

Nevada and New Mexico: Two Particularly Promising States for HLW Repositories

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ABSTRACT

Based upon active involvement and monitoring of nuclear waste management programs in the USA and abroad since 1973, the authors contend the long-term public health and national security interests of the nation and its residents can best be served by promptly pursuing dual paths in Nevada and New Mexico. Majority acceptance of nuclear facilities by neighboring residents/parties is the only equitable way sustainable progress can be achieved in handling nuclear waste.

Based on the historical record, public acceptance levels fluctuate with time, as do the objectivity and credibility of related reports of acceptance. Several counties in Nevada supported the selection and evaluation of the Yucca Mountain site until 1987, and its host community, Nye County, still supports it. Contingent upon a favorable ruling by the NRC on the 2008 Yucca Mountain Project SNF/HLW repository construction license application and the establishment of an implementing organization with credible leadership, we advocate that residential opinions in all counties in Nevada be verified by a state-wide referendum. In the meantime, New Mexico continues to be the optimal region to explore alternative sites.

INTRODUCTION

The more than 55-year-long [1] unsuccessful and costly search in the USA for a safe and secure deep-geological repository for disposal of long-lived highly-radioactive waste (HLW)¹ [2,3], schematically illustrated in Figures 1-4, was stopped in early 2010 by the Obama Administration (the Administration) [4]. At that time, the U.S. Nuclear Regulatory Commission (NRC) was reviewing the U.S. Department of Energy's (DOE's) June 2008 construction license application (CLA) for a deep geological, man-made/mined repository for up to 70,000 metric tons (MT) of heavy metals or an equivalent amount of uranium, both referred to herein as HLW,¹ at the Yucca Mountain Project (YMP) site in Nevada [5]. The legality of this action by the Administration was promptly challenged, but pending the related rulings by the U.S. Court of Appeals for the District of Columbia Circuit (the Court), the Administration continued to consider the YMP HLW repository "not workable" and pursued other HLW storage and disposal solutions. In January 2013, the Administration presented a new framework strategy for the management and disposal of used nuclear fuel (UNF) and HLW in the USA [6] for consideration by the U.S. Congress that projected the alternate HLW repository would open by 2048. This framework was specified in the January 2012 report of the *Blue Ribbon Commission on America's Nuclear Future* (BRC) [7].

In August 2013, the Court ruled that neither the Administration nor any of its federal agencies had the legal authority to stop the Yucca Mountain program without Congressional consent [8]. Although this ruling meant that the evaluation of the YMP site could and should proceed without undue delay, the existing evaluation funds were limited to about 11 million U.S. dollars (\$11 M). At the end of 2013, the YMP HLW disposal program remains at a standstill pending Congressional action followed by enabling legislation.

¹ As used in this document, the term/acronym HLW includes UNF, SNF, and HLW. It is also often used synonymously with the expression "the back end of the nuclear fuel cycle".

