INDEPENDENT SCIENTIFIC PANEL REVIEW OF
EXHUMATION WORKING GROUP RECOMMENDATIONS
June 14, 2014

INTRODUCTION

The Independent Scientific Panel (ISP) has reviewed the document titled "Recommendations for Phase 1 Exhumation Studies" dated November 2013, prepared by the Exhumation Working Group (EXWG), and comments submitted by stakeholder groups.

The ISP appreciates the opportunity to comment on the EXWG recommendations. The ISP consists of the following members:

- Dr. James Clarke
- Dr. John Garrick
- Dr. Kristin Shrader-Frechette
- Dr. Chris Whipple

GENERAL COMMENTS

DOE and NYSERDA are faced with the decision of how to best cleanup the West Valley site for the public good. To engender public support, the studies should be transparent as to their assumptions.

The ISP appreciates the work of the EXWG and believes that the recommended studies will improve the understanding of the benefits and drawbacks of various levels of exhumation of the Waste Tank Farm (WTF), State-Licensed Disposal Area (SDA) and NRC-Licensed Disposal Area (NDA) if the studies are performed in light of our comments below. The ISP also appreciates that the EXWG has directly addressed the issue of reducing uncertainty and while this is always important it should not become an end in itself. Approaches that help us to manage uncertainty (whatever it may be) are needed as well.

Organization and Analysis to Enhance Transparency

We believe that clearer organization of the studies will enhance transparency as the outcomes of the studies are compared against other alternatives for achieving the goal of protecting the public and the environment. When a decision is made, decision theory necessitates that there should be a clear indication of what the options are for making the decision. Having a performance measure for the options will then facilitate the right decision, usually in the form of risks, benefits and costs of the individual options.

Similarly, data-quality analysis requires establishing the level of precision and accuracy needed, before beginning any studies. Given the long time frames and the uncertainties involved, it also is especially important for every study to have an appropriate sensitivity and uncertainty analysis, so that the conclusion-drivers and decision-drivers are obvious. The EXWG, or other appropriate subject matter expert working group, also should clarify the degree to which reducing uncertainty in various models nevertheless is unable to reduce uncertainty in prediction, given the "irreducible uncertainty" in long-term (1,000 years and longer) hydrogeological models.

One member of the ISP cautions that because some elements of the analysis may not be reducible to quantitative risk assessment, projections based on such an assessment may contain substantial uncertainties that cannot reliably be quantified using standard statistical methods. As many economists such as Sir Nicholas Stern (2008) recognize, where experts don't know the frequency-based probability distribution, deep uncertainty typically cannot be reliably characterized by probabilities. As a result, although risk assessors commonly represent uncertainty by a probability distribution of frequency of occurrence for each scenario, this representation faces at least 3 problems. These include (a) the frequent problem of expert overconfidence and poor calibration (Lin and Bier 2008); (b) lack of empirical validation for expert opinions about probabilities – such as those tens of thousands of years in the future, and (c) the difficulty with using a Bayesian inference mechanism when it requires the prior distribution to be elicited without any knowledge of the data upon which the prior assessment will be later updated.

To help reduce typical problems (a)-(c), one member of the ISP believes the EXWG should ensure that uncertainty analyses include two main correctives. One corrective is (1) guarding against common errors (such as underestimating the tails in the distributions of normalized deviations from the true values), by using techniques such as those in Quigley and Revie (2011), Hammitt and Shlyakhter (1999), and Shlyakhter (1994). A second corrective is (2) empirically validating expert subjective probabilities, by using something like the classic EU-US NRC methods (EU and US NRC 2000, Cooke and Kelly 2010), as illustrated in many joint EU-US NRC studies (e.g., Goossens, Cooke, and Kraan 1998; Goossens et al 1998, 1997; Brown et al 1997; Haskin et al 1997; Little et al 1997, Cooke et al 1995; Harper 1995). Without correctives such as (1) and (2), it is difficult to see how the exhumation working group and performance assessors can meet the most important requirement of scientific methods, empirical control, and difficult to see how the results will appear credible to all.

Clarity on Risk-Cost-Benefit Analysis, Use of Scenarios in Analysis

The ISP also notes that the studies will be enhanced by a risk-cost-benefit analysis of the exhumation options (none, partial and full), through a team of interdisciplinary specialists, because cost assessment is a leading driver of site decommissioning and exhumation, conclusions are sensitive to cost, especially as they relate to time and discount rate. The risk-cost-benefit analysis should take into consideration the Full Cost Accounting Study conducted by Synapse Energy

Economics and show precisely why Synapse is correct/incorrect in concluding that full exhumation is the cheapest option.

The ISP encourages the EXWG to conduct its analysis based on a variety of scenarios. The use of scenarios will connect sources of exposure to receptors through environmental pathways and exposure routes, specific to the remedial approach being evaluated. A scoping analysis should be performed to quantitatively determine where uncertainty can impact the risk measures of the different options or scenarios. Such information is important guidance on how refined the uncertainty analysis should be for different facets of the overall problem. Without a scoping analysis, the studies could result in a runaway analysis mode if a rigorous assessment is not done on all elements of the problem. Without the benefit of a scoping analysis, there is the risk of doing an extensive amount of unnecessary work.

