EEG-87

IDENTIFICATION OF ISSUES CONCERNING BURIED TRANSURANIC WASTE

Lawrence E. Allen

Environmental Evaluation Group
New Mexico

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FOREWORD

The purpose of the New Mexico Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the Waste Isolation Pilot Plant (WIPP) Project to ensure the protection of the public health and safety and the environment of New Mexico. The WIPP Project, located in southeastern New Mexico, became operational in March 1999 for the disposal of transuranic (TRU) radioactive wastes generated by the national defense programs. The EEG was established in 1978 with funds provided by the U.S. Department of Energy (DOE) to the State of New Mexico. Public Law 100-456, the National Defense Authorization Act, Fiscal Year 1989, Section 1433, assigned the EEG to the New Mexico Institute of Mining and Technology and continued the original contract DE-AC04-79AL10752 through DOE contract DE-AC29-89AL58309. The National Defense Authorization Act for Fiscal Year 1994, Public Law 103-160, and the National Defense Authorization Act for Fiscal Year 2000, Public Law 106-65, continued the authorization.

The EEG performs independent technical analyses on a variety of issues. Now that the WIPP is operational, these issues include facility modifications and waste characterization for future receipt and emplacement of remote handled waste, generator site audits, contact handled waste characterization issues, the suitability and safety of transportation systems, mining of new panels, and analysis of new information as part of the five year recertification cycles as mandated by the WIPP Land Withdrawal Act. Review and comment is provided on the annual Safety Analysis Report and Proposed Modifications to the Hazardous Waste Facility Permit. The EEG also conducts an independent radiation surveillance program which includes a radiochemical laboratory.

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ACRONYMS

αLLW	Alpha Low Level Waste
AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
AMWTP	Advanced Mixed Waste Treatment Plant
CAO	Corrective Action Order
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH	Contact Handled
DOE	Department of Energy
EEG	Environmental Evaluation Group
EPA	Environmental Protection Agency
IEER	Institute for Energy and Environmental Research
INEEL	Idaho National Engineering and Environmental Laboratory
LANL	Los Alamos National Laboratory
LLW	Low Level Waste
LTS	Long-term Stewardship
LWA	Land Withdrawal Act
MDA	Material Disposal Area
NAS	National Academy of Science
NMED	New Mexico Environment Department
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
ORNL	Oak Ridge National Laboratory
PMP	Performance Management Plan
ROD	Record of Decision
SEIS	Supplemental Environmental Impact Statement
SRS	Sanvannah River Site
TA	Technical Area
TRU	Transuranic
WIPP	Waste Isolation Pilot Plant

EXECUTIVE SUMMARY

A directive by the Atomic Energy Commission in 1970 required that the sites around the U.S. nuclear weapons complex begin retrievable storage of transuranic (TRU) waste. Prior to this directive, TRU waste was typically disposed of by placement into cardboard boxes or carbon steel drums, which were then dumped into shallow pits or trenches. Some liquid waste was also disposed into pits and trenches, but more often it went into shafts and boreholes. The lower threshold of TRU waste was defined in the directive as that having a concentration greater than 10 nCi/g. Waste disposed of before the 1970 directive is referred to as buried waste.

This lower threshold was redefined by the Department of Energy (DOE) in 1982 to a minimum concentration of 100 nCi/g. Waste containing TRU elements below this threshold is designated Low Level Waste (LLW). This redefinition resulted in much of what was previously buried TRU waste to become buried commingled TRU/LLW waste. This, in addition to haphazard maintenance of early disposal records, has resulted in considerable uncertainty in the volume and location of buried TRU waste.

Most of the buried waste is located at five sites in the DOE complex: 1) Idaho National Engineering and Environmental Laboratory (INEEL), 2) Hanford Site, 3) Los Alamos National Laboratory (LANL), 4) Oak Ridge National Laboratory, and 5) Savannah River Site. While some of the buried waste is planned for exhumation and disposal at WIPP, the disposition of the majority is undecided. However, it would appear that, unless forced by court order or negotiated agreements with host states, the DOE intends to manage this waste through Long-Term Stewardship.

Much of the focus of this report is on the buried waste at LANL. A review of the disposal history at LANL's various burial sites underscores the uncertain nature of buried waste volumes, concentrations, and locations. This uncertainty continued despite DOE Order 5820.2A, which was in place for approximately 10 years, that the buried waste should be characterized for use in development of site closure strategy.

It is recommended that the DOE apply risk analysis methodology as a basis for informed decision-making concerning the disposition of buried waste. This methodology should consider National Academy of Science comments and concerns about Long-Term Stewardship, DOE's experience at INEEL's Pit 9, the Nuclear Regulatory Commission's guidance concerning disposal of waste, and the reasoning behind development of the WIPP repository. Risk analysis will require development of better information on the buried waste. Following this type of analysis, the potential impact on WIPP repository limits could be determined.

1.0 STATEMENT OF PROBLEM

The generation of transuranic (TRU) waste began in the early 1940s with the development of the atomic bomb, escalated through the cold war, and continues today. After the anticipated closure of the Rocky Flats Site, most of the TRU waste will be located at five major Department of Energy (DOE) weapons sites: Los Alamos National Laboratory (LANL); Hanford Site; Idaho National Engineering and Environmental Laboratory (INEEL); Oak Ridge National Laboratory (ORNL); and the Savannah River Site (SRS) (DOE 2000b).

Early disposal practices around the production complex typically involved placing solid waste into cardboard boxes or drums and dumping into shallow pits or trenches. Liquid waste was also disposed into pits and trenches, but more often it went into shafts and boreholes, often mixed with grout or concrete. Disposal records showing the composition and spatial distribution of the waste are haphazard, often missing, or inadvertently destroyed (Rogers 1977).

A directive in 1970 by the Atomic Energy Commission (AEC) required that the sites begin retrievable storage of TRU waste for possible, eventual disposal in a future repository (DOE 2000a). This repository, the Waste Isolation Pilot Plant (WIPP), began receiving TRU waste in March 1999. The DOE defines TRU waste generated after the 1970 directive as “stored” waste while that generated and disposed before 1970 is defined as “buried” waste. The distinction between these two types of waste is often blurred. Some post-1970 waste has been “stored” in burial grounds in a similar manner to the pre-1970 waste. Indeed, at LANL, ORNL, and SRS, some of what was retrievably stored waste has been deemed as irretrievable and is now considered as buried waste (DOE 2000a).

The lower threshold of TRU waste was originally defined in the 1970 directive as that having a concentration greater than 10 nCi/g. This was redefined by the DOE in 1982 (DOE Order 5820.1) to a minimum concentration of 100 nCi/g. Waste containing TRU elements below this threshold is designated Low Level Waste (LLW) and is commonly called alpha Low Level Waste (αLLW). However, because of this redefinition, the TRU waste buried or stored before 1982 may have become commingled TRU waste and αLLW. The redefinition and haphazard maintenance of disposal records has resulted in great uncertainty in the volume and location of buried TRU waste.