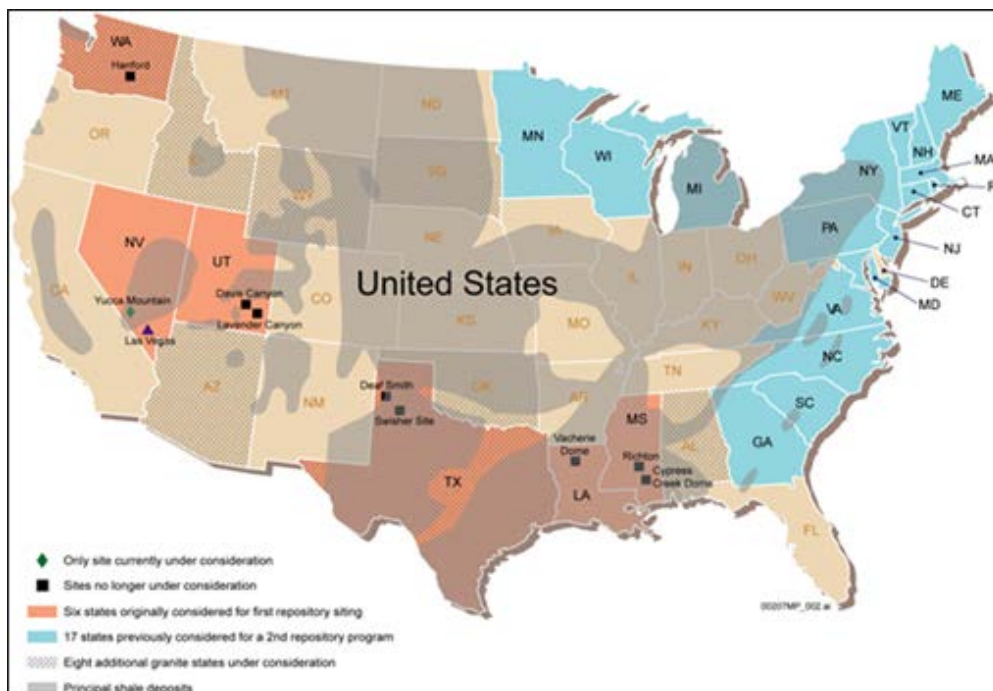


Fig. 1. U.S. map showing sites, areas, and states considered during the past 30 years for hosting a HLW repository. (Although seven past rock salt sites are shown, i.e., Davis Canyon, Lavender Canyon, Deaf Smith Canyon, Swisher Site, Vacherie Dome, Richton (dome), and Cypress Creek Dome, the US's abundant rock-salt deposits are not shown. They are shown in Figure 2.

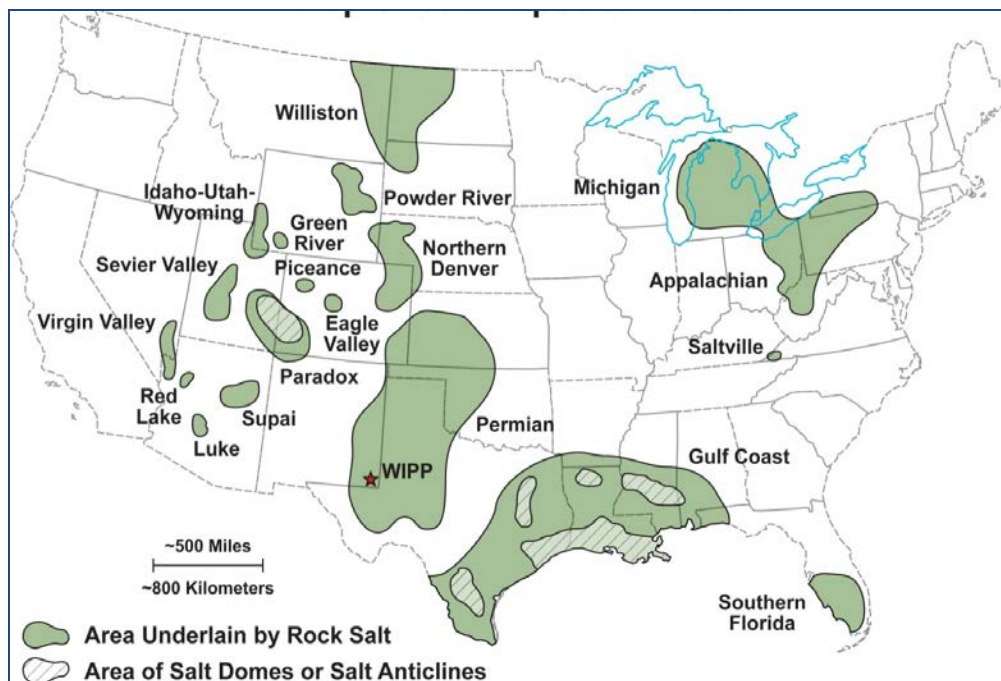


Fig. 2. Locations, areas, and regions with thick rock-salt deposits in the USA. “WIPP” denotes the location of the Waste Isolation Pilot Plant deep geological repository for long-lived, transuranic, radioactive waste (TRUW) schematically illustrated on Figure 4 that opened in March 1999.

