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Review of the Risk Screening Assessment for the Mixed Waste Landfill, SWMU76

Citizen Action (through New Mexico Community Foundation)

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The following report was made possible with a grant from the Monitoring and Technical Assessment Fund (MTA) to assist in performing independent technical studies of the Mixed Waste Landfill (MWL), a hazardous waste site containing radioactive and chemical legacy wastes located at Sandia National Laboratories (SNL). The funding, established as a part of a $6.25 million court settlement between the U.S. Department of Energy (DOE) and 39 nonprofit and environmental groups, assists tribes and other non-governmental organizations in conducting their own independent technical studies of sites at DOE facilities.

Citizen Action commissioned Dr. Marvin Resnikoff, Radioactive Waste Management Associates, New York, to review Sandia National Laboratories' risk assessment for the Mixed Waste Landfill and evaluate whether the objectives identified under the Phase 2 RCRA Facility Investigation to "determine thoroughly the contaminant source, define the nature and extent of contamination, identify potential contaminant transport pathways, evaluate potential risks posed by the levels of contamination identified, and recommend remedial action, if warranted, for the landfill" were satisfied. A copy of Dr. Resnikoff's curriculum vitae is included with this report.

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- Marvin Resnikoff, Ph.D.

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For
Citizen Action
Albuquerque, NM

The purpose of the Phase 2 RCRA Facility Investigation (RFI) for the mixed waste landfill (MWL) was "to determine thoroughly the contaminant source, define the nature and extent of contamination, identify potential contaminant transport pathways, evaluate potential risks posed by the levels of contamination identified, and recommend remedial action, if warranted, for the landfill."[1] In this report we review the risk screening assessment for the MWL to evaluate whether the objectives have been satisfied and whether additional work must be undertaken. Our general conclusion is that the contaminant source has not been identified and the potential risks posed by the landfill have not been fully evaluated. Until this is done, recommendation of remedial action alternatives is premature.

Background

In this background section, we briefly summarize information from Sandia reports as it pertains to risk assessment. To prepare this report we reviewed the list of documents in Appendix A. The author's resume appears in Appendix B. In the following section we review the steps outlined by the EPA for a proper risk assessment and Sandia's approach.

The MWL, a 2.6 acre fenced area, approximately 5 miles southeast of the Albuquerque airport[2], and approximately 1.25 mile from the proposed La Semilla park[3], received radioactive and mixed waste from March 1959 through December 1988. According to

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[1] Sandia National Laboratories, DOE/SNL/NM Responses to NMED October 30, 1998, NOD for "Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation, New Mexico," Attachment 9, "Risk Screening Assessment for SWMU 76," updated June 1999, p. 1.

[2] Sandia National Laboratories, "Deployment of an Alternative Cover and Final Closure of the Mixed Waste Landfill, Sandia National Laboratories, New Mexico," September 23, 1999.

[3] Personal communication, S Dayton, Citizen Action to M Resnikoff, RWMA, June 2001.

Sandia, approximately 100,000 ft^3 containing 6,300 curies of activity were disposed of at the MWL.[4] But, the exact volume and activity are not known since "contents of some of the older pits and their volumes are not specifically known due to the absence of disposal records."[5] Further, the exact radionuclide inventory has not been revealed to the public.[6] The MWL consists of a series of unlined cylindrical and square pits to a depth of 25' in the 0.6 acre classified area, and an unclassified section of 2.0 acres containing seven trenches, approximately 130' long, 40' wide and 25' deep.[7] See Figure 1.

Phase 1 RFI field work was conducted in September 1989, with additional work completed June 1990. A Phase 2 investigation was initiated in 1992 and completed in 1995.[8] The Phase 2 investigation concluded that MWL contaminants "present little risk to groundwater or as air emissions to potential receptors."[9] Based on an industrial-use scenario, the Phase 2 report also concluded that the MWL will "not significantly affect human health."[10] This risk screening assessment assumed continuing administrative control by Sandia.

Surface and subsurface soil samples, groundwater samples and direct gamma surveys were conducted under standard QA/QC procedures, though the detection limits could have been improved by an order of magnitude. Groundwater was collected in 4 monitoring wells, MW1, MW2, MW3 and MW4, and compared to background readings in well BW1, upgradient from the landfill. Monitoring well MW-4, adjacent to Trench D, was drilled more recently (at the end of 1992), at an angle of 6^o to the vertical so that it sloped under trench D. Samples from these monitoring wells were taken for volatile organics (VOC), semi-volatile organics, metals and radionuclides. Sampling was conducted for specific radionuclides Pu, Sr, Th, and gross alpha spec and gross beta spec. Duplicates and blanks were also taken to assure measurements accurately reflected field results and not laboratory and apparatus contamination; spiked samples were used to verify measurement efficiency. The Phase 2 report concluded that tritium was the radionuclide of primary concern. Tritium contamination is primarily centered around pit 33 in the classified area of the landfill, and in soils near Trench C in the unclassified area of the landfill. The highest concentrations are at a depth of 30'. Sampling in 1982 indicated that tritium had migrated beyond the classified area fence.[11] According to

[4] Sandia National Laboratories, *Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation*, for the US Department of Energy, Albuquerque, NM, September 1996, p. E-1.
[5] Sandia National Laboratories and Ecology and Environment, Inc., *Report of the Phase 1 RCRA Facility Investigation of the Mixed Waste Landfill, Albuquerque, NM,* September 1990, p. 2-2.
[6] The author has written to Sandia and attempted to obtain a full radionuclide and toxic chemical inventory of waste in the MWL, but has not been successful.
[7] *Ibid.*
[8] Sandia National Laboratories, *Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation*, for the US Department of Energy, Albuquerque, NM, September 1996.
[9] *Ibid.*
[10] *Ibid.*
[11] Peace, JL, "Tritium in Surface Soils at the Mixed Waste Landfill, Technical Area 3, Sandia National Laboratories, New Mexico, SAND95-1611, April 1996.