According to the DOE, the disposition of buried TRU waste will be determined on a site by site basis working with states and stakeholders (DOE 2000a). However, it would appear that unless forced by lawsuit, the DOE plans to manage most of this waste by in-situ methods, relying on institutional controls and monitoring. A recent draft Performance Management Plan (PMP) for Accelerating Cleanup at LANL discusses the removal of the stored TRU waste and its shipment to WIPP, but assumes the buried waste will remain in-place (LANL 2002). However, the reliance on institutional controls for long term in-situ management of buried waste has been criticized by a National Academy of Science committee (NAS 2003).

Recently, the court ruled that the DOE commitment to remove TRU waste from Idaho and ship it to New Mexico for disposal at WIPP applies to all TRU waste including that which was buried prior to 1970[1] (D. ID 2003). Moreover, the DOE has been packaging drums of alpha low level mixed waste from the SRS into large ten-drum overpacks with drums of TRU waste and disposing of these ten-drum overpacks at WIPP. The low level waste has been managed as TRU waste and used to blend high activity TRU waste down to meet transportation limits (WSRC 1999). At INEEL, the DOE plans to "blend up" mixed low-level waste with TRU waste for disposal at WIPP (DOE 2001). Hence, if commingled mixed LLW and TRU waste were to be exhumed, it would appear that precedents exist for disposal at WIPP.

As a result of long term management concerns about buried waste as well as the Idaho court rulings, the Environmental Evaluation Group (EEG) began examining technical issues concerning buried TRU waste because of its potential final disposition at the WIPP. EEG's overview of the buried TRU waste throughout the DOE complex shows the extent of the situation. This report then focuses on one DOE facility in New Mexico, LANL, in an effort to understand the level of uncertainty in the status of the buried TRU inventory.

However, because of the uncertainty associated with volume and spatial distribution estimates of the buried TRU waste, informed decision-making is difficult at this time. To go forward, the DOE must examine methods to reduce this uncertainty so that decisions concerning the disposition of this waste can be made on a sound scientific basis.

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[1] The Environmental Evaluation Group has no direct or implied opinion with respect to this case.

2.0 BACKGROUND OF BURIED TRANSURANIC WASTE

Until identified as a separate waste category by the AEC in 1970, TRU waste was typically disposed in shallow burial sites in a similar manner as LLW. Solid wastes were dumped into pits or trenches and liquid wastes were often put into shafts or underground tanks. Following the AEC directive, TRU waste was required to be stored for retrieval in the likelihood of future disposal into a repository. Under this directive, TRU waste was defined by the AEC as that which contains greater than 10 nCi/g of TRU alpha-emitting radionuclides. The DOE revised this definition in 1982, raising the lower limit of TRU alpha-emitting radionuclides with half-lives greater than 20 years from 10 to 100 nCi/g.

In 1997 the Institute for Energy and Environmental Research (IEER) criticized the DOE for waste management practices that de-prioritized the cleanup of buried TRU waste in favor of shipment of the easier, stored wastes to the WIPP (Fioravanti and Makhijani 1997). Included in their criticisms were: 1) inconsistencies in reported buried waste inventories, and 2) lack of programmatic management planning in characterization and cleanup of buried waste.

In response to this report, the DOE requested updated information on buried TRU waste from the various DOE Field Offices. These data were compiled and analyzed, indicating that the total volume of shallowly buried TRU waste at DOE facilities is approximately 126,000 m^3 containing about 745,000 Curies. Another 11,000 m^3 of TRU waste containing about 10,000 Curies was disposed of at intermediate depths (DOE 2000a). Buried waste is typically within 30 m of the surface while waste at intermediate depths was disposed of into boreholes, shafts, or by hydrofracture techniques at depths between 30 m and 300 m. The level of confidence associated with these figures has been judged by the DOE Field offices as low to medium (DOE 2000a). Another 32,000 m^3 of contaminated soil incidental to these wastes has been estimated, mostly associated with liquid discharges at the Hanford Site. Since contaminated soil is present at each site, these soil volumes are under-reported, with some sites not even attempting an estimate. Hence, the confidence in this number is even lower. The breakdown of these estimates by facility is shown in Table 1. The DOE estimates that about one-third of the buried TRU waste, mostly from INEEL, is planned for excavation, treatment and disposal at WIPP (DOE 2000a).

*Table 1. Summary of Buried TRU Waste by Facility**

	Buried Waste		Intermediate		Soil	
	(m^3)	(Ci)	(m^3)	(Ci)	(m^3)	(Ci)
Facility	TRU	Activity	TRU	Activity	TRU	Activity
Hanford	75,800	67,800	-	-	31,600	25,400
INEEL	36,800	634,000	-	-	-	-
LANL	8,620	21,000	3,690	7,690	162	10
NTS	21	229	95	343	-	86
ORNL	570	6	6,880	2,100	-	53
SRS	4,530	21,900	-	-	-	-
Total	126,000	745,000	11,000	10,000	>32,000	26,000

*From Table 1 (DOE 2000a). A dashed line means "not applicable" to that site, however it is known that TRU-contaminated soils are present at all sites.

The IEER criticism concerning lack of programmatic planning for management of buried waste was addressed in the DOE report by a restatement of their policy: "DOE's current approach for managing buried TRU-contaminated wastes and environmental media is to address them in the same manner as other environmental restoration issues, i.e., on a site-specific basis working with federal, state, and local regulatory agencies and other stakeholders" (DOE 2000a). Lack of a national cleanup strategy for buried waste has led to frustration of state regulators and various stakeholders. This is evidenced by a variety of state orders and lawsuits, regulatory actions, and stakeholder comments.

2.1 Idaho National Engineering and Environmental Laboratory

INEEL contains, by far, the largest activity in their buried waste. The current inventory reported in Table 1 represents wastes having a TRU concentration in excess of the 10 nCi/g limit, and is thus a mixture of TRU waste and αLLW (DOE 2000a). Separate estimates of the TRU portion were not reported. The DOE is currently proceeding with exhumation of some of these wastes, but a final decision concerning the management of other wastes has not been made (DOE 2000a).

However, the United States District Court for the District of Idaho recently sided with the State of Idaho that an agreement between the State and the DOE required the removal of all TRU waste from the state, including that which has already been buried. The DOE argued that the agreement only required the removal of retrievably stored waste (D. ID 2003). So, unless overturned by a higher court, the decision on the removal of buried TRU waste at INEEL has been made for the DOE.

2.2 Hanford Site

Hanford has the largest volume of buried TRU waste of all of the sites. At this time, it is the DOE's intention that most of this waste will be managed by in-situ containment (DOE 2000a). However, the buried waste at Hanford is regulated by the Environmental Protection Agency (EPA) under CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act). The Tri-Party Agreement between the State of Washington, the EPA, and the DOE indicates that milestones concerning this waste are yet to be determined (WDE/EPA/DOE 2003). Most of the TRU waste is buried at the 200 Area, in the Central Plateau of the Hanford Site; prioritization for cleanup has concentrated on those areas closer to the Columbia River (DOE 2002).

