PHASE 1 EXHUMATION STUDY PLAN

Revision 2

WEST VALLEY DEMONSTRATION PROJECT AND
WESTERN NEW YORK NUCLEAR SERVICE CENTER

Prepared for:

United States Department of Energy and
New York State Energy Research and Development Authority

Prepared By:

WVDP EXHUMATION WORKING GROUP
Enviro Compliance Solutions, Inc. (ECS)
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Acronyms & Abbreviations

DQO	Data Quality Objective
DOE	United States Department of Energy
ECS	Enviro Compliance Solutions, Inc.
EPA	United States Environmental Protection Agency
EXWG	West Valley Exhumation Working Group
FEIS	Final Environmental Impact Statement
GIS	Geographic Information System
GPS	Global Positioning System
HLW	High Level Waste
IAEA	International Atomic Energy Agency
NDA	NRC Licensed Disposal Area
NRC	United States Nuclear Regulatory Commission
NYSERDA	New York State Energy Research and Development Authority
QA/QC	Quality Assurance/Quality Control
SDA	State Licensed Disposal Area
SME	Subject Matter Expert
SOW	Statement of Work
TIP	Task Implementation Plan
WNYNSC	Western New York Nuclear Service Center
WTF	Waste Tank Farm
WVDP	West Valley Demonstration Project

I. Summary-Level Study Plan

Enviro Compliance Solutions, Inc. (ECS) and the West Valley Exhumation Working Group (EXWG) have prepared this Study Plan to describe the recommended exhumation-related studies to be performed as part of the Phase 1 Studies at the West Valley Demonstration Project (WVDP) and Western New York Nuclear Service Center (WNYNSC). The Plan presents the purpose, scope, estimated level of effort, and schedule for the studies, which the EXWG has prioritized for the following three reasons: (1) they carry a high likelihood of success toward the goal of an increased understanding of published waste inventories; (2) the derived information will support time-critical decisions by the agencies regarding full and selective exhumation scenarios, which in turn will help scope later studies by the EXWG and other Phase I study groups; and (3) they are not dependent on the strategies and future results of parallel studies being performed by others.

The EXWG had previously prepared and submitted recommendations for Phase 1 exhumation studies to the United States Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA), the joint sponsoring agencies for the studies (ECS, 2013). Based on review comments received from the agencies, the Independent Scientific Panel (ISP), and the public, and upon further evaluation by the EXWG, certain refinements were made to the three originally recommended studies. The revisions made to the earlier recommendations prior to the preparation of this Study Plan are summarized in Exhibit I-1.

Exhibit I-1: Summary of Revisions to Recommended Studies

Study	Original Recommended Tasks	Recent Revisions
1	▪ Update Radionuclide Inventories ▪ Process and Apply Inventory Data	▪ Add comparison of previous inventory estimates in response to citizen concerns
2	▪ Statistical Evaluation of Inventory Source Data ▪ Review of Previous Radiological and Geophysical Surveys ▪ Review of Potential Field Investigation Methods	▪ Eliminate statistical evaluation of source data due to lack of defensible basis for assigning probability distributions to data derived from historical records ▪ Change emphasis of previous survey review to better support proposed field studies ▪ Add a statistically-based field investigation as part of these initial studies to accelerate the overall Phase 1 study schedule.
3	▪ Review of Precedent Projects at Other Sites	▪ Take advantage of the experience of the SMEs by considering exhumation approaches applicable to West Valley that have no precedent at other sites, and conceptualize a series of the most relevant approaches from the information gathered to help guide future Phase I studies and Agency decisions.

Based on comments received from the ISP and further evaluation by the EXWG, it was concluded that any attempt to substantiate the reliability and utility of the current waste inventory should focus on new field confirmation studies rather than continued analysis of historic information. The EXWG is, therefore, now proposing targeted field studies as part of this initial phase of work rather than limiting the scope to an evaluation of potential field investigation methods. This change will accelerate the collection of critical information on the

waste inventory, particularly in the State Disposal Area (SDA) and the NRC Disposal Area (NDA), thus allowing time in the future for any necessary follow-on studies. An Environmental Statistician (Doug Splitstone) was added as a Subject Matter Expert (SME) to the EXWG in order to enhance the statistical validity of planned field studies. The proposed enhancement to Study 3 reflects the unique features of the waste units at West Valley, particularly as related to the Waste Tank Farm (WTF) and to a lesser extent the NDA, which may not have a precedent at sites with conditions similar to those at West Valley.