Sandia, a total of 1861 Ci tritium had been disposed in the MWL, 410 Ci in trenches and 1451 Ci in the classified area (822 Ci in Pit 33).

Localized hot spots are also present in the MWL. Direct gamma or neutron dose rates above pits 35, 36 and pit SP-4 are far above background, with direct gamma readings of 50 mr/y, 6 mr/y and 0.5 mr/y, respectively.

According to the risk assessment, for subsurface soils, the primary mechanism for human contact is percolation through the soil down to groundwater, approximately 460' below the ground surface. Sandia data showed that ten organic compounds and three organic analytes were measured above background in groundwater.[12] In addition, Prof. Mark Baskaran, a geologist who reviewed Sandia's measurements, has convincingly shown that uranium, with isotopic concentrations unlike natural uranium, has reached groundwater.[13] Admittedly the concentrations are low, but Sandia nevertheless denies that any materials from the MWL have reached groundwater. Since groundwater is approximately 460' below the ground surface, and with annual precipitation of 8 inches per year, major concentrations of radionuclides, toxic chemicals and metals were not expected to reach groundwater, according to Sandia.

In addition to Sandia and other reports mentioned above, the Environmental Health Department of the City of Albuquerque, reviewed measurements by Sandia and found that chloride levels beneath Trench D were significantly higher than background chloride concentrations, indicating potential leakage from the MWL.[14]

The above positive findings could be due to the fact that Sandia disposed of 271,500 gallons of reactor cooling water into Trench D in 1967. In response to Professor Baskaran's report regarding uranium in groundwater, Sandia contested whether any of this coolant water could have reached the aquifer. But as they contested Professor Baskaran's findings, Sandia never revealed that a much larger total of 19,414,470 gallons, not 271,500 gallons, had actually been disposed of in leach fields near or in the MWL. In response to a FOIA request by Citizen Action, a Sandia memo shows that 12,556,970 gallons and 6,586,000 gallons, were released in Area III and Area V, respectively, in the time period 1963-1971. These waters contained a total activity of 35 curies.[15]

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12 Sandia National Laboratories, *Environmental Restoration Project DOE/SNL/NM Responses to NMED October 30 1998, NOD for "Report of Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Sandia National Laboratories, Albuquerque, NM,* US Department of Energy, Attachment 9, June 10, 1999 (update), p. 21.

13 Baskaran, M., *Mixed Waste Landfill Review*, Department of Geology, Wayne State University, Detroit, MI 48202, July 5, 2000. Sandia dismisses these measurements as false positives.

14 Memo, D Earp, geohydrologist, to Dr. Bruce Thompson, Chair, Groundwater Protection Advisory Board, Environmental Health Department, City of Albuquerque, November 29, 2000.

15 Memo from M Goodrich to A Parsons, Sept 13, 1989.

In addition to this large water volume, other FOIA documents recently received by Citizen Action reveal that it was not until 1975 that SNL required liquid wastes to be solidified before being placed in the MWL.[16] According to the risk assessment and aside from potential groundwater contamination, the primary mechanisms for contaminant transport to the public is from wind erosion of surface soil, with lesser contributions from surface water and biota.[17]

A summary of fate and transport at the MWL is listed in Table 9 of the risk assessment report.[18] According to Sandia, all mechanisms or pathways for reaching humans (surface runoff, migration to groundwater, food chain uptake and transformation) have a low significance except wind erosion. Furthermore, a potential event that is not likely to affect the landfill is a major rainstorm and flooding of the landfill. One hundred and 500-year floods are not expected to reach the surface of the MWL[19], though throughout the course of geologic time, soil from the Manzanita Mountains washed down and filled the present plain.[20]

Though not explicitly stated, the pathways presented in the risk assessment assume a no-action alternative and are based on current measurements. Table 9 assumes the site remains under Sandia or government administrative control for the indefinite future. If this were not the case, other transport mechanisms are possible such as a residential scenario where a home is constructed by excavating a foundation thereby bringing buried radioactive and toxic chemical materials to the surface or another event such as a well drilled through the landfill to the water table. Other possible scenarios include agricultural use of the land or disruption of the site by burrowing animals.

Sandia determined the risk due to background concentrations of radiological and non-radiological contaminants. These are subtracted from the risk due to concentrations of radiological and non-radiological contaminants at the MWL. Ten of the COCs are organics and do not have associated background concentrations. Documents recently released to Citizen Action in response to their FOIA request state that between the years 1959-1962, hazardous chemicals, including acids, solvents, trichloroethylene (TCE), carbon tetrachloride, and toluene based chemicals, many believed to have been radioactively contaminated, were placed in the landfill. Liquids were disposed of in the MWL until 1976 after which they were solidified according to FOIA documents.

