6.

A special problem is the failure of DOE/Sandia and the NMED HWB to characterize the tritium and VOC contamination in the unsaturated zone and in the groundwater below the classified area of the MWL dump. The known inventory of tritium wastes buried in pits in the central and southern region of the classified area is 1,450 curies which is 60% of the total inventory of 2400 curies of tritium wastes buried at the MWL dump. Figure 17 shows the inventory of tritium buried in the discrete pits in the classified area. A large new release of tritium wastes into the unsaturated zone below the unlined pits and trenches at the MWL dump was discovered in the incorrectly designed DOE/Sandia field study in 2008. The new large release of tritium contamination and possibly other contamination from the MWL dump to the vadose zone below the is described in Section 10.

The long history of disposal of tritium wastes and other wastes in the classified area of the MWL dump and the very slow lateral speed of travel of groundwater in the fine-grained alluvial fan sediments of only 0.17 feet per year [9] (i.e., only 17 feet in 100 years) requires the installation of two new monitoring wells at locations inside the MWL dump to characterize and monitor groundwater contamination at the water table immediately downgradient from where the large inventory of tritium wastes and other contaminants are buried in the central and southern region of the classified area. The locations for the two new monitoring wells inside the MWL dump should be selected after accurate knowledge of the direction of groundwater flow at the water table is gained from the installation of the new monitoring wells at locations outside the MWL dump. Core shall be collected from the boreholes for the new wells. The core shall be analyzed for tritium contamination and other contaminants of concern including trace metals. Soil gas samples shall be collected from the boreholes for analysis of tritium and solvents.

11.1.3. A reliable network of monitoring wells is required in the ARG Deposits at the Sandia MWL dump. A monitoring well network was not installed in the ARG Deposits below and downgradient of the Sandia MWL dump although this network is a mandatory requirement of both the NMED Consent Order [1] and RCRA. The regulatory requirements are discussed in Section 7. The direction of groundwater flow in the ARG Deposits is not accurately known but the best information is that the direction of flow is to the northwest. A phased approach should be used to install the required network of monitoring wells in the ARG Deposits. In the first phase, contaminant detection monitoring wells should be installed at appropriate locations north and west of the MWL dump. The water quality data and water levels measured in the new wells along with the water level measured in the existing well MWL-MW6 will be used to select the locations for additional contaminant detection monitoring wells and the background water quality monitoring well. The background well shall be installed in the ARG Deposits at an appropriate location that is hydraulically upgradient from the MWL dump.

11.2. The proposed soil gas monitoring well network in the unsaturated zone below the Sandia MWL dump is technically unsupportable. The soil gas monitoring well network proposed in the DOE/SANDIA 2007 LTMMP [4] is too sparse with only three vertical monitoring wells located outside the boundary of the dirt cover. The locations of the three proposed vadose zone monitoring wells are displayed on Figure 31.

11.2.1. The proposed network of three vadose zone monitoring wells is not adequate to protect groundwater from contamination from the solvent and tritium wastes buried in the Sandia MWL dump. The DOE/Sandia proposed 2007 LTMMP [4] does not include monitoring the vadose zone for tritium. Monitoring for tritium is a requirement because of the new large release of tritium to the vadose zone that was discovered in the limited 2008 field investigation [68]**.** The large new release of tritium is discussed in Section 10. It is important for the monitoring well network in the LTMMP to include wells at appropriate locations to monitor for tritium contamination in the vadose zone <u>below</u> the unlined pits and trenches. The required monitoring of the tritium contamination can be accomplished by the analysis of soil-gas samples for tritium. The analysis of tritium concentrations in soil-gas samples collected from multiple-port monitoring wells is a routine monitoring activity at the Los Alamos National Laboratory.

The proposed network of three vadose zone monitoring wells is described as follows in the DOE/Sandia 2007 LTMMP:

> VOC concentrations with depth shall be monitored using three Flexible Liner Underground Technologies (FLUTe™) soil-vapor monitoring wells (hereinafter referred to as FLUTe™ wells) that provide data regarding VOC concentrations versus depth. <u>The FLUTe™ wells are constructed in vertical boreholes located immediately outside the perimeter of the MWL cover with the locations selected near areas where the highest concentrations of VOCs were detected during earlier studies at the MWL</u> [Emphasis supplied]. Figure 3.4.1-1 [Figure 30 in this report] shows the locations of the three FLUTe™ wells. Soil-vapor sampling ports were installed in each FLUTe™ well at depths of 50, 100, 200, 300, and 400 feet. <u>Soil-vapor data collected from the FLUTe™ wells will be used to assess current VOC distributions with depth and to monitor VOC concentrations over time, allowing early identification of any potential threats to groundwater</u> [Emphasis supplied] (p. 3-12).

NOTE. The three FLUTe™ wells have not been installed at this time. The text of the DOE/Sandia 2007 proposed LTMMP was written in the past tense because the report was submitted to NMED before the required date of <u>**after**</u> the NMED's approval of the DOE/Sandia Corrective Measures Implementation Report. This issue is discussed above at the beginning of Section 11.

The three FLUTe™ wells are not a sufficient number of vadose zone monitoring wells to allow early identification of any potential threats to groundwater from the VOCs and tritium wastes buried in the MWL dump. In addition, the proposed locations of the three FLUTe™ wells are not close to the areas where the highest concentrations of VOCs were measured during earlier studies at the MWL dump.

Figure 26 shows that the highest concentrations of Total VOC contamination measured in the 1994 field investigations were in soil gas samples collected from borehole #10 located inside the northern quadrant of the unclassified area between Trenches B and C. The location of borehole #10 and the measured concentrations of Total VOCs and PCE are displayed on Figures 26 and 27. The measured concentrations for Total VOCs and PCE were as follows:

- Total VOCs [10 ft bgs – 30,700 ug/L, 30 ft bgs – 27,700 ug/L (22,000 ug/L, duplicate)]
- PCE [10 ft bgs – 1,700 ug/L, 30 ft bgs – 2,700 ug/L (2,200 ug/L, duplicate)]

Comparison of Figure 31 to Figures 26 and 27 shows that the proposed locations for the three FLUTe™ wells are not close to borehole #10 or the other boreholes where high concentrations of Total VOCs or PCE were measured.

FLUTe™ well VW-1. Comparison of Figure 31 to Figures 26 and 27 shows that proposed well VW-1 is located west of the boundary of the dirt cover and west of the northwestern quadrant of the unclassified area. Well VW-1 is located approximately 15 feet northeast of the 1994 second round borehole #2 where the following **<u>low</u>** VOC concentrations were measured in soil gas samples collected at 10 ft bgs and 30 ft bgs:

- Total VOCs [10 ft bgs – 160 ug/L, 30 ft bgs – 830 ug/L]
- PCE [10 ft bgs – 160 ug/L, 30 ft bgs – 360 ug/L]

The lateral distances between borehole #10 and borehole #2 and the proposed FLUTe™ well VW-1 are 130 feet and 140 feet, respectively. Accordingly, the low VOC concentrations measured in borehole #2 indicate that low VOC concentrations will also be measured in FLUTe™ well VW-1. ***In summary, the proposed location for FLUTe™ well VW-1 does not provide "early identification of any potential threats to groundwater."***

FLUTe™ well VW-2. Comparison of Figure 31 to Figures 26 and 27 shows that proposed well VW-2 is located west of the boundary of the dirt cover and west of the southwestern quadrant of the unclassified area. Well VW-2 is located approximately 35 feet west of the 1994 third round borehole #1 where low concentrations of Total VOCs and PCE were measured in soil gas samples. Even lower concentrations of VOCs will by expected at the proposed location of FLUTe™ well VW-2 because of the further distance from the MWL dump. The low concentrations measured in borehole #1 follow:

- Total VOCs [10 ft bgs – 326 ug/L, 30 ft bgs – 893 ug/L]
- PCE [10 ft bgs – 130 ug/L, 30 ft bgs – 300 ug/L]

Comparison of the proposed location of FLUTe™ well VW-2 on Figure 31 to the locations of the 1994 and 2008 boreholes on Figures 26 and 27 shows that the FLUTe™ well VW-2 is located a great distance from any borehole where high concentrations of Total VOCs and PCE were measured. ***In summary, the proposed location for FLUTe™ well VW-2 does not provide "early identification of any potential threats to groundwater."***

FLUTe™ well VW-3. Comparison of Figure 31 to Figures 26 and 27 shows that proposed well VW-3 is located east of the boundary of the dirt cover and approximately 50 feet southeast of the southeastern corner of the classified area. The proposed location for well VW-3 is inappropriate because of the low concentrations of Total VOCs and PCE that were measured in the soil gas samples collected from the two first round 1994 boreholes #16 and #17. Even lower VOC concentrations will be expected at the proposed location for FLUTe™ well VW-3. The low concentrations measured in boreholes #16 and #17 follow:

Borehole #16

- Total VOCs [10 ft bgs – 142 ug/L, 30 ft bgs – 310 ug/L]
- PCE [10 ft bgs – 34 ug/L, 30 ft bgs – ND (not detected)]

Borehole #17

- Total VOCs [10 ft bgs – 125 ug/L, 30 ft bgs – 330 ug/L]
- PCE [10 ft bgs – 32 ug/L, 30 ft bgs – ND (not detected)]

In summary, the proposed location for FLUTe™ well VW-3 does not provide "early identification of any potential threats to groundwater."

The proposed locations for the three FLUTe™ wells in the DOE/Sandia 2007 LTMMP are inappropriate. The description in the proposed 2007 LTMMP that the vadose zone monitoring wells will be installed ***"near areas where the highest concentrations of VOCs were detected during earlier studies at the MWL"*** requires that the monitoring wells are installed inside the boundaries of the MWL dump. Monitoring wells are required in the northern part of the unclassified area near the locations of the eight 1994 boreholes #5, #6, #7, #8, #9, #10 and #11 because of the high concentrations of VOCs that were measured in the soil gas samples collected from the boreholes.

A monitoring well is also required at the southern boundary of the classified area at the location of the 2008 probehole DP3 because of the high concentrations of Total VOCs that were measured in the soil gas samples with the highest concentrations of Total VOCs, PCE and TCE measured in the soil gas samples collected at the depth of 50 ft bgs. The nature and extent of VOCs contamination in the vadose zone at probehole DP3 is unknown and yet to be determined.

An additional problem is that the nature and extent of the VOCs and tritium contamination in the vadose zone below the MWL dump was not accomplished in the limited 2008 field investigation [68] or in the earlier RCRA RFI investigations [69] in 1994 and 1995. For example, Table 5 shows the large increase in contamination in the soil gas samples collected at the depth of 30 ft bgs compared to the lower concentrations measured in the samples collected at 10 ft bgs. Even higher contaminant concentrations are expected to be present at greater depths below 30 ft bgs.

Moreover, another problem is that the presence of VOCs and tritium contamination in the vadose zone below the trenches in the southern quadrant of the unclassified area and in the vadose zone below the pits in the classified area of the MWL dump was not adequately investigated in the limited 2008 field investigation or the earlier RCRA RFI field investigations in 1994. A new comprehensive investigation of the nature and extent of contamination in the vadose zone below the MWL dump is required in order to install the required network of monitoring wells in the vadose zone for the long-term monitoring of the release of contamination from the unlined pits and trenches.

The three proposed FLUTe™ wells in the DOE/Sandia 2007 LTMMP are not at appropriate locations to monitor the release of tritium contamination from the large inventory of tritium wastes buried in the unlined pits in the classified area of the MWL dump. Three vadose zone monitoring wells are not enough and the distance of the three proposed monitoring wells from the unlined disposal pits in the classified area is too great. For example, the distance of each proposed FLUTe™ well from the very large inventory of 822 Curies of tritium wastes buried in Pit 33 in the classified area is as follows:

- Proposed FLUTe™ well MWL-VW1 is located ~ 300 feet west of Pit 33.
- Proposed FLUTe™ well MWL-VW2 is located ~ 350 feet southwest of Pit 33.
- Proposed FLUTe™ well MWL-VW3 is located ~ 150 feet southeast of Pit 33.

