THE SUCCESSFUL 1998 CERTIFICATION OF THE WASTE ISOLATION PILOT PLANT TRANSURANIC WASTE REPOSITORY - TEN IMPORTANT LESSONS LEARNED

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ABSTRACT

The Waste Isolation Pilot Plant (WIPP) site in New Mexico (Fig. 1) is the candidate location for the United States of America's (USA's) disposal of defense-generated transuranic radioactive waste (TRUW)(a) in a deep geological repository. The WIPP site has been investigated and analyzed since 1974, and all surface and subsurface facilities required to open and operate a TRUW repository at the WIPP site were in place in 1988. Ten years later, in May 1998, the U.S. Environmental Protection Agency (EPA) announced that it had reviewed and approved the Compliance Certification Application (CCA) submitted in October 1996 by the U.S. Department of Energy (DOE) for the opening, operation, and decommissioning of a specially designed and constructed deep geological repository at the WIPP site. The EPA's certification of the WIPP TRUW repository is a first-of-a-kind global landmark.

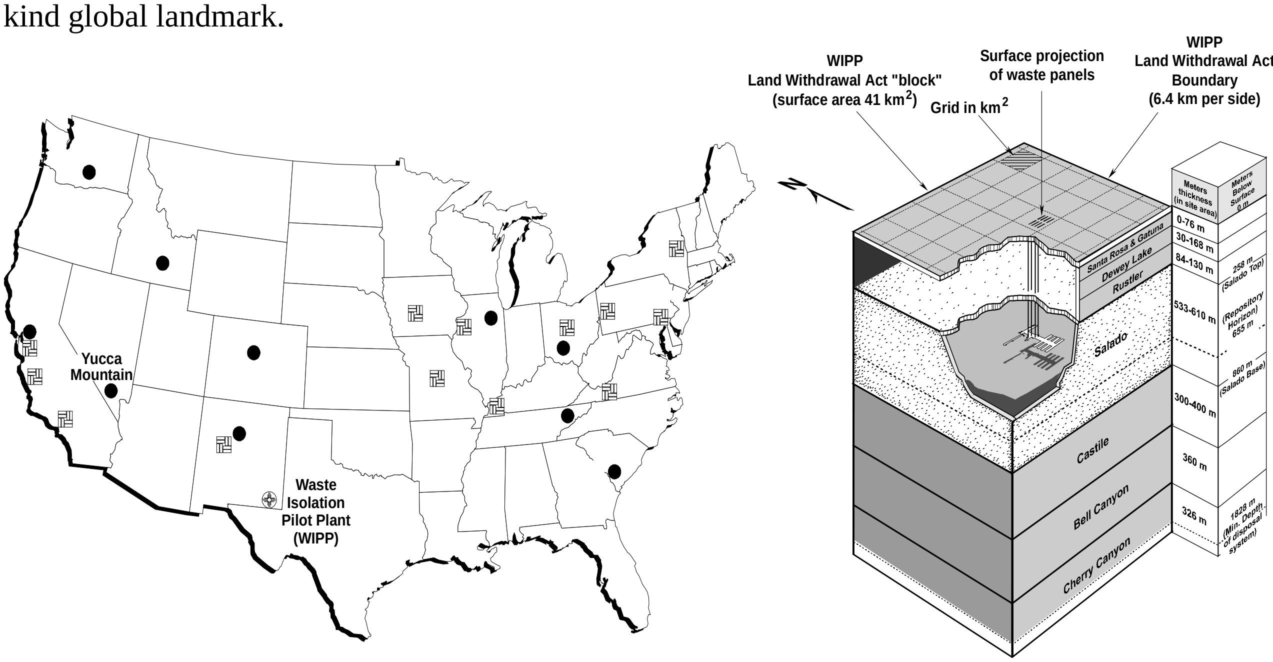

Fig. 1. Locations of 10 large- (black circles) and 13 small-quantity (thatched squares) TRUW generator/storage sites and the WIPP site, and a schematic illustration of the controlled area at the WIPP site.

(a) TRUW contains more than 3,700 becquerels (Bq) (100 nanocuries [nCi]) of alpha-emitting, transuranic (atomic weight greater than uranium [atomic number 92]) isotopes with half-lives greater than 20 years, per gram of waste. However, TRUW may not exceed a surface dose rate of 10 sieverts (Sv) (1,000 rems) per hour.