The non-radiological and radiological contaminants of concern are shown in Table 10 and 11, respectively, of the Risk Screening Assessment. For radiological contaminants,

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16 SNL Project Document Plan 92-24, Site Health and Safety Plan Form.

17 "Risk Screening Assessment For SWMU 76," 6/10/99, p. 30.

18 *Ibid.*

19 Sandia National Laboratories, "Draft Site-Wide Environmental Impact Statement," DOE/EIS-0281, April 1999, Fig. 4.6-6.

20 Van Hart, D, "Geologic Study of Near-Surface Sediments, Technical Area 3, Sandia National Laboratories," September 30, 1998.

the dose conversion factors (DCF) in FGR[21] No. 11 are employed. The DCF's relate the amount of radioactivity taken in by an adult male to the dose commitment in millirems.

Generally for currently measured soil, the estimated excess cancer risk is greater than 1.E-6, up to 5.E-5. For radiological COC's, the guideline being used by Sandia is 75 mrem/year, compared to the calculated 15.1 mrem/year. Other guidelines that could be employed by Sandia are the NRC's 25 mrem/yr total effective dose equivalents (TEDE) or the EPA's 15 mrem/yr TEDE for a decommissioned site. Sandia concludes that the MWL is eligible for unrestricted radiological release. As we discuss later, Sandia's arguments are flawed.

Baseline Risk Assessment

According to the EPA, "The goal of the RI/FS[22] is to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site."[23] Several standard steps are generally taken in order to select the best remedy for a site. These steps include "characterizing the contaminants, the potential exposures, and the potentially exposed population sufficiently to determine what risks need to be reduced or eliminated and what exposures need to be prevented."[24] Within this process, the baseline risk assessment evaluates the risk associated with the no action alternative. The Feasibility Study (FS) then compares the risk of different alternatives to the baseline risk.

Data Collection and Evaluation

This step involves gathering and analyzing relevant site data, including characterizing site conditions. This also involves determining the nature of the wastes, including identifying potential chemicals and radionuclides of concern. By sampling groundwater, soil and air, Sandia has identified chemicals and radionuclides currently of concern in the sampled media. But Sandia neglected to provide "information on the amounts of hazardous substances disposed,"[25] that is, to identify "all potential or suspected sources of contamination."[26] This important purpose of the Phase 2 investigation, "to determine

[21] US Environmental Protection Agency, "Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion," 1988.
[22] RI/FS is the EPA's acronym for remedial investigation and feasibility study, the reports that characterize the site and develop remediation alternatives, respectively.
[23] US Environmental Protection Agency, "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)," EPA/540/1-89/002, December 1989, Sect. 3.1.
[24] US EPA (1989), Sect. 3.2.
[25] US EPA (1989), Sect. 4.2.
[26] *Ibid.*

thoroughly the contaminant source," was not accomplished. This was verified by the New Mexico Environment Department (NMED).[27]

Why is it important to know the full inventory? Because the information allows one to estimate the hazardous life of the landfill, the useful life of containers, the potential radiation dose to future residents and therefore should guide the feasible remediation alternatives. To understand the full present and future potential hazard, Sandia needs to provide the full radiological and toxic chemical inventory of the landfill. The combined inventory for the classified and unclassified sections of the MWL should be listed.

Determining the full radionuclide inventory has been done at many DOE landfills across the country. As an example, the full inventory of the mixed waste storage facility at INEEL is shown in Tables 1 and 2. This waste material was generated at many DOE facilities, but primarily at Rocky Flats. Despite the diversity of sources, DOE-Idaho was able to investigate the generating source and inventory by reviewing generator records, taking gas samples and using non-intrusive means. As seen in the tables, the total mass of organic chemicals and metals and the total radioactivity of all radionuclides, and the sources of these materials are listed. Sandia should provide a similar listing for the MWL. The Phase II report lists ion exchange resins, activation products and MFP for mixed fission products, without specifying specific radionuclides. The total tritium is listed – 1861 Ci, and the likely locations, while also acknowledging that no information is available for trenches A through D. The Phase II report estimates 200 Ci of Sr-90 and Cs-137, but it is unclear how this information was derived. Many trenches and pits contain mixed fission products, reactor debris and bomb test materials. These wastes contain unevaluated concentrations of Sr-90 and Cs-137, plutonium and activation products. Further, without solidification with a grout, ion exchange resins would contain up to 50% water.[28] But Sandia and the NMED continue to maintain, incorrectly in my opinion, the drummed resins were solid.[29] Radionuclides in wet ion exchange resins would have a greater opportunity to move over time.

As an example of important missing information, consider the following. Pit 35 has very high direct gamma rates at the surface, 50 millirems per hour (mr/h). What accounts for these high direct gamma readings? Pit 35 contents are listed as 686 kg depleted uranium (DU) and 203 Ci tritium. Neither of these materials account for high gamma readings. Pit 35 also contains neutron generator tubes and targets and neutron activated brass. These materials may have high Co-60 and Nb-94 concentrations that may account for high survey results, but Sandia's documents have no further information. Nb-94 has a long half-life, 20,000 years. Knowing the source of Pit 35 contents and how the radionuclides were generated, Sandia could develop additional information about pit contents. Similarly, Pit 36 has direct gamma rates of 6 mr/h, but the pit contents were