The comparison of Figure 20 to Figure 22 shows that borehole DP1 was the closest borehole to Pit 33 and the other pits in the classified area where a large inventory of tritium wastes are buried. Figure 20 shows the tritium contamination measured in core samples collected at the depth of 10 feet below ground surface (ft bgs) and 30 ft bgs from borehole DP1 as follows:

- 10 ft bgs – 75,400 pCi/L
- 30 ft bgs – 1,270,000 pCi/L

The tritium contamination measured at 30 ft bgs in borehole DP1 is 16.8 times greater than the measured concentration at 10 ft bgs. The tritium contamination at depths greater than 30 ft bgs at the location of borehole DP1 and below the unlined pits in the classified area of the MWL dump is not known but must be investigated. The tritium contamination below the unlined pits in the classified area is expected to be at much higher concentrations than measured at borehole DP1. It is important to install a multiple-port vadose zone monitoring well at an appropriate location between borehole DP1 and Pit 33.

11.3. The proposed soil moisture monitoring in the unsaturated zone is not protective and must be revised. The proposal in the DOE/Sandia 2007 LTMMP is to monitor the travel of water through the dirt cover installed over the surface of the MWL dump with neutron probe measurements in three angled access holes (described as access tubes) installed below the unlined pits and trenches at the MWL dump. The locations where DOE/Sandia has already installed the three angled access holes below the MWL dump are displayed on Figure 31 as MWL-VZ1, MWL-VZ-2 and MWL-VZ-3.

Figure 31 shows that the coverage of the three access holes is too limited to provide information regarding water flowing through the cover, through the buried wastes and carrying contamination into the vadose zone below the unlined pits and trenches. The NMED HWB issued a Notice of Disapproval (NOD) letter on October 10, 2008 for the DOE/Sandia Corrective Measures Implementation Plan that rejected the use of the neutron probe access holes for long-term monitoring of the performance of the dirt cover as follows:

> **Part 2 Comments –** comment #3. In NOD Comment 9, the NMED concluded that the neutron probes will only be able to evaluate soil moisture at depths in the vadose-zone that are considerably deeper than the base of the soil cover. Because it would take substantial time for moisture to move through the vadose zone to the depths of the neutron probe access tubes, and because the current design does not monitor for breakthrough of moisture from the cover to the waste, NMED does not agree that such moisture monitoring offers the best possible design for an early warning system. Thus, NMED will place more emphasis on other types of monitoring in the LTMMP.

The January 31, 2006 report by TechLaw inc.[47] advised the NMED that the neutron probe access holes installed below the buried wastes were a mistake because they did not monitor the breakthrough of moisture from the cover to the waste. The TechLaw Inc. report recommended the installation of instrumentation in the dirt cover to measure the breakthrough of moisture but the dirt cover installed over the dump did not include the instrumentation.

Section 12.0. The DOE/Sandia fate and transport computer modeling does not recognize the groundwater contamination from the highly toxic wastes buried in the Sandia MWL dump. As part of the Final Order [46] selecting the dirt cover remedy for the Sandia MWL dump, the New Mexico Environment Department (NMED) required that the Corrective Measures Implementation Plan (CMIP) include a comprehensive fate and transport computer model. One purpose of the computer model was to determine if contaminants will move from the unlined pits and trenches at the MWL dump down through the vadose zone to groundwater.

DOE/Sandia performed the fate and transport computer modeling as a probabilistic performance assessment to evaluate the potential for groundwater contamination from the highly toxic wastes buried in the Sandia MWL dump. The findings from the computer modeling were presented in two editions of a DOE/Sandia fate and transport report titled *"Probabilistic Performance-Assessment Modeling of the Mixed Waste Landfill at Sandia National Laboratories"* by Chris Ho, Tim Goering, Jerry Peace, and Mark Miller (the DOE/Sandia FTM Report). The First Edition was published in November 2005 [78] and the Second Edition in January 2007 [2]**.** The Second Edition includes revisions to address comments made by the NMED in November of 2006.

A major reason that the NMED should order DOE/Sandia to retract the 2007 FTM Report [2] is because the computer modeling does not recognize that the wastes buried in the MWL dump have contaminated the groundwater with cadmium, chromium, nickel, nitrate and possibly the highly toxic solvent tetrachloroethene (PCE). The 2007 FTM Report rejected the computer calculations that determined the groundwater is now contaminated with PCE. PCE is a contaminant in the vadose zone below the MWL dump. <u>The PCE has probably contaminated the groundwater but is prevented from detection by the defective monitoring well network at the MWL dump.</u>

Only two the seven monitoring wells installed at the MWL dump (i.e., wells MWL-MW1 and -MW3) were at locations that could detect groundwater contamination released from the unlined pits and trenches. The two monitoring wells had well-known features that prevented the wells from detecting the PCE contamination in the groundwater. The irony is that DOE/Sandia discarded the findings in the 2007 FTM Report [2] that the PCE wastes released from the MWL dump have contaminated the groundwater in favor of the unreliable data from the defective monitoring well network that indicates the groundwater is not contaminated with PCE. The features that prevented monitoring wells MWL-MW1 and -MW3 from being able to detect PCE contamination in the groundwater below the MWL dump are described in Section 9 and summarized below in Section 12.2.

12.1. The DOE/Sandia 2007 FTM Report [2] does not recognize the groundwater contamination that has been present for more than the past 20 years from the wastes buried in the Sandia MWL dump. The available groundwater analytical data from 1990 to the present time show that the groundwater below the Sandia MWL dump is contaminated with cadmium, chromium, nickel and nitrate wastes released from the unlined pits and trenches in the MWL dump. The scientific basis for the groundwater contamination is from the comparison of analytical results for groundwater samples collected from monitoring wells MWL-MW1 and -MW3 to the analytical results from the new background monitoring well MWL-BW2 that was installed in 2008. Previous to 2008, the MWL dump had no upgradient groundwater monitoring well for assessment of background water quality.

The cadmium, chromium, nickel and nitrate groundwater contamination was present in the groundwater samples collected from the two monitoring wells MWL-MW1 and -MW3 beginning with the first water samples collected in 1990. The DOE/Sandia 2007 FTM Report [2] does not recognize the groundwater contamination that has been present for more than the past 20 years from the wastes buried in the MWL dump.

The failure of the computer modeling to recognize the known groundwater contamination is an important reason the DOE/Sandia 2007 FTM Report [2] must be retracted. The evidence under RCRA criteria that the wastes buried in the MWL dump have contaminated the groundwater with cadmium, chromium, nickel and nitrate is presented in Section 9.8 and also in Section 8 for the nickel contamination.

A second reason that the NMED should order the retraction of the DOE/Sandia 2007 FTM Report is that neither version 1 or version 2 were provided to the public for review and comment as required for major documents by the May 26, 2005 Final Order [46]. The FTM Report was a major document because it was required by the Final Order. The required process for public review is described in Section 11.0.

The comparison of the water quality data from the monitoring well network at the MWL dump to the conclusions presented in the DOE/Sandia FTM Report shows

- 1). the inadequate design of the computer modeling and
- 2). the arbitrary and inconsistent application by DOE/Sandia of the conclusions from the computer modeling.

First, the 2007 FTM Report [2] authors accepted the conclusion from the computer model that the MWL dump would not contaminate the groundwater with trace metal or radionuclide contaminants for the next 10,000 years. However, as discussed below, the water quality data from the monitoring wells show that the MWL dump is the source for the trace metal cadmium, chromium and nickel contamination that is reliably detected in the groundwater beginning in 1990.

Secondly, the 2007 FTM Report [2] authors ignored the conclusion from the Monte Carlo computer modeling and also from an earlier computer modeling study in 1995 [79] that the groundwater beneath the MWL dump is currently contaminated with the highly toxic solvent tetrachloroethene (PCE). Instead, the authors cited the monitoring well network at the MWL dump as evidence the groundwater is not contaminated with PCE. However, the monitoring wells are defective by wrong location, corrosion and other factors compromising the water quality data for full knowledge of the detection and the nature and extent of PCE contamination in the groundwater. The factors that prevent the detection of the PCE groundwater contamination are described in Section 9 and summarized below in Section 12.2.

The DOE/Sandia FTM Reports [2, 78] used a probabilistic performance assessment methodology known as “Monte Carlo simulations” in the computer modeling because of

- 1). the great uncertainty concerning the type and amount of wastes buried in the unlined pits and trenches at the MWL dump,
- 2). the great uncertainty in the chemical properties of the commingled wastes that increase the potential for groundwater contamination to occur and
- 3). the great uncertainty in the properties of the contaminant travel pathways in the vadose zone below the MWL dump.

The contaminants that were assessed in the computer modeling for danger to contaminate the groundwater below the MWL dump included heavy metals, radionuclides and volatile organic compounds (VOCs) as follows:

- Heavy Metals – The only heavy metals included in the computer modeling with Monte Carlo simulations were cadmium and lead. The DOE/Sandia FTM Reports [78,2] used the Monte Carlo simulations to make the incorrect conclusion that none of the heavy metals (lead and cadmium) contaminated the groundwater below the MWL dump during a period longer than the next 10,000 years as follows:

- Neither lead nor cadmium were simulated to reach the groundwater in 1,000 years (or extended periods past 10,000 years) (p. 75).

The above conclusion from the computer modeling is shown to be incorrect by the testimony at the NMED December 2004 Public Hearing that described the cadmium contamination that is currently present in the groundwater below the MWL dump. In addition, the NMED November 2006 Moats Report [31] presented extensive water quality data that documented the cadmium contamination in the groundwater below the MWL dump (see Section 9.8.3 of this report). The cadmium contamination in the groundwater below the MWL dump is discussed below in Section 12.3.

The DOE/Sandia computer modeling did not include assessment of the danger for the other heavy metal wastes that are known to be buried in the MWL dump to contaminate the groundwater. The other heavy metals include in part beryllium, chromium and nickel. The study of the historic groundwater quality data is proof that the groundwater below the MWL dump is contaminated beginning with the first groundwater samples collected in 1990 and up to the present time in 2011 with the heavy metals cadmium, chromium and nickel from the wastes buried in the dump. The nickel, chromium and cadmium contamination in the groundwater from the wastes in the MWL dump is discussed in Sections 9.8.1, 9.8.2 and 9.8.3 of this report, respectively.

- Radionuclides – The radionuclides assessed for groundwater contamination in the DOE/Sandia FTM Reports [78,2] include americium-241, cesium-137, cobalt-60, plutonium-238, plutonium-239, radium-226, radon-222, strontium-90, thorium-232, tritium and uranium-238. The computer modeling with Monte Carlo simulations predicted that none of the radionuclides would contaminate the groundwater below the MWL dump during a 1,000 year evaluation period as follows:

- None of the radionuclides were simulated to reach the groundwater within 1,000 years for all realizations (p. 74).

The Monte Carlo simulations in the DOE/Sandia FTM Reports [78,2] do not recognize that the wastes buried in the MWL dump have already contaminated the groundwater with cadmium. The conclusion in the 2007 FTM Report [2] based on computer modeling that the cadmium wastes will not contaminated the groundwater with the trace metal cadmium is obviously incorrect. The failure of the computer modeling to recognize the groundwater contamination from the heavy metal cadmium means the computer modeling is also not reliable to predict groundwater contamination from the radionuclides that are heavy metals including americium-241, cesium-137, cobalt-60, plutonium-238, plutonium-239, radium-226, radon-222, strontium-90, thorium-232, and uranium-238.

- Volatile Organic Compounds (VOCs) – The solvents (i.e., VOCs) known to be present as soil-gas contamination in the vadose zone below the MWL dump include in part tetrachloroethene (PCE), trichloroethene (TCE), dichloro-difluoromethane, 1,1,1-trichloroethane (1,1,1-TCA), trichlorofluoromethane, and 1,1,2-trichloro,1,2,2-trifluoroethane. However, PCE was the only VOC assessed with computer modeling in the DOE/Sandia FTM Reports [78,2] for danger to contaminate the groundwater below the MWL dump. The Monte Carlo simulations identified that the groundwater is currently contaminated with PCE at concentrations the Environmental Protection Agency (EPA) has determined to cause cancer in drinking water [66]. The DOE/Sandia 2007 FTM Report [2] disregarded the findings from the computer modeling that the groundwater was contaminated with PCE in favor of the unreliable groundwater monitoring data for the MWL dump as follows:

> Groundwater monitoring for VOCs at the MWL has been conducted for sixteen years, since September 1990, and there is no evidence that wastes from the MWL have contaminated groundwater (p.72).