However, the initial excitement and euphoria associated with this achievement have been replaced by frustration over the very slow permitting process for regulated hazardous constituents mixed with about 60 percent of the existing TRUW and the legal challenges of the EPA's 1998 certification and to the opening of the WIPP TRUW repository. In May 1998, the New Mexico Environment Department (NMED) issued a draft permit for public review and revised it in November 1998 based on comments received. The NMED's most recent schedule projects a final ruling on the permit application in June 1999. At the end of 1998, the two legal challenges are scheduled to be addressed in January and June of 1999, respectively. A favorable ruling in January would allow the WIPP TRUW repository to open shortly thereafter for TRUW not containing regulated hazardous constituents, also referred to as non-mixed TRUW, as opposed to mixed TRUW.

Several important lessons were learned the past five years (through 1998) during the certification and draft permitting of the WIPP TRUW repository. Although all earth-sciences information is site-specific, regulatory requirements typically state and country dependent, each project is unique, and the lessons learned at the WIPP site continue, the learned at the WIPP site during the past five years have universal implications and applications.

INTRODUCTION AND BACKGROUND

The WIPP Land Withdrawal Act of 1992 (LWA)(1) as amended in 1997(2), is the main law for safe disposal of TRUW in the USA. Pursuant to the LWA, the DOE must develop and operate a deep geological repository for safe disposal of TRUW at the WIPP site (Fig. 1) in compliance with the environmental protection regulation requirements promulgated by the EPA.

The DOE's Science Advisor, Sandia National Laboratories (SNL) has characterized the WIPP site, since 1974 and the surface and subsurface facilities required to operate a TRUW repository there were in place in 1988. On the 13th of May 1998, the EPA announced that it had approved the DOE's CCA(3) for safe disposal of up to 175,584 cubic meters (m^3) of defense-generated TRUW in the WIPP repository. As illustrated in Fig. 2, the TRUW will be emplaced at a depth of 650 meters (m) about 200 m from the bottom of a 600-m thick, more than 200-million year old, undisturbed, virtually impermeable bedded salt formation. The EPA's certification(4) of the WIPP TRUW repository crowns 24 years of site characterization and repository development efforts. Furthermore, it is the first of a kind certification of a specially designed and constructed deep geological repository for safe disposal of long-lived radioactive waste, a global milestone.

However, about 60 percent of the existing 106,000 m^3 TRUW may be mixed with regulated hazardous constituents that are governed by a different set of laws and regulations. The DOE must, therefore, also obtain a separate permit, also referred to as the Resource Recovery and Conservation Act of 1976 (RCRA)(5) Part B Permit, from the NMED before this mixed-TRUW may be received, stored, or disposed of at the WIPP site. On the 15th of May 1998, the NMED issued a draft permit for public review and comments. Based on the comments received, the NMED issued a revised draft permit on the 13th of November 1998(6). The revised draft permit will be subjected to a public hearing process, beginning on February 22, 1999. At the end of 1998, the NMED's most recent schedule projects a final ruling on the permit application in June 1999. In the meantime, pending the NMED's final ruling, the DOE intends to open the WIPP repository for non-mixed TRUW.