This pre-1970 TRU waste has not been included in the recent lawsuits between the state of Washington and the DOE. However, the state of Washington recently reviewed the Revised Draft Hanford Site Solid Waste Program Environmental Impact Statement and commented that the pre-1970 potential TRU waste inventory was not complete and was not adequately analyzed. Their comments also criticized the cursory manner in which institutional controls and long-term stewardship were to be applied (WDE 2003).

2.3 Los Alamos National Laboratory

LANL contains a lesser amount of buried TRU waste than INEEL and Hanford, but has a considerable volume of αLLW in burial grounds. TRU waste and αLLW are commingled as a result of the 1982 change in TRU definition. In addition, TRU waste is potentially commingled with other types of LLW. LANL also has TRU waste buried in absorption beds and at intermediate depths in shafts.

After years of discussion concerning cleanup of contaminated areas, including burial sites, the New Mexico Environment Department (NMED) issued a Draft Corrective Action Order (CAO) (NMED 2002a) to LANL in May 2002. This accompanied a Determination of Imminent and Substantial Endangerment to Health and the Environment resulting from contamination at the laboratory. NMED stated the purpose of the draft order was to:

1) accelerate pace of investigation and cleanup at high priority sites,
2) prioritize investigation and cleanup activities,
3) provide specific requirements and schedules for completion, and
4) ensure more stable funding from DOE headquarters (NMED 2002b).

This draft order prompted the filing of a lawsuit in the United States District Court for the District of New Mexico by the University of California, manager of LANL (D. NM 2002a). The University of California claimed that NMED did not have the legal authority to investigate and require cleanup of the radioactive components of its mixed wastes. NMED has subsequently issued the final Corrective Action Order, stating that its intent was not to regulate the radioactive component and that monitoring and reporting requirements are only for radionuclides incidental to regulation of solid and hazardous waste (NMED 2002c). Following this final Order, the University of California filed a Notice of Dismissal for their lawsuit (D. NM 2002b).

A more in-depth discussion of LANL buried TRU waste is provided in Section 3.0 of this report.

2.4 Oak Ridge National Laboratory

ORNL reports a small volume of shallow buried TRU solid waste, but has the largest volume of waste at intermediate depths of any site. However, the DOE acknowledges that volume estimates are not available for many of the TRU-contaminated wastes (DOE 2000a). Most of this waste at intermediate depths was disposed of by hydrofracture techniques. This involved creation of a fracture at a selected depth by cutting a slot in a well-casing and injection of water at pressure. Then a mixture of waste and grout was injected into the well which would flow into the fracture and solidify. This practice resulted in groundwater contamination and was discontinued in 1984.

In addition to hydrofracturing, liquid TRU waste was also dumped into pits and trenches. This has created a volume of TRU-contaminated soil which has not been estimated by the site.

The DOE currently plans on managing most of the buried waste in-situ. However, some of the buried TRU waste at Oak Ridge may be excavated in a pilot study (DOE 2000a).

2.5 Savannah River Site

TRU waste was segregated at SRS prior to the 1970 directive requiring retrievable storage. However, this was done using a SRS definition of TRU which continued past 1970 (Fioravanti and Makhijani 1997). Until 1974, STS defined retrievable TRU as, "waste containing more than 0.1 curie of TRU elements per package." This resulted in a commingling of TRU waste with αLLW. In addition to solid TRU waste, SRS has sludge waste contained in tanks. The potential disposition of this waste is unknown.

Like ORNL, volume estimates for some disposed TRU waste at SRS are not available. In addition, contaminated soil estimates were not reported. DOE is currently planning to manage the SRS buried waste with in-situ containment (DOE 2000a).

2.6 Nevada Test Site (NTS)

There are relatively small volumes of shallow buried waste and waste at intermediate depths at NTS. The waste at intermediate depths is associated with the greater confinement disposal shafts. In-situ containment is the most likely method of management currently envisioned by the DOE.

2.7 Required Assessment of Buried Waste

Uncertainty pervades the DOE complex concerning buried waste estimates despite DOE Order 5820.2A, Radioactive Waste Management, that was in effect from 1988 until the promulgation of DOE Order 435.1 in 1999. Section 3.i, Buried Transuranic-Contaminated Waste, required sites to assess buried TRU, including:

1) Characterization of waste, including information on types and quantities of radioactive and hazardous chemicals. This information was to be verified by appropriate sampling/analysis/monitoring techniques.
2) Development of a closure strategy using the characterization information.
3) Development of a site closure plan including legal, regulatory, technical and budgetary requirements.

There is little evidence that sites adhered to this Order. Some sites characterized the surrounding environment (geological, vegetative, etc.) of the burial sites, perhaps in anticipation of feasibility analyses concerning waste disposition, but failed to reduce uncertainty on waste volume estimates.

3.0 BURIED WASTE AT LOS ALAMOS NATIONAL LABORATORY

For LANL, DOE currently reports a total of 12,310 m^3 with an activity of 28,690 Ci for buried and intermediate depth TRU waste (DOE 2000a). Waste volumes are reported by Material Disposal Areas (MDA), which are located within the various Technical Areas (TA). Figure 1 shows the Technical Areas at LANL.

3.1 Geological Setting of Disposal Sites

LANL and its disposal sites are situated on the Pajarito Plateau, consisting of finger-like mesas formed from Bandelier Tuff, which resulted from major eruptions in the Jemez Mountains' volcanic center about 1.2 to 1.6 million years ago. The mesas are separated by deep east-to-west oriented canyons. The tuff varies from 1000 ft in thickness in the western part of the plateau to about 260 ft eastward towards the Rio Grande. The conglomerate of the Puye Formation underlies the tuff and interfingers with Chino Mesa basalts along the Rio Grande. The conglomerate and basalt is, in turn, underlain by sediments of the Santa Fe Group (LANL 1999).

These sediments contain the main aquifer for the region. While localized perched water tables are found in alluvia and basalts, none are located in the tuff. Water depths below the mesa tops, which host the waste burial sites, are typically about 1200 ft (Walker et al 1981). Figure 2 shows a geological cross section of the Pajarito Plateau.

