The Real Costs of Cleaning Up Nuclear Waste
Summary of Report Findings

The study evaluated two cleanup Alternatives presented in the Department of Energy's 2005 draft Draft Environmental Impact Statement (DEIS).
• Waste Excavation Alternative 1: Total exhumation of the wastes, off-site disposal, followed by complete site release for unrestricted use.
• Onsite Buried Waste Alternative 2: Partial waste removal, stabilization of buried wastes for permanent onsite disposal.

Findings and Recommendations

■ **Waste Excavation is less expensive than Buried Waste.** Over a 1000 year timeframe, Waste Excavation presents the least risk to a large population and the lowest economic social and project cost. Over 1000 years, the Waste Excavation approach costs $9.9 billion while the Onsite Buried Waste approach costs between $13 and $27 billion, depending on if a catastrophic release occurred accidentally or not.*

■ **Waste Excavation poses significantly lower risks to future generations after closure activities cease.** The Onsite Buried Waste approach poses a risk to residents long after closure activities have ended. In contrast, Waste Excavation leaves behind a contamination-free area after 73 years.

■ **The Onsite Buried Waste approach inadequately protects the health and environment of residents, and is an unrealistic cost.** It poses a risk to residents if controls fail while dangerous radionuclides are buried at West Valley.

■ Waste Excavation poses a risk to onsite workers during the relatively short period of time for remediation activities. It also does not "solve" the problem of West Valley's nuclear waste disposal, rather it prevents further contamination, prevents a catastrophic release that could cause severe damage to populations in the Great Lakes region, and mitigates the problem by transferring the waste to a less risk-prone site. (It is important, yet unfortunately beyond the scope of this analysis, to note that wastes which have left the site are not risk free. Rather, they will have to be stored somewhere else and may also pose a threat to future generations.)

■ **Based on these findings, we recommend that the Department of Energy and NYS agencies take the following actions for any new West Valley DEIS.**

• Reject current assumptions about timeframe, institutional controls and continuity, and budget requirements as presented in the 2005 DEIS due to their inability to adequately protect health and the environment as required by federal statute.

• Assume that, until shown otherwise, the safest and most economically viable option is to fully excavate the wastes buried at West Valley (Alternative 1).

• Explore other options for retrievable, monitored, above-ground storage of nuclear waste at a more stable site. In addition, the full costs of remediating West Valley must be factored in to decisions being made for new reprocessing and nuclear power.

• In the new DEIS, revisit the following topics more rigorously and with public input:
1) the probability of maintaining effective institutional controls over the expected lifetime of radioactive elements buried at the site; 2) the risk of erosion control failure with or without

the maintenance of controls; the rate of release and source of contamination should there be an erosion control failure; and 3) the potential for radioactively contaminated groundwater to move rapidly through sand layers in West Valley soils.

• In the new DEIS, revisit the following budget topics more rigorously, with public input: 1) the costs of addressing contaminated groundwater and drinking water for local populations and watersheds; 2) the costs of addressing contamination impacting Lake Erie; and 3) the economic opportunity cost of lost development ability at the site.

• Evaluate options for mitigating radioactive waste at West Valley based not only on project cost alone, but also on project and post-closure risks over the expected lifetime of radioactive elements buried at the site.

Additional Full Cost Accounting Analysis Results

1. **The Department of Energy's DEIS analysis of Alternatives 1 and 2 are unrealistic, and, more importantly, incomplete.** The DEIS uses a period of analysis far too short to reflect real costs and risks, and does not adequately address real harm risks as well as monetary costs to the public and the environment. With Waste Excavation, as soon as closure activities cease—in an estimated 73 years—the site is released to the public and there are no remaining costs. With Onsite Buried Waste, however, the site must be maintained into perpetuity. *In this case, perpetuity is not a dozen years, or even two or three generations—the buried radioactive waste would have to be monitored, tracked, and maintained in place for tens of thousands of years. Despite this basic axiom, the DEIS only allocates a skeleton budget for 200 years.*