As scenarios are analyzed in light of cost-risk-benefit the parametric analysis at appropriate intervals will provide valuable insight especially as it relates to worker safety and shielding with respect to short-lived radionuclides which pose worker risk. One member of the ISP suggests risk-cost-benefit assessments for increments of 30 years, given that (a) erosion-control practices such as bank stabilization, sheet piles, and armoring typically have lifetimes of about 30 years; (b) DOE Alternative 2 only includes actions at the site for 30 years and suggests replacing monitoring wells at 25-year intervals; and (c) site economic conclusions will be compared to Synapse conclusions that include some evaluation increments as short as 16, 30, and 37 years.

The U.S. Nuclear Regulatory Commission (NRC) has set a period of 1,000 years as the performance period for commercial low-level waste. Also, the Department of Energy has a 1,000 year performance period for its self-regulated low-level waste disposal. However, one member of the ISP cautions that DOE's 1000-year performance period for low-level waste may not be applicable because West Valley contains buried transuranic (TRU) wastes, and the U.S. Environmental Protection Agency (EPA) sets TRU regulatory standards (more stringent than low-level-waste standards) that DOE must meet.

Concerns also have been expressed by stakeholders and analysts that this period may not be sufficient to understand the nature of risks over time at the West Valley site. While the decay of radionuclides with time is highly predictable, other aspects of site performance are less certain and uncertainties increase with time. In order for a well-informed decision to be made, analysis of how risks vary with time is a desirable input. Analyses need to be done to confirm whether or not peak doses occur within the 1,000 year NRC period; if this is found not to be the case, analyses to periods of peak dose should be conducted. Therefore the full risks, costs, and benefits of each option and scenario should be calculated at multiple, distinct intervals up to 1,000 years – or longer, if the peak dose occurs beyond 1000 years – so that the use of short time frames does not appear to bias decision making in favor of one option over another.

Relationship of Decision making to Future Site Use

As the studies examine the feasibility of a various approaches, the objective of the cleanup will influence decision making with respect to the dose criteria to be met. Although not directly related to the scope of the EXWG studies, some consideration of future site uses is integral to the ultimate decision. Based on our knowledge of other sites, we encourage DOE and NYSERDA to engage regional planners, county and municipal governments and stakeholders in dialogue about potential future uses sooner rather than later. This will be influenced by technical feasibility, safety to humans and the environment, and community benefit and cost.

Coordination with Other Working Groups

The EXWG and Erosion Working Group should be kept apprised of and coordinate with the work of the other. Both Working Groups should consider the impacts of climate change in their work and be provided access to climate change expertise where they deem it relevant to their conclusions and recommendations. This coordination will assist in the prioritization of decisions.

COMMENTS RELATED TO THE PROPOSED STUDIES

Following are comments related to the three proposed studies.

STUDY 1 WASTE INVENTORY ANALYSIS:

The ISP appreciates the desire and necessity of having an accurate inventory for the SDA and NDA to aid in decision making about potential cleanup activities. As noted in the EXWG Recommended Studies a number of previous estimates of inventories have been conducted over the years. These prior studies and the proposed Inventory Analysis, in and of themselves, are unlikely to add significant new information as to the location of wastes. The level of effort in conducting another Waste Inventory Analysis may not produce sufficient new inventory information to reduce uncertainty in light of the larger risks associated with "what can go wrong" scenarios that would overwhelm the uncertainties in the inventory.

There is evidence that the radionuclide inventory in the disposal sites may not be the largest factor from the point of view of reducing uncertainties with respect to making exhumation decisions. Most of the inventory is in solid form, but partitioning between the solid and liquid forms is critical to the consequences of an event that could penetrate the trenches. Direct measurements of radionuclide concentrations have been conducted in the past, but it is not known if any recent such measurements have been made. The bulk of the measurements of which we are aware date from the 1970s and 1980s and were conducted as part of a much larger research project. Radionuclide concentrations entrenched in water can be derived from chemical equilibrium calculations, and above-ground radiation monitoring could provide some insights and checks regarding the locations and magnitude of the waste inventory.

For these reasons, time and effort now would be better spent on understanding the outcome of the different options at the point of the decision that needs to be made, e.g., complete exhumation versus partial levels of exhumation versus other alternatives for achieving use of the site, including restrictive use. At a later time this study may be warranted, in conjunction with conservative approaches and technical solutions, to address safety during any removal operations.

We also note that the recommendations do not address the cost of full or partial exhumation of materials from the three waste areas, including the costs of redisposing of them elsewhere. Such costs may be sensitive to inventory measures such as activity and volume; however, developing information on uncertainties in inventory without assessing the impact on cost may be of limited use.