This Study Plan presents details of the recommended exhumation studies, including the revisions cited above, which are planned to be implemented over an approximate 17-month period to accommodate field studies in the summer of 2016 that will require an extensive lead time for the development and approval of necessary radiation protection, health and safety, and quality assurance plans. This Study Plan is complete in terms of the overall scope of work expected to be performed, but is not intended to provide a level of detail that would allow immediate execution of the planned work upon Agency Notice to Proceed. A series of Task Implementation Plans (TIPs) will be prepared in the future to provide more detailed operational approaches for certain components of work.

The Study Plan is organized in four sections. Section I (this section) provides an introduction and states the purpose of the studies. This section also summarizes necessary resources, reporting, deliverables, estimated level of effort, and milestones for the combined studies. Section II presents details of Study 1, which focuses on an updating of the waste inventories and the initial application of the inventories to selective exhumation scenarios. Section III presents details of Study 2, which entails the planned field studies to help substantiate that the inventories have sufficient utility to support decision-making, particularly as regards selective exhumation scenarios. Section IV presents details of an initial evaluation of potential methods for waste exhumation, handling, and disposal that have been shown through completed efforts at other sites to be more cost-effective and equally protective when compared to those methods evaluated in the Final Environmental Impact Statement (FEIS, DOE/NYSERDA, 2010).

A. Purpose of Collective Studies

The FEIS presented exhumation alternatives for the SDA, NDA, and WTF, along with predictions of future conditions under each alternative. The exhumation alternatives considered in the FEIS were limited to sitewide removal and sitewide leave-in-place. DOE and NYSERDA differed in their views of the conclusions of the FEIS exhumation analysis and the uncertainty thereof. The purpose of the collective Phase 1 exhumation studies is to enable improved forecasts of future exhumation alternatives at the WVDP and WNYNSC, to evaluate and potentially reduce the associated uncertainty, and to assist the agencies in reaching consensus on those waste exhumation alternatives eventually selected for final analysis.

In planning the Phase I exhumation studies, the agencies indicated a need for the EXWG to also address yet-to-be-defined selective (partial) exhumation scenarios. Recognizing that the reliability of the current waste inventory is of central importance to the development and evaluation of any selective exhumation scenario, the EXWG has focused its initial studies on the following objectives: updating the inventory; projecting the inventory estimates into the future; conducting additional characterization to determine whether the inventory can be confirmed with field measurements; and

providing information about specific locations, radionuclide activities, and volumes of materials that may be exhumed under various selective exhumation scenarios. The same information would also help refine the full exhumation alternative.

B. Data Quality Objectives

The development of the technical approach for the studies followed the U.S. Environmental Protection Agency (EPA) data quality objectives (DQO) process (EPA 2006), as appropriate. The DQO process provides a useful mechanism for specifying technical objectives on which to base the scope of the proposed studies, and involves the following seven steps:

1. ***State the Problem:*** Describe the problem(s) to be studied.
2. ***Identify the Goals:*** Identify the questions the study will attempt to resolve.
3. ***Identify Information Needed:*** Identify data inputs required to answer the study questions.
4. ***Define the Study Boundaries:*** Establish the spatial and temporal boundaries of the problem(s), as well as boundaries on data collection, as appropriate.
5. ***Develop the Analytic Approach:*** Identify the decision logic that will be used to meet study goals.
6. ***Specify Performance or Acceptance Criteria:*** Define the allowable variability related to sample collection, parameter measurement, etc.
7. ***Develop the Plan for Obtaining Data:*** Define the program for the collection of the identified data.

Not all DQO steps will apply equally to each of the proposed studies. For example, the control of data quality in Study 1 is inherently constrained by how well the current inventory satisfies the acceptance criteria, which is unknown at this point in time. Study 2 is meant to address inventory uncertainty, and is inherently more quantitative in nature and better lends itself to the DQO process. Study 3 relies on expert judgment for interpretation of how work at other sites can be transferred to conditions at the SDA, NDA, and WTF. DQOs are more difficult to apply to Study 3 because the study is not based on measurements.