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[27] Email from L Voss, NM Dept of the Environment, to M Resnikofff, RWMA, May 29, 2001.
[28] Oztunali, OI and GW roles, "Update of Part 61, Impacts Analysis Methodology," NUREG/CR-4370, p. A-19.
[29] Letter from R Kennett, NM Environment Department, to S Dayton, Citizen Action, May 24, 2001.

listed as 673 kg DU and 13 kg lithium. The pit also contains neutron generator tubes and targets, rings from reactor fuel elements and 4 55-gallon drums containing fission product contaminated waste. The curie content of these materials is not listed. Pit SP-4 has surface direct gamma readings of 0.5 mr/h. This high gamma dose is likely due to Co-60 and Nb-94 from nuclear reactor vessel plates from a decommissioned nuclear reactor, but the curie content again is not listed. Trench A contains 17 55-gallon drums containing mixed fission products in demineralizer resins. But the exact curie content is not listed. Each trench and pit in the MWL contains similar mysteries. The presence of these fission products, and particularly the presence of activation products and actinides, such as Pu-239, indicates that the MWL will remain hazardous essentially forever. It must be assumed bomb test materials from NTS contain Pu-239.

Many pits (1,2, 3A and B, and 4 through 11, and Pits U-1 through U-3) and trenches (such as trench C which contains metal turnings), contain depleted uranium, likely in metal form. This includes DU from burn tests and contaminated weapons components. When exposed to air at elevated temperatures, uranium metal will oxidize or burn. In 1979, metal turnings from NMI in Concord, Massachusetts self-ignited en route to the Barnwell low-level radioactive burial ground. FOIA documents reveal a DU fire occurred at the MWL in 1974.

Several pits contain test debris from NTS. This is likely to contain a mixture of plutonium and fission products. Some pits, such as SP-1, and trenches C and D, contain hazardous and unspecified chemicals. As pointed out earlier, unsolidified, hazardous chemical wastes such as acids, solvents, TCE and carbon tetrachloride, were disposed of in the classified section of the MWL from 1959-1962.

Though Sandia's sampling QA/QC procedures are reasonably good, there are three concerns:

1) As recommended by the EPA, water samples should generally be unfiltered. "If unfiltered water is of potable quality, data from unfiltered water samples should be used to estimate exposure."[30] "While filtration of groundwater samples provides useful information for understanding chemical transport within an aquifer, the use of filtered samples for estimating exposure is very controversial because these data may underestimate chemical concentrations in water from an unfiltered trap. Therefore, data from unfiltered samples should be used to estimate concentrations in water from an unfiltered trap."[31] Often radioactive particles are filtered out of a sample and the radioactive particles remaining on the filter are not separately measured. Apparently, for the most part Sandia took unfiltered samples, but how the laboratory processed these samples is unclear, e.g., were the particulates filtered out at the laboratory and discarded?

[30] US EPA (1989), Sect. 4.5.3
[31] US EPA (1989), Sect. 6.5.2.

2) In several instances, Sandia considered samples with high concentrations suspect; duplicate samples with lower concentrations were taken, and the samples with high concentrations discarded. In contrast, no samples with low concentrations were discarded. Statistically suspect high concentrations should reflect a similar number of suspect low concentrations. The effect of discarding only samples with high concentrations is to bias measurements on the low side. In one case, a newly operating laboratory was criticized, but only the high measurements were excluded. If the lab's QA/QC procedures are correct, as they appeared to be, the sample should not have been excluded. Blank and spiked samples should have uncovered any error in laboratory procedures. But if the lab's procedures were incorrect, then all the samples sent to that lab should have been excluded, not just those with high concentrations.
3) Soil measurements of Pu at three different laboratories gave different results. These cannot be reanalyzed since the soil core samples were discarded by Sandia.

Exposure Assessment

This step involves analyzing contaminant releases, the exposed population and the potential exposure pathway. For each pathway, exposure concentrations and contaminant intakes were estimated by Sandia. Here Sandia considered the current concentrations in soil and groundwater, together with the likely exposure pathways. Inhalation of radioactive particulates due to wind erosion of the landfill was considered the likely pathway to humans. The possibility of radionuclides other than tritium entering groundwater is discounted due to the 460' depth below the ground surface of the aquifer. This argument parallels the argument DOE made for Nevada Test Site groundwater modeling, that was roundly criticized by the National Academy of Sciences.[32]

Generally for currently measured soil, Sandia estimates the excess cancer risk as greater than 1.E-6, up to 5.E-5. That is, the likelihood of contracting fatal cancer is one chance per million or greater. For radiological COC's, the guideline being used by Sandia is 75 mrem/year, compared to the calculated 15.1 mrem/year. EPA's guideline for unrestricted release of a decommissioned site is 15 mrem/y. That is, for the measured radiological COC's, the MWL is on the borderline for EPA's guideline for unrestricted release. Nevertheless, Sandia concludes that the MWL is eligible for unrestricted radiological release. The NRC criteria is 25 mrem/yr TEDE.

We disagree with Sandia's assessment that the site is eligible for unrestricted release on three grounds: a) Sandia does not consider future risk under realistic scenarios, b) there has not been a full disclosure of contents, migration and contamination so far, and c) Sandia ignores the high direct gamma exposure rates over several of the pits.

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[32] National Academy of Sciences, *Long-Term Institutional Management of U.S. Department of Energy Legacy Wastes*, National Academy Press, 2000, Sidebar 7-2.