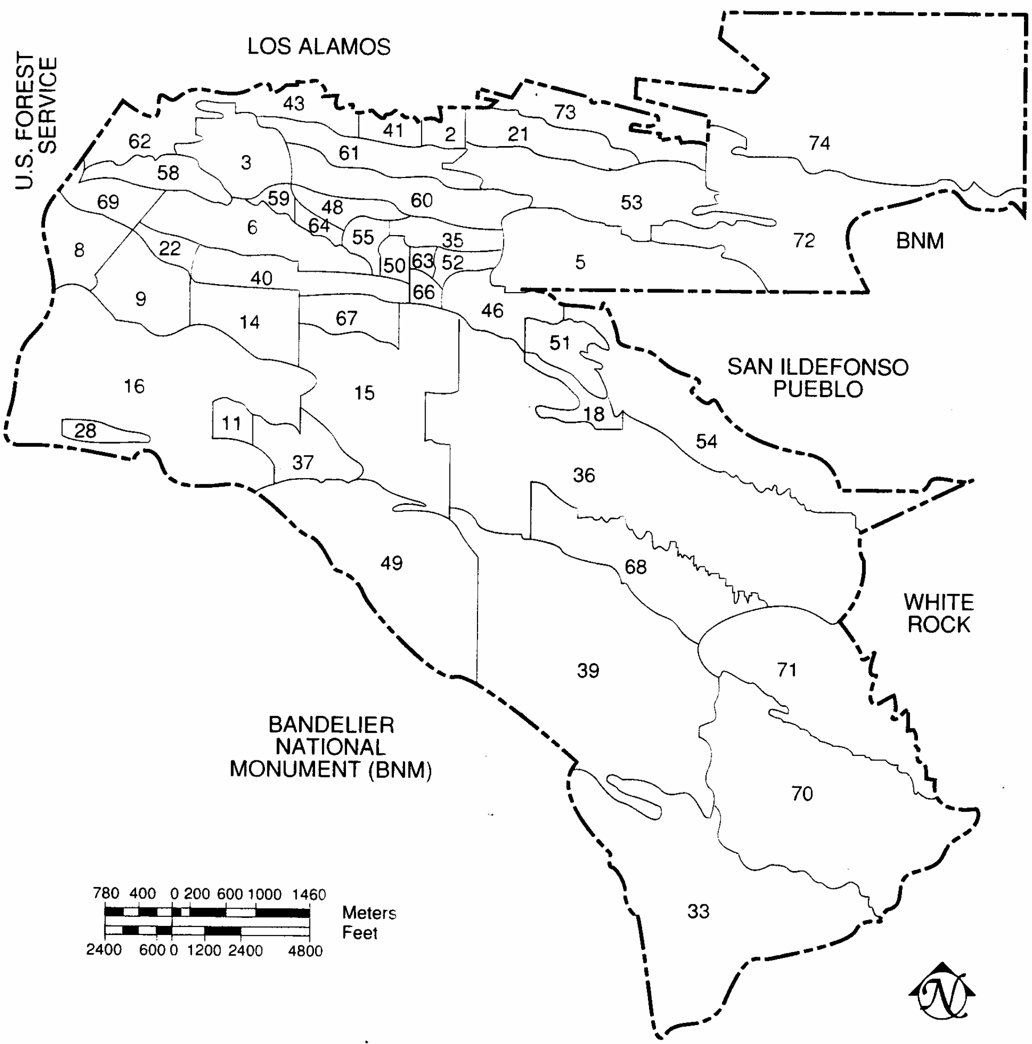

Figure 1. Technical Areas at Los Alamos National Laboratory (LANL 1999).

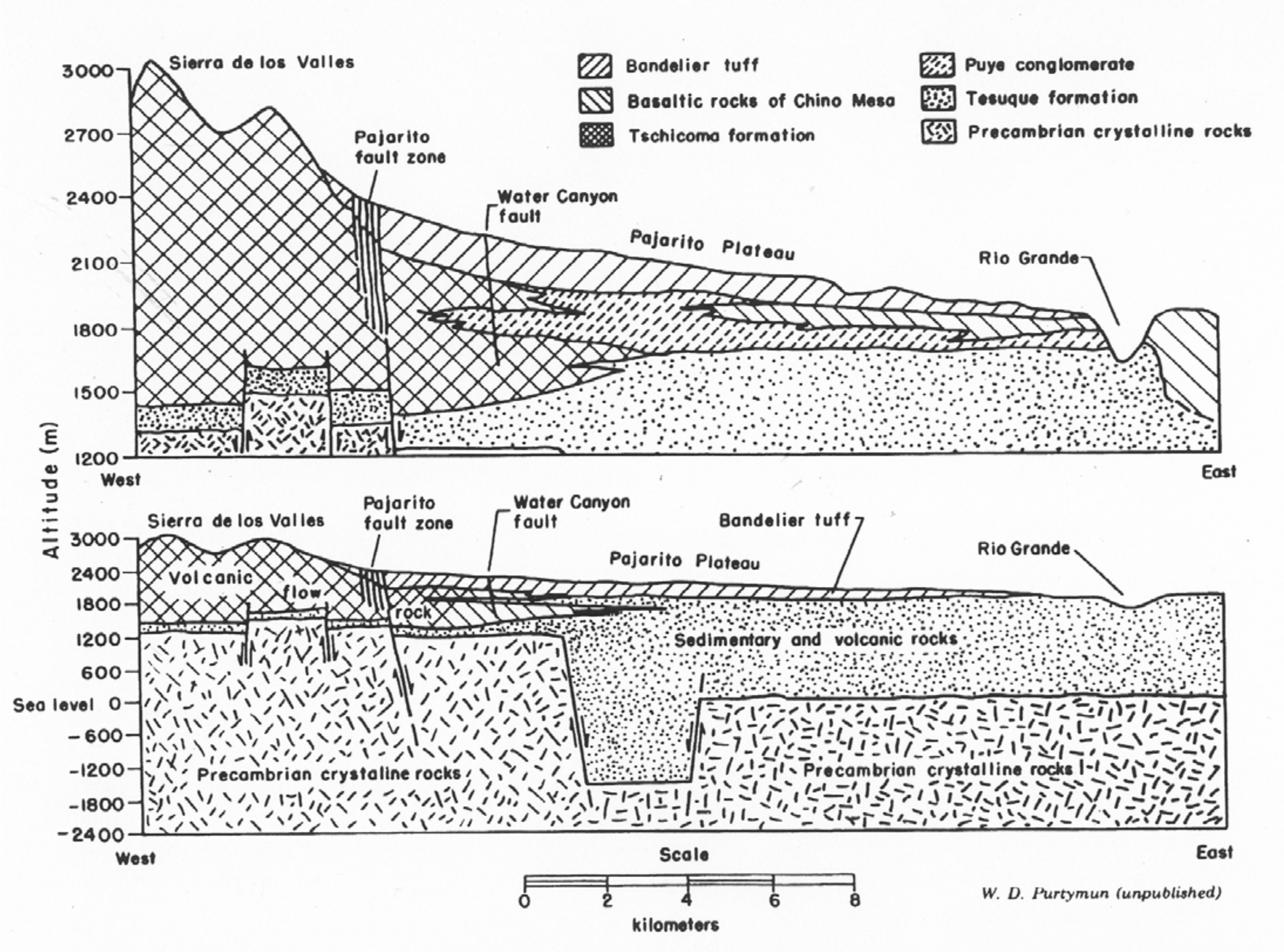

Figure 2. Geological cross section of the Pajarito Plateau (Rogers 1977).

3.2 Description of Disposal Areas

LANL began disposing of solid radioactive wastes in 1944, mostly in cardboard boxes and plastic bags. The history of TRU waste disposal is summarized below.

3.2.1 MDA A. TA-21.

This area was used for disposal of TRU waste during 1945 and 1946. Four of the five pits are known to contain TRU waste (Walker et al 1981). According to maps at the time of disposal, the pits are 38 m long by 5.5 m wide. Disposal records for this area are unavailable (Rogers 1977).

Walker et al. (1981) reports 700 m^3 of TRU waste are estimated for this area. This volume was derived by estimating that five percent of all waste was TRU waste. The remainder was assumed to be LLW. This ratio presumably resulted from historical data, but was not justified in the report. The Walker report is dated prior to the change in the lower limit of TRU waste from 10 nCi/g to 100 nCi/g. However, this same figure is still being reported by the DOE for this area (DOE 2000a).