In the case of the exhumation studies, the problems to be studied (Step 1) and the questions to be resolved (Step 2) must necessarily be formulated in light of a series of seven topical questions previously prepared by the agencies to help the EXWG focus on those areas for which further analysis may facilitate interagency consensus related to exhumation alternatives. Five of the seven topical questions will be directly addressed by the three studies proposed herein. These include:

Question 1: Can the long-lived inventory in the SDA, NDA, and WTF be somehow selectively removed to reduce the time that these facilities will pose a hazard? If so, at what cost?

Question 2: If the long-lived inventory cannot be selectively removed from the disposal areas, can the waste be "mined" out of the SDA and NDA while leaving a majority of the surrounding soil in place? If so, at what cost?

Question 3: If the long-lived inventory cannot be selectively removed from the tanks, could portions of the tanks be removed while leaving surrounding tank material, or just the vaults, in place? If so, at what cost?

Question 4: Are the robust facilities shown in the FEIS for conducting tank and disposal area removals necessary, or can removals be done using less robust, yet still protective methods, at lower cost?

Question 6: With respect to each of these questions, what are the uncertainties associated with estimations of changes in source term and cost given currently available information? Would additional studies likely better quantify and/or reduce these uncertainties? If so, what are these additional studies?

In order to better focus the proposed studies, the five broad topical questions and the corresponding problems to be studied were transitioned into a series of more specific questions aligned with the corresponding waste removal alternatives and/or waste areas. These refined questions represent Step 2 of the DQO process, and are addressed in later sections of this Study Plan within the context of the specific studies designed to resolve the respective questions.

The other two topical questions not directly addressed by the proposed initial set of studies include the following:

Question 5: Would answers to any of the above questions change if we waited for 30, 60, 90, or 120 years before undertaking the action? For example, could the action go from a remote action to a contact-handled action?

Question 7: Are there exhumation uncertainties or data needs that can be addressed only through a pilot exhumation? Would such a pilot exhumation action be feasible and reasonable considering health and safety, worker exposure, waste generation, and cost? Given these considerations, what would be the costs/benefits of a pilot exhumation?

Study 1 will provide baseline information for future application to Question 5 by projecting the makeup of the inventories at the four future timeframes of interest. Beyond that, studies corresponding to these two topical questions will be more effectively addressed and scoped once specific exhumation alternatives are at least preliminarily identified. This is particularly the case for selective exhumation scenarios. The full exhumation alternative is already sufficiently defined to address these two questions; however, there is value to be gained by a more integrated approach across all exhumation scenarios once the proposed initial studies are completed and future exhumation studies targeting specific scenarios are planned.

The same need for a preliminary identification of exhumation scenarios is also true for that portion of Questions 1-4 pertaining to the estimated costs. Conceptual-level estimates of expected costs of implementation will be initially developed following the preliminary development of specific exhumation approaches to help guide the agencies in their decision process. The cost estimates will then be refined as new information is collected and decisions are advanced; therefore, final cost estimates for the selected exhumation scenarios will likely be the last work product completed by the EXWG.

C. Project Management Approach

The Phase I studies will be performed by the Subject Matter Experts (SMEs) comprising the EXWG under the management of the ECS Study Area Manager. Because most of the work will be office-based and the SMEs are not co-located, the day-to-day activities will be performed remotely with coordination of the work efforts through weekly conference calls and periodic face-to-face meetings. Overall coordination of the individual work activities into an appropriately integrated series of studies will be the responsibility of the ECS Study Manager.

The field investigation phase of the project will involve a Site Project Manager, who will be on site to assist the ECS Study Area Manager by coordinating day-to-day activities at the WVDP and WNYNSC. The Site Project Manager will act as a central point of contact for communications with the agencies, and will be responsible for field logistics, scheduling, training, activity-specific security, arranging for site access, and other day-to-day needs that arise in the course of the field studies. The Site Project Manager will also support the preparation and field execution of the required plans, as well as direct subcontracting arrangements for equipment and operators that will be required to support field studies.