2. **Extending the period of analysis to 1000 years, a first step in setting a period more in line with the decay times for high-risk radioactive waste (yet not nearly long enough for some of the most dangerous radionuclides), reveals that the long-term site maintenance costs are burdensome and expensive.**

3. **The total costs of this analysis must be taken as a whole, undiscounted cost.** In standard capital investments, a discount rate is applied to account for future interest earnings. Over periods of 1000 years, any substantial discount rate implies that the health and wellbeing of future generations has no present value (i.e. no worth to us today). Since the plans being considered are ostensibly meant to protect the public for many generations, we cannot reasonably assume that there is no value to public heath in the year 1000. Therefore, the discount rate must be zero, or near zero. While the choice of a discount rate for short term decisions is an economic question, the choice of an intergenerational discount rate is a matter of ethics and policy. The value of future lives and health is a strong argument for not using an economic discount rate in this analysis. **However, if standard federal Office of Management and Budget discount rates (3% and 7%) are employed, Alternatives 1 and 2 cannot be said to be significantly different from an economic standpoint.**

4. **As a practical necessity, we are compelled to use a precautionary approach at West Valley**. We cannot know the costs which may occur if wastes are left buried at West Valley, but we do know if a release occurred, it would have expensive and disastrous consequences. The costs of exhuming radioactive contamination will be expensive in the short-term, but the costs of maintaining buried waste in an attempt to thwart future disaster will be far more expensive and far less certain. In a precautionary sense, we should

excavate and move the wastes while we still know what is in the ground, how to handle it, and have some chain of responsibility still available.

5. **We adjusted the underlying budget assumptions and included enhanced erosion controls in Alternatives 1 and 2 to bring balance to their relative long term risks,** calling the new options Waste Excavation Alternative 1A and Buried Waste Alternative 2A. We considered that: 1) erosion would need to be kept rigorously under control at the site; 2) security would need to be held at a relatively rigorous level to ensure intruders could not access wastes; 3) a spreading plume of contaminated groundwater would have to be remediated to prevent contaminants from entering the local watershed; and 4) the inevitable and powerful forces of time and erosion could eventually expose wastes catastrophically, leading to high costs of remediation for water consumers.

(Excerpts from Executive Summary of ***The Real Costs of Cleaning Up Nuclear Waste)***

*Under the assumptions of a non-discounted future. This does not include all the societal costs due to resources or lack of data.

Valuing the Future:
The Viability of Institutional Controls Over 1,000 Years

The report investigated the risks of losing institutional controls for the Onsite Buried Waste approach and examined issues surrounding very long periods of time: continuity of governments, language, ethical issues with leaving an enormous hazard to future generations and valuing future costs.

Institutional Controls Unreliable Over the Long-Term

Wastes that would be left at the site are extremely long-lived. For example, one of the longest lasting radionuclides, thorium-232, has a half-life of 14 billion years. If the buried waste is left at West Valley, government would need to monitor the waste for thousands of years; such monitoring and control activities are called institutional controls. However, controls are not foolproof and have failed at many sites resulting in the need for additional remediation. Controls failed multiple times at West Valley, including the overflowing trenches in the State Disposal Area. *These incidents are not unique to the site and such failures speak to the unreliability of controls as a long term strategy for preventing harm to people.* Understanding that there is no guaranteed place or technology to truly isolate long-lasting radioactive waste, these failures suggest that the real solution is to first minimize additional production of nuclear waste from atomic power, weapons and the nuclear fuel chain.

1,000 Year Continuity in Government and Language Improbable

Maintaining institutional controls at a nuclear waste site first requires a continuity of government and language. *A fundamental obstacle to maintenance of institutional controls is the improbability of thousand-year continuity in either government or language.* A thousand years is a long time for any government to endure, let alone institutional controls at a particular waste site. It is of course impossible to look forward in time and see the world of 3008; as an alternative, we can look the other way, at the world of a thousand years ago. In 1008, Vikings were attacking England; the Norman Conquest was still decades away. Of the governments and nations that exist today, only Iceland has an unbroken lineage spanning the last thousand years. If the government of any country (other than Iceland) had made a commitment in 1008 to protect an important site for a thousand years, there is no guarantee that anyone would still know about that commitment today.