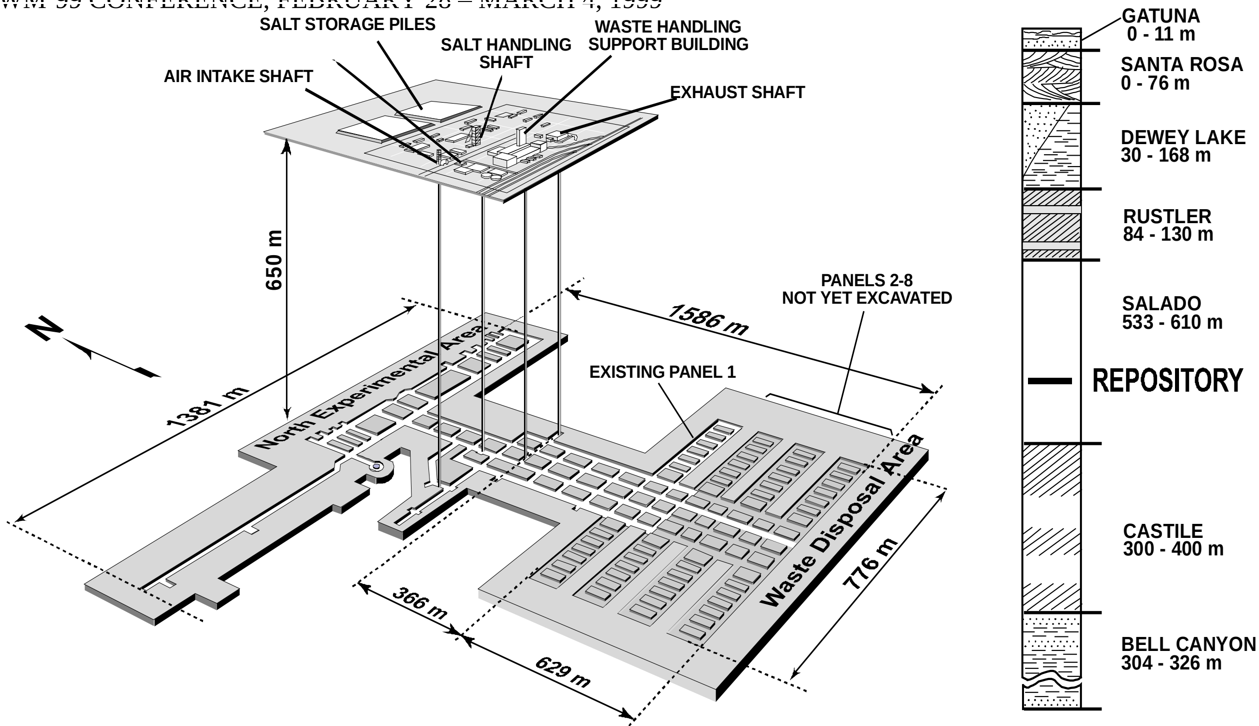

Fig. 2. Layout of the WIPP TRUW repository and the stratigraphic column (including main rock formation/unit names and thickness ranges) at the WIPP site

The following 10 select important lessons learned during the past five years of the 24-year-long, circuitous process leading to the EPA’s certification and the NMED’s draft hazardous waste permit are described and discussed below in random order of importance:

1. The time required by the licensing/permitting agency is not necessarily related to the scientific complexity, stringency of the regulatory framework, amount of information submitted, or toxicity of the waste;
2. Although good science is imperative to the licensing/permitting of a repository for long-lived radioactive waste, good science alone will not suffice; legal issues and personal and organizational agendas increase in visibility and influence the closer it gets to certification/permitting;
3. Scientific curiosity and schedule and budget constraints may be overcome by focusing scientific and engineering resources on the information required to demonstrate compliance with applicable laws and regulations;
4. The assumptions and disciplines involved in research and development must be closely integrated and carefully documented;
5. Complex scientific and technical information needs to be communicated to stakeholders (affected and interested parties and the general public) in terms that are readily understood outside the group of experts directly involved in the research and analyses;
6. Independent peer reviews enhance the credibility and acceptance of a scientifically advanced and complex program;
7. The decision making process has to be transparent, well documented, and defensible;

8. The decision making process has to involve broad-based internal and external participation throughout;
9. Measures to enhance public acceptance and support should be considered and implemented at an early stage and iteratively throughout the project; and
10. Strong leadership and a skilled, internally cooperative, motivated management organization are imperative prerequisites to the level of success of scientifically complex and politically and emotionally charged programs.

DESCRIPTION AND DISCUSSION OF TEN LESSONS LEARNED

At the end of 1998, the NMED estimates that its final ruling on the DOE’s May 1995 11,000-page RCRA Part B Permit application will occur in July 1999. If this estimate is correct, the time expended between the DOE’s submittal of the permit application and the NMED’s final ruling will amount to more than four years. In comparison, the time expended between the DOE’s submittal of the 24,000-page CCA(3) in October 1996 and the EPA’s final ruling in May 1998 amounts to less than one year and seven months. Thus, the first lesson learned is that the degree of toxicity, scientific complexity, and the regulatory stringency and prescriptiveness associated with the safe disposal of hazardous waste and TRUW, respectively, are not necessarily reflected in the amount of time the involved regulating agency will require to reach a final ruling.