D. Collective Resource Pool

Resources that will be employed to execute the proposed exhumation studies will include the following, as appropriate for specific tasks:

- EXWG Subject Matter Experts
- ECS[1] Personnel
  - Study Area Manager
  - Site Project Manager
  - Field and Office Support Personnel
- NYSERDA and DOE Management and Technical Staff
- Subcontracted Services (e.g., Drilling, Geophysics, Surveying, and Analytical Services)

E. Routine Reporting

Routine reporting will include weekly progress updates and monthly technical progress reports with budget and schedule status. Bi-weekly conference calls will also be held with NYSERDA and DOE to address project status and any items that require a decision or action by the two agencies. During the course of field activities, any safety incidents or observations of unusual or suspicious conditions or activities will be immediately reported to the appropriate WVDP and WNYNSC management personnel.

F. Project Deliverables

Deliverables will include: (1) Technical Implementation Plans (TIPs) to be prepared as individual work elements are authorized by the agencies; (2) Technical Memoranda to document interim findings on specific study topics as proposed herein or as requested by the agencies: and (3) draft and final reports on the overall study results for each of

[1] ECS is the Phase 1 Studies Contractor retained jointly by DOE and NYSERDA.

the three major studies upon completion of all tasks. Specific deliverables for each of the three studies are described further in Sections II-IV.

G. Overall EWG Study Resource Needs and Level of Effort

Exhibit I-2 presents a summary-level estimate of the level-of-effort for the three proposed studies. The estimated resources and level-of-effort apply only to the SMEs and ECS personnel identified in Section C above. Labor associated with subcontracted work will be incorporated into competitively bid fixed prices or unit rates and will not be tracked as labor hours. The estimates reported in Exhibit I-2 will be updated as TIPs are prepared and expected field durations are clarified through the competitive bids received from subcontractors.

Exhibit I-2: Estimated Level of Effort (Man-Hours) by Major Study

Study No.	Study Description	Study Area Manager	SMEs	Field PM	Field Tech Support	Admin Support	TOTAL
1	Waste Inventory Analysis	24	512	--	--	24	**560**
2	Evaluation of Waste Inventory Utility	224	968	490	900	120	**2,702**
3	Identification of Potential Exhumation Scenarios	60	540	--	--	40	**640**
1-3	Project Management	400	--	--	--	80	**480**
TOTAL		**708**	**2,020**	**490**	**900**	**264**	**4,382**

H. Milestones

The proposed studies are expected to be completed in 17 months following Notice to Proceed from DOE and NYSERDA. The overall duration is dependent primarily on the field studies to be performed under Study 2, which are planned to be split between the 2015 and 2016 field seasons to accommodate a lengthy planning process for the intrusive boring work. Studies 1 and 3 are to be completed in 2015 except for any future revisions due to the Study 2 findings. The schedule is also dependent on agency authorization, access restrictions, logistical factors, changes to the plan resulting from progressive study findings, and weather delays. The project schedule will be updated on a monthly basis as part of the project status reports.

II. Study 1 – Waste Inventory: Analysis and Application

A. Purpose

The purpose of Study 1 is to:

- Respond to concerns raised during the November 2013 Quarterly Public Meeting regarding the selection of the inventory for use in the Phase 1 studies and how that inventory compares to other previous inventory estimates.
- Update the radionuclide inventories for the NDA, SDA, and WTF to account for radiological decay and build up, and to account for any waste processing that may have occurred at the WTF subsequent to inventory development.
- Support future Phase 1 studies by the EXWG and pending decisions by DOE and NYSERDA related to selective waste exhumation scenarios by providing information about specific locations, radionuclide activities, and volumes of materials that may be exhumed under various scenarios.

B. Data Quality Objectives

The results of Study 1 will only be as reliable as the current inventories upon which the study is based. The reliability of the inventories is not known at this time and is being investigated under Study 2. As such, quantitative acceptance criteria normally defined under the DQO process cannot be established for Study 1. The study objectives can still be met, however, given the nature of the key questions being addressed. In particular, the results of Study 1 will provide critical information to the agencies in support of pending decisions regarding the efficacy of selective waste exhumation and what scenarios should be carried forward through the Phase 1 Study process and considered by the agencies in the context of their Phase 2 decision process. Once the procedures and protocols for Study 1 have been established, and Study 2 results begin to shed more light on whether an independent confirmation of the inventory can be made with field investigation, appropriate corrections can be made to the Study 1 findings that may or may not impact the agency decision-making process.