A thousand years is also a long time in the history of language—long enough for a language to change beyond recognition. While something called the English language has existed for centuries, it changes fast enough so that modern readers cannot understand words written a thousand years ago. The English literature classic that dates back a thousand years, *Beowulf*, is no longer readable, and has to be translated into modern English in order for anyone but a few specialists to understand it. A warning from the author of *Beowulf* written in the English of roughly 1000 years ago would be incomprehensible to all but a handful of experts today. In 3008, when the English of this report is as ancient as the language of *Beowulf* is today, will casual readers and potential intruders on a waste site be able to read our warning signs? There is no reason to assume that the Department of Energy could adequately address safety and communication issues at West Valley for the Onsite Buried Waste option.

Protecting Rights of Future Generations

One of the best-known authors to address nuclear waste issues is Kristin Shrader-Frechette, a University of Notre Dame scientist who argues that burial of nuclear waste in repositories is mistaken, both because of the scientific uncertainty in predictions of geological events over the millennia, and because waste burial compromises the rights of future generations to equal treatment and free, informed consent. She calls for using monitored, above-ground waste storage so that future generations can make their own decisions and apply new technologies to the problem without facing additional risks from unretrievable buried waste disposal. Every generation should have the right to equal treatment and to give or withhold informed consent to avoidable hazards. *No generation has the right to impose its hazards on those who come later. These principles, rather than cost calculations, should determine our choices about nuclear waste.*

Ethical Policy Requires Zero Discounting Over 1,000 Years

Economists discount future costs and benefits, expressing them in present value terms—a process that is nothing more than compound interest in reverse. For instance, at a 3 percent discount rate, $103 next year has a present value of $100 today, because $100 is the amount one would have to put in the bank today at 3 percent interest, in order to end up with $103 next year.* For short- and medium-term private financial decisions, discounting is essential. For intergenerational public policy decisions, the case for discounting is much less compelling. Rather than any individual weighing complete costs against complete benefits, nuclear waste policy consists of choices about what this generation will or will not do for those who will come later. *That is, the choice of an intergenerational discount rate is a matter of ethics and policy, not a market determined economic decision.*

Fairness requires that all generations be treated as equally important. *This means that the discount rate that would apply if all generations had equal resources must be very zero, or close to zero.* Indeed, in 2001, the DOE in a *Report to Congress on Long-Term Stewardship* recommended that discounting should not be used when calculating future site maintenance costs for federal nuclear waste sites. The same conclusion—the discount rate for a 1,000-year analysis must be zero—can be reached by a different argument. The existence of regulatory requirements for protection of sites that will remain dangerous for 1,000 years must imply that we care today about health hazards that will be experienced in 3008. Costs and benefits incurred in that distant year must have a significant present value; otherwise, we could ignore them and we could “prove” via discounting that it is not cost-effective to spend anything today on our successors a thousand years down the road. At a discount rate of 1.4 percent, considered implausibly low by many conventional economists, $1 million in 3008 has a present value of $1 today. Thus it would not be worth spending more than $1 today to prevent $1 million of harm in 3008. To validate the commonsense idea that outcomes in 3008 matter today, the discount rate must be no more than a few tenths of a percent per year or zero. *If we care about the long-term impacts of today’s nuclear waste, stretching across much more than a 1,000 years, then the only supportable discount rate is zero.*

(Excerpts from Section 5 of ***The Real Costs of Cleaning Up Nuclear Waste)***

*This example, like the entire discussion of discounting in the report, assumes the use of inflation-adjusted, or constant-dollar, amounts.

Drinking Water Costs & Public Health Impacts

The study evaluated the following public health and social costs and impacts: treating contaminated drinking water, lost land revenues and radiation doses and cancer deaths.