In performing an inventory analysis the calculations and resulting conclusions should take into account the full range and distribution of all conclusions about the site inventory, contained in the inventory studies, including standard deviations and averages for each of the conclusions in the inventory studies.

Given that the vitrified HLW is likely to be on site pending a permanent repository, the EXWG should estimate, based on current inventory estimates, whether and how much additional Greater-Than-Class C Waste that has no current disposal pathway would be created by full exhumation of the three waste areas.

STUDY 2 EVALUATION OF METHODS TO ADDRESS INVENTORY UNCERTAINTY:

The three approaches proposed by the EXWG could improve understanding of the uncertainties. As noted above, the uncertainties in the inventory exist, but are overshadowed by uncertainties elsewhere in the process, such as erosion.

The ISP finds that a Monte Carlo type analysis less useful than an improved understanding of the partitioning of the wastes as a contributor to uncertainty. The ISP recommends that studies be conducted to better understand the degree of partitioning taking place in the trenches between the solid waste, the trench water, and entrapment in the soil. Uncertainty analyses that will improve decision making included (1) partitioning of the waste (estimation of radionuclide concentrations in the trench leachate), (2) models and analyses for the groundwater release pathways, and (3) evaluation of disposal area slope stabilities and non-seismic slope failures. A quantitative risk assessment (QRA), such as the one performed for the SDA, will aid in the understanding of uncertainty as the principal driver of risk. Given such a large degree of uncertainty, it is especially important for site studies to rely in part on pilot projects for waste exhumation.

Sampling of soil gases, and remote sensing technologies may produce data that could be compared against the models. In addition to surface readings, drilling at an angle below the waste areas could yield relevant monitoring data. In addition to modeling with

Microshield, RESRAD could be used and the two could be compared against each other and sample results. If the sample results and models aligned the confidence level in the inventory analysis would be higher. If they did not align it may suggest that the inventory analysis is insufficient or that the wastes are not uniformly mixed for example.

The ISP notes that on Page 7 a fifth potential outcomes of Study 2 is possible. That outcome is: decisions about the three areas are insensitive to the uncertainties about the inventories. In addition, the EXWG should address the question of how important waste inventory uncertainty is to a decision to exhume all or part of the waste and how much uncertainty reduction would produce a different decision.

STUDY 3 REVIEW OF PRECEDENT PROJECTS:

The review of precedent projects will provide essential information to decision making. In conducting this study the EXWG should be mindful of the following:

- There is considerable experience with complex sites with unlined burial grounds, such as superfund sites, that could be considered and would inform decision making.
- The boundary conditions of the projects need to be considered; in particular those projects need to distinguish differences between projects that remain in government control and precedent projects that are intending to return the site to private or commercial use, even if it is restricted. There are many private cleanup operations that may be stronger precedent models than projects that are on government sites, especially those with unlined burial areas. Different projects have different remediation goals and West Valley has its own set of requirements. The stakeholder situation varies by project and needs to be very much a part of the determining the value added of precedent projects.
- The EXWG specifically mentions Pit 9 at the Idaho National Laboratory in Section 4 – Review of Precedent Projects. Pit 9 is a small part of the overall Subsurface Disposal Area that constitutes 97 acres of near surface TRU waste disposal. Pit 9 was selected as a pilot exhumation study (that ultimately was not implemented) based on the belief that a good inventory was available. Subsequent analyses, including other disposal portions of the Subsurface Disposal Area yielded a proposed "risk-informed" targeted retrieval of about 25 acres. This approach was adopted and was implemented.
- In gathering information from precedent projects, an additional objective of this study should include parametric cost estimations, including the relative contributions to cost from exhumation, transportation and redisposal.
- In considering treatment options, rather than reducing activity, which seems unlikely, the EXWG should consider treatment to reduce mobility and leachability.
- In addition, conveyor systems with radiation measurement capabilities, such as "segmented gate" systems, have been used to sort exhumed radioactive material into groups based on disposal site acceptance criteria. If the conditions permit, this can save on disposal costs relative to unsorted disposal. However,

once materials from the SDA, NDA, or WTF were retrieved, it would be inadvisable and almost certainly unacceptable to regulators for any of it to return into the area from which it came.

- The notion of being able to separately exhume the high risk radionuclides may be possible, but it may not be practical, depending on specific waste inventories. For example, some radionuclides have enough of a specific radiation signature that it might be possible to detect them in a soil conveyor system appropriately instrumented, mentioned above. Cs-137 (30 y half-life) might be detectable in this fashion. While Cs-137 and Sr-90 (29.12 y) are important from a worker risk standpoint, from an overall risk standpoint they are seldom the driver of the risk of a nuclear disposal site. Other more long-life radionuclides tend to drive the long term risk of such sites such as C-14 (5730 y half-life), Pu-238 (87.7 y) and other transuranics, I-129 (1.57×10^7 y), and Tc-99 (2.1×10^5 y half-life).
- Similarly, in addition to existing technologies at precedent projects, new and innovative technologies and adaptation of technologies, such as tunnel boring machines should be studied.