Exposure assessments should not only consider current exposures, but future exposures as well. EPA guidance states that "actions at Superfund sites should be based on an estimate of the reasonable maximum exposure (RME) expected to occur under both current and future land-use conditions."[33] "RME is the highest exposure that is reasonably expected to occur at a site."[34] According to the EPA, a risk assessor should also "consider the characteristics of the current population, as well as those of any potential future populations that may differ under an alternate land use."[35] Further, for risk assessment purposes, Sandia should not assume administrative controls past 100 years. Sandia needs to "determine if any activities associated with a current land use are likely to be different under an alternate future land use."[36] For time periods greater than 100 years, different land uses should be considered. One potential land use could be the Mesa del Sol development and a city park that could be built near the MWL.

Any assessment of future exposures should consider a residential or residential farmer scenario. After the 100-year institutional control period, one scenario not considered by Sandia is exhumation of soil for a house foundation. This would bring radioactive and toxic chemical contaminants from these unlined pits and trenches to the surface. A future family could plant a garden in the contaminated soil, or a farmer could plant crops, or raise cattle on exhumed contaminated soil. Under this scenario, other pathways are also possible. The potential doses to a future family could then be far higher since the trenches and pits contain plutonium and fission products that have so far been observed in trace amounts in soils. The highest tritium concentrations are at a 30' depth; the highest Pu-238 and Pu-239/240 are at 70' below grade, as detected in core samples from MW-4 drilling logs.[37] A second scenario not investigated is the possibility of drilling a well through the MWL. This may have serious consequences for the following reason. As indicated above, numerous pits and trenches contain depleted uranium, including uranium shavings. This depleted uranium appears to be in metallic form though 19 highly oxidized DU plates are listed as buried in Pit 31. The frictional heat due to drilling could ignite uranium metal, oxidizing it to UO_2 or U_3O_8, releasing uranium and other materials in the MWL to the air. As previously mentioned, oxidation of uranium metal has occurred during transport of uranium metal shavings from NMI in Concord, Massachusetts to the Barnwell, South Carolina low-level waste landfill. It is also the principle behind the use of depleted uranium tank penetrators used in the Gulf War and Kosovo. These uranium metal penetrators rapidly oxidize when striking a target. A risk assessment should also consider the radiation doses incurred by children. Children ingest

[33] US EPA (1989), Sect. 6.1.2.
[34] *Ibid.*
[35] *Ibid.*
[36] US EPA (1989), Sect. 6.2.2.
[37] Sandia has discounted the high Pu measurements on the grounds that the laboratory, Quanterra, was just starting up. Why Sandia can discount some Quanterra samples, not others, is not explained in Sandia reports. And why a rigorous QA/QC program, with the use of blanks and spiked samples, could not catch these laboratory measurement problems has also not been explained by Sandia.

more soil and drink milk. This needs to be taken into account, along with smaller organ size, metabolism rates and ICRP-60 dose conversion factors.

Finally, the site cannot be released for unrestricted use because the direct gamma or neutron dose rates above pits 35, 36 and Pit SP-4 are greater than 15 mr/yr (EPA), 75 mr/yr (DOE) or 100 mr/yr (the NRC standard for operating nuclear facilities). The possibility of exhuming the contents of pits 35, 36 and Pit SP-4 was internally discussed among Sandia personnel and rejected.[38] Instead, the present course of capping the MWL was decided: "We have selected the option of covering the landfill and closing the site through risk assessment, long-term monitoring and institutional controls."[39]

While this critique is focused on Sandia's baseline risk assessment, it is important to note that even without a proper risk assessment, Sandia intends to move ahead with an active vegetative cap on the MWL. While this action would clearly reduce the direct gamma dose rate from pits 35, 36 and SP-4, a vegetative cap can only be considered an interim solution and cannot absolve Sandia from its obligation for continual monitoring and maintenance of the MWL for its hazardous life. Though Sandia disputes all claims on underground movement of contaminants, scientifically credible studies have shown that uranium and chloride have reached groundwater beneath the site. The cap may not halt this migration. A vegetative cap may have other problems that should be carefully considered. Wind can erode the cap. If this were to occur, the soil shielding would be lost and direct gamma exposures would increase. Further, clay can crack and synthetic liners will degrade due to heat and ultraviolet rays. Finally, vegetation and burrowing animals can compromise the cap. Thus, a cap would have to be maintained into the indefinite future. The alternatives, no action or exhumation, also have drawbacks. If capping were the selected alternative, a dedicated trust fund should be established for monitoring and maintenance of the MWL; monitoring and maintenance should not be subject to the yearly Congressional budget battle.

Risk Characterization

Given the intake of radionuclides and toxic chemicals, the cancer risks and the noncancer hazard quotients can be estimated. This estimate is accomplished by multiplying the yearly intake by the slope factors, for toxic chemicals, or the dose conversion factors for radionuclides. Since polluters can only be held responsible for their actions and not those that occur naturally, background cancer risks are subtracted. For radionuclides, Sandia has chosen to employ the older dose conversion factors, based on ICRP-30[40]. At RWMA we generally use the newer DCF's, based on ICRP-60.[41] This allows one to specifically

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[38] Memo from J Gould to D Fate, SNL, Nov. 20, 1998.
[39] *Ibid.*
[40] International Commission on Radiological Protection, "Limits for Intake by Workers," ICRP 30, Annals of the ICRP Vol 6, 7, 8, Pergamon Press (1982).
[41] International Commission on Radiological Protection, "1990 Recommendations of the International Commission on Radiological Protection," ICRP 60, Annals of the ICRP Vol 21, Pergamon Press (1990).

evaluate the dose to children as well as adults. Sandia's risk calculations apply to an adult male. Sandia does not separately calculate the dose to the fetus or a child. DOE has been slow to use the latest DCF's developed by the ICRP, though it should be noted that ICRP-68 and ICRP-78 based on ICRP-60 are now being used for occupational exposures at the government's Y-12 plant in Oak Ridge.