3.2.2 MDA B. TA-21.

Area B may have been the first disposal area for the laboratory, however, the number of pits and their locations are unknown. Waste disposal records between 1944 and 1947 are missing (Rogers 1977). According to the Walker report the Laboratory records suggest 100 g of plutonium may be buried in Area B. Based on this value and using the 10 nCi/g lower limit, Walker et al. estimated that about two percent of the total reported waste is TRU waste. This results in a volume of 430 m^3. The DOE is now reporting a volume of 525 m^3 (DOE 2000a).

3.2.3 MDA C. TA-50.

TRU waste was buried at MDA C from 1948 though 1964, using six pits (Walker et al 1981). Four of the pits are 185.9 m long by 12.2 m wide as measured from engineering drawings. The depths of these pits were not recorded (Rogers 1977). Pit 5 is 214.9 m long by 33.5 m wide and 5.5 m deep. Pit 6 is 153.9 m long by 30.5 m wide and 7 m deep. Disposal records were maintained for this site (Rogers 1977) for which the DOE is reporting 2600 m^3 of TRU waste.

Shafts were used for wastes containing larger quantities of radioactive materials. These shafts vary in size and depth, but some are reported to be as shallow as 3 m (Rogers 1977). It was estimated that 42 unlined shafts and 6 lined shafts may contain TRU waste (Walker et al.1981). The Walker report estimated 140 m^3 of TRU waste to be contained in these shafts while the current DOE estimate is 70 m^3 above the 100 nCi/g limit (DOE 2000a).

3.2.4 MDA G. TA-54.

Waste disposal began in Area G in 1957 and continues today. Disposal records have been maintained throughout the history of Area G. Pits 1 through 6 contain TRU solid waste that was disposed prior to the 1970 directive requiring retrievable storage (Walker et al. 1981). Pit 2 is reported to contain drums of sludge TRU waste which was mixed with concrete. The DOE is currently reporting 4790 m^3 of TRU waste buried in these pits (DOE 2000a), although the Walker et al. report indicated 8500 m^3.

A more recent analysis of disposal records resulted in a revision of the buried waste inventory for Area G (Shuman 1997). While Walker discusses the completeness of disposal records as the basis for that inventory estimate, according to Shuman, "The lack of detailed shipment records for radioactive waste disposed prior to 1971 required that an alternative means of characterizing the waste be developed." He goes on to discuss extrapolation methods for estimating the buried waste inventory from production records in the 1970s. Different types of early production that could not be estimated by extrapolation were accounted for using various assumptions.

Walker reports that some of the shafts used before 1971 are thought to contain TRU waste and that, generally, wastes with higher levels of radioactivity were disposed of in shafts as opposed to disposal in pits. However, the DOE is currently estimating only 6 m^3 of TRU waste at intermediate depths in these shafts.

While Area G is the best known of the burial sites, significant uncertainty is still attached to volume and activity estimates. The reliance on the use of extrapolation techniques and assumptions could be viewed as a questionable basis for long-term waste management decisions.

3.2.5 MDA T. TA-21.

This area was one of the original disposal areas at the site, with the construction of four absorption beds in 1945 for disposal of untreated liquid waste (Rogers 1977). A treatment plant was built in 1952 for removal of radionuclides from this waste. Residues from this plant were mixed with cement and disposed of in Areas C and G. In 1967 a new treatment plant was constructed where treated waste residues were mixed with cement and pumped into disposal shafts.

These shafts are 1.2 to 2.4 m in diameter and are relatively shallow, only up to 24 m deep. It is estimated that 56 of these shafts contain TRU waste (Walker et al. 1981). The Walker report estimated the TRU waste volume in the shafts at 3800 m^3. Using the higher TRU limit, the DOE has separated this into 3610 m^3 of TRU waste and 190 m^3 of αLLW (DOE 2000a).

3.3 Uncertainty of Estimates

A review of the reported inventories of LANL buried waste reflects on the uncertainty of these estimates. The 1981 Walker report suggested a buried TRU waste inventory of 18,000 m^3 at the 10 nCi/g limit. However, activity was not reported. In 1984, the DOE reported 11,486 m^3 of buried waste containing 6580 Ci. An additional 1140 m^3 of contaminated soil was also reported (DOE 1984). Presumably the reduction in reported waste between 1981 and 1984 was due to the revision of the lower TRU waste limit.

In 1986 10,000 m^3 of buried TRU waste was reported with an associated 6350 Ci (DOE 1986). The reduction in waste from 1984 was not explained. 1140 m^3 of contaminated soil was still reported. For 1987 through 1992, the DOE reported 14,000 m^3 of buried TRU waste containing 9230 Ci and 1140 m^3 of contaminated TRU soil (DOE 1987b; 1988a; 1989; 1990; 1991; 1992). The increase of 4000 m^3 in TRU waste was explained as resulting from experiments conducted in the early 1960's that had been declassified.

LANL did not report buried TRU waste for 1993 and stated that the volume of TRU contaminated soil was unknown (DOE 1994). In 1994 and 1995 the 14,000 m^3 volume was again reported, but now the number of Curies was noted as not available because of "no information". Soils were still reported as unknown (DOE 1995a; 1996a). The same volume of buried TRU waste was reported in 1996, but now an estimate of 108 m^3 of contaminated soil was also reported (DOE 1997a).

In the most recent estimate (DOE 2000a), DOE separated the buried TRU waste into that buried at shallow depths (pits and trenches) and that at intermediate depths (shafts and boreholes). An intermediate depth is defined as generally between 30 and 300 m. While this is mostly the case complex-wide, many of the shafts at LANL are quite shallow, with depths less than 30 m. The combined shallow buried volume and the intermediate depth volume for LANL is 12,310 m^3 containing 28,690 Ci, a similar volume but a significantly larger number of Curies than in previous estimates. The volume of TRU contaminated soil is reported at 162 m^3 containing 10 Ci. However, this is only the soil associated with the absorption beds. In the text of the DOE report, it is stated that for TRU contaminated soil proximate to solid buried waste, the best figure is the historical estimate given in 1988, showing LANL to have 1000 m^3 of this type of waste (DOE 1987a).

While the TRU waste inventory volume did not vary greatly between 1984 and 2000, the reported number of Curies ranged significantly. Also, considerable uncertainty lies in the spatial distribution of the waste. The inventory numbers result from review of disposal records (some of which are missing (Rogers 1977)) and rough estimates of the TRU versus the LLW portions of the waste (Walker at al. 1981). As discussed in Section 2.0, no apparent attempt was made towards refining these estimates despite the standing DOE Order 5820.2A that was in effect for about 10 years. Reasonably certain volume estimates and an understanding of their spatial distribution are necessary for proper decision-making concerning long-term management of the waste. Figure 3 shows the estimated volume of buried TRU waste and Curies over time.