The second lesson learned is that, although the good science provided by SNL was imperative to the successful certification and draft permitting of the WIPP TRUW repository, good science alone will not suffice to overcome all potential challenges. The attention to and concern about socio-economic, legal, and political issues and agendas tend to increase as the certification and permitting processes advance and might reach a point where their individual or collective importance may actually overshadow the importance of good science. For example, two lawsuits have been filed against the certification and opening of the WIPP TRUW repository. The main litigating issues are: (a) the process employed by the EPA to certify the WIPP TRUW repository, and (b) an injunction seeking to block the opening of the WIPP TRUW repository until the NMED issues the final permit. Both lawsuits involve the New Mexico Attorney General’s office.

The third lesson learned is that, although good science was imperative to the successful certification and permitting of the WIPP TRUW repository, one of the DOE Carlsbad Area Office’s (CAO’s) most challenging management tasks was to balance scientific and engineering curiosity with budget and schedule constraints. Specifically, prior to the EPA’s December 1993 promulgation of site-specific disposal regulations for the WIPP TRUW repository(7), also referred to as the final disposal regulations, 116 scientific- and engineering-related activities were designed and proposed by the SNL to collect the data information deemed required to provide valuable insight into a broad range of scientific questions. The EPA’s disposal regulations augmented by the EPA’s February 1996 promulgation of criteria for compliance with the disposal regulations provided the CAO and SNL a very detailed baseline/road map for certification that was used to focus the scientific and engineering programs.

Specifically, in April 1994, the Manager of the CAO directed SNL to conduct a probabilistic assessment of the 116 proposed scientific activities in terms of providing information in response to the long-term safety performance criteria defined by the EPA in the final disposal regulations. The 116 proposed activities were evaluated in more than 46,000 combinations and 1,300,000 performance assessments in an activity referred to as the System Prioritization Method (SPM). The SPM identified eight main scientific activities that, contingent upon being conducted and providing the projected results, would provide a probability of 0.96 that the WIPP TRUW repository would comply with the final disposal regulations(7).

Based on the results of the SPM(8), the Manager of the CAO directed SNL to focus the scientific program on the eight activities. As subsequently evidenced by the EPA's certification of the WIPP TRUW repository(4), the SPM approach successfully identified the most important scientific and engineering activities and facilitated (a) the focusing these programs accordingly and (b) the certification of the WIPP TRUW repository. The SPM was also instrumental to the almost three-year advancement of the CAO's schedule for the certification of the WIPP TRUW repository.

The fourth lesson learned is that a conservative assumption in one discipline is very likely to affect other disciplines, often unfavorably, because the disposal system is a coupled system. Thus, disciplines cannot be treated in isolation or be compartmentalized, they must be real-time integrated to avoid unnecessary set backs. Also, conservative assumptions may be naively or intentionally combined to create unrealistic doomsday scenarios and deliberately used to compromise the acceptance and credibility of the safety/performance assessment results and/or the disposal concept.

In addition, it is absolutely critical that all assumptions and data are documented in detail to facilitate subsequent rigorous and thorough reviews and analyses by the regulator(s), oversight groups, and other affected or interested parties. This challenge was accentuated by the EPA's February 1996 compliance criteria(9), which included three peer review requirements and compliance with a new set of DOE-external quality assurance (QA) requirements. Considerable time and resources were spent by the CAO to establish the quality of and enhance the linkages among WIPP assumptions and data dating back to 1974. Although the CAO and its main contractors accomplished this Herculean effort without a schedule set back, a solid QA program and thorough documentation are always more cost-effective and credible than post-mortem enhancement of documentation.