The radionuclide and chemical cancer risks should then be combined. Contrary to EPA guidance, Sandia has chosen not to sum the toxic chemical and radionuclide cancer risks. "Estimates of the lifetime risk of cancer to exposed individuals resulting from radiological and chemical risk assessments may be summed in order to determine the overall potential human health hazard associated with a site."[42] This can be done if the risk values have the same basis. Because the basis for toxic chemical and radionuclide slope factors differ, Sandia has chosen not to sum the cancer risks. The slope factors for chemical carcinogens generally represent an upper bound or 95th percent confidence limit value, while radionuclide slope factors are best estimate values based on Japanese bomb survivor data. That is, summing the risks would give us a total cancer risk that is somewhere between "best estimate" and "upper bound." "In addition to medium-specific concerns, there may be several potential current and future routes of contaminant transport within a medium and between media at a site,"[43] e.g., cattle feeding on grass raised in contaminated soil.

Conclusions

Sandia sampling data show that tritium is moving at the MWL. Further, trace amounts of toxic chemicals and radionuclides have been detected in groundwater, 460' below the site surface. Because of the depth of groundwater below the MWL and the semi-desert conditions, one does not expect major movement of radionuclides or toxic chemicals. However, at specific locations at the MWL, the direct gamma dose rates are high, preventing release of the site for unrestricted use in the site's present condition.

A risk assessment must examine not just current conditions, but future pathways and populations. The EPA has advised that for time periods greater than 100 years, administrative controls should not be assumed. A future resident or farmer could unearth trench or pit contents in the process of laying a building foundation or other intrusive activities. This contaminated earth could be used for growing crops or gazing cattle. Therefore, it is important to know the full radionuclide and hazardous chemical inventory in order to know the risk and hazardous life of the MWL. Sandia does not have this information. At least it has not been made publicly available. The purpose of the Phase 2 RCRA Facility Investigation for the mixed waste landfill (MWL), "to determine thoroughly the contaminant source," has not been met. Without this information, it is

[42] US EPA (1989), Sect. 10.7.3.
[43] US EPA (1989), Sect. 4.5.1.

difficult to judge remediation alternatives. I therefore recommend that Sandia devote resources to fully characterizing the radionuclide inventory of the MWL, as has been done at other DOE facilities.

Given the radionuclide inventory of the MWL, I recommend that Sandia conduct a risk assessment that properly includes future scenarios, assuming no administrative control of the MWL after 100 years. This risk assessment should be reviewed by independent 3rd parties and not in-house. This baseline risk assessment should then guide the selection of alternatives. The proposed plan for the MWL should be subject to public review and comment at a public hearing. Any plan that leaves the waste in place should have a dedicated monitoring and maintenance fund to provide for continuing monitoring of the MWL, and maintenance, including fence construction and removal of any plant growth with deep roots.

Appendix A. References

1) Baskaran, Ph.D, Mark, *Mixed Waste Landfill Review*, Department of Geology, Wayne State University, Detroit, MI 48202, July 5, 2000.

2) City of Albuquerque, Memo, D Earp, geohydrologist, to Dr. Bruce Thompson, Chair, Groundwater Protection Advisory Board, Environmental Health Department, November 29, 2000.

3) Environmental Restoration Project, *Deployment of An Alternative Cover and Final Closure of The Mixed Waste Landfill, Sandia National Laboratories, New Mexico*, Sandia National Laboratories, September 1999.

4) Goering, Timothy J., McVey, Michael D., Strong, Warren R., et al., *Analysis of Instantaneous Profile Test Data from Soils Near the Mixed Waste Landfill, Technical Area 3, Sandia National Laboratories/New Mexico*, Sandia National Laboratories, SAND95-1637, February 1996.

5) National Academy of Sciences, *Long-Term Institutional Management of U.S. Department of Energy Legacy Wastes*, National Academy Press, 2000.

6) Office of Emergency and Remedial Response, *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A*), U.S. Environmental Protection Agency, EPA/540/1-89/002, December 1989.

7) Oztunali, OI and GW roles, “Update of Part 61, Impacts Analysis Methodology,” NUREG/CR-4370, p. A-19.

8) Peace, Jerry L., Goering, Tim J., McVey, Michael D., *Tritium in Surface Soils at the Mixed Waste Landfill, Technical Area 3, Sandia National Laboratories, New Mexico*, Environmental Restoration Project, Sandia National Laboratories, SAND96-1611, April 1996.

9) Robinson, Paul, *Summary of Data Identifying Organic Compounds Detected in Groundwater Beneath the Mixed Waste Landfill, Sandia National Laboratories, Albuquerque, NM*, Southwest Research and Information Center, January 2001.

10) Sandia National Laboratories and Ecology and Environment, Inc., “Report of the Phase 1 RCRA Facility Investigation of the Mixed Waste Landfill, Albuquerque, NM,” September 1990.