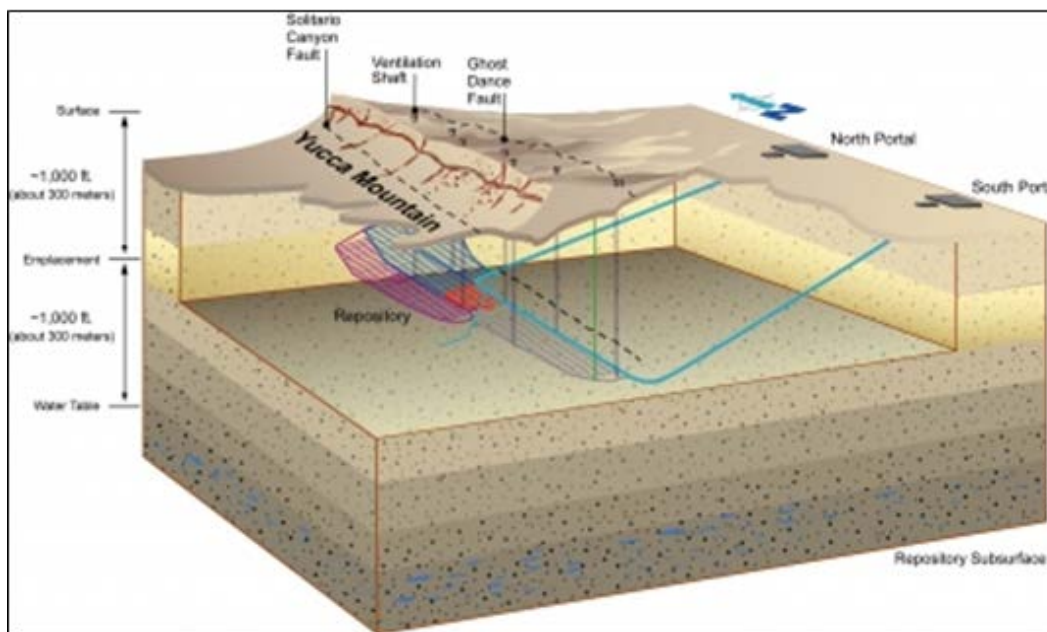


Fig. 3. Cutaway image of Yucca Mountain, its sequence of effusive-volcanic-rock layers, and the planned network of repository tunnels. The existing U-shaped access/exit tunnels and their adjoining test rooms/niches were closed in 2009. (Source: U.S. Department of Energy, 2010.)

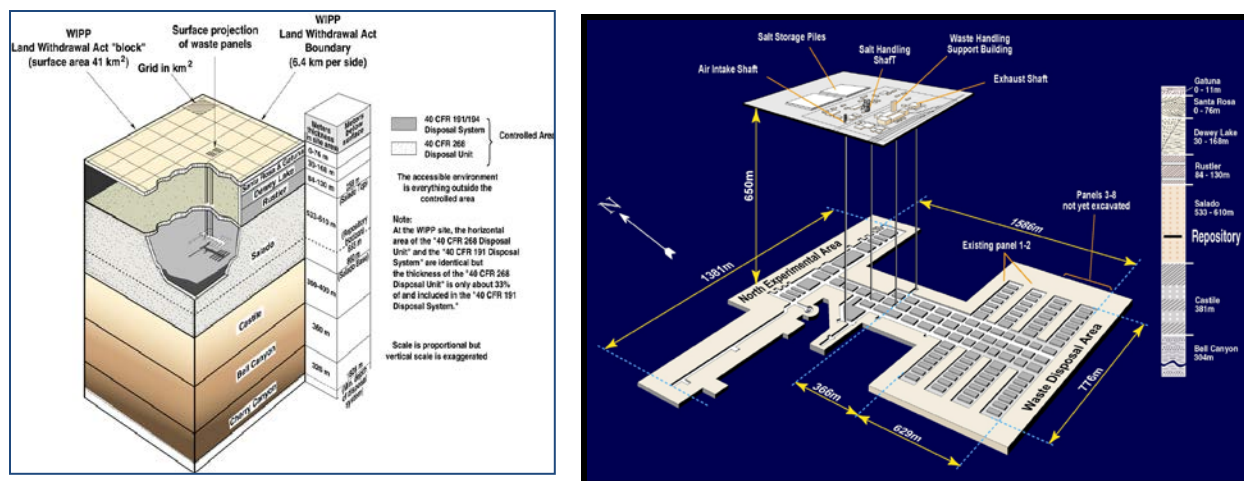


Fig. 4. Schematic illustrations of the 41 km² area and the underlying 1,830-m-deep portion of the geological setting at the WIPP site set-aside from public access (= "controlled area") to the left, and the 2012 layout of the WIPP TRUW repository and its adjoining URL, the North Experimental Area, and the stratigraphy at the WIPP site (the numbers shown under each named unit is its vertical thickness) to the right. The easternmost four panels are referred to as panels 1-4 and the westernmost panels are referred to as panels 5-8. The 2012 repository layout shown here has since been modified with panels located south (to the right) of panels 5 and 8.

Based on statements made by the majority leader of the Senate after the August 2013 Court ruling, the Administration still opposes the continued evaluation of the YMP site. In our opinion, abandoning the YMP site extends the potential radiation exposure of 150 million people residing within 50 miles of the

131 sites in 39 states shown in Figure 5. Of these 131 sites, some are currently filled to or close to capacity and present an actual or perceived adverse health effect from HLW for at least another 20 years. Weighing this exposure against fully evaluating a remote and subterranean site surrounded by fewer than 50,000 people within an 80-km (50-mile) radius, that has been studied for two decades at a financial investment in excess of \$7 billion (B), is, in our opinion, neither rational environmental stewardship nor effective governance.