1. Step 1: Define the Study Problem

The fundamental problem to be studied is to determine what reduction in waste volume, activity, or other parameter of interest would be achieved under a variety of selective exhumation scenarios being considered by the agencies. Together with the results of Study 2, the information will support future decisions related to long-term risk, engineering and radiological controls, and waste exhumation and disposal costs.

Topical Questions Addressed in Study 1

Question 1: *Can the long-lived inventory in the SDA, NDA, and WTF be somehow selectively removed to reduce the time that these facilities will pose a hazard?*

Question 6: *With respect to each of these questions, what are the uncertainties associated with estimations of changes in source term and cost given currently available information? Would additional studies likely better quantify and/or reduce these uncertainties?*

2. Step 2: Identify the Goals

- Determine the degree to which previously derived estimates of the waste inventories are consistent with the current inventories selected for use in the Phase I Study process, and evaluate what the source of any significant observed differences may be.
- Account for radiological decay by updating the published inventories to better reflect site conditions at the expected time of remedial action and further into the future.
- Determine, based on current inventories, what benefit would be gained by selectively removing only certain portions of the waste units.

3. Step 3: Identify Information Needed

- Results of a critical comparative evaluation of the basis and robustness of previously derived estimates of the waste inventories against the current inventories selected for use in the Phase I Studies.
- Computational results that update the inventories to account for natural radioactive decay and build-up. In the case of the WTF, the inventory update will also account for waste processing performed at the waste tanks since the development of the most recent waste inventory.
- Results of a mathematical formulation that addresses in a progressive, stepwise manner how much of an exhumation target (e.g., radiological activity) would be reduced as specific waste units are exhumed, with the objective of determining an optimum balance between the percent reduction of the targeted parameter versus the percent of total waste that would have to be removed.

4. Step 4: Define the Study Boundaries

- The spatial scale to be used for the data evaluations in most of Study 2 will be the smallest scale of individual waste units reported in the inventories. This would include 50-foot sections of waste trenches in the SDA and NDA, and individual holes or caissons in the NDA.
- Due to differing inventory structures, the comparative evaluation of inventories (Task 1.1) will be conducted at the smallest spatial scale that will allow for an 'apples vs. apples' comparison between inventories.
- Study 1 will be limited to those radionuclides deemed to be of primary significance to future exposure risks and decisions. The basis of radionuclide selection is explained in Section II.C.b.

5. Step 5: Develop the Analytic Approach

- Both qualitative and quantitative approaches will be used to complete the comparative evaluation of inventories based on comparable time periods, locations, and radionuclides.
- Radioactive decay of 58 selected radionuclides will be computed using the Bateman equation under the assumption of equilibrium between parent radionuclides and the corresponding short half-life daughters.

- The benefit to be gained under selective removal scenarios will be initially evaluated for each waste area by comparing certain parameters of interest (e.g., activity) in specific waste units to the total value of both that same parameter and the total waste volume in the corresponding waste area (i.e., SDA, NDA, or WTF).

6. Step 6: Specify Performance or Acceptance Criteria

- For the quantitative comparison of inventories, an order of magnitude (10x) difference in values was chosen as the threshold for designating outliers for further evaluation. A 10x factor is small enough to capture any true differences, but large enough so as not to be tripped by acceptable differences in calculation methods or assumptions.
- Radiological decay rates are well-established based on the direct measurement of natural decay for the radionuclides of interest; therefore, the acceptability of the updated inventory values will be fully dependent on the reliability of the baseline inventory, which is being investigated in Study 2.
- The same is true for the evaluation of selective exhumation scenarios. That is, no new measurements are being taken, and the reliability of the predicted percent reductions in targeted parameters will be dependent solely on the reliability of the baseline inventory that forms the basis of the calculations.