The fifth lesson learned is that it is imperative to public acceptance that complex scientific and technical concepts and information, particularly when involving descriptions of radiation safety and risk, are presented in readily understood terms rather than in sophisticated scientific and engineering terms and/or jargon. The fundamental premise for this simple concept is that *if the information is not understood, it is not accepted*. This fundamental premise is even more important when dealing with programs involving nuclear/radioactive materials because they are associated with a 50-year-old stigmatic legacy associated with the human and environmental nuclear devastations at Hiroshima and Nagasaki and the negative publicity and perception associated with the Three Mile Island and Chernobyl accidents. Indeed, the numerous safety/performance assessments presented in the CCA(3) and in response to subsequent inquiries from the EPA and others demonstrated to the satisfaction of the EPA that both the projected amount of radionuclides under disturbed conditions and the maximum annual dose to an individual associated with 10,000-year of release of radionuclides from the WIPP TRUW repository would be at least one order of magnitude below the corresponding limits defined by the EPA in the final disposal regulations(7). Specifically, the projected/calculated total cumulative release of radionuclides from the WIPP TRUW repository during the 10,000-year regulatory period reported in the CCA(3) is at least 20 times lower than the two containment limits defined in Section 40 CFR 191.13 of the disposal regulations (Fig. 3). Furthermore, the maximum annual radiation dose to an individual is 0.0047 mSv(3,10), which is 32 times lower than the 0.15 mSv-per-year individual protection limit defined in Section 40 CFR 191.15 of the disposal regulations(7).

CONCEPTUAL MODEL FOR DISTURBED SCENARIO E1 E2

EPA PERFORMANCE ASSESSMENT VERIFIED REGULATORY COMPLIANCE

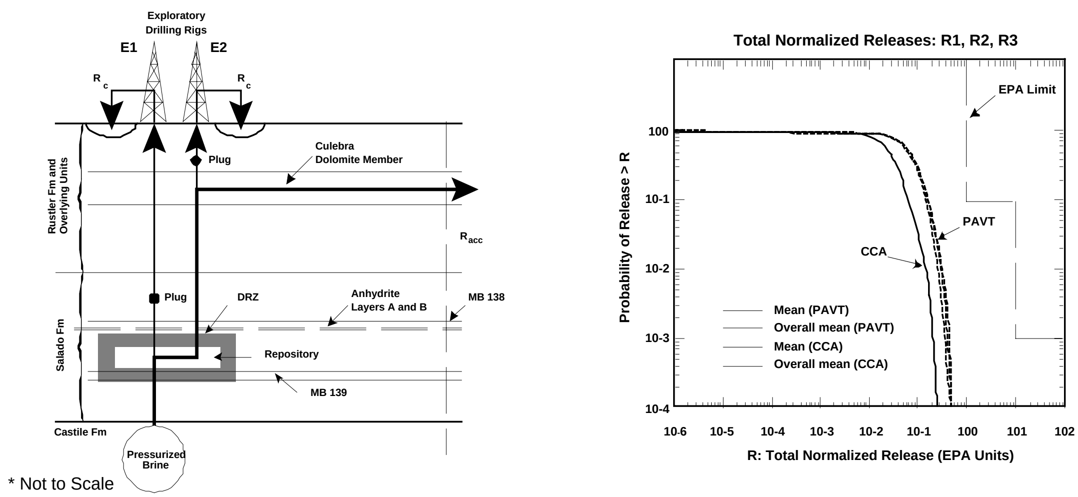

Fig. 3. Schematic illustration of the "highest-consequence" disturbed scenario and the cumulative radionuclide releases from probable (CCA) and EPA- requested (PAVT) disturbed scenarios.

However, it was found that those numbers mean very little to the general public. The CAO therefore also employed more readily understood concepts in its interactions with regulators, oversight groups, and other affected or interested parties. For example, the radiation exposure from the WIPP TRUW repository was compared to the radiation exposure received from other normally occurring radiation exposures such as a chest x-ray (0.10-0.20 mSv) and the average natural background radiation in the USA of 3.6 mSv. To further illustrate the inherent safety of the WIPP TRUW repository it was pointed out that:

- The maximum permissible annual radiation dose to an individual defined in the disposal regulations is 24 times lower than the average annual background radiation in the USA;
- The potential radiation dose received by an individual from the WIPP TRUW repository is 768 times less than the average natural background radiation in the USA;

- All radionuclide containment and isolation at the WIPP site/repository is provided by the natural (geologic) setting within the controlled area (Fig. 1); and
- Both the rock mass volume within the controlled area of the WIPP site and the lateral distance between the emplaced TRUW and the accessible environment are less than half of that allowable under the disposal regulations.

In other words, despite utilizing less than half the controlled area allowable by the EPA, the potential maximum radiation exposure from the WIPP TRUW repository under extremely low-probability conditions is 32 times lower than the disposal regulations and 768 times lower than the average natural background radiation in the USA.