11) Sandia National Laboratories, *Environmental Restoration Project DOE/SNL/NM Responses to NMED October 30 1998, NOD for "Report of Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Sandia National Laboratories, Albuquerque, NM*, US Department of Energy, January 28, 1999.

12) Sandia National Laboratories, *Environmental Restoration Project DOE/SNL/NM Responses to NMED October 30 1998, NOD for "Report of Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Sandia National Laboratories, Albuquerque, NM*, Attachment 9, US Department of Energy, January 26, 1999.

13) Sandia National Laboratories, *Environmental Restoration Project DOE/SNL/NM Responses to NMED October 30 1998, NOD for "Report of Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Sandia National Laboratories, Albuquerque, NM*, US Department of Energy, Attachment 9, June 10, 1999 (update).

14) Sandia National Laboratories, *Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation*, for the US Department of Energy, Albuquerque, NM, September 1996.

15) Sandia National Laboratories, *Site-Wide Environmental Impact Statement, Volume I*, DOE/EIS-0281, October 1999.

16) Sandia National Laboratories, Memo from J Gould to D Fate, SNL, Nov. 20, 1998.

17) Sandia National Laboratories, Memo from M Goodrich to A Parsons, SNL, Sept 13, 1989.

18) Van Hart, Dirk, *Geologic Study of Near-Surface Sediments, Vol. 1*, prepared for Mixed Waste Landfill Cover Project, Sandia National Laboratories, Albuquerque, NM, September 1998.

Appendix B. Resume of Marvin Resnikoff, Ph.D.

Dr. Marvin Resnikoff is Senior Associate at Radioactive Waste Management Associates and is an international consultant on radioactive waste management issues. He is Principal Manager at Associates and is Project Director for risk assessment studies on radioactive waste facilities and transportation of radioactive materials. Dr. Resnikoff has concentrated exclusively on radioactive waste issues since 1974. He has conducted studies on the remediation and closure of the leaking Maxey Flats, Kentucky radioactive landfill for Maxey Flats Concerned Citizens, Inc. under a grant from the Environmental Protection Agency, the Wayne and Maywood, New Jersey thorium Superfund sites and on proposed low-level radioactive waste facilities at Martinsville (Illinois), Boyd County (Nebraska), Wake County (North Carolina), Ward Valley (California) and Hudspeth County (Texas). He has conducted studies on transportation accident risks and probabilities for the State of Nevada and dose reconstruction studies of oil pipe cleaners in Mississippi and Louisiana, residents of Canon City, Colorado near a former uranium mill, residents of West Chicago, Illinois near a former thorium processing plant, and residents and former workers at a thorium processing facility in Maywood, New Jersey. In West Chicago he calculated exposures and risks due to thorium contamination and served as an expert witness for plaintiffs A Muzzey, S Bryan, D Schroeder and assisted counsel for plaintiffs KL West and KA West. He is presently serving as an expert witness for a separate group of plaintiffs in West Chicago, including R Dassion. He also evaluated radiation exposures and risks in worker compensation cases involving G Boeni and M Talitsch, former workers at Maywood Chemical Works thorium processing plant. He recently completed work in a major personal injury cases involving former uranium mines and mills in South Texas. In June 2000, he was appointed to a Blue Ribbon Panel on Alternatives to Incineration by DOE Secretary Bill Richardson.

Under a contract with the State of Utah, Dr. Resnikoff is a technical consultant to DEQ on the proposed dry cask storage facility for high-level waste at Skull Valley, Utah and proposed storage/transportation casks. He is assisting the State on licensing proceedings before the Nuclear Regulatory Commission. In addition, at hearings before state commissions and in federal court, he has investigated proposed dry storage facilities at the Point Beach (WI), Prairie Island (MN) and Palisades (MI) reactors. He is also presently preparing studies on transportation risks and consequences for the State of Nevada and Clark and White Pine Counties.

In Canada, he has conducted studies on behalf of the Coalition of Environmental Groups and Northwatch for hearings before the Ontario Environmental Assessment Board on issues involving radioactive waste in the nuclear fuel cycle and Elliot Lake tailings and the Interchurch Uranium Coalition in Environmental Impact Statement hearings before a Federal panel regarding the environmental impact of uranium mining in Northern Saskatchewan. He has also worked on behalf of the Morningside Heights Consortium regarding radium-contaminated soil in Malvern and on behalf of Northwatch regarding decommissioning the Elliot Lake tailings area before a FEARO panel. More recently he completed a study for Concerned Citizens of Manitoba regarding transportation of irradiated fuel to a Canadian high-level waste repository.

He was formerly Research Director of the Radioactive Waste Campaign, a public interest organization conducting research and public education on the radioactive waste issue. His duties with the Campaign included directing the research program on low-level commercial and military waste and irradiated nuclear fuel transportation, writing articles, fact sheets and reports, formulating policy and networking with numerous environmental and public interest organizations and the media. He is author of the Campaign's book on "low-level" waste, *Living Without Landfills*, and co-author of the Campaign's book, *Deadly Defense, A Citizen Guide to Military Landfills.*

Between 1981 and 1983, Dr. Resnikoff was a Project Director at the Council on Economic Priorities, a New York-based non-profit research organization, where he authored the 390-page study, *The Next Nuclear Gamble, Transportation and Storage of Nuclear Waste*. The CEP study details the hazard of transporting irradiated nuclear fuel and outlines safer options.