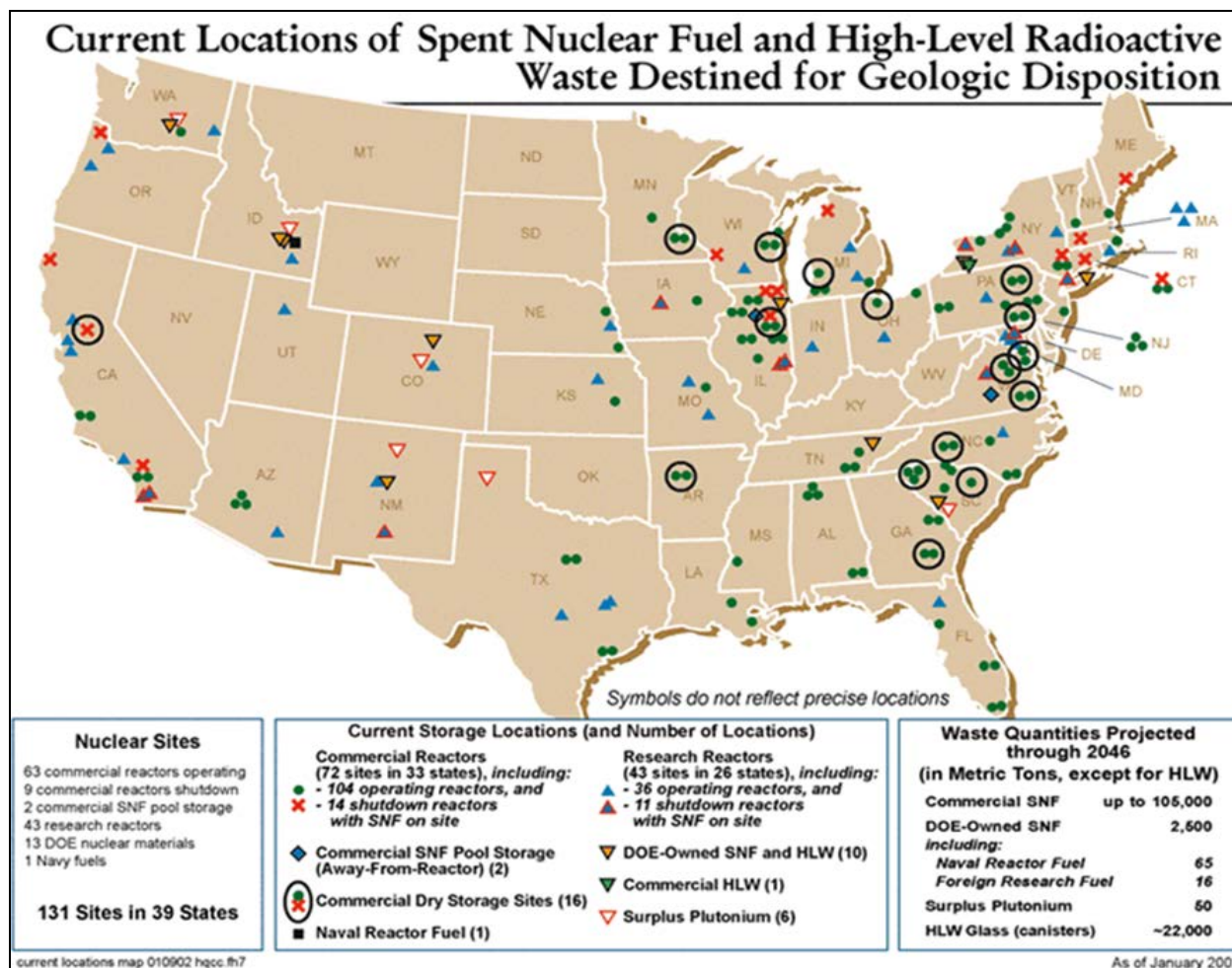


Fig. 5. Schematic illustration of the 131 sites in 39 states storing HLW in January 2002.

This paper summarizes the status of HLW management in the USA at the end of 2013, highlights some of the related major issues, and then concisely describes and discusses promising roads forward. Although considerable attention is given to the Administration in this paper, the reader should be aware that the failure to comply with the laws pertaining to the repository dates back to 1 February 1998, predating the Administration by more than 10 years. The information presented herein includes only a fraction of the available information supporting our conclusions. Data sources in the **REFERENCE** section provide links to other historical material.