The CAO also introduced and promoted a domestic risk-reduction concept based on the fact that TRUW needs to be either inhaled or ingested to pose a significant public health risk. It was pointed out that the existing TRUW is currently stored in temporary surface and near-surface structures that are considerably more susceptible to damage by natural forces and human accidents that could cause airborne or groundwater-borne releases of radionuclides than is the WIPP TRUW repository. It was also pointed out that more than 53 million permanent residents currently live within 80 km of the 23 TRUW storage sites, whereas fewer than 100,000 residents live within the same distance from the WIPP site, and only 30 permanent residents live within a 10-km radius of the WIPP site. Notwithstanding these compelling safety facts, enclaves of opposition continue to state that the WIPP TRUW repository is unsafe and is not a national solution to the TRUW problem. It should be recognized that emotional and factually unsupported statements are common distractions and constraints to highly visible, emotionally and politically charged programs like the WIPP program. Indeed, two common constraints to the success of these types of programs are:

1. One can only reach the portion of the audience that is objectively interested in facts; and
2. Even if the information is understood, personal and organizational agendas may take precedence and overshadow public recognition of the importance and merits of facts.

Thus, the sixth lesson learned is that independent peer reviews are an excellent means to enhance the credibility and acceptance of the scientific program, quality of data, conceptual models, and safety/performance assessment results and to dispel perceptions based on misunderstandings or lack of confidence in the messenger. For example, the CAO sponsored one international and seven domestic independent peer reviews of key components of the WIPP TRUW disposal system, as presented in the CCA, which were conducted to the expressed satisfaction of the EPA.

The international peer review of the safety/performance assessment models and results presented in the CCA(3) was conducted by a group of international experts identified, retained, and coordinated in a joint effort by the world's two most preeminent international radioactive waste management organizations, i.e., the Organisation for Economic Co-operation and Development/Nuclear Energy Agency (OECD/NEA) and the International Atomic Energy Agency (IAEA). The 1996 joint

NEA/IAEA peer review group report(11) concluded that the models and results reported in the CCA met all international standards.

Three of the seven domestic peer reviews, i.e., conceptual models, waste characterization analyses, and engineered barriers evaluation, were requested by the EPA, whereas the other four domestic peer reviews were conducted at the initiative of the CAO. Renowned experts without any direct interest or involvement in the WIPP project, i.e., no conflict of interest, conducted all seven peer reviews. To further strengthen their independence, the peer reviews were facilitated by a specially retained independent organization. With one exception, i.e., the Spallings conceptual model, the independent peer review groups approved of all remaining assumptions, data, and models used in the CCA. Although the conceptual models peer review group stated that the Spallings conceptual model was unacceptable, it concluded that the related results presented in the CCA were overly conservative and adequate for use in the CCA.

In summation, the eight peer reviews greatly contributed to the enhancement of confidence in and acceptability of both the disposal concept and the results presented in the CCA. It should be noted that the efforts invested by the CAO during 1994 and 1995 to enhance the quality of the documentation of assumptions and data (see lesson four above) were instrumental to the efficient and cost-effective conduct of the peer reviews and, possibly, their favorable outcome.

In addition to the above peer reviews, the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine, through the National Research Council’s Board on Radioactive Waste Management, have maintained a dedicated “Committee on WIPP” since 1978. This committee has issued two major and eight letter reports on the WIPP TRUW repository. Its most recent report(12) emphasizes the inherent safety provided by the geologic setting at the WIPP. It also questions the conservative assumptions and the scientifically unfounded human intrusion requirements governing the CCA results.

By statute, the state of New Mexico has had its own oversight group since 1978. Over the years, this oversight group, the New Mexico Environmental Evaluation Group (EEG), has produced some 60 reports on WIPP related issues. By definition, most of these reports are critical of the DOE and/or raise issues associated with the WIPP project that the EEG believes need additional DOE attention. It should be noted that the EEG does not have the advanced modeling capability required to assess many of the very complex issues raised by EEG and others. The EEG is thus unable to promptly address and close out these issues and has to defer their analysis to the DOE. As expected, issues raised by the EEG (and others) are used by opponents to the WIPP TRUW repository to question both the credibility of the DOE and/or the safety of the WIPP TRUW repository. The EEG is thus perceived by many to oppose the WIPP TRUW repository. Fortunately, the long-standing monitoring of and commenting on WIPP issues by the NAS Committee on WIPP, the favorable peer reviews of all key components of the WIPP TRUW repository system, and, ultimately, the EPA’s certification of the WIPP TRUW repository place the issues raised by the EEG and others in the appropriately balanced, wholistic perspective.