<u>The above statement continues the long-standing practice by DOE/Sandia and NMED to ignore the overall failure of the groundwater monitoring at the Sandia MWL dump.</u> All of the monitoring wells at the MWL dump were known to be defective for the detection of PCE contamination in the groundwater (see discussion below in Section 12.2). In addition, the high-flow purging and sampling methods used to collect the groundwater samples had well known properties to prevent detection of PCE contamination. The defective monitoring well network is extensively described in other sections of this report and is summarized below.

12.2. The monitoring well network installed at the Sandia MWL dump during the RCR RFI Phase 2 Investigation was defective and all of the monitoring wells required replacement. The DOE/Sandia FTM Reports [78,2] did not acknowledge the many reports in the NMED Administrative Record that described the need to replace the defective groundwater monitoring well network at the MWL dump. Instead, the DOE/Sandia 2007 FTM Report [2] makes the following statement:

> The Phase 2 RCRA facility investigation was completed in 1995. This investigation included . . passive and active soil gas sampling; borehole drilling; installation of groundwater monitoring wells; groundwater sampling; vadose zone tests; aquifer tests; and risk assessment (p.13).

The DOE/Sandia FTM Reports [78,2] do not discuss the many deficiencies in the Phase 2 RCRA Facility Investigation that were described in the NMED 1998 Notice of Deficiency (NOD) Report [10] for the Phase 2 RCRA Facility Investigation. The NMED NOD Report is summarized in Section 5.6 of this report. A copy of the report is in Appendix A. The above list of activities in the Phase 2 RCRA facility investigation are discussed below:

<u>Soil-gas sampling.</u> Section 10 of this report describes the reasons the soil-gas sampling performed during the Phase 2 RCRA Facility Investigation was inadequate. The primary reasons were 1). the insufficient number of soil-gas boreholes at locations near the individual trenches and pits, and 2). the soil-gas samples were collected only to a maximum depth of 30 feet below ground surface.

However, the knowledge gained from the soil-gas VOC plume below the Sandia Chemical Waste Landfill (CWL dump) showed the need to collect soil-gas samples to a minimum depth of 250 feet below the Sandia MWL dump. Figure 30 shows that the maximum soil-gas VOC contamination in the vadose zone below the CWL dump were at a depth of greater than 200 feet below ground surface. Figure 30 shows that the collection of soil gas samples only to a maximum depth of 30 feet below ground surface at the MWL dump was not sufficient to characterize the nature and extent of the soil-gas VOC contamination in the vadose zone below the MWL dump.

Borehole drilling. The locations of the seven defective monitoring wells at the MWL dump at the time of the DOE/Sandia 2007 FTM Report are displayed on Figure 6. Three of the seven defective monitoring wells at the MWL dump (wells MWL-MW2, -MW3 and -BW1 were drilled with the mud-rotary method and the screened intervals were contaminated with bentonite clay drilling muds. The bentonite clay drilling muds have well known properties to prevent monitoring wells

- 1). from producing reliable and representative water samples for detection of contaminants of concern for the MWL dump and
- 2). from producing reliable aquifer test data for the calculation of the lateral speed of groundwater travel.

The NMED 1998 NOD Report [10] rejected the data collected from the aquifer tests performed in the MWL dump monitoring wells during the Phase 2 RCRA Investigation. In addition, the NMED 1993 Report by Moats and Winn [23] described the three mud-rotary monitoring wells at the MWL dump as follows:

> The use of mud-rotary drilling methods should be avoided in any future monitor well installations at the MWL. Mud rotary is not a preferred drilling technology due to its potential detrimental impacts to ground-water quality and the hydraulic characteristics of an aquifer (p. 3).

Installation of groundwater monitoring wells. All of the seven monitoring wells at the MWL dump that are displayed on Figure 6 were deficient for the intended purpose of monitoring groundwater contamination at the water table below and hydraulically downgradient of the dump. The need to replace the seven wells was understood soon after the wells were installed. None of the wells were replaced until 2008. Section 5 summarizes six reports issued over the years 1991 to 1998 that describe the reasons the seven monitoring wells were defective and required replacement.

- Incorrect well locations and incorrect depth of well screens. The NMED 1998 NOD Report [10] recognized that

- 1). well MWL-MW1 was the only monitoring well installed at an appropriate location hydraulically downgradient from the MWL dump and
- 2). well MWL-MW4 required replacement because the upper screen was installed too deep below the water table.

In addition, the geologic cross-section in Figure 7 shows that the screens in wells MWL-MW4, -MW5 and -MW6 were installed too deep to monitor contamination from the MWL dump. Moreover, Figure 6 shows the incorrect locations of the contaminant detection monitoring wells MWL-MW2, -MW5, -MW6 and the background water quality monitoring well MWL-BW1 because of the southwest direction of groundwater flow at the water table below the MWL dump. The best knowledge of the southwest direction of groundwater flow at the water table below the MWL dump is displayed on the contour map in Figure 14. The comparison of Figures 6, 7 and 14 shows that the only two monitoring wells that were installed at locations that could detect groundwater contamination from the Sandia MWL dump were the defective monitoring wells MWL-MW1 and -MW3.

The groundwater contamination from the wastes buried in the MWL dump that were detected in the water samples collected from the two wells MWL-MW1 and -MW3 beginning with the first samples collected in 1990 included cadmium, chromium, nickel and nitrate. The nature and extent of the contamination is not known because the two monitoring wells were not a sufficient number and in addition, the two wells were defective for accurate knowledge of the groundwater contamination at the discrete locations of the two wells. However, the groundwater contamination detected in the two wells MWL-MW1 and -MW3 satisfy RCRA criteria as evidence of contamination from the wastes buried in the Sandia MWL dump. The contamination detected in the groundwater samples collected from the two monitoring wells is described in Section 9.8. The nickel groundwater contamination from the wastes buried in the MWL dump is also described in Section 8.

Other contaminants may have been present in the groundwater at the location of the two defective monitoring wells MWL-MW1 and -MW3 but detection was prevented because of

- 1). the mud-rotary drilling method used to install well MWL-MW3,
- 2). the corroded stainless steel screens that were present in the two wells beginning in 1992 [43] (See Section 9.6) and
- 3). the improper high-flow purging and sampling methods that stripped VOC contaminants including PCE from the water samples (See Section 9.7).

<u>The NMED HWB did not enforce the requirement in RCRA and the NMED Consent Order for the replacement of the defective monitoring wells MWL-MW1 and -MW3 with reliable monitoring wells to determine the nature and extent of groundwater contamination below the Sandia MWL dump at the location of the two defective wells.</u>

- **Corroded stainless steel well screens.** The stainless steel well screens in the four monitoring wells MWL-MW1, -MW2, -MW3 and -BW1 were recognized as corroded beginning in 1992 [43]**.** The properties of corroded stainless steel well screens to prevent the detection of the contaminants of concern for the wastes buried in the MWL dump is well known and extensively described in the technical literature. This issue is discussed in Section 9.6 of this report.

<u>Improper methods used for groundwater sampling.</u> The monitoring wells at the MWL dump were purged and sampled with improper high-flow pumping methods that purged wells MWL-1, -MW2, -MW3 -MW4 and -BW1 to dryness and collected water samples up to a week later from the highly aerated groundwater that slowly refilled the monitoring wells. The combination of the corroded well screens and the purge-to-dry sampling methods had a synergistic effect to prevent the detection of heavy metal contaminants and VOC contaminants in the groundwater samples collected from five of the seven monitoring wells. Keep in mind that only wells MWL-MW1 and MWL-MW3 were at locations that could detect groundwater contamination from the MWL dump. The incorrect high flow purge-to-dry sampling methods are discussed further in Section 9.7 of this report.

Unreliable data collected from aquifer tests. The NMED 1998 NOD Report [10] rejected the aquifer test data that was collected from the defective monitoring wells in the Phase 2 RCRA Facility Investigation. Nevertheless, DOE/Sandia [9] continued to use the rejected aquifer test data to calculate lateral travel times for groundwater below and away from the MWL dump in the fine-grained alluvial fan sediments and in the ARG Deposits. This issue is discussed in Section 5.6 of this report. A copy of the NMED 1998 NOD Report is in Appendix A.

Risk Assessment. A risk assessment was not performed for groundwater contamination in the Phase 2 RCRA Facility Investigation. The presence of groundwater contamination for the four constituents cadmium, chromium, nickel and nitrate were in the analytical results for the water samples collected in the early 1990s from monitoring wells MWL-MW1 and -MW3. However, the groundwater contamination was not recognized in the Phase 2 RCRA Facility Investigation (RFI) Report [69]**.** The water quality data in the 1996 Phase 2 RFI Report were not recognized by DOE/Sandia and NMED as evidence of groundwater contamination from the MWL dump because a reliable background monitoring well was not installed until 2008. The groundwater contamination beneath the MWL is presented in this Gilkeson/Citizen Action report Sections 9.8.1, 9.8.2, 9.8.3 and 9.8.4.

The NMED 1998 NOD Report [10] included a requirement for a risk assessment of the groundwater pathway to evaluate impacts from the cadmium, nickel and other contaminants in the groundwater but the risk assessment was not performed. See Deficiency No. 9.C. in the copy of the NOD Report in Appendix A.

12.3. The DOE/Sandia 2007 FTM Report does not recognize the cadmium contamination in the groundwater below the MWL dump. There is certain evidence under RCRA criteria that the groundwater below the MWL dump is contaminated with cadmium from the wastes buried in the dump. The evidence is presented in Section 9.8.3. The actual amount of the cadmium groundwater contamination is not known because a reliable network of monitoring wells was not installed at the MWL dump during the Phase 2 RCRA Facility Investigation up to the present.

The repeated detection of cadmium in the groundwater samples collected from the MWL dump monitoring wells is Finding No. 82 in the Hearing Officer's Report [43] for the NMED December 2004 Public Hearing. Finding 82 is pasted below:

> "82. Low levels of cadmium have been detected in approximately one-third of all groundwater samples collected since 1990, some above the EPA Maximum Contaminant Level ("MCL"). NMED attribute these elevated levels to laboratory error, due to evidence of quality control issues and subsequent sampling at lower levels [Emphasis supplied]."

The Hearing Officer’s Report determined that cadmium contamination was present in the groundwater below the MWL dump. There was only uncertainty if the amount of the contamination exceeded the EPA Drinking Water Standard MCL. The nature and extent of cadmium contamination in the groundwater below the MWL dump is still not known because a reliable network of monitoring wells was not installed.

The detection of cadmium in the groundwater samples collected from the MWL dump monitoring wells is described in the DOE/Sandia 2007 FTM Report [2] as follows:

> Cadmium has occasionally been detected in MWL groundwater at concentrations above the EPA MCL, although these detections are sporadic and unpredictable [Emphasis supplied]. Because the cadmium detections above the MCL are inconsistent, it is believed that these detections do not indicate contamination from the MWL. Nevertheless, cadmium is considered a contaminant of concern, and the fate and transport of cadmium was modeled (p. 14).

The primary reason the detection of cadmium in the MWL dump monitoring wells is "sporadic and unpredictable" is because the defective monitoring wells MWL-MW1 and -MW3 were the only monitoring wells at locations that could detect cadmium contamination from the MWL dump. However, the two monitoring wells did not provide reliable and representative groundwater samples for accurate knowledge of the cadmium groundwater contamination. The features in the two wells that prevented the detection of cadmium and other contamination from the MWL dump are described in Sections 1.7.1 and 9. The water quality data presented in Section 9.8.3 show that cadmium contamination from the MWL dump was detected under RCRA criteria in the groundwater samples collected from the two defective monitoring wells.

A contradiction in the DOE/Sandia 2007 FTM Report [2] is that the report acknowledges cadmium is occasionally detected in the groundwater below the MWL dump at concentrations above the EPA Drinking Water Standard of 5 ug/L. However, the 2007 FTM Report [2] then makes the obviously incorrect conclusion that no cadmium will reach the groundwater for a period longer than 10,000 years:

> Neither lead nor cadmium were simulated to reach the groundwater in all 100 realizations for 1,000 years. Extended simulation periods (>10,000 years) also did not yield any breakthrough of lead or cadmium to the water table (p. 52).