7. Step 7: Develop the Plan for Obtaining Data

The plan for obtaining the information (DQO Step 3) to address the study goals (DQO Step 2) consists of three major tasks, which are presented in detail in Section II.C. In summary, the following three tasks are planned:

- Task 1.1 (Section II.C.1): Evaluation of differences between each previous reported inventory and the inventory selected for use for each waste area in order to better understand the sources of any significant differences and to determine how best to use the selected inventories as the basis of the proposed Phase I studies.
- Task 1.2 (Section II.C.2): Correction of the selected baseline inventories to account for natural radiological decay for a new base year and for four other future time periods identified by the agencies (2020 plus 30 years, 60 years, 90 years, and 120 years).
- Task 1.3 (Section II.C.3): Application of the updated inventories to prioritize what waste units should be exhumed or treated to best achieve a selective exhumation target, and to quantify the percentage of the target that would be removed as additional prioritized waste units are introduced into a given selective removal scenario.

C. Tasks to Be Performed

Three distinct tasks will be performed under Study 1. The approach to these tasks, as presented in this section, has been developed to a level of detail necessary for gaining agency approval for the study based on the value to be gained versus the estimated costs and schedule. An effort will be made to evaluate the SDA, NDA, and WTF in as

consistent of a manner as possible, whether for full or selective (partial) exhumation scenarios. However, it must be remembered that differences exist between the waste areas, both in their physical features and in the amount of information that is currently available, so that some differences in the approaches will by necessity exist between the SDA, NDA, and particularly the WTF.

1. Task 1.1: Comparison of Previous Inventories

Current and former EXWG members were the primary developers of the most current waste inventories for the SDA, NDA, and WTF, as reported in the following documents:

- *"Estimated Radionuclide Inventory for the NRC-Licensed Disposal Area at the West Valley Demonstration Project"* (URS Corporation, 2000 -- Dr. Ralph Wild}
- *"SDA Radiological Characterization Report"* (URS Corporation, 2002 -- Dr. Ralph Wild)
- *"Residual Radionuclide Inventory Estimate for the Waste Tank Farm, Supplemental Report"* (WVNSCO, 2005 -- Steve Marschke)

These inventories are considered to be the most recent and robust waste inventories yet developed for the corresponding waste units, and thus were selected for use in the proposed Phase I studies. However, as indicated in Exhibit II-1 below, numerous other attempts to quantify the waste inventories of the SDA, NDA, and WTF have been completed over the last 40^{+} years. Although several of the Exhibit II-1 inventories were based on the same source (i.e., the disposal records), differences in the inventories are known to exist. Thus it is necessary to evaluate these differences and to determine how best to use the above-referenced inventories as the basis of the proposed Phase I studies.

Exhibit II-1: Previous Waste Inventories to be Used for Comparison

Inventory Report	Basis of Comparison
State Disposal Area (SDA)	
"Low Level Radioactive Waste Site Burial Inventory for the West Valley Site" (Kelleher and Michael, 1973)	Provides inventory data through December 1972, i.e., for Trenches 1 through 11. Most SDA data are provided in: Table I - Volumes Buried by Trench, including Start and Stop Dates and Waste and Excavated Volumes; and Table II - Quantities of Nuclides Buried by Trench for By-product Material (e.g., H-3, Co-60, Cs-137, Ra-226), Special Nuclear Material, and Source Material. These data will be compared to similar data provided in or extracted from URS 2002. All radionuclide data will be decay corrected to a common date prior to performing any comparisons.
"*Compilation of West Valley Solid Radioactive Waste Burial Operations*" (Duckworth, 1981)	Essentially identical to Kelleher and Michael (1973) and Envirosphere (1986) inventories; to be combined for comparative purposes.
"Ground-Water Hydrology and Subsurface Migration of Radionuclides at a Commercial Radioactive-Waste Burial Site, West Valley, Cattaraugus County, New York" (Prudic, 1986)	Leachate concentration data only; therefore, it won't be possible to compare absolute inventories. However, the Prudic data (e.g., Tables 13, 15, and 16) is considered important because it is based on actual samples taken from within the SDA, and will be used to compare the relative amounts of various radionuclides.