The seventh lesson learned is that, in order to maintain and enhance acceptance among potentially affected and interested parties, the decision making process must be founded on clearly defined goals, objectives, and criteria that are transparent to any outside reviewer. For example, as described further under lessons number eight and nine below, respectively, the SPM and the CAO Disposal Decision Plan (DDP) (Fig. 4) provided the CAO Manager tools in support of a transparent process, method, and credible data for defensible and traceable decision-making.

The eighth lesson learned is that, in order to gain broad acceptance of a scientific program in support of a deep geological repository for safe disposal of long-lived waste or of any significant decision for that matter, one must also allow for broad involvement in the planning and implementation of the related program/decision. As indicated above, *regulatory input to, or definition of, program objectives, goals, and safety criteria is particularly important to a broad-based acceptance of any decision or result*. For example, during the SPM effort, the CAO, supported by SNL, held eight periodic public meetings to solicit and discuss input from interested parties and to report on progress and results, including the distribution of 11 topical “white papers”. The input received during these meetings was documented, considered, responded to, and used as deemed appropriate by the CAO during the planning and execution of the SPM. Indeed, the involvement of and quality feedback from interested parties throughout the SPM effort significantly enhanced the credibility and public acceptance of the SPM process, its results, and the proposed disposal concept.

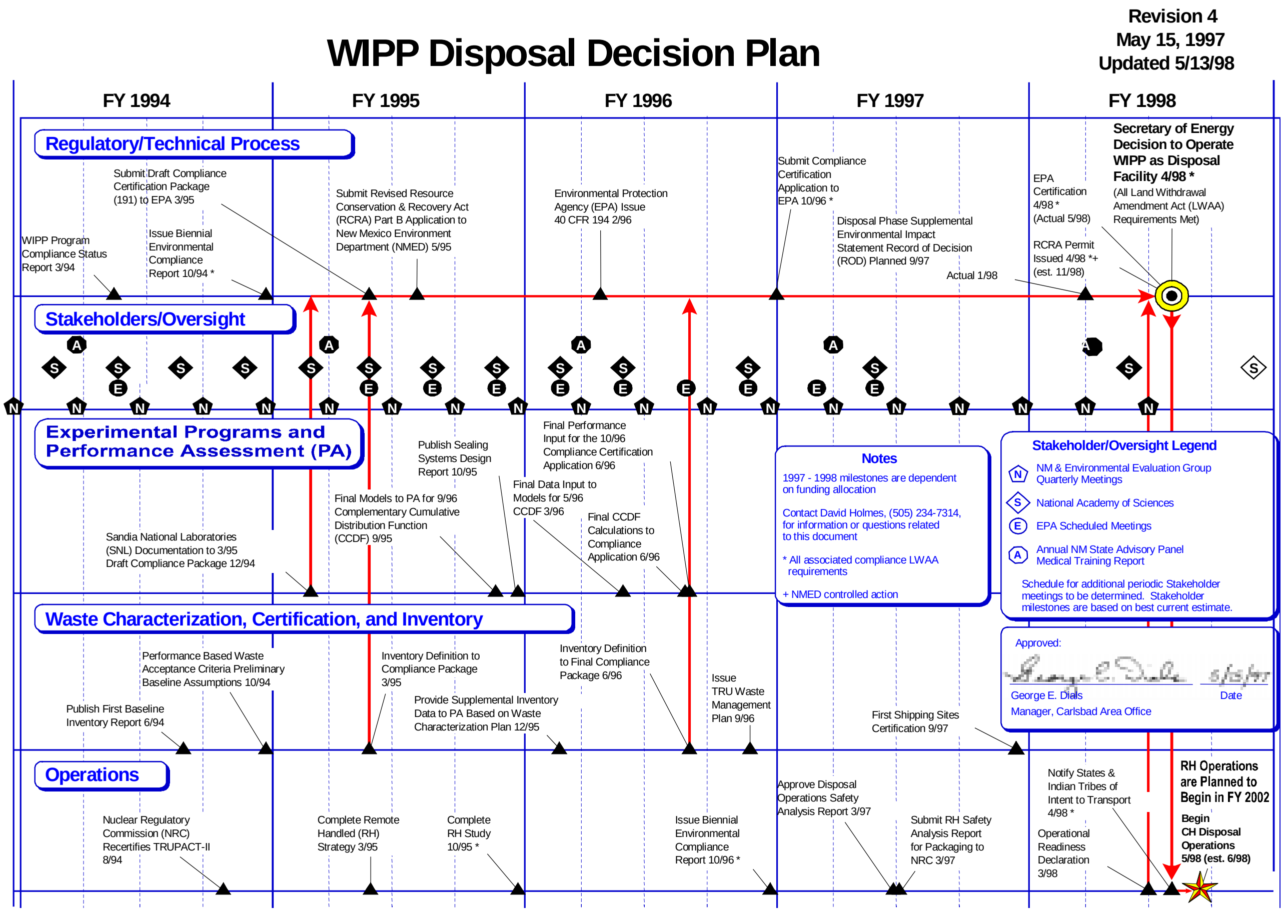

Fig. 4. The CAO Disposal Decision Plan, Revision 4

The ninth lesson learned is that measures to enhance public and political participation and support should be considered and integrated into the decision making process at an early stage. Indeed, a very fundamental cornerstone in the CAO's successful three-year advancement of the EPA's certification for the WIPP TRUW repository is embodied in the CAO DDP (Fig. 4), as amended by evolving laws and regulations. As shown in Fig. 4, the five-year CAO DDP integrated the nation's TRUW management system and included 47 scheduled public meetings (see Stakeholders/Oversight section). In addition, during the one-year SPM process, data and information were shared by the CAO in eleven topical white papers in eight public meetings attended by representatives from the regulators, the EEG, and other affected and interested parties. During 1995 alone, the CAO was represented in 35 public events. Notwithstanding these frequent iterative interactions, late external and/or legal input is virtually unavoidable. However, the probability that major issues will appear at a late stage is significantly less if iterative interactions with regulators, oversight groups, and other affected and interested parties, *including opponents*, are initiated early and maintained throughout the project.