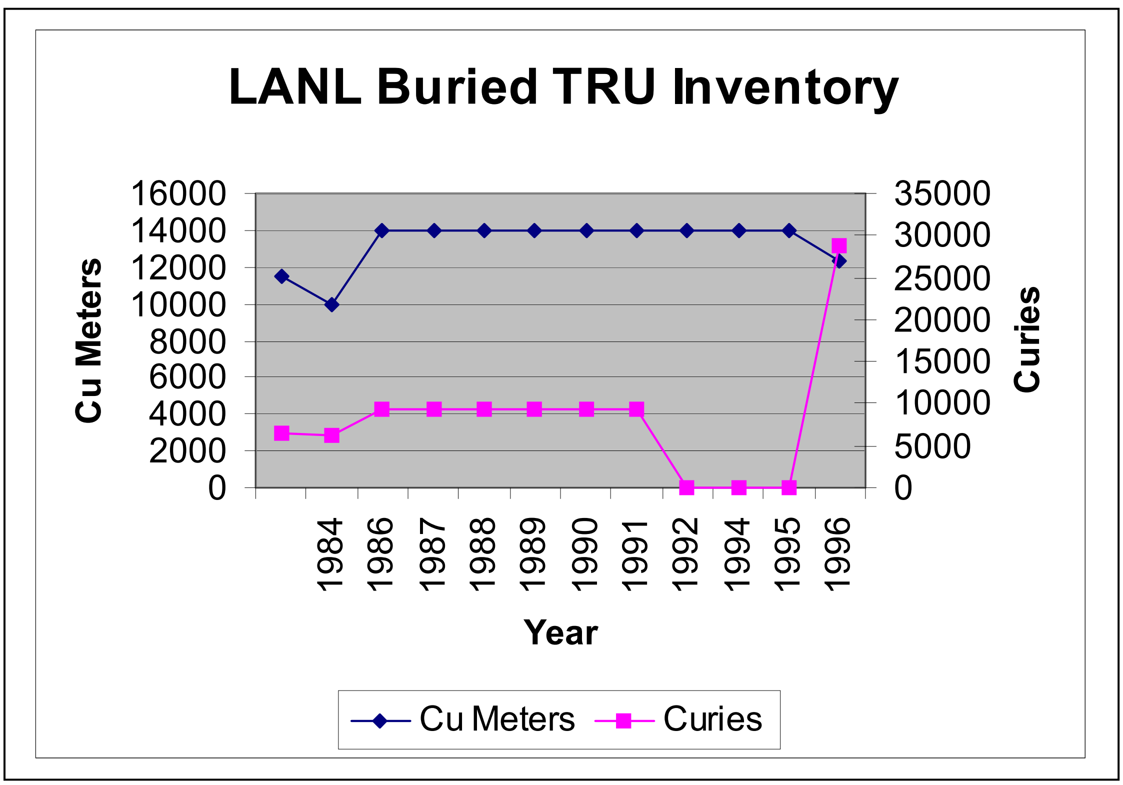

Figure 3. Changes in reported LANL buried TRU Waste inventory by year.

4.0 LONG-TERM MANAGEMENT OF BURIED WASTE

Decisions concerning the long-term management of buried TRU waste at LANL would involve either exhumation for permanent disposal at WIPP or in-situ management and reliance on long-term stewardship for protection of people and the environment. These decisions affect both present and future generations because of the long half-lives of some of the TRU waste components. Therefore, proper decision-making would require a high degree of confidence in the volume of waste, its composition, and its location. However, decisions concerning the disposition of this waste have already been made despite the stated low-confidence in the inventory.

Buried waste is not subject to the DOE Order 435.1, the current order concerning management of radioactive waste (DOE 1999). Therefore, there does not appear to be a required methodology in place for making decisions about buried waste.

Decision-making concerning disposition of waste should include a risk analysis of the effects of exhuming, characterizing, and transporting to WIPP versus the risk of leaving the waste buried. This risk analysis should address the concerns that the NAS committee has expressed about long-term stewardship. It should also consider lessons-learned as well as technology developed for the Pit 9 project at INEEL. Finally, it should consider Nuclear Regulatory Commission (NRC) requirements for shallow burial of TRU waste and the reasoning behind development of the WIPP as a permanent repository for TRU waste. It would appear as though the risk analysis approach concerning the buried waste has not been used by the DOE to date. They have committed themselves to cleanup before obtaining sufficient data, such as at Pit 9, or have automatically assumed that long-term stewardship would take care of the problem.

4.1 Long-Term Stewardship

The Draft Performance Management Plan (LANL 2002) for environmental work at LANL assumes the in-situ management of buried waste after transfer of the site to the National Nuclear Security Administration for long-term stewardship (LTS). However, the National Academy of Science noted that an adequate assessment of stewardship risks has not been done, especially during the recent emphasis on accelerated cleanup. The NAS committee noted (NAS 2003), "The failure to link LTS to cleanup undermines credibility and strengthens the fear among skeptical stakeholders and regulators that a hollow promise of stewardship is being imposed as a substitute for more costly and complete near-term cleanup." The credibility of LTS use would be enhanced if proper evaluations were conducted concerning the management of buried TRU waste. Indeed the chief recommendation by the NAS Committee states, "DOE should explicitly plan for its stewardship responsibilities, taking into account stewardship capabilities, when making cleanup decisions. DOE should also implement steps to anticipate and carry out those responsibilities throughout the cleanup process."

The NAS committee also points out, "the legacy wastes are the permanent responsibility of the U.S. government, a fact reflected incompletely in the regulatory structure within which DOE operates." However, "DOE's current practice at the sites examined by the committee aims at remediating a site enough to secure agreement on a Record of Decision (ROD) for site closure. Because current regulations do not capture all of DOE's responsibilities,…, the DOE's practice ignores factors important to LTS" (NAS 2003).

In the WIPP Final Supplemental Environmental Impact Statement (SEIS) (DOE 1997b), statements concerning buried stored TRU waste may also be extended to pre-1970 TRU waste. When comparing risks for intrusion scenarios at WIPP versus those at generator sites, after discussing the low risk at WIPP the SEIS states, "In contrast, waste in surface facilities or **shallow-buried** storage would be easily accessible in the event of loss of institutional control …" (emphasis added). The NAS committee (NAS 2003), in discussing problems with institutional control stated, "…regulators have agreed to remedies at DOE sites with only scant provisions for LTS, assuming that institutional controls are self-executing and self-enforcing. Experience with institutional controls demonstrates some of their limitations and fallibility, particularly over the long term."

Following review of the WIPP Compliance Certification Application, EEG provided specific examples of the failure of institutional controls, specifically those dealing with government ownership and regulation, records, and markers (EEG 1997). After consideration of these and other comments, the EPA denied DOE's request to take credit for passive institutional controls for prevention of human intrusion scenarios during performance assessment (EPA 1998).

4.2 Pit 9 Experience

Lack of certainty about the actual inventory proved to be a problem for the Pit 9 project at INEEL. Pit 9 has not received any waste since 1969. Its inventory was based on available shipping records, process knowledge, written correspondence, and the Radioactive Waste Management Information System (INEL 1993). Thus, Pit 9 was considered to be one of the better characterized burial pits in the DOE complex.