Because a reliable network of monitoring wells was not installed at the MWL dump, the full extent of the cadmium contamination in the groundwater has not been established.

The Monte Carlo simulations did not identify the existing contamination of cadmium in the groundwater. Therefore, the DOE/Sandia FTM Report [2] can not make accurate conclusions based on the Monte Carlo simulations that the groundwater below the MWL dump is not contaminated with cadmium, lead, other heavy metals, and the radionuclides that are heavy metals including americium-241, cesium-137, cobalt-60, plutonium-238, plutonium-239, radium-226, strontium-90, thorium-232, and uranium-238.

At the Sandia MWL dump, the NMED Hazardous Waste Bureau (HWB) has allowed DOE/Sandia to use the inaccurate and unreliable computer modeling results in the DOE/Sandia FTM Reports [2,78] instead of requiring accurate water quality data from a reliable network of monitoring wells. This practice by the NMED HWB is illustrated by the following excerpt from the NMED November 2006 Moats Report [31].

> Cadmium has been detected at low concentrations in the vadose zone, but only along the western boundary of the landfill. The fate and transport model of Ho et al (11/2005) predicts that groundwater is unlikely to be affected in the future by any of these contaminants occurring in the vadose zone. The results of up to 14 years of groundwater monitoring conducted at the MWL further support this conclusion (p. 5).

In fact, the above conclusion in the text of the NMED November 2006 Moats Report [31] is contradicted by the data in Appendix A of the 2006 Moats Report that show cadmium contamination in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 (see the discussion in section 9.8.3). In addition, the above conclusion in the November 2006 Moats Report is also contradicted by the finding No. 82 in the Hearing Officer's Report [43] that is discussed on the previous page and the groundwater quality data in Section 9.8 that show the groundwater is contaminated with cadmium, chromium, nickel and nitrate from wastes released from the MWL dump. The nature and extent of the cadmium and other groundwater contamination has been prevented from reliable and accurate detection by the unreliable monitoring well network with only the <u>two</u> defective monitoring wells MWL-MW1 and -MW3 at locations that can detect groundwater contamination from the MWL dump.
.
The November 21, 2006 NMED Response to Public Comments [75] for the DOE/Sandia Corrective Measures Implementation Plan is an important example of where the NMED used the incorrect conclusions in the DOE/Sandia 2005 FTM Report [78] to set aside public concerns for groundwater contamination from the wastes buried at the Sandia MWL Dump. For example, the first response by the NMED (Response R1) does not recognize the groundwater contamination from the MWL dump that at a minimum includes cadmium, chromium, nickel, nitrate and probably the highly toxic solvent tetrachloroethene (PCE). Moreover, Response R1 relies on the badly flawed and unreliable DOE/Sandia 2005 FTM Report as an assurance for "little chance that groundwater contamination will occur." Response R1 follows:

> The low levels of contaminants released from the Mixed Waste Landfill (MWL) have not caused groundwater to become contaminated beneath the landfill and are unlikely to cause groundwater contamination in the future. <u>The fate and transport model (FTM) recently completed by Sandia predicts little chance that groundwater contamination will occur</u> [Emphasis supplied].
>
> None of the modeled radionuclides and heavy metals was simulated by the FTM to reach groundwater during the 1,000-year performance period or the extended 10,000-year period.

The NMED Response to Public Comments Report [75] further uses the unreliable DOE/Sandia 2005 FTM Report [78] to set aside public concerns that the NMED dirt cover remedy in the DOE/Sandia Corrective Measures Implementation Plan (CMI Plan) would not prevent groundwater contamination as follows:

> There is no new information in the FTM that suggests that the NMED should defer approval of the CMI Plan [i.e., approval of the dirt cover remedy]. The FTM's prediction that there is only a small chance that groundwater will become contaminated at levels exceeding regulatory

> standards corroborates and validates NMED's existing testimony presented at the hearing held on the Corrective Measures Study (p. 4).
>
> Hence, there is no new information generated by the FTM that would form the basis for a different remedy for the landfill. The results instead strongly support the NMED's chosen remedy (cover with bio-intrusion barrier) as an acceptable alternative that is protective of human health and the environment (p. 4).

First, the 2006 TechLaw Report [47] was held secret from the public at the time the NMED issued the Response to Comments Report [75]**.** The secret 2006 TechLaw Report recommended for the NMED to not approve the DOE/Sandia 2005 FTM Report [78]**.** The NMED did not release the 2006 TechLaw Report to the public until 2009.

Second, the NMED did not comply with the Final Order [46] issued on May 26, 2005 and the Class 3 Permit Modification [74] issued on August 2, 2005 that required the NMED to provide the public with the opportunity to comment on the DOE/Sandia 2005 FTM Report [78] before the NMED approved the report. The NMED did not allow the public to comment on the two versions of the DOE/Sandia FTM Reports [78,2]**.**

Third, the discussion in this section establishes the requirement for the NMED to order DOE/Sandia to retract the unreliable DOE/Sandia FTM Reports [78,2] with no opportunity for revision until an unknown date in the future after the necessary data are collected from reliable networks of monitoring wells.

Fourth, the information presented in this report and specifically in Section 6.1 documents the incorrect testimony provided by the NMED staff to the NMED December 2004 Public Hearing for the dirt cover remedy. The incorrect testimony was that
1). There was a reliable network of seven monitoring wells at the Sandia mixed waste landfill, and
2). There was no evidence of groundwater contamination from the buried wastes.

12.4. The DOE/Sandia 2007 FTM Report disregarded the computer modeling that predicted tetrachloroethene (PCE) contamination in the groundwater below the MWL dump. The Monte Carlo simulations in the DOE/Sandia FTM Reports [2,78] predict that the groundwater below the MWL dump is presently contaminated with PCE, possibly at concentrations above the current EPA MCL of 5 ug/L. The conclusion in earlier computer modeling studies in 1995 by E. Klavetter [79] was also that the groundwater below the MWL dump would become contaminated from the PCE contamination that was measured in the vadose zone below the MWL dump. The DOE/Sandia 2007 FTM Report [2] summarizes the findings in the earlier computer modeling study as follows:

> The potential downward vertical transport of six organic compounds to groundwater by both aqueous-phase transport and vapor-phase transport was evaluated in 1995 (Klavetter, 1995). The study showed that PCE could eventually migrate to groundwater through vapor-phase transport. Although the modeling predicted that the most likely PCE concentrations in groundwater would be considerably lower than the detection limit of 0.5 ppb, sensitivity analyses suggested that PCE concentrations could potentially reach 1 to 5 ppb within 50 years (Klavetter, 1995a) (p. 72).

12.4.1. <u>The PCE contamination identified by the DOE/Sandia computer modeling to be in the groundwater below the MWL dump is known to cause cancer from drinking the water.</u> The Environmental Protection Agency (EPA) has determined that PCE in drinking water at the current Drinking Water Standard (DWS) Maximum Contaminant Level (MCL) of 5 ug/L may cause cancer [66]. The EPA will promulgate a new DWS MCL in 2011. The EPA has indicated that the new DWS MCL for PCE will be set at 0.05 ug/L [66] which is a hundred fold tightening of the current standard of 5 ug/L. The standard is tightened because PCE at any concentration in drinking water may cause cancer.
The DOE/Sandia 2007 FTM Report [2] identified that the groundwater below the Sandia MWL dump is contaminated at the present time with PCE at concentrations above 0.05 ug/L as follows:

- Figure 29 shows that 87 of the 100 Monte Carlo simulations in the 2007 FTM Report [2] predict the groundwater below the MWL dump to be contaminated with PCE at concentrations greater than 0.05 ug/L.
- Figure 29 shows that 59 of the 100 Monte Carlo simulations in the 2007 FTM Report [2] predict the groundwater below the MWL dump to be contaminated with PCE at concentrations greater than 0.5 ug/L.

The DOE/Sandia 2007 FTM Report [2] makes the following statement about the 100 computer modeling Monte Carlo Simulations on Figure 29 that predict the groundwater below the MWL dump is contaminated now with PCE:

> The majority of the realizations [i.e., Monte Carlo simulations] show the aquifer [PCE] concentrations peaking before 50 years. Depending on the time of disposal, this corresponds to peak [PCE] concentrations [in groundwater] occurring by 2010 – 2040. <u>*So far, no detectable amounts of PCE have been found in the groundwater at the MWL*</u>. [Emphasis supplied]. <u>This is still consistent with the simulations, which show a large amount of variability in the simulated concentrations resulting from uncertainty included in the input parameters</u> [Emphasis supplied] (p. 55).

- The above statement shows the arbitrary rejection by DOE/Sandia of the computer modeling in favor of the water quality data from the defective monitoring wells that are not reliable to detect the PCE groundwater contamination.
- The above statement also shows that DOE/Sandia were aware the computer modeling should not have been performed because of the great uncertainty that existed in the input parameters.

- 1). In the 2007 FTM Report [2], DOE/Sandia continue to cling to the conclusion that there was a reliable network of monitoring wells at the MWL dump despite numerous reports over the period of 1991 to 1998 that recognized all of the seven monitoring wells were defective and required replacement (Six of the reports are summarized in Section 5).

- 2). DOE/Sandia selectively give credence to conclusions from the Monte Carlo simulations that predict no groundwater contamination (i.e., the cadmium simulations) but ignore and dismiss the Monte Carlo simulations that identify the groundwater contamination from the highly toxic PCE wastes that are in the vadose zone below the MWL dump.

DOE/Sandia throw out the computer modeling predictions of PCE contamination in the groundwater because of too much uncertainty for the Monte Carlo simulations. For the same reason, the Monte Carlo simulations that show no groundwater contamination from the cadmium wastes buried in the MWL dump should be thrown out. The conclusions in the DOE/Sandia 2007 FTM Report ignore the fact that the wastes buried in the MWL dump have contaminated the groundwater with cadmium, chromium, nickel, nitrate and possibly many more contaminants including the highly toxic solvent PCE.

12.5. The 2007 FTM Report 1). prevents knowledge of the existing groundwater contamination and 2). prevents knowledge of the defective monitoring well network. NMED should order DOE/Sandia to retract and not revise the badly flawed 2007 FTM Report [2] which fails to present the dangerous groundwater contamination that is known to be present from the highly toxic wastes buried in unlined pits and trenches at the MWL dump. The 2007 FTM Report also omits knowledge of the defective monitoring well network at the MWL dump.

With the exception of the new background monitoring well MWL-BW2, there are no reliable groundwater monitoring wells at the MWL dump at this time. There is an immediate need to install reliable monitoring wells in the two zones of saturation below the MWL dump that require networks of monitoring wells.

- The upper zone that requires a network of monitoring wells is the water table in the fine-grained alluvial fan sediments.

- The deeper zone that requires a network of monitoring wells is the highly productive ARG Deposits that are the important groundwater resource for Albuquerque and the surrounding region.

- It is important to install the new monitoring wells with air-rotary underreamer casing advance drilling methods or sonic drilling methods with no use of bentonite clay or organic drilling additives.

- It is important for the new monitoring wells to be constructed with PVC well screens and PVC casing. Screen lengths shall not be greater than 15 feet.

- It is important to use low-flow purging and sampling methods for the collection of groundwater samples from all of the new monitoring wells.