The tenth and final lesson learned is that, in order to ensure the successful implementation of the above nine lessons learned, it is imperative that the management organization has strong leadership and is motivated, adequately skilled, and internally cooperative. It also needs to be vested with the appropriate authority to be able to credible interact with the regulator(s), oversight groups, and other affected and interested parties. The benefit of this type of CAO management organization greatly contributed to the prompt and detailed planning of the nation's TRUW management and disposal (Fig. 4) as well as the subsequent successful implementation of the CAO DDP, which advanced the certification of the WIPP TRUW repository almost three years.

Based on annual CAO budgets of 175 million dollars and a three-year advancement of the WIPP program, the related potential cost-savings derived essentially from the above described 10 lessons learned equate to 525 million dollars, not including significant related system-wide cost savings. Conversely, every day the opening of the WIPP TRUW repository is delayed costs the taxpayers about 500,000 dollars for maintaining operational readiness of the WIPP TRUW repository alone.

CONCLUDING REMARKS

In closing, 24 years of site characterization and analyses by the SNL have proven beyond any regulatory doubt(4) that the bedded salt formation proposed by the DOE for a deep geological repository for long-lived radioactive waste at the WIPP site exhibits excellent radionuclide containment and isolation characteristics. Indeed, the apparent safety provided by rock salt in terms of containing and isolating long-lived radionuclides was suggested by the National Academy of Sciences in 1957. Consequently, 42 years later with the EPA's certification of the WIPP TRUW repository on the 13th of May 1998, this notion has been formally corroborated.

The ten lessons learned during the past five years of successful certification and permitting processes for the WIPP TRUW repository are special but not exclusive to the WIPP project, and may be of particular interest and value to other radioactive waste management programs facing or expecting to face similar challenges. Although there is no global cookbook success formula for projects of this type, there are project management techniques – such as, clearly defined scientific objectives; comprehensible and credible results; and transparent, justifiable, and encompassing decisions – which, if used, provide great potential for the involved and affected parties to develop a relationship of common ownership and cooperation.

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