BACKGROUND

Two rulings by the US Court of Appeals for the District of Columbia Circuit (the Court) in the second half of 2013 set the stage for the current status and the pending progression of the USA's HLW-

management program. In August 2013, the Court ruled that the Administration did not have the statutory authority to unilaterally stop the YMP HLW repository project and directed the Secretary of Energy and the NRC to promptly revive the evaluation of the YMP HLW repository [8]. By law, the evaluation of the YMP site must continue until existing laws for HLW disposition are either amended or replaced. However, the NRC does not have adequate funds for completing its review of the 2008 CLA. Although the August 2013 court ruling does not apply to the new strategy presented by the Administration in January 2013 for the management of the back end of the nuclear fuel cycle [6], both the implementation of this strategy and the continued evaluation of the YMP site require enabling legislation. At the end of 2013, the USA's HLW management program remains at a standstill until the enabling legislation for either or both of the YMP the 2013 strategy is enacted. The November 2013 Court ruling awarded \$ 350 M to three nuclear utilities due to the DOE's inability to provide a central storage or disposal facility for their HLW between 2002 and 2008 [9]. It also directed the Secretary of Energy to seek Congressional approval for utilities to defer payment of the annual \$ 750 M dollars into the Nuclear Waste Fund (NWF) until the DOE has a viable HLW disposition solution for commercial HLW.

DISCUSSION TOPICS

Consequences of Abandoning the YMP site

Abandoning the YMP repository before its performance, safety and risks have been credibly established by the NRC will delay the opening of the US's first HLW repository at least another 20 years. The most apparent related adverse consequences are:

- The extended time radiation risks will be imposed on the 150 million residents within 80 km (50) miles of existing nuclear power plant used fuel basins.
- The multi-billion dollar increase in the total amount of the annual "breach-of-standard-contract" payments and awards due the nuclear utilities.
- The related charges to taxpayers and utility payers for the breach of these contracts.
- The lack of contributions to the Nuclear Waste Fund (NWF).
- The loss of a multi-billion dollar investment in research and construction.
- The lost opportunity of permanently closing an unused but existing facility.
- The negative impact on nuclear energy growth.
- The increased open access to HLW by terrorists.
- Increased charges in the future for consent-based approval of new facilities and for their construction.

Congressional Action(s)

It is very unlikely that either the Senate or the House of Representatives will be able to or is interested in finding the time to agree on enabling legislation and then obtain the President's enacting signature to proceed with any of the paths proposed by the Administration. Thus, the enabling legislation for the 2013 strategy and the funds required for the NRC's CLA review may not be enacted until late 2014, at the earliest.

Another reason for our pessimistic view is the fact that the existing HLW program has been in violation of the 1992 Act [2], as amended [3], since 1 February 1998, but Congress has failed to address this violation during the past 14 years. Monetarily, early action in the present saves funding in the future.

For the purposes of looking forward, we assumed that *both* the 2013 strategy and the YMP program will be fully funded no later than in 2015. Both strategies are required because:

- While HLW can be reduced in volume, there will still be residual HLW that must be contained and isolated from humans and environments until it is rendered harmless. Current regulations put this range somewhere between 10,000 and 1,000,000 years.
- The very large number of current HLW localized storage sites are challenging and expensive to safeguard and more vulnerable to human intrusion than a deep geological repository.
- *Safe and secure disposal of HLW is a government obligation that shall be executed without undue delay, as noted in the Joint Convention [10].*

Consent-based Siting of Nuclear Facilities in the USA and Abroad

The 2013 strategy introduced the concept of *consent-based* siting for the nation's future HLW storage and disposal facilities. Although this concept was attributed to the recommendations presented by the BRC in January 2012 [7], it had previously been both successfully and unsuccessfully applied in the US and abroad since the early 1970's and 1980's. The global historical record for the siting of facilities shows that majority consent has gradually evolved into a fundamental, challenging, integral component of defensible societal decision-making to achieve public and political support.

The term majority can be readily defined, whereas the term "consent" is imprecise and nebulous.

As elaborated upon in a WM2013 paper [11], one approach for identifying the groups from which consent should be sought is to *reserve it for the individuals residing in the areas directly affected by the radiation risks imposed by the proposed nuclear facility*. Opinions expressed by people and parties not physically exposed to the potential radiation risk should not be allowed to skew the decision-making process.

Some elected local and state officials in Nevada, including the Majority Leader of the Senate, are not in favor of the YMP HLW-repository. To the best of our knowledge, the majority opinion of the residents in Nevada has not yet been established in a credible manner. Consequently, in the event the NRC rules that the YMP HLW repository meets all applicable regulations, an acceptance referendum could be conducted in Nevada to establish the related actual opinions in each county.

The WIPP repository success in New Mexico is attributable to and still benefits from strong local acceptance; the opposite may be said about the YMP site. We suggest that the following two-step approach [11] be used to more credibly demonstrate acceptance and support among affected parties at both county and state levels in Nevada and other candidate disposition facility states:

1. Identify the affected counties and states by using either a conservative, scoping, repository-performance/safety assessment (P/SA) or a defensible, preliminary/initial, stand-off distance from the perimeter of the proposed site pending periodically updated performance/safety assessments (P/SAs).
2. Conduct a state-wide referendum in the affected state(s) and then evaluate them by county, with priority given to the facility-host counties.