Section 13. References

1. New Mexico Environment Department (NMED), April 2004. *Compliance Order on Consent Pursuant to the New Mexico Hazardous Waste Act § 74-4-10*. Prepared by the New Mexico Environment Department in the matter of Respondents U.S. Department of Energy and Sandia Corporation, Sandia National Laboratories, Bernalillo County, New Mexico. April 29, 2004. http://www.nmenv.state.nm.us/hwb/SNL/Order_on_Consent/final/SNL_CONSENT_ORDER_April-29-2004_FINAL.pdf

2. Ho, C.H., T.J. Goering, J.L. Peace, M.L. Miller, January 2007. "Probabilistic Performance-Assessment Modeling of the Mixed Waste Landfill at Sandia National Laboratories (2nd Edition)," Sandia Report SAND2007-0170, Sandia National Laboratories, Albuquerque, New Mexico. <http://www.sandia.gov/caps/SAND2007-0170.pdf>

3. New Mexico Environment Department August 11, 2004 Fact Sheet for the Sandia Mixed Waste Landfill on the Public Comment Period and Procedures to Request a Public Hearing on the Intent to Approve a Class 3 Permit Modification Request for Corrective Measures for the Mixed Waste Landfill, Sandia National Laboratories, EPA ID No. NM58900110518 Bernalillo County, New Mexico. http://www.nmenv.state.nm.us/hwb/SNL/MWL/Fact_Sheet_08-11-2004.pdf

4. Sandia National Laboratories/New Mexico (SNL/NM), September 2007. "Mixed Waste Landfill Long-Term Monitoring and Maintenance Plan," Environmental Restoration Project, Albuquerque, New Mexico. http://www.nmenv.state.nm.us/hwb/documents/Final_SNL_MWL_LTMMP_Sept_2007.pdf

5. Sandia National Laboratories/New Mexico (SNL/NM), May 2003. "Mixed Waste Landfill Corrective Measures Study," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico, May 21, 2003. http://www.nmenv.state.nm.us/hwb/SNL/CMS/MWL_CMS_Final_Report.pdf

6. J. L. Peace, November 20, 1996. Memorandum to John Peace. Subject: Mixed Waste Landfill above-ground Maintenance and Waste Disposal. Memorandum on the need to remediate the collapsed cement and plywood caps on the disposal pits in the classified area of the Sandia MWL dump.

7. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), October 2008. Letter to P. Wagner (U.S. Department of Energy) and F. Nimick (Sandia National Laboratories), RE: Notice of approval: Summary report for mixed waste landfill monitoring well plug and abandonment and installation—decommissioning of groundwater monitoring well MWL-BW1, Installation of groundwater monitoring well MWL-BW2 April, 2008, Sandia National Laboratories, EPA ID NM5890110518 HWB-SNL-08-015. http://www.nmenv.state.nm.us/hwb/documents/10-10-2007_NMED_Notice_of_Approval_Monitoring_WellPandAPlan_MWL-BW1_Repl-MWL-BW2.pdf

8. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), January 2009. Letter to P. Wagner (U.S. Department of Energy) and F. Nimick (Sandia National Laboratories), RE: Notice of approval: Summary report for mixed waste landfill monitoring well plug and abandonment and installation—decommissioning of ground-water monitoring wells MWL-MW1, 2, and 3; Installation of groundwater monitoring wells MWL-MW7, 8, and 9, September, 2008, Sandia National Laboratories, EPA ID#NM5890110518 HWB-SNL-08-020.
http://www.nmenv.state.nm.us/hwb/documents/SNL-08-020_1-15-2009_NOA_MWL_PandA-123_Instal789.pdf

9. Goering, T.J., G.M. Haggerty, D. Van Hart, and J.L. Peace, 2002. “Mixed Waste Landfill Groundwater Report, 1990 through 2001, Sandia National Laboratories, Albuquerque, New Mexico,” SAND2002-4098, Sandia National Laboratories, Albuquerque, New Mexico. [See Appendix D in the electronic copy of this report]
.

10. Garcia, Benito M., October 30, 1998. New Mexico Environment Department Notice of Deficiency Report for the DOE/Sandia *Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation (RFI), Sandia National Laboratories, Albuquerque, New Mexico.* [See Appendix A hard copy or electronic copy]

11. US EPA. 1992. *RCRA Groundwater Monitoring: Draft Technical Guidance,* November 1992. EPA 530-R93-001.
http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/sitechar/gwmonitr/rcra_gw.pdf

12. Langmuir, D., 1997. *Aqueous Environmental Geochemistry.* Prentice-Hall, Inc., Upper Saddle River, New Jersey.

13. Puls, R.W., and M.J. Barcelona, 1989. “*Groundwater Sampling for Metals Analyses.”* Report Number EPA/540/4-89/001. U.S. Environmental Protection Agency, Ada, Oklahoma.

14. Stumm, W., and J. J. Morgan, 1996. *Aquatic Chemistry. 3rd Edition.* John Wiley and Sons, Inc., New York.

15. Australian Drilling Committee, 1997. DRILLING – *The Manual of Methods*, *Applications, and Management*. Australian Drilling Industry Training Committee Industry. CRC Press LLC.

16. Gibb, J.P., and K.V.B. Jennings. 1987. *“How Drilling Fluids and Grouting Materials Affect the integrity of Ground Water Samples from Monitoring Wells.” Ground Water monitoring Review* 7(1): 33.

17. Brobst, R.P. and P.M. Buszka. 1986. *“The Effect of Three Drilling Fluids on Ground-Water Sample Chemistry.” Ground Water Monitoring Review* 6(1): p. 62-70.

18. Jennings, K.V.B. 1986. *“The Effects of Grouts, Sealants, and Drilling Fluids on the Quality of Ground Water Samples”* In: *Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring,* Columbus, Ohio, May 19-22, 1986.

19. Ford, Robert and Steven D. Acree, September 30, 2005. Memorandum: *Impacts of Monitoring Well Construction Practices at the Los Alamos National Laboratory.* United States Environmental Protection Agency National Risk Management Research Laboratory, P.O. Box 1198, Ada, OK 74820.

20. Ford, Robert and Steven D. Acree, February 10, 2006. Memorandum: *Impacts of Hydrogeologic Characterization Well Construction Practices at the Los Alamos National Laboratory.* United States Environmental Protection Agency National Risk Management Research Laboratory, P.O. Box 1198, Ada, OK 74820.

21. Ford, Robert and Steven D. Acree, February 16, 2006. Memorandum: Review of Los Alamos National Laboratory *Well Screen Analysis Report* (LA-UR-05-8615). United States Environmental Protection Agency National Risk Management Research Laboratory, P.O. Box 1198, Ada, OK 74820.

22. Acree, Steven D. and Richard T. Wilkin, March 30, 2009. Memorandum: Review of Los Alamos National Laboratory *Well Screen Analysis Report* (WSAR), Rev. 2 (LA-UR-07-2852) and *Groundwater Background Investigation Report* (GBIR), Rev. 3 (LA-UR-07-2853) United States Environmental Protection Agency National Risk Management Research Laboratory, Ground Water and Ecosystems Restoration Division, P.O. Box 1198, Ada, OK 74820

23. Moats, William and Lee Winn, March, 1993. *"Review of Ground Water Monitoring at Sandia National Laboratories's Mixed Waste Landfill."* Report by the New Mexico Environment Department. [See Appendix B hard copy or electronic copy]

24. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), March 2007. Letter to P. Wagner (U.S. Department of Energy) and F. Nimick (Sandia National Laboratories), RE: Replacement of Mixed Waste Landfill Groundwater Monitoring Well MWL-BW1, Sandia National Laboratories, EPA ID NM5890110518. March 23, 2007. http://www.nmenv.state.nm.us/hwb/SNL/SNL_3-23 2007_Replacement_of_MWL_Mon_Well_BW1.pdf

25. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), July 2007. Letter to P. Wagner (U.S. Department of Energy) and F. Nimick (Sandia National Laboratories), RE: Replacement of Mixed Waste Landfill Groundwater Monitoring Wells MWL-MW1 and MWL-MW3, Sandia National Laboratories, EPA ID NM5890110518. July 2, 2007. http://www.nmenv.state.nm.us/hwb/documents/7-2-2007_NMED_SNL_Require_Replacement_MWL_Wells_MW1_and_MW3.pdf

26. Hewitt, Alan D., 1992. *"Potential of Common Well Casing Materials to Influence Aqueous Metal Concentrations."* Groundwater Monitoring Review, Spring 1992. pages 131 - 136.

27. Thompson, Joseph L., 1996. *"Radionuclide Sorption on Well Construction Materials."* Groundwater Monitoring Review, Summer 1996. pages 163 - 167.

28. George, R.P., Muraleedharan, P., Sreekumari, K.R., and H. S. Khatak, 2007. "Influence of surface characteristics and microstructure on adhesion of bacterial cells onto a type 304 stainless steel." Corrosion Science and Technology Division. Materials Characterization Group. Indira Gandhi Centre for Atomic Research, Kalpakkam 603 102, India.

29. Bennett Sample Pumps, Inc. April 4, 2007. Email to Dave McCoy from Bennett Sample Pumps, Inc. describing the capability of the Bennett sampling pump used to collect groundwater samples from the MWL dump monitoring wells for low-flow purging and sampling. Email date April 4, 2007. [Appendix C hard copy and electronic copy].

30. Environmental Protection Agency Region 6, September, 26, 1994. Notice of Deficiency Report for the DOE/Sandia *Phase 2 RCRA Facility Investigation (RFI) Work Plan for the Sandia Mixed Waste Landfill*, March 1993.

31. Moats, William P., David L. Mayerson1, and Brian L. Salem, November 2006. *Evaluation of the Representativeness and Reliability of Groundwater Monitoring Well Data, Mixed Waste Landfill, Sandia National Laboratories* New Mexico Environment Department/Hazardous Waste Bureau, November 2006. http://www.nmenv.state.nm.us/hwb/SNL/MWL/Eval_Rep_Reliability_GW_Mon_Well_Data_MWL_(11-2006).pdf

32. Sandia National Laboratories, New Mexico (SNL/NM), February 2008. "Mixed Waste Landfill Annual Groundwater Monitoring Report Calendar Year 2007," Environmental Restoration Project, Sandia National Laboratories, New Mexico. http://www.nmenv.state.nm.us/hwb/documents/SNL_2-21-2008_MWL_2007_Annual_GW_Report.pdf

33. Sandia National Laboratories, New Mexico (SNL/NM), May 2009. "Mixed Waste Landfill Annual Groundwater Monitoring Report Calendar Year 2008," Environmental Restoration Project, Sandia National Laboratories, New Mexico. http://www.nmenv.state.nm.us/hwb/documents/SNL_5-27-2009_MWL_CY2008_AnnualGWMonRpt.pdf

34. Sandia National Laboratories, New Mexico (SNL/NM), June 2010. "Mixed Waste Landfill Annual Groundwater Monitoring Report Calendar Year 2009," Environmental Restoration Project, Sandia National Laboratories, New Mexico. http://www.nmenv.state.nm.us/hwb/documents/SNL_6-7-2010_MWL_GW_Monitoring_Report_CY09_June2010.pdf

35. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), June 2007. Letter to P. Wagner, (U.S. Department of Energy) and F. Nimick (Sandia National Laboratories), RE: Notice of Disapproval: Monitoring Well Plug and Abandonment Plan and Replacement Well Construction Plan, Decommissioning of Groundwater Monitoring Well MWL-BW1, Installation of Replacement Groundwater Monitoring Well MWL-BW2, April 9, 2007, Sandia National Laboratories, NM 5890110518, HWB-SNL-07-014. June 19, 2007. http://www.nmenv.state.nm.us/hwb/documents/6-19-2007_NMED_NOD_Monitoring_Well_PandA_Plan_and_Replacement_Well_Construction_Plan_for_BW-.pdf

36. Sandia National Laboratories/New Mexico (SNL/NM), July 2007. "DOE/SNL Response to NMED's Notice of Disapproval: Monitoring Well Plug and Abandonment Plan and Replacement Well Construction Plan, Decommissioning of Groundwater Monitoring Well MWL-BW1, Installation of Replacement Groundwater Monitoring Well MWL-BW2, April 9, 2007; and Revised Plan, July 2007," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico. http://www.nmenv.state.nm.us/hwb/documents/8-3 2007_SNL_Response_Monitoring_Well_PandA_Plan_and_Replacement_Well_Const_MWL-BW1_and_MWL-.pdf

37. Griffith, Stacy, April 2008. DOE/Sandia *Summary Report for Mixed Waste Landfill Monitoring Well Plug and Abandonment and Installation: Decommissioning of Groundwater Monitoring Well MWL-BW1 and Installation of Groundwater Monitoring Well MWL-BW2.* Sandia National Laboratories/New Mexico. http://www.nmenv.state.nm.us/hwb/documents/Summary_Rpt_MWL_MW_PandA_Install-Decom_GW_Mon_Well_MWL-BW1_Install_GW_Mon_Well_MWL-BW2_4-200.pdf

38. Sandia National Laboratories/New Mexico Environmental Restoration Project, September 2008. DOE/Sandia *Summary Report for Mixed Waste Landfill Monitoring Well Plug and Abandonment and Installation: Decommissioning of Groundwater Monitoring Wells MWL-MW1, -MW2 and -MW3, and Installation of Groundwater Monitoring Well MWL-MW7, -MW8 and -MW9.* Sandia National Laboratories/New Mexico. *ftp://ftp.nmenv.state.nm.us/hwbdocs/HWB/snl/MWLDrillingSummaryReport_Final_Sept08.pdf*

39. U.S. Department of Energy, May 1991. Tiger Team Assessment of the Sandia National Laboratories, Albuquerque.

40. Rea, Ken, 1991. Los Alamos National Laboratory EM Division Technical Review of the 1991 DOE/Sandia Report –*Compliance Activities Workplan for the Mixed Waste Landfill,* Sandia National Laboratories, June 1991.