Drinking Water Costs

The site poses a significant danger to people who live along Buttermilk and Cattaraugus Creek, the residents of Buffalo and the large population along the shores of Lakes Erie and Ontario. These populations are endangered by the risk of a radionuclide leak. We estimated water replacement costs if there were a catastrophic release of radionuclides approximately 500 years from the time of closure expected in the Onsite Buried Waste option. The costs are substantial in the first year—at over $272.7 million dollars—and then decline to $27.5 million per year to maintain the Buffalo and Erie County Water Authority's water treatment plants. This is only a case example, and does not include a substantial population along Lakes Erie and Ontario who could also be impacted.

Exposures to Radioactive Pollution and Projected Cancer Deaths

We evaluated the public's exposure to West Valley radionuclides from both a rapid leak and a continuous leak scenario. We found that the radioactive waste buried at the site poses an unacceptable risk to the populations in the surrounding area, including those that draw their water from Lake Erie. Potential radiation doses from various exposure pathways could lead to enormous doses and illnesses. The doses to people living downstream and those drinking contaminated surface water will exceed standards, leading to adverse health effects as well as unnecessary deaths from cancer. Leaving these wastes in the ground presents a significant burden and public health threat to future generations as the waste will be radioactive for thousands to millions of years.

Scenario 1: Over 800,000 Lake Erie Water Users Exposed to Substantial Radiation

If just one percent (1%) of radioactivity leaked from the site in a particular year, we calculated that a large population of over 800,000 Lake Erie water users would be exposed to substantial radiation, and that people downstream along the Buttermilk and Cattaraugus Creeks would be exposed to doses well in excess of federal and state standards.

Scenario 2: One Plant's Polluted Water Could Result in 334 Cancer Deaths

If just 1% of the radioactivity leaks, starting in year 100 to 1,000 years into the future, it is expected that 400,000 people receiving Lake Erie water from the Sturgeon Point Water Treatment Plant would be exposed to up to 334,320 person-rems,* resulting in the cancer deaths of up to 334 people. *This means that from 100 to 1,000 years into the future it is expected that up to 334 of the people receiving their water from one Treatment Plant are expected to die of cancer as a result of their exposure to contaminated water from Lake Erie.* The number of cancer fatalities would be greater if it included the entire population in the United States and Canada which receive their drinking water from Lake Erie, although it would be spread throughout a larger total population.

Lost Land Revenues

As long as people are restricted from utilizing the land at the site, there will be lost land revenues. As a highly conservative hypothetical estimate, we assume that if the fully remediated land were used for agricultural purposes, it could bring in $130,000 a year, which would be lost if the site is not cleaned up to allow such use.

(Excerpts from Section 4 of ***The Real Costs of Cleaning Up Nuclear Waste)***

*“Person-rem” is a measurement of the collective dose in rems that a specific population is exposed to over a certain time period. The person-rem units represent the average dose per person times the number of people exposed. Doses are presented in units of rem or millirem (1 rem is equivalent to 1,000 mrem).

Severe Erosion Problems at West Valley Site

The report found that erosion is a powerful and fast moving force at the West Valley site. West Valley sits on a geologically young landscape which is undergoing a relatively rapid rate of erosion. Within the next few hundred years, erosion is estimated to create damaging gullies. **This region could expect to have hundreds of new gullies form with erosion removing the plateau surface in the next few thousand years.** Wastes that would be left at the site are extremely long-lived and radioactive for thousands to millions of years. It is easy to imagine that if erosion is uncontrolled, gullies will penetrate a buried waste area.

<u>Predicted Erosion Breaches Buried Waste Areas</u>
Unless erosion and other institutional controls are rigorously maintained, we predict that the disposal areas could be breached in less than 1000 years and as quickly as 150 years from now without any controls in place. This breach would be a catastrophic failure, leaking high concentrations of radioactive waste into the watershed and then quickly into Lake Erie. Since severe erosion problems are estimated to occur at the site within hundreds of years, clearly, the long-term disposal of buried waste at the site is not an environmentally sound approach. Currently, there is a large plume of contaminated groundwater moving towards Buttermilk Creek. However, even more worrisome for the downstream population and the priceless resource of the Great Lakes is the potential for streams near the site to undercut or expose buried wastes. The following is a summary of the erosion problems that were investigated in the report.