In February 1976, assisted by four engineering students at State University of New York at Buffalo, Dr. Resnikoff authored a paper that changed the direction of power reactor decommissioning in the United States. His paper showed that power reactors could not be entombed for long enough periods to allow the radioactivity to decay to safe enough levels for unrestricted release. The presence of long-lived radionuclides meant that large volumes of dismantled reactors would still have to go to low-level waste disposal facilities. He has assisted public interest groups NECNP and CAN on the decommissioning of the Yankee-Rowe and Haddam Neck reactors, and is presently serving as a technical consultant and expert witness in NRC hearings on the License Termination Plan for Haddam Neck.

Dr. Resnikoff is an international expert in nuclear waste management, and has testified often before State Legislatures and the U.S. Congress. He has extensively investigated the safety of the West Valley, New York and Barnwell, South Carolina nuclear fuel reprocessing facilities. His paper on reprocessing economics (Environment, July/August, 1975) was the first to show the marginal economics of recycling plutonium. He completed a more detailed study on the same subject for the Environmental Protection Agency, "Cost/Benefits of U/Pu Recycle," in 1983. His paper on decommissioning nuclear reactors (Environment, December, 1976) was the first to show that reactors would remain radioactive for hundreds of thousands of years.

Dr. Resnikoff has prepared reports on incineration of radioactive materials, transportation of irradiated fuel and plutonium, reprocessing, and management of low-level radioactive waste. He has served as an expert witness in state and federal court cases and agency proceedings. He has served as a consultant to the State of Kansas on low-level waste management, to the Town of Wayne, New Jersey, in reviewing the cleanup of a local thorium waste dump, to WARD on disposal of radium wastes in Vernon, New Jersey, to the Southwest Research and Information Center and New Mexico Attorney General on shipments of plutonium-contaminated waste to the WIPP facility in New Mexico and the State of Utah on nuclear fuel transport. He has served as a consultant to the New York Attorney General on air shipments of plutonium through New York's Kennedy Airport, and transport of irradiated fuel through New York City, and to the Illinois Attorney General on the expansion of the spent fuel pools at the Morris Operation and the Zion reactor, to the Idaho Attorney General on the transportation of irradiated submarine fuel to the INEL facility in Idaho and to the Alaska Attorney General on shipments of plutonium through Alaska. He was an invited speaker at the 1976 Canadian meeting of the American Nuclear Society to discuss the risk of transporting plutonium by air. As part of an international team of experts for the State of Lower Saxony, the Gorleben International Review, he reviewed the plans of the nuclear industry to locate a reprocessing and waste disposal operation at Gorleben, West Germany. He presented evidence at the Sizewell B Inquiry on behalf of the Town and Country Planning Association (England) on transporting nuclear fuel through London. In July and August 1989, he was an invited guest of Japanese public interest groups, Fishermen's Cooperatives and the Japanese Congress Against A- and H- Bombs (Gensuikin).

Between 1974 and 1981, he was a lecturer at Rachel Carson College, an undergraduate environmental studies division of the State University of New York at Buffalo, where he taught energy and environmental courses. The years 1975-1977 he also worked for the New York Public Interest Group (NYPIRG).

In 1973, Dr. Resnikoff was a Fulbright lecturer in particle physics at the Universidad de Chile in Santiago, Chile. From 1967 to 1973, he was an Assistant Professor of Physics at the State University of New York at Buffalo. He has written numerous papers in particle physics, under grants from the National Science Foundation. He is a 1965 graduate of the University of Michigan with a Doctor of Philosophy in Theoretical Physics, specializing in group theory and particle physics.

Dr. Marvin Resnikoff

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EXPERIENCE:

April 1989 - present **Senior Associate**, Radioactive Waste Management Associates, management of consulting firm focused on radioactive waste issues, evaluation of nuclear transportation and military and commercial radioactive waste disposal facilities.

1978 - 1981; 1983 - April 1989 **Research Director**, Radioactive Waste Campaign, directed research program for Campaign, including research for all fact sheets and the two books, *Living Without Landfills*, and *Deadly Defense.* The fact sheets dealt with low-level radioactive waste landfills, incineration of radioactive waste, transportation of high-level waste and decommissioning of nuclear reactors. Responsible for fund-raising, budget preparation and project management.

1981 - 1983 **Project Director**, Council on Economic Priorities, directed project which produced the report *The Next Nuclear Gamble*, on transportation and storage of high-level waste.

1974 - 1981 **Instructor**, Rachel Carson College, State University of New York at Buffalo, taught classes on energy and the environment, and conducted research into the economics of recycling of plutonium from irradiated fuel under a grant from the Environmental Protection Agency.

1975 - 1976 **Project Coordinator**, SUNY at Buffalo, New York Public Interest Research Group, assisted students on research projects, including project on waste from decommissioning nuclear reactor.

1973 **Fulbright Fellowship** at the Universidad de Chile, conducting research in elementary particle physics.

1967 - 1972 **Assistant Professor of Physics**, SUNY at Buffalo, conducted research in elementary particle physics and taught range of graduate and undergraduate physics courses.

1965 - 1967 **Research Associate**, Department of Physics, University of Maryland, conducted research into elementary particle physics.

EDUCATION

University of Michigan	PhD in Physics, June 1965
Ann Arbor, Michigan	M.S. in Physics, Jan 1962
	B.A. in Physics/Math, June 1959