41. U.S. Department of Energy Oversight Bureau, October 13, 1994. Memorandum: Review of the March 10,1993 RCRA RFI Phase 2 Work Plan for the Sandia Mixed Waste Landfill.

42. Sandia National Laboratories, Albuquerque, New Mexico, January 28, 1999. DOE/SNL/NM Responses to NMED October 30, 1998 NOD for "Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

43. Pruett, Jennifer J., April 20, 2005. Hearing Officer's Report: Proposed Findings of Fact and Conclusions of Law, IN THE MATTER OF REQUEST FORA CLASS 3 PERMIT MODIFICATION FOR CORRECTIVE MEASURES FOR THE MIXED WASTE LANDFILL SANDIA NATIONAL LABORATORIES BERNALILLO COUNTY, NEW MEXICO EPA ID NO. NM5890110518. http://www.nmenv.state.nm.us/hwb/SNL/MWL/MWL%20Hearing%20Officers%20FOF%20and%20COL%20April%2020%202005.pdf

44. Dinwiddie, R.S. (New Mexico Environment Department), September 1997. Letter to M.J. Zamorski (U.S. Department of Energy), "Request for Supplemental Information: Background Concentrations Report, SNL/KAFB." September 24, 1997.

45. WERC, August 31,2001. Final Report Independent Peer Review of the U.S. Department of Energy Sandia National Laboratories' Mixed Waste Landfill August 31, 2001 – Performed by WERC: A Consortium for Environmental Education and Technology Development. http://www.werc.net/outreach/landfill_review/final%20report.pdf

46. Curry, Ron, May 26, 2005. New Mexico Environment Department Final Order by Secretary Ron Curry for the installation of dirt cover over the Sandia MWL dump. http://www.nmenv.state.nm.us/hwb/SNL/MWL/Final_Decision/Final_Order_(05-26-2005).pdf

47. TechLaw Inc., January 31, 2006. Technical Review of the [Sandia] Probabilistic Performance Assessment Modeling of the Mixed Waste Landfill at the Sandia National Laboratories, of the Mixed Waste Landfill Corrective Measures Implementation Plan, Dated November 2005. In response to: NMED Work Assignment No. 06110.310.

48. U.S. EPA Office of Inspector General, April 14, 2010. Hotline Report – *Region 6 needs to improve Oversight Practices.* Report No. 10-P-0100, April 14, 2010. http://www.epa.gov/oig/reports/2010/20100414-10-P-0100.pdf

49. U.S. Environmental Protection Agency, April 2004. EPA Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action for Facilities Subject to Corrective Action Under Subtitle C of the Resource Conservation and Recovery Act. EPA 530-R-04-030, April 2004.
http://www.epa.gov/osw/hazard/correctiveaction/resources/guidance/pdfs/gwhb041404.pdf

50. U.S. Environmental Protection Agency, 1987. EPA RCRA Facility Assessment Report for Sandia National Laboratories Albuquerque, New Mexico Facility.

51. Agency for Toxic Substances Disease Registry, August 2005. Agency for Toxic Substances Disease Registry (ATSDR) Division of Toxicology Public Health Statement on Nickel – CAS# 7440-02-0. ATSDR - Public Health Statement: Nickel

52. New Mexico Water Quality Control Commission, December 1, 1995. New Mexico Water Quality Control Commission (WQCC) Title 20 – Environmental Protection / Chapter 6 – Water Quality / Part 2 – Ground and Surface Water Protection.

53. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), October 10, 2008. Letter to P. Wagner (U.S. Department of Energy) and F. Nimick (Sandia National Laboratories), RE: Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Plan, November 2005 Sandia National Laboratories, NM3890110518 SNL-05-025.
http://www.nmenv.state.nm.us/hwb/documents/SNL-05-025_10-10-2008_NOD_MWL_CMI_WP.pdf

54. Sandia National Laboratories / U.S. Department of Energy, November 2005. Mixed Waste Landfill Corrective Measures Implementation Work Plan. Sandia National Laboratories Albuquerque, New Mexico Environmental Restoration Project.
http://www.nmenv.state.nm.us/hwb/SNL/MWL/SNL_Mixed_Waste_Landfill_CMI_Work_Plan_(11-2005).pdf

55. Los Alamos National Laboratory, November 2005. "Well Screen Analysis Report." LAUR-05-8615, ER2005-0841.

56. National Research Council, 2007. ***Plans and Practices for Groundwater Protection at the Los Alamos National Laboratory: Final Report* –** Committee for the Technical Assessment of Environmental Programs at the Los Alamos National Laboratory, National Research Council, 2007. Plans and Practices for Groundwater Protection at the Los Alamos National Laboratory: Final Report

57. Los Alamos National Laboratory, May 2007. "Well Screen Analysis Report – Revision 2." LAUR-07-2852, ER2007-0249.

58. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), September 18, 2006. Notice of Disapproval Letter to M. Johansen (U.S. Department of Energy) and D. McInroy (Los Alamos National Laboratory), RE: Notice of Disapproval Well Screen Analysis Report Los Alamos National Laboratory, EPA ID# NM0890010515 HWB-LANL-05-022.
ftp://ftp.nmenv.state.nm.us/hwbdocs/HWB/lanl/Groundwater/General/WSAR/NOD-WSAR%20Sep%2018%202006.pdf

59. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), April 5, 2007. Letter to D. Gregory (U.S. Department of Energy) and D. McInroy (Los Alamos National Laboratory), RE: Well Evaluations for Intermediate and Regional Wells – Los Alamos National Laboratory,

60. Hewitt, Alan D., 1994. *"Dynamic Study of Common Well Screen Materials."* Groundwater Monitoring Review, Winter 1994. pages 87 - 94.

61. Sandia National Laboratories, New Mexico (SNL/NM), January 2006. "Mixed Waste Landfill Annual Groundwater Monitoring Report for Groundwater Sampling in April 2005," Environmental Restoration Project, Sandia National Laboratories, New Mexico.
http://www.sandia.gov/ltes/docs/MWLannGWmonRpt_April2005.pdf

62. New Mexico Environment Department (NMED), October 2001. "Use of Low-Flow and Other Non-Traditional Sampling Techniques for RCRA Compliant Groundwater Monitoring," Hazardous Waste Bureau, New Mexico Environment Department, Santa Fe, New Mexico. October 30, 2001.
http://www.nmenv.state.nm.us/HWB/data/11-7low-flow_final.pdf

63. Collins, S.S., G.A. Bailey and T.O. Jackson, February, 2003. *Review of Low-Flow Bladder Pump and High-Volume Air Piston Pump Groundwater Sampling Systems at Sandia National Laboratories, New Mexico.* DOE Waste Management 2003 Conference, February 23-27, 2003, Tucson, Arizona. Information Bridge: DOE Scientific and Technical Information - - Document #826321

64. Puls, R.W., and M.J. Barcelona, 1996. "Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures," Technology Innovation Office, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.
http://www.epa.gov/tio/tsp/download/lwflw2a.pdf

65. Sandia National Laboratories, New Mexico (SNL/NM), November 2006. "Mixed Waste Landfill Annual Groundwater Monitoring Report Calendar Year 2006," Environmental Restoration Project, Sandia National Laboratories, New Mexico.
http://www.nmenv.state.nm.us/hwb/documents/SNL_MWL_Annual_GWReport_12-13-2006.pdf

66. Federal Register, March 29, 2010. Environmental Protection Agency. National Primary Drinking Water Regulations; Announcement of the Results of EPA's Review of Existing Drinking Water Standards and Request for Public Comment and/or Information on Related Issues. Part II. EPA Six-Year Review *in* Federal Register, Vol. 75. No. 59, pp. 15500 – 15572. Six-Year Review 2 of Drinking Water Standards | Six-Year Review 2 of Drinking Water Standards | US EPA

67. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), November 20, 2006. Letter to P. Wagner (U.S. Department of Energy) and L. Shephard (Sandia National Laboratories), RE: Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Work Plan, November 2005, and Requirement for Soil-Vapor Sampling and Analysis Plan, Sandia National Laboratories, EPA ID NM5890110518, HWB-SNL-05-025. http://www.nmenv.state.nm.us/hwb/SNL/MWL/SNL_NOD_11-20-2006_MWL_CMI_WP.pdf

68. Sandia National Laboratories/New Mexico Environmental Restoration Project, August 2008. *Investigation Report on the Soil-Vapor Volatile Organic Compounds, Tritium, and Radon Sampling at the Mixed Waste Landfill, August 2008*. http://www.nmenv.state.nm.us/hwb/documents/Final_MWL_Soil-Vapor_Report_August_2008.pdf

69. Sandia National Laboratories/New Mexico (SNL/NM), September 1996. "Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Sandia National Laboratories, Albuquerque, New Mexico," Sandia National Laboratories/New Mexico, Albuquerque, New Mexico.

70. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), February 14, 2008. Letter to P. Wagner (U.S. Department of Energy) and F. Nimick (Sandia National Laboratories), RE: Response to Public Comment and Approval With Modifications Soil-Vapor Sampling and Analysis Plan for the U.S. Department of Energy/Sandia National Laboratories' Mixed Waste Landfill – Sandia National Laboratories, EPA ID# NM 5890110518 HWB-SNL-05-025. http://www.nmenv.state.nm.us/hwb/documents/SNL-05-025_2-14-2008_App_w-Mod_MWL_SV_SAP.pdf

71. Sandia National Laboratories/New Mexico (SNL/NM), March 1993. "Mixed Waste Landfill Phase 2 RCRA Facility Investigation Work Plan, Sandia National Laboratories/New Mexico," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

72. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), September 26, 2008. Letter to P. Wagner (U.S. Department of Energy) and F. Nimick (Sandia National Laboratories), RE: Approval of the Investigation Report on the Soil-Vapor Volatile Organic Compounds, Tritium, and Radon Sampling at the Mixed Waste Landfill, August 2008 – Sandia National Laboratories, EPA ID# NM 5890110518 HWB-SNL-08-018. http://www.nmenv.state.nm.us/hwb/documents/SNL-08-018_9-26-2008_SVReportApproval.pdf

73. Sandia National Laboratories/New Mexico Environmental Restoration Project, January 2010. *Mixed Waste Landfill Corrective Measures Implementation Report*. United States Department of Energy Sandia Site Office. MWL CMI_Final_Jan 2010.pdf on ftp.nmenv.state.nm.us

74. New Mexico Environment Department (NMED), August 2005. Letter from J. Kieling (Manager, Permits Management Program) to P. Wagner (U.S. Department of Energy Sandia Site Office/NNSA) and P. Davies (Sandia National Laboratories/New Mexico) RE: Remedy Decision and Class 3 Permit Modification Request to Incorporate into RCRA Permit Corrective Measures for Mixed Waste Landfill (SWMU 76) Sandia National Laboratories EPA ID# NM5890110518 HWB-SNL-04-021. August 2, 2005. http://www.nmenv.state.nm.us/hwb/SNL/MWL/Final_Decision/Permit_Language_for_the_Mixed_Waste_Landfill.pdf

75. New Mexico Environment Department, November 2006. New Mexico Environment Department (NMED) November 2006 Response to Comments on the Sandia MWL Corrective Measures Implementation Plan.
http://www.nmenv.state.nm.us/hwb/snlperm.html

76. WERC, January 31, 2003. Final WERC Report - Independent Technical Peer Review of the U.S. Department of Energy Sandia National Laboratories' "Working Draft" Corrective Measures Study November 2002 Mixed Waste Landfill.
http://www.werc.net/outreach/corrective_measures_study/finalreport.pdf

77. Bearzi, J. (New Mexico Environment Department Hazardous Waste Bureau), October 10, 2008. Letter to P. Wagner (U.S. Department of Energy) and F. Nimick (Sandia National Laboratories), RE: Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Plan, November 2005, Sandia National Laboratories, NM5890110518 – SNL-05-025.
http://www.nmenv.state.nm.us/hwb/documents/SNL-05-025_10-10-2008_NOD_MWL_CMI_WP.pdf

78. Ho, C.H., T.J. Goering, J.L. Peace, M.L. Miller, November 2005. "Probabilistic Performance-Assessment Modeling of the Mixed Waste Landfill at Sandia National Laboratories (1st Edition)," Sandia Report SAND2005-6888, Sandia National Laboratories, Albuquerque, New Mexico.
http://www.nmenv.state.nm.us/hwb/SNL/MWL/Fate_and_Transport_(Probabilistic_Performance-Assessment_Modeling_of_the_MWL;%2011-20

79. Klavetter, E., 1995. BOSS Simulations of Organic Compound Transport at the MWL, memo to T. Goering and J. Peace, August 28, 1995, Sandia National Laboratories, Albuquerque, NM.