The Pit 9 project was considered an interim action by the DOE in the sense that waste would be exhumed and separated, and the DOE would gain experience that could be applied to other disposal sites. The stated primary objective (INEL 1993) of this action is, "to reduce the potential for migration of Pit 9 contaminants into the environment. The Pit 9 interim action will stabilize the site, prevent further degradation, and achieve risk reductions; thus, the interim action advances the goal of expediting total Site cleanup."

However, higher concentrations of radionuclides were found in Pit 9 than the initial inventory suggested. Probe holes showed one drum estimated to contain over 1000 g of plutonium buried in the pit (Jewell et al 2002), well over the administrative limit which ensures criticality will not occur.

After a history of contract and contractor problems (Fioravanti and Makhijani 1997), the methods for cleanup of Pit 9 are again under development. The Glovebox Excavator Method (Figure 4) is being tested to retrieve and characterize waste, working on small portions of the pit at a time (INEEL 2002). Characterization and packaging of waste can be done while minimizing risk of exposure to workers in this system. The success of this method can then be assessed for its use on other burial sites, such as those at LANL.

Given the uncertainty of the buried waste inventory and demonstrated problems that the DOE has had with reliance on old disposal records, LANL should determine a means for proper characterization of the TRU waste burial sites. This can be done in conjunction with the NMED Corrective Action Order. LANL could determine whether boreholes or probes would be beneficial for in-situ characterization, or if an exhumation process such as that being tested at INEEL is preferred. Relying on LTS, which itself is based on uncertain characterization and questionable assumptions of institutional controls, does not reflect sound engineering and scientific decision-making concerning management of TRU waste.

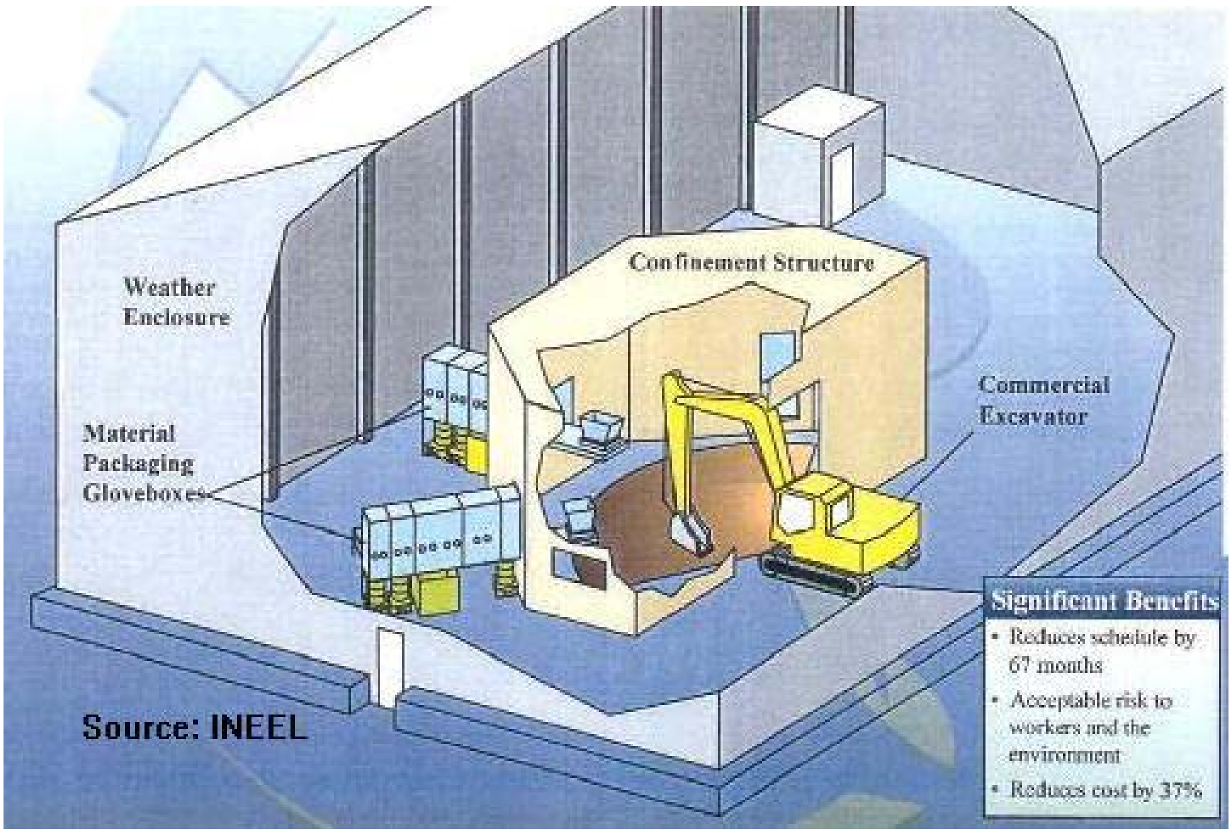

Figure 4. Conceptualization of Glovebox Excavator Method.

4.3 Nuclear Regulatory Commission Requirements

According to the DOE, buried waste was disposed of in a manner consistent with NRC guidance for near-surface disposal of LLW which was acceptable for then-existing government and commercial disposal practices (DOE 2000a). Examination of current NRC requirements for disposal of TRU waste may useful in the decision-making process concerning buried waste.

The NRC would consider TRU waste as "greater than Class C waste" which would "not be generally acceptable for near-surface disposal" (10 CFR § 61.55(3)(iii)). However, "[t]here may be some instances where waste with concentrations greater than permitted for Class C would be acceptable for near-surface disposal with special processing or design. … Class C waste must also be stable" (10 CFR § 61.7(5)).

However, one condition of stability is that "waste must not be packaged for disposal in cardboard or fiberboard boxes" (10 CFR § 61.56(a)(1)). Obviously, much of the buried waste would not meet the current NRC requirements.

Additionally, the NRC specifies that Class C containers must be designed to maintain their properties for over 300 years (10 CFR § 61.7). The top of waste must be a minimum of five meters below the top surface of the cover or must be disposed of with intruder barriers designed to protect against an inadvertent intrusion for at least 500 years (10 CFR § 61.52).

4.4 Reasoning Behind WIPP

In 1981 the DOE published a ROD to proceed with the WIPP because it provided an acceptable solution for long-term disposal of TRU waste with minimal risk of radioactive release to the environment. The DOE concluded that the consequences of the no-action alternative were unacceptable (DOE 1981).

Consequently, the WIPP has been developed at a substantial investment by U.S. taxpayers for the safe disposal of TRU waste. The WIPP has been accepting waste since March 1999.

5.0 EFFECT ON WIPP CAPACITY

The uncertainties associated with the in-situ volumes of pre-1970 buried TRU waste make it nearly impossible to determine an effect on WIPP capacity. Any volume that may be shipped to WIPP should be the result of reasoned decision-making between alternative waste management options. Once a decision is made to ship a volume of buried LANL TRU waste to WIPP the exhumation and characterization would be required. These same uncertainties pertain to the INEEL buried waste (or any other site) should it be the DOE's intention to ship these TRU waste to WIPP.