"*Site Characterization of the LLRW Disposal Area at West Valley, New York*" (Envirosphere, 1986)	Provides inventory data through March 1975, i.e., for Trenches 1 through 14. For the period through December 1972, essentially identical to the Kelleher and Michael (1973) inventory. Most SDA data are provided in: Table 2-2 - similar to Kelleher and Michael Table I; Table 2-3 - Trench 6 Characteristics; Table 2-5 - Major Radionuclide Inventories (e.g., H-3, Co-60, Cs-137, Ra-226, U-235, U-238); Table 2-6 - Radionuclides by Trench 6 Hole; and Table 2-7 - Special Nuclear and Source Material by Trench.
"*New York State Licensed Disposal Area Waste Characterization Report*" (WVNS, 1995)	Waste volumes (Table 3.1) and radioactivity (Attachment B) are presented for 50-foot segments for each trench, which will be compared to the similar URS 2002 estimates. WVNS inventory also presents waste distribution by class (Table 3.7), which will be compared to the URS 2002 distributions.
NRC Disposal Area (NDA)	
"Low Level Radioactive Waste Site Burial Inventory for the West Valley Site" (Kelleher and Michael, 1973)	Most NDA data for 1966 through 1972 are provided in Table III, including number of holes filled, volume, and Zr-95, Co-60, and total radioactivity. This data will be compared to similar data provided in or extracted from URS 2000.
"Information on the Confinement Capability of the Facility Disposal Area at West Valley, NY" (Nicholson and Hurt, 1985)	For a select few radionuclides (e.g., H-3, Co-60, Sr-90/Y-90, Cs-137/Ba-137m, and Pu-214), Section II provides the total inventory within the NDA, as opposed to the inventory by burial location. These data will be compared to similar data provided in or extracted from URS 2000.
"West Valley NRC Licensed Disposal Area Radionuclide and Hazardous Chemicals Inventory" (Ryan, 1992)	Provides the total inventory and the inventory by waste category (e.g., fuel, hulls, hardware, etc.) for classes of radionuclides (e.g., fission products, actinides, activation products, total Pu), but not by disposal location. These data will be compared to similar data provided in or extracted from URS 2000. It is noted that URS 2000 refers to Ryan 1992 as a source of radionuclide distributions.
"NRC Licensed Disposal Area Waste Characterization Report" (WVNS, 1993b)	Details of the derivation of the WVNS inventories are not available, and documentation of the corresponding methods and assumptions is insufficient to allow inventory calculations to be repeated or verified (URS, 2000). Nevertheless, these documents will be reviewed in order to capture the full evolution of the NDA inventory.
"NRC Licensed Disposal Area Waste Characterization Report" (WVNS, 1995)	
Waste Tank Farm (WTF) – Limited to Inventories Prepared Post-Vitrification	
"Waste Storage Tank 8D-3 Radioisotope Inventory Report" (WVNS, 2002a)	Based on agency comments on these three inventory documents and the range of factors addressed in the comments, as well as agency requests for additional clarification regarding specific technical issues, a Supplemental Report was prepared that is the source of the baseline inventory for the WTF (WVNSO, 2005). The review under Task 1.1 will: (1) summarize the inventories from WVNS, 2002a, 2002b, and 2002c; (2) document the reviewing agencies comments/concerns; and (3) show how those concerns were addressed in WVNSCO, 2005 to arrive at the current WTF inventory.
"High-Level Waste Tanks 8D-1 and 8D-2 Radionuclide Inventory Report as of September 1, 2002" (WVNS, 2002b)	
"Waste Storage Tank 8D-4 Radioisotope Inventory Report" (WVNS, 2002c)	

A qualitative comparison of the inventories will first be completed based on an evaluation of the various data sources and the sufficiency and completeness of the methods by which the data were converted to an estimate of in-ground inventories.

The three inventories proposed for use in the Phase I studies (URS 2000, URS 2002, WVNSCO 2005) will provide the baseline against which the other historical inventories will be compared, with expert judgment used to highlight the pluses and minuses of each approach.

The qualitative comparison will be followed by a quantitative evaluation of the results of each reported inventory against the baseline inventory for each waste area. Because the compartmentalization of each inventory varies to some degree, with the most recent inventory estimates more detailed than previous estimates, it will not be possible to perform a one-to-one comparison of all parameters. For example, URS 2002 presents the SDA trench inventories by 50-foot segments, whereas most of the earlier estimates did not go to that level of detail. Thus, it will not be possible to compare individual 50-foot segment estimates; rather, a comparison of estimates on a trench-by-trench basis will be performed. Similarly, URS 2000 and URS 2002 present inventories for up to 230 radionuclides, whereas the earlier references only provide inventories for a few of the most prevalent radionuclides. Only those radionuclides that appear in both the most recent and earlier estimates can be compared. As highlighted in the second column of Exhibit II-1, each earlier inventory will be examined to determine what data are amenable for comparison to data that is either available in or extractable from URS 2000, URS 2002, or WVNSCO 2005.