We also suggest a distinction between states and counties affected by the main facility and those affected by the related radioactive-waste transportation [11]. This binary consensus-establishing approach needs to be further refined based on the type of nuclear facility considered and its related infrastructure and operations.

Pending the development of quantitative consent-based siting criteria, we strongly advise against abandoning the YMP HLW repository for any other reason than unacceptable radiation risks to current and future generations and environments, because:

- Consent is a stakeholder-appealing, qualitative concept that, based on the historical record, will change with time.

- Majority-opinion in Nevada remains to be credibly verified by a state-referendum contingent upon and subsequent to a favorable ruling by the NRC on the 2008 CLA [5].
- The YM HLW repository could advance the opening of the nation's first HLW repository by up to 20 years.
- Aborting the YMP repository after an investment of more than 35 years and \$7 B misrepresents the state-of-the-art repository sciences expertise available in the USA; undermines the future of nuclear energy; and sets the USA's repository program back at least 20 years.
- Also, as emphasized in the underpinnings of the 2013 strategy [6], the 2012 BRC report [7], and in the Joint Convention [10] and its predecessor and related Conventions, to which the USA is a signatory, the necessary time for a new HLW repository in the USA could be shortened by:
 - 1) Early identification of areas in the contiguous US with both long-standing nuclear cultures and adequate (large) volumes of HLW-repository host rocks with already established comprehensive domestic and/or foreign repository sciences expertise and databases; and
 - 2) Co-locating the HLW-storage and disposal facilities.

Siting of Deep Geological Repositories in the USA and Abroad

In the event another repository cannot be located in host rock similar to that at the YMP site (unsaturated welded tuff), other potentially suitable host-rock types would have to be pursued. Repository sciences and engineering knowledge cultivated over the past 25 years at the YMP site may not be readily transferable to other rock types. Whereas no other nation has pursued effusive volcanic rock as the host rock for a HLW repository, they have developed the current state-of-the-art repository sciences and engineering for other HLW repository host rocks. For example, France and Switzerland have evaluated argillites/mudstones, Finland and Sweden have evaluated igneous/crystalline rocks, and Germany and the US have evaluated rock salt as repository host rocks since the 1970's. Promptly identifying and adopting select elements of other national HLW repository programs embody clear promises of expediting the development and increasing public confidence in a new HLW disposal site/concept [12-14]. However, in terms of time saving, the most promising paths forward in the USA are still tuff, i.e., the YMP site, and rock salt.

The Yucca Mountain Site

The Administration has claimed since February 2009, that the YMP site is not workable [4]. It has taken several actions since then designed to prevent its development. Two of these actions were the creation of the BRC in 2010 and the new strategy which it presented on 11 January 2013 [6]. However, the 2013 strategy did not recognize any of the following YMP site attributes:

- First and foremost, its existence.
- The advanced development stage of its HLW repository.
- The long-term willingness of residents of the host county to support the HLW repository.
- The inherent schedule, cost, and national security benefits of the YMP site.

The YMP site is still the only current legal option in the USA for disposal of HLW. A statewide referendum in Nevada, as outlined in the preceding text, would provide an excellent opportunity to credibly determine on a county basis whether or not the hosting of the YMP HLW repository is acceptable to its neighboring residents. We believe it is financially irresponsible to abandon the YMP HLW repository unless it cannot meet licensing regulations or imposes undue burdens on the local population.

Again, the USA's HLW stockpiles will be on the order of 100,000 MT by 2025 and 146,000 MT by 2048. Although proposals have been made to expand the YMP repository capacity [15], we do not believe this

to be possible due to existing geological constraints at the YMP site for the current HLW-disposal concept. Furthermore, the suitability of the YMP site and the radiation risks of its proposed 70,000 MT HLW repository still have to be fully evaluated by the NRC. We thus strongly advocate an “all of the above” approach that would consider both the YMP site and other sites to ensure adequate and timely-available domestic HLW-disposal capacity through 2040 and, preferably, beyond.

The YMP site also provides a very promising locale for a surface, near-surface or underground HLW storage facility. For example, the existing ingress and egress tunnels and sequence of volcanic “welded” rocks could be used to expedite the development of an underground, industrial-scale, HLW storage facility adjacent to the repository. This configuration would drastically reduce transportation distances and related radiation and proliferation risks. Or, the storage facility could be adjacent to the repository patterned after the highly-secure Swedish central SNF storage (Clab) facility/concept shown in Figure 6, where there is only one common point for both ingress and egress; and inadvertently-released airborne radioisotopes would be contained underground.