80. DOE/Sandia, November, 2002. "Sandia Mixed Waste Landfill Corrective Measures Study Appendix H: MWL Alternative V.b. – Complete Excavation with Off-site Disposal"
http://www.nmenv.state.nm.us/hwb/SNL/CMS/App_H_Eval_of_Near-Term_Excavation.pdf

81. U.S.EPA OIG, October 20, 2010. EPA OIG Hotline Report. *Region 6 Needs to Improve Oversight Practices:* http://www.epa.gov/oig/reports/2010/20100414-10-P-0100.pdf,

SECTION 14. TABLES.

Table 1. Sandia MWL Dump Monitoring Wells and the reasons they are defective.

Table 2. Water table elevations measured in the new monitoring wells MWL-MW7, MW8, MW9 and BW2 in October 2008 compared to the expected water table elevation calculated for monitoring well MWL-MW3 that was plugged and abandoned.

Table 3. Total and Dissolved Nickel Measured in the Water Samples Produced From Monitoring Well MWL-MW1, -MW-3, -BW1 and - MW2 at the Sandia Mixed Waste Landfill. The four wells have stainless steel screens.

Table 4. Pumping data for the four monitoring wells at the SNL MWL dump with screens across the water table in the fine-grained alluvial fan sediments.

Table 5. The Total VOC, PCE and TCE contamination measured in the 1994 RCRA RFI soil-gas boreholes located at the Sandia MWL dump.

Table 1. Sandia MWL Dump Monitoring Wells*

* The locations of the eleven monitoring wells are displayed on Figures 6 and 8.

Year of Installation		Well No. / Current Status
- 1988	–	well MWL-MW1 / The defective monitoring well was plugged and abandoned in 2008.
- 1989	–	wells MWL-MW2, -MW3 and -BW1 / The three defective monitoring wells were plugged and abandoned in 2008.
- 1993	–	well MWL-MW4 / The defective monitoring well is in the current network.
- 2000	–	wells MWL-MW5 and -MW6 / The two defective monitoring wells are in the current network.
- 2008	–	wells MWL-MW7, -MW8 and -MW9 / The three defective monitoring wells are in the current network.
- 2008	–	well MWL-BW2 / The new background water quality well may be defective because the drilling and well construction requirements in the NMED 2004 Consent Order were not followed

- Reasons the monitoring wells are defective.
- Wells MWL-MW1 and -MW3 were the only two monitoring wells with any capability to detect groundwater contamination from the MWL dump.
- Wells MWL-MW2, -MW5, -MW6 and -BW1 – four wells installed at incorrect locations and too distant from MWL dump to detect groundwater contamination.
- Wells MWL-MW1, -MW2, -MW3 and -BW1 – corroded stainless steel well screens prevented the detection of many contaminants.
- Wells MWL-MW2, -MW3 and -BW1 – mud-rotary drilling method contaminated the three wells with bentonite clay drilling muds that prevented the detection of many contaminants and prevented collection of reliable data on speed of groundwater travel.
- Wells MWL-MW4, -MW5 and -MW6 – three wells with screens installed too deep to detect contamination at water table and measure elevation of water table.
- Well MWL-MW5 – screen installed across two zones of saturation prevented well from having any use. In addition, the screen is contaminated with bentonite clay/cement grout with properties to prevent the detection of groundwater contamination and prevent collection of reliable data on speed of groundwater travel.
- Wells MWL-MW7, -MW8 and -MW9 – three wells installed in 2008 were drilled with improper methods with 30-ft screens installed too deep to detect groundwater contamination and measure the elevation of the water table below the MWL dump.
- Wells MWL-MW1, -MW2, -MW3, -MW4, -MW7, -MW8, -MW9 and -BW1 – the high-flow pumping methods purged the wells dry and highly aerated water samples were collected up to a week later. This sampling method removes volatile and trace metal contaminants from the collected water samples.

Table 2. Water table elevations measured in the new monitoring wells MWL-MW7, MW8, MW9 and BW2 in October 2008 compared to the expected water table elevation calculated for monitoring well MWL-MW3 that was plugged and abandoned.

–	Water table elevation [A] (ft asl) [B] Oct. 2008 / Oct. 2009	Change in feet [C]	Difference in feet compared to expected water table elevation [D] in well MWL-MW3
– Well MWL-MW9 (located ~80 feet north of well MW3)	4888.20 / 4888.17	- 0.03	- 22.1 feet
– Well MWL-MW8 (located ~80 feet south of well MW3)	4891.59 / 4891.50	- 0.09	- 18.7 feet
– Well MWL-MW7 (located ~250 feet south of well MW3)	4891.90 / 4891.79	- 0.11	- 18.4 feet
– Well MWL-BW2 (located ~550 feet east of well MW3)	4910.99 / 4910.50	- 0.5	+ 0.7 feet

[A] The water table elevations for wells MWL-MW7, -MW8, -MW9 and -BW2 are for the measurement data in October 2008 and October 2009 posted on the water table contour maps in the DOE/Sandia annual groundwater reports for the MWL dump.

[B] ft asl = elevation in feet above mean sea level

[C] The change in feet is the difference for water levels measured in 2008 and 2009.

[D] The observed rate of decline of the water table is 0.62 foot per year. Therefore, the expected water table elevation at well MWL-MW3 in October 2008 is calculated by subtracting 0,93 feet from the measured elevation of 4911.25 ft asl on April 02, 2007

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Table 3. Total and Dissolved Nickel Measured in the Water Samples Produced From Monitoring Well MWL-MW1, -MW-3, -BW1 and - MW2 at the Sandia Mixed Waste Landfill. The four wells have stainless steel screens.

- Date	- Well MW1 Nickel (ug/L) [A] T [B] / D [C]	- Well MW3 Nickel (ug/L) T / D	- Well BW1 Nickel (ug/L) T / D	- Well MW2 Nickel (ug/L) T / D
- 09 - 90	46 / 43	ND [D] <40 / ND < 40	ND <40 / ND <40	ND <40 / ND <40
- 01 - 91	NA [E] / NA	NA / NA	NA / NA	NA / NA
- 04 - 91	NA / NA	NA / NA	NA / NA	NA / NA
- 10 - 91	NA / NA	NA / NA	NA / NA	NA / NA
- 07 - 92	150 / 63	66 / 43	ND <40 / ND <40	ND <40 / ND <40
- 01 - 93	78 / NA	26 (j) [F] / NA	ND <40 / NA	ND <40 / NA
- 04 - 93	97 / 94	37 (j) / 33 (j)	7.5 / 16	14 (j) / 13 (j)
- 11 - 93	95 / NA	ND < 40 / NA	ND < 40 / NA	ND < 40 / NA
- 05 - 94	110 / NA	ND <40 / NA	NA / NA	ND <40 / NA
- 10 - 94	130 / NA	ND <40 / NA	9.8 (j) / NA	ND <40 / NA
- 04 - 95	120 / NA	NA / NA	9.3 (j) / NA	7.5 (j) / NA
- 10 - 95	107 / NA	7.99 (j) / NA	1.96 (j) / NA	NA / NA
- 04 - 96	145 / NA	3.67 (j) / NA	ND < 0.81 / NA	3.42 (j) / NA
- 04 - 97	NA / NA	NA / NA	NA / NA	NA / NA
- 10 - 97	NA / NA	NA / NA	NA / NA	NA / NA
- 04 - 98	398 / 538	36.2 / 28.5	2.9 (j) / NA	5 (j) / 4
- 11 - 98	490 / 467	18 / 18.3	7.19 / 9.47	4.49 / 3.42
- 04 - 99	266 / 313	31 / 31.3	12.8 / 14.3	5.31 / 4.37
- 04 - 00	279 / 281	25.1 / NA	16.5 / NA	124 / NA
- 04 - 01	252 / NA	14.1 / NA	191 / NA	88.2 / NA
- 04 - 02	265 / NA	96.1 / NA	13.6 / NA	89.7 / NA
- 04 - 03	374 / NA	NA / 69.4	26.6 / NA	52 / NA
- 04 - 04	401 / NA	56 / NA	33.2 / NA	10.5 / NA
- 04 - 05	424 / 405	17.3 / 11.5	35.5 / NA	8.02 / 7.11
- 04 - 06	477 / NA	157 / NA	68 / NA	6. 76 / NA
- 04 - 07	436 / 284	84.8 / 120	NA / NA	7.34 / 5.41

[A] ug/L = micrograms per liter or parts per billion
[B] T = Concentration of total nickel measured in an unfiltered water sample
[C] D = Concentration of dissolved nickel measured in a filtered water sample
[D] ND = nickel was not detected at the listed minimum detection level
[E] NA = nickel was not analyzed in samples collected on this date
[F] (j) = the listed value is an estimated value

- A median dissolved nickel concentration of 1.2 ug/L was measured in water samples collected on seven dates in 2008 and 2009 from the new background water quality monitoring well MWL-BW2 with a range from 0.82 to 1.7 ug/L.

- The NMED proposed trigger concentration for total and dissolved nickel in groundwater below the Sandia MWL dump is 50 ug/L.

- The EPA recommends for nickel concentrations in drinking water to not exceed 100 ug/L.

- Sources for Nickel Data: Data from 1990 – 2001; Table 4-2 in Goering et al., 2002; Data from 2002 – 2007; Sandia Annual Reports for groundwater monitoring at the Sandia MWL Dump

Table 4. Pumping data for the four monitoring wells at the SNL MWL dump with screens across the water table in the fine-grained alluvial fan sediments.

Well No.	Date Purged	Date Sampled	Pumping Rate (liter/min)	Pumping Period (minutes)	Volume Pumped (gallons)	Volume in Screen (gallons)	Was Well Pumped Dry?
- BW1	01/24/91	Same	3.71	56	55	16.5	No
- BW1	05/07/91	Same	2.91	107	82	16.5	No
- BW1	08/06/91	Same	2.42	134	86	16.4	No
- BW1	10/16/91	Same	1.74	163	75	16	No
- BW1	04/28/94	?	1.74	78	36	< 16	Yes
- BW1	04/08/05	04/15/05	?	?	12.5	?	Yes
- BW1	04/04/06	04/18/06	?	?	8	?	Yes
- MW1	01/24/91	Same	3.89	68	70	20.2	No
- MW1	05/07/91	Same	2.42	119	76	20.3	No
- MW1	07/31/91	Same	3.60	77	73	18.8	No
- MW1	10/15/91	Same	1.97	163	84	19	No
- MW1	05/31/94	?	1.78	88	41	< 19	Yes
- MW1	04/04/05	04/11/05	?	?	33	?	Yes
- MW1	04/05/06	04/12/06	?	?	34	?	Yes
- MW1	04/04/07	04/05/07	?	?	16	?	Yes
- MW2	01/28/91	Same	3.63	54	52	23.8	No
- MW2	05/02/91	Same	3.29	90	78	23.8	No
- MW2	08/01/91	Same	1.67	123	54	21.9	No
- MW2	10/14/91	Same	2.57	80	54	22	No
- MW2	04/29/94	?	2.54	52	35	< 22	Yes
- MW2	04/05/05	04/12/05	?	?	23	?	Yes
- MW2	04/03/06	04/10/06	?	?	20	?	Yes
- MW2	04/02/07	04/06/07	?	?	12	?	Yes
- MW3	01/28/91	Same	4.01	33	35	18.3	No
- MW3	05/02/91	Same	2.91	58	45	19.1	No
- MW3	08/05/91	Same	3.79	63	63	17.6	No
- MW3	10/15/91	Same	2.23	61	36	20	No
- MW3	04/29/94	?	2.20	40	23.2	< 20	Yes
- MW3	04/07/05	04/13/05	?	?	14	?	Yes
- MW3	04/07/06	04/13/06	?	?	13	?	Yes
- MW3	04/03/07	04/11/07	?	?	9	?	Yes
- BW2	03/13/08	Same	1.55	360 (6 hours)	150	42	No
- BW2	10/06/09	Same	?	?	39	?	No

***** All data are from the New Mexico Environment Department Administrative Record or DOE/Sandia Reports.

Table 5. The Total VOC, PCE and TCE contamination measured in the 1994 RCRA RFI soil-gas boreholes located at the Sandia MWL dump.