The Land Withdrawal Act (LWA 1992) specified a maximum volume of combined contact handled and remote handled waste of 175,564 m^3. At the time of the initial certification, it was estimated that 65 percent of the waste to be emplaced was to be newly generated waste and projected waste. The total disposal volume (repository maximum) equaled the previously generated waste (stored waste) plus the newly generated waste times a scaling factor of 2.05 (DOE 1996b). The planned disposal volume was virtually unchanged by 2000 (DOE 2000b). Thus, even if the total estimated volume of buried waste at LANL were to be sent to WIPP, it would appear that there is sufficient capacity according to the LWA limit. Figure 5 shows the effect of LANL buried TRU waste on the contact handled repository limits.

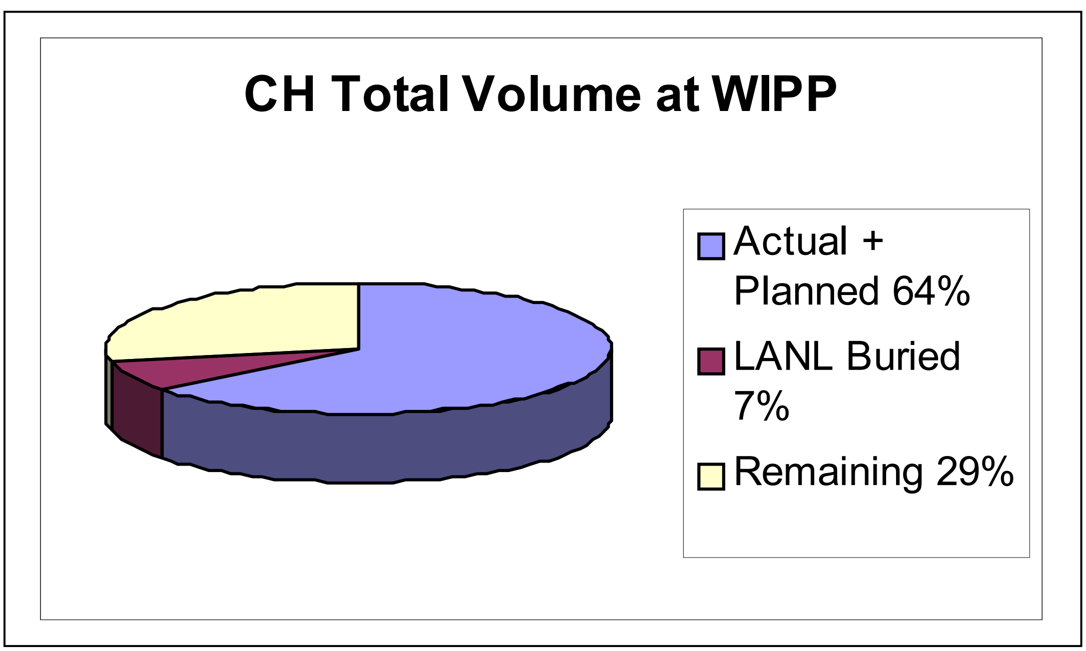

Figure 5. Total LANL Buried TRU Waste in relation to WIPP CH waste capacity as of 2000 (DOE 2000b).

The WIPP SEIS considered the pre-1970 buried waste (along with DOE non-defense waste and some commercial waste) in Alternative 1 in its analysis. However, this alternative assumed all of the buried TRU waste would be shipped to WIPP, greatly expanding the repository. All of the buried waste could not be accommodated at WIPP under the legally-imposed volume limits. More than likely, if adequately studied, some portion of the buried TRU waste would be disposed in WIPP with the remainder to be managed in-situ. Since the SEIS, volumetric reduction of some waste can be achieved through facilities such as the Advanced Mixed Waste Treatment Plant (AMWTP) at INEEL. However, as recently reported by the DOE Inspector General, much of the volumetric reduction may be negated by the use of overpack containers for transportation and disposal (DOE 2003).

6.0 CONCLUSIONS

Decisions concerning the disposition of the pre-1970 buried TRU waste at LANL appear to have been made by the DOE. This waste, and much of the other buried TRU waste around the complex, seems destined to be managed in-situ, relying on long-term stewardship to safeguard present and future generations as well as the environment. A recent NAS committee commented that long-term stewardship, and its reliance on institutional controls, is a convenient alternative for saving present-day dollars. However, the details of how such stewardship would work and the realistic impacts from relying on stewardship have not been considered by the DOE.

Disposition of buried TRU waste using alternatives rather than long-term stewardship, has been mostly forced by state governments. Such action was recently taken by the State of Idaho for the buried TRU waste at INEEL. These decisions have come through the courts instead of through the DOE working with the states and stakeholders. Another example of this is the recently filed lawsuit by the University of California against the State of New Mexico for attempting to issue a Corrective Action Order for characterization of mixed-waste sites at LANL. Proper characterization of the sites, as well as characterization of the radioactive component, is necessary for sound decision-making concerning long-term management of the waste. The current uncertainty associated with the buried TRU waste estimates and their spatial distribution suggests that a good technical basis does not yet exist for such decisions.

The WIPP SEIS pointed out the higher long-term risk of leaving retrievably stored TRU waste in shallow burial grounds versus permanent disposal in the WIPP. Buried TRU waste would seem to have the same consequences. The risk to human health and the environment that necessitates disposal of TRU waste at the WIPP would seem to be similar regardless of the time period in which the waste was generated, either before or after 1970.

Safe exhumation and characterization methods for handling buried TRU waste, such as the Glovebox Excavator Method, are currently being tested. Through such technology and the use of ALARA, risk to workers can be minimized, allowing potential reduction of risk to current and future generations.

Issues concerning the mixture of LLW and TRU waste within burial sites do not appear to prevent the DOE from treating the waste as TRU. The DOE has set precedents for the "blending up" of waste to achieve the TRU definition for disposal at WIPP.

7.0 RECOMMENDATIONS

It is necessary to develop better information on the pre-1970 buried TRU waste at LANL in order to plan for its final disposition. Beginning with the largest single quantity of buried TRU waste, i.e. TA-54, MDA G, the DOE should: 1) determine whether in-situ characterization methods such as probe holes, etc. would be beneficial in reducing the uncertainty of the volume estimate and increase the knowledge of the spatial distribution of the waste, and/or 2) determine the applicability of using existing exhumation and characterization technology such as the Glovebox Excavator Method being tested at INEEL.

Following the recommendations by the NAS committee, the DOE should develop realistic parameters concerning risks associated with Long-Term Stewardship and the validity of institutional control assumptions. It would seem incongruous that the DOE would determine that it is better to dispose of post-1970 stored TRU waste at WIPP but the same type of waste that was generated before that date is safe to be managed in-situ. Consistent assumptions and parameters should be used for disposition of all TRU waste. Once the volume and spatial uncertainty is reduced, along with realistic LTS assumptions, risk analysis could be used to determine long-term management of the waste. Such an analysis could be used to determine if some buried TRU waste should be sent to WIPP while other TRU waste should be managed in-situ.

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