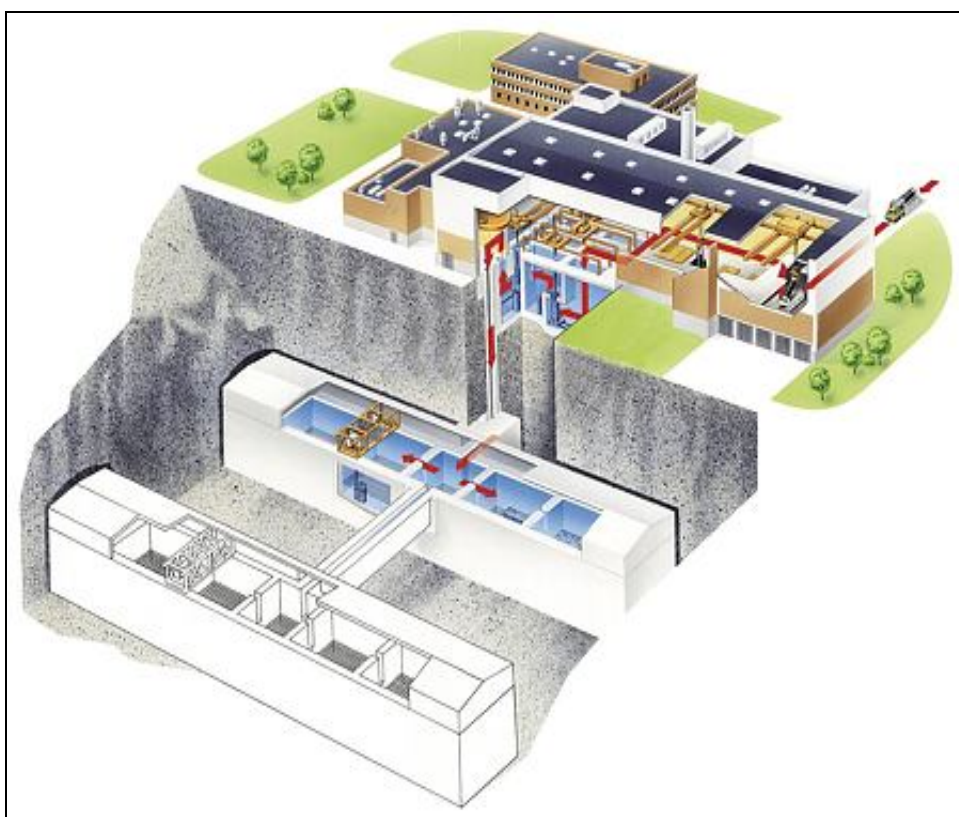


Fig. 6. Schematic illustration of the Swedish Central Storage Facility (Clab) for SNF, which is to be co-located (Clink) with the Encapsulation Facility (Inka). (Courtesy of SKB, <http://www.skb.se>)

The Waste Isolation Pilot Plant Site and Beyond

In 1972, politicians and businesspeople in New Mexico invited the DOE to evaluate the suitability of New Mexico’s vast rock-salt deposits for safe and secure disposal of HLW. The characterization and evaluation of the WIPP site (Figures 3 and 4) then commenced in 1973. In 1975, Sandia National Laboratories (SNL) designed and conducted comprehensive surface-based site characterization studies followed by full-scale, underground, in-situ tests for TRUW and HLW disposal. At that time, the master plan was to dispose of long-lived, TRUW ~650 m below the ground surface and HLW ~100 m deeper in

the 200+-million-year-old, 600-m-thick Salado Formation (rock-salt). The disposal of HLW was subsequently precluded by congressional legislation and resultant DOE policy.

The WIPP repository was licensed by the EPA in May 1998 for safe disposal of 175,584 m³ of TRUW, or a maximum amount of curies. However, it did not open for disposal operations until 1999 due to a legal challenge. It is currently in an advanced and mature operations stage. The layout has been redesigned and new panels are being planned. Additional rock-salt panels could be added in the future [16,17], provided they do not impact the post-closure P/SAs to the extent that the WIPP repository fails to comply with applicable regulations.