- **35 of the 43 boreholes are located outside the boundary of the MWL dump.**
- **All of the soil-gas samples were collected only to a maximum depth of 30 feet Below ground surface (ft bgs). At 41 of the 43 boreholes, there was an increase in the Total VOC soil-gas concentrations measured at 30 ft bgs compared to 10 ft bgs. The increase was more than double at 34 boreholes.**
- **The borehole locations are displayed on Figures 26, 27 and 28. The Trench Names are displayed on Figure 2 and the Pit names are displayed on Figure 3.**

- **Boreholes for the northern part of the unclassified area of the MWL dump 12 of the 20 boreholes are located outside the boundary of the MWL dump**

1. <u>Eight boreholes located inside the northern part of the unclassified area.</u>

<u>Borehole #5</u>	**Total VOCs [A] (ppbv) [B]**		**PCE [C] (ppbv)**		**TCE [D] (ppbv)**	
	10 ft bgs [E]	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	340	**1,130**	**240**	**520**	**100**	**270**
Change	**3.3 X increase [F]**		**2.17 X increase**		**2.7 X increase**	

<u>Borehole #6</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	410	**1,690**	**240**	**720**	**ND [G]**	**280**
Change	**4.1 X increase**		**3 X increase**		**~5 X increase**	

<u>Borehole #7</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	810	**3,710**	**310**	**1,100**	**100**	**540**
Change	**4.6 X increase**		**3.5 X increase**		**5.4 X increase**	

<u>Borehole #8</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	630	**3,210**	**200**	**790**	**110**	**520**
Change	**5.1 X increase**		**4 X increase**		**4.7 X increase**	

<u>Borehole #9</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	2,460	**4,630**	**380**	**690**	**180**	**370**
Change	**1.9 X increase**		**1.8 X increase**		**2.1 X increase**	

<u>Borehole #10</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	30,700	**27,700**	**1,700**	**2,500**	**ND**	**600**
Change	**10% decrease**		**1.5 X increase**		**~12 X increase?**	

<u>Borehole #11</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	8,020	**9,500**	**5,200**	**5,900**	**540**	**ND**
Change	**1.2 X increase**		**1.1 X increase**		**~ 90% decrease?**	

<u>Borehole #12</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	1,990	**3,010**	**1,700**	**1,600**	**290**	**570**
Change	**1.5 X increase**		**5% decrease**		**1.96 X increase**	

Table 5 continued

2. Five boreholes outside the western boundary of the northern part of the MWL dump along a north-south line 30 feet west of the center of Trench A.

	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
Borehole #2	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	754	2,510	521	1,200	210	450
Change	3.3 X increase		2.3 X increase		2.1 X increase	
Borehole #3	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	1,510	3,960	1,080	1,700	310	530
Change	2.6 X increase		1.6 X increase		1.7 X increase	
Borehole #4	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	1,170	4,510	627	1,300	279	490
Change	3.9 X increase		2.1 X increase		1.76 X increase	
Borehole #5	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	596	1,000	339	240	185	120
Change	1.7 X increase		30% decrease		35% decrease	
Borehole #6	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	358	2,420	186	670	114	330
Change	6.76 X increase		3.6 X increase		2.9 X increase	

3. Three boreholes outside the western boundary of the northern part of the MWL dump along a north-south line 75 feet west of the center of Trench A.

	Total VOCs (ppbv)		PCE (ppbv)		TCE (ppbv)	
Borehole #1	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	110	1,010	110	450	ND	230
Change	9.2 X increase		4.1 X increase		~ 4 X increase	
Borehole #2	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	160	830	160	360	ND	190
Change	5.2 X increase		2.25 X increase		~ 4 X increase	
Borehole #3	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs	10 ft bgs	30 ft bgs
	239	880	84	280	54	210
Change	3.7 X increase		3.3 X increase		3.9 X increase	

Table 5 continued

4. <u>Four boreholes located outside the northern boundary of the unclassified area of the MWL dump on a west-east line greater than 50 feet north of Trenches A, B, C and D.</u>

<u>Borehole #1</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	472	**980**	**251**	**450**	**131**	**230**
Change	**2.1 X increase**		**1.8 X increase**		**1.76 X increase**	

<u>Borehole #7</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	371	**1,930**	**247**	**1,000**	**124**	**460**
Change	**5.2 X increase**		**4 X increase**		**3.7 X increase**	

<u>Borehole #8</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	340	**1,610**	**205**	**800**	**123**	**400**
Change	**4.7 X increase**		**3.9 X increase**		**3.25 X increase**	

<u>Borehole #9</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	541	**1,140**	**279**	**465**	**210**	**330**
Change	**2.1 X increase**		**1.7 X increase**		**1.6 X increase**	

- **Boreholes for the southern part of the unclassified area of the MWL dump All of the 14 boreholes are located outside the boundary of the MWL dump**

5. <u>Four boreholes located outside the western boundary of the southern part of the unclassified area of the MWL dump along a north-south line 30 feet west of the center of Trench F</u>

<u>Borehole #2</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	754	**2,510**	**521**	**1,200**	**210**	**450**
Change	**3.33 X increase**		**2.3 X increase**		**2.1 X increase**	

<u>Borehole #3</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	1,510	**3,960**	**1,080**	**1,700**	**310**	**530**
Change	**2.6 X increase**		**1.6 X increase**		**1.7 X increase**	

<u>Borehole #4</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	1,170	**4,510**	**627**	**1,300**	**279**	**490**
Change	**3.85 X increase**		**2.1 X increase**		**1.76 X increase**	

<u>Borehole #5</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	596	**1,000**	**339**	**240**	**185**	**120**
Change	**1.68 X increase**		**30% decrease**		**36% decrease**	

Table 5 continued

6. <u>Three boreholes located outside the eastern boundary of the southern part of the unclassified area of the MWL dump along a north-south line 30 feet east of the center of Trench E.</u>

<u>Borehole #19</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	477	**2,400**	**69**	**260**	**220**	**630**
Change	**5 X increase**		**3.77 X increase**		**2.86 X increase**	

<u>Borehole #10</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	479	**929**	**260**	**280**	**120**	**250**
Change	**1.3 X increase**		**1.1 X increase**		**2.1 X increase**	

<u>Borehole #9</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	335	**555**	**83**	**120**	**98**	**250**
Change	**1.64 X increase**		**1.45 X increase**		**2.55 X increase**	

7. <u>Two boreholes located outside the eastern boundary of the southern part of the unclassified area of the MWL dump along a north-south line 50 feet east of the center of Trench E</u>

<u>Borehole #12</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	476	**1,055**	**76**	**140**	**230**	**405**
Change	**2.2 X increase**		**1.84 X increase**		**1.76 X increase**	

<u>Borehole #11</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	310	**1,230**	**ND**	**140**	**120**	**270**
Change	**3.97 X increase**		**~3 X increase**		**2.25 X increase**	

8. <u>Five boreholes located outside the southern boundary of the unclassified area of the MWL dump along a west-east line 15 feet south of the southern boundary</u>

<u>Borehole #4</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	476	**1,055**	**76**	**140**	**230**	**405**
Change	**2.2 X increase**		**1.84 X increase**		**1.76 X increase**	

<u>Borehole #5</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	310	**1,230**	**ND**	**140**	**120**	**270**
Change	**3.97 X increase**		**~3 X increase**		**2.25 X increase**	

<u>Borehole #6</u>	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	754	**2,510**	**521**	**1,200**	**210**	**450**
Change	**3.33 X increase**		**2.3 X increase**		**2.14 X increase**	

Table 5 continued

Borehole #7	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	1,510	**3,960**	**1,080**	**1,700**	**310**	**530**
Change	**2.62 X increase**		**1.6 X increase**		**1.71 X increase**	

Borehole #8	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	1,170	**4,510**	**627**	**1,300**	**279**	**490**
Change	**3.85 X increase**		**2.07 X increase**		**1.76 X increase**	

- **Boreholes for the classified area of the MWL dump**
  All of the 10 boreholes are located outside the boundary of the classified area

9. <u>Three boreholes located outside the northern boundary of the classified area of the MWL dump along a west-east line 15 feet north of the classified area</u>

Borehole #10	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	275	**810**	**130**	**280**	**126**	**250**
Change	**2.9 X increase**		**2.15 X increase**		**2 X increase**	

Borehole #11	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	173	**490**	**87**	**150**	**86**	**160**
Change	**2.8 X increase**		**1.7 X increase**		**1.9 X increase**	

Borehole #12	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	282	**260**	**43**	**ND**	**53**	**120**
Change	**8% decrease**		**decrease?**		**2.26 X increase**	

10. <u>Four boreholes located outside the eastern boundary of the classified area of the MWL dump along a north-south line 15 feet east of the classified area</u>

Borehole #13	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	115	**140**	**30**	**ND**	**72**	**140**
Change	**1.2 X increase**		**decrease?**		**1.9 X increase**	

Borehole #14	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	177	**370**	**48**	**ND**	**113**	**240**
Change	**2.1 X increase**		**decrease?**		**2.1 X increase**	

Borehole #15	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	135	**540**	**33**	**ND**	**93**	**250**
Change	**4 X increase**		**decrease?**		**2.7 X increase**	

Borehole #16	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	142	**310**	**34**	**ND**	**84**	**210**
Change	**2.2 X increase**		**decrease?**		**2.5 X increase**	

Table 5 continued

11. <u>Three boreholes located outside the southern boundary of the classified area of the MWL dump along an east-west line 15 feet south of the classified area</u>

Borehole #17	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	125	**330**	**32**	**ND**	**76**	**230**
Change	**2.6 X increase**		**decrease?**		**3 X increase**	

Borehole #18	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	542	**1,310**	**56**	**150**	**435**	**630**
Change	**2.4 X increase**		**2.7 X increase**		**1.5 X increase**	

Borehole #19	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**	**10 ft bgs**	**30 ft bgs**
	477	**2,400**	**69**	**260**	**220**	**630**
Change	**5 X increase**		**3.77 X increase**		**2.86 X increase**	

12. <u>2008 Probehole DP3 located along the southern boundary of the classified area approximately 15 feet north-east of 1994 borehole #18 shown above in category 10.</u>

Probehole DP3	**Total VOCs (ppbv)**		**PCE (ppbv)**		**TCE (ppbv)**	
	10 ft bgs	**50 ft bgs**	**10 ft bgs**	**50 ft bgs**	**10 ft bgs**	**50 ft bgs**
	658	**1,330**	**53**	**120**	**39**	**140**
Change	**2 X increase**		**2.26 X increase**		**3.6 X increase**	

[A] Total VOCs = Total Volatile Organic Compounds – The borehole locations and Total VOCs soil-gas concentrations are shown on Figure 26.

[B] (ppbv) = parts per billion volume

[C] PCE = the solvent tetrachloroethene – The borehole locations and PCE soil-gas Concentrations are shown on Figure 27.

[D] TCE = the solvent trichloroethene – The borehole locations and TCE soil-gas Concentrations are shown on Figure 27.

[E] ft bgs = feet below ground surface

[F] 3.3 X increase means the soil-gas concentration measured at 30 ft bgs is 3.3 times Greater than the soil-gas concentration measured at 10 ft bgs.

[G] **ND** = the constituent was not detected in the soil-gas sample.