<u>Estimated 500 Gullies in 10,000 Years</u>
There are approximately an estimated 64 gullies and streams per square mile in this region. Over the roughly 15,000 year period that this landscape has evolved, we estimate that the density of gullies doubles every 3,000 years. This region could expect to have over 500 new gullies, or stream splits, form in the next 10,000 years. It is easy to imagine that if erosion is uncontrolled, at least one of these gullies will penetrate a buried waste area. In fact, it will take far fewer than 500 gullies and far less time for the entire plateau surface to erode.

<u>20 % of Plateau Surface Estimated to Erode in 10,000 Years</u>
Using a bench-scale (30 x 50 ft) experiment as a model for the evolution of the site landscape, we estimated that within 10,000 years, 20% of the plateau surfaces that are un-gullied today will have eroded away across the lower Buttermilk watershed. There are various reasons why this is a conservative rate. First, Buttermilk Creek tributary gullies drop more rapidly and over more waterfalls than in the bench-scale model which lead to faster erosion rates in reality. Deforestation and impervious surface runoff increase erosion rates, and we expect climate change to result in more severe storm events, when the most severe erosion occurs.

<u>Erosion Will Create Damaging Gullies Within a Few Hundred Years</u>
A 1993 document concluded from 35 years of repetitive air photos that the head cut on Franks Creek advanced an average of 7.5 feet per year and on Erdman Brook advanced 10.5 feet per year. From these rates, we would expect that within several hundred years, this erosion will have opened new areas on the adjacent plateaus to damaging gullies. *At the rate of plateau-edge removal anticipated for Franks Creek, we*

might anticipate a breach of the northeast edge of the state-licensed disposal area in less than 400 years due to side-cutting alone. In addition, there are concerns about landslides and a Buttermilk side-slope retreat.

Worse Case Scenarios Result in Contaminated Public Water Supplies
Landslides, gullies, and stream cuts all put the West Valley site at high risk of erosional failure. There is a significant probability that at some point in the future while the radioactive waste still poses a threat, controls will fail, or an unforeseen major storm and flooding will result in a serious failure. Erosion controls typically have short life spans of 10 to 25 years. Many of the erosion controls proposed have short design lives, raising the question: Can we count on a system design so sound and repairs made so frequently that the dangerous contaminated waste at the site is never released?

There is a tremendous risk of erosion penetrating the buried wastes at the West Valley site. A major concern with the Onsite Buried Waste cleanup option is the potential for waste to be released and impact water supplies. We looked at two worse case scenarios resulting in the leaching of contaminants into public water supplies.

Scenario 1: Expanding desiccation allows escape or exchange of trench water leachate into Erdman Brook or Franks Creek. Then contaminated liquid and sediment migrate to Buttermilk and Cattaraugus Creek stream bed and point bars, and are also taken up by the food chain. Lastly, a 10 or 100 year storm event flushes the system, including gullies and desiccation cracks. The timeframe could be less than a century.

Scenario 2: After centuries, trenches containing contaminated leachate are exposed by a landslide. This sudden exposure of the end of a trench will allow a release of fluid waste contents, in addition to the processes described in Scenario 1. Because of the need to have conditions that promote landslides, this scenario may occur in centuries.

Preventing erosion and landslides at West Valley will be difficult, if not impossible, over the long term. Over a period of years to decades, erosion controls can be ineffective under design conditions—and if the system maintenance is neglected, or if a rare extreme flood occurs, mechanisms can become ineffective quickly. For example, levees along rivers are not designed to allow floodwaters into towns, and yet this is a regular occurrence throughout the Midwest. *The probability that institutional controls, memory, and budgets will remain effectively in place throughout the next millennium is highly unlikely, and therefore we should be concerned about any plan to try to maintain critical control features if buried wastes remain at West Valley.*

(Excerpts from Section 6 of ***The Real Costs of Cleaning Up Nuclear Waste)***