As mentioned above, the WIPP site was once considered for safe and secure disposal of both HLW and TRUW, and related, full-scale, in-situ tests were thus conducted well into the last half of 1980 in the North Experimental Facility (Figure 5). These tests, augmented by off-site in-situ and laboratory tests and analyses conducted in the USA and in Germany during the past 30 years [e.g., 18], have repeatedly and conclusively corroborated the 1957 National Academy of Sciences' (NAS) conclusions that salt is a very suitable host rock for containment and isolation of HLW [1]. However, although the current WIPP repository layout can be expanded both horizontally and vertically, expanding the mission of WIPP to accommodate on-site storage and disposal of a large quantity of HLW may not be an attractive or even viable solution for the following reasons:

1. In 1993, the EPA was appointed the only federal regulator for the safe and secure management and disposal of TRUW at the WIPP site and the NRC is currently not involved in the on-site TRUW management and disposal operations. *In the event the WIPP site was considered again for safe and secure disposal of HLW, both the current regulatory oversight and applicable federal regulations would have to be modified, because the NRC presently has the national charter to regulate and oversee the safe and secure management and disposal of all HLW.*
2. *The resolution of this regulator issue could be time consuming, and could adversely affect the ongoing TRUW-disposal operations.*

We are, however, convinced that New Mexico is an exceptionally promising locale for both HLW-storage and -disposal facilities, but the anticipated adverse impacts of necessary regulatory oversight change diminish and partially negate the attractiveness of the WIPP site. The more politically palatable and less time-consuming option would be to limit the expansion of the WIPP mission to defense-generated HLW (DHLW), because, scientifically speaking, its characteristics are much more “benign” and its volume is only a fraction of the commercially-generated HLW (CHLW) volume. Furthermore, both TRUW and DHLW have the same generator, the US government.

SUMMARY OF OBSERVATIONS, CONCLUSIONS AND RECOMMENDATIONS

One HLW repository will not meet the USA's HLW disposal needs through the first half of 2000. We thus advocate/recommend that both the YMP site evaluation and the BRC's 2013 strategy be promptly pursued. The timing of legalities required for progress and the related allocation of financial resources, as well as the establishment of a credible implementing entity, will govern the rate of progress and, perhaps, even the outcome. Timely progress remains of utmost importance to national security, public health, and the collection of fees imposed on the nation's nuclear utility-rate payers. Indeed, a realistic HLW disposal solution has been one of the cornerstones of the NRC's Nuclear Waste Confidence rule for more than 30 years, and absent one, the future of nuclear energy in the USA and perhaps abroad is also at risk.

We also believe that if the NRC was promptly given adequate financial resources to review the CLA without interruption and then approved it no later than in 2015, the YM repository could open in the second half of 2020. This also requires an implementing organization with adequate management

expertise and financial resources. The nation's first HLW repository could even open in the first half of 2020 if the disposition paths for CHLW and DHLW were separated and the WIPP mission was expanded to include DHLW. However, the DHLW only constitutes about 10% of the nation's current HLW, so at least one additional HLW repository would still be needed for the CHLW.

The major hurdle cited by the Administration since 2009 has been the very strong public opposition in Nevada. However, to the best of our knowledge, neither the magnitude nor physical proximity of this opposition has been credibly polled or documented. Anecdotally, the residents and elected representatives of the host county for the YMP site have repeatedly expressed their willingness to host it for more than a decade. We are guardedly optimistic that if the CLA meets the applicable regulations, the site would once again be able to gain majority support by the residents in Nevada. We endorse and fully support the consent-based, nuclear facility hosting concept proposed by the 2013 strategy, the BRC, and successfully employed at WIPP and in Finland, France, and Sweden for more than 20 years. However this concept needs to be defined quantitatively before implementation, as does the political robustness of the affected community and state's veto right.

The 2013 strategy projects the USA's first new multi-user HLW storage and new HLW repository to open by 2025 and by 2048, respectively [6]. Both of these opening milestones are achievable, provided the implementing HLW disposition organization benefits from capable leadership, stable funding, and political support all the way up to and including the Secretary of Energy.

At the end of 2013, the probability for achieving and advancing these two milestones is particularly promising in Nevada and New Mexico. The primary positive attributes in Nevada are:

- The huge, already guarded, surface area available at and adjacent to the YMP site.
- The very-advanced stage of its candidate HLW repository.
- The broad public support in the country hosting the site.

The primary positive attributes in New Mexico are:

- Long-standing, strongly-expressed, interest in and willingness by local communities, e.g., Eddy County and Lea County, and the state government, to host them both.
- Proven track record of having supported WIPP since 1973.
- Familiarity with the successful siting and development of a deep geological repository in rock salt that has operated safely and been re-certified three times since March 1999.
- Abundant, thick and laterally-extensive, tectonically-stable, 200+-million-year-old, rock-salt formations.
- Abundant, resident state-of-the-art repository science experts and rock salt databases, as well as long-standing, professional relationships with rock-salt experts and data in Germany.

In closing, we strongly recommend the paths forward for the two HLW repositories and the nation's first central HLW storage facility be closely integrated and expeditiously pursued in a manner similar to how it successfully evolved in Finland and Sweden. Co-locating HLW storage and disposal facilities offers significant time and cost savings.

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