If any of the Exhibit II-1 inventories have radioactivity estimates that vary by more than an order of magnitude (10x) from the baseline inventories for the spatial and temporal scale of interest, an attempt will be made to identify the reasons for such a large discrepancy. An order of magnitude was chosen as the threshold because it is believed to be small enough to capture any true differences, but large enough so that small differences in calculations or assumptions will not trip the threshold.

If a greater than tenfold difference is identified, reasons for the differences will be investigated by a more thorough evaluation of the basis of the outlier inventory estimate compared to that of the most recent inventory. If the source of the difference cannot be identified, the potential impact of the difference on future EXWG studies will be described. Modifications may be made to the baseline inventories if it is deemed necessary to resolve differences. *There is no intent, however, to either extend the evaluation to the historical disposal records or to produce a new, independent inventory.*

A Technical Memorandum will be prepared upon completion of Task 1.1 to summarize the comparative findings and results. The planned evaluation is expected to resolve citizen concerns regarding inventory selection; however, if any major concerns are raised regarding the selected (baseline) inventories, these will be reported to the agencies so that an appropriate path forward can be developed.

2. Task 1.2: Update Waste Inventories to Account for Radiological Decay

The 2000 NDA and 2002 SDA inventories both use the Year 2000 as the base year. In Task 1.2, these reported inventory values will be updated using the Bateman equation for radiological decay from 2000 to a new base year more consistent with the start of any planned remedial program. DOE and NYSERDA have designated Year 2020 as a reasonable new base year. In addition, the inventories will be decay corrected for four

future time periods previously identified by the agencies in Topical Question 5 (2020 plus 30 years, 60 years, 90 years, and 120 years). These future time periods correspond to up to four half-lives for Cs-137, which contributes a high percentage of the activity from short-lived radionuclides in the inventory. The same methodology used to calculate the updated base year inventories will be used to calculate the inventory changes into the future.

For the NDA and SDA, URS 2000 and URS 2002 present estimates for 230 radionuclides, including a significant number of radionuclides with zero reported inventory values (e.g., 87 radionuclides for the SDA). However, URS 2002 indicates that over 99% of the activity is due to 17 'Principal Radionuclides.' To limit the amount of work to be performed in this task while still meeting the project objectives, the number of radionuclides to be included in the waste inventory updates will be reduced to those that are either: (1) required for Part 61 waste classification; (2) most important to public health risk from off-site releases; (3) most important to worker safety; or (4) required as part of a natural decay series.

Using these criteria, the updated inventory estimates will be calculated for 58 radionuclides, as identified in Exhibit II-2a. The selected list includes all 17 of the 'Principal Radionuclides' from the URS 2002 inventory, as well as 31 of the 33 'Primary Nuclides' analyzed in Garrick, et al, 2009. The other two primary radionuclides from the Garrick study, Pm-137 and Cm-242, will not be included in the proposed study because they are not part of a decay chain, they were not a significant term in the 2000 inventory, and they have short half-lives.

Exhibit II-2a: Radionuclides Included in the SDA and NDA Inventories

H-3 ^*	Kr-85	Pu-238 ^*	Pb-214	Ra-224	Pa-231 *
Ni-63 ^*	Cs-135 *	U-238 ^*	Bi-214	Rn-220	Ac-227 *
Cs-137 ^*	I-129 *	Th-234 ^	Po-214	Po-216	Th-227
Ba-137m ^	Am-243	Pa-234m ^	Pb-210 *	Pb-212	Pu-241 ^*
Co-60 ^*	Np-239	Pa-234	Bi-210	Bi-212	Am-241 ^*
Ni-59 ^*	Tc-99 *	U-234 *	Po-210 *	Po-212	Np-237
C-14 ^*	Cl-36	Th-230 *	Th-232 *	Tl-208	Pa-233
Fe-55 ^*	Zr-93 *	Ra-226 *	Ra-228 *	Pu-239 ^*	U-233 *
Sr-90 ^*	Nb-94 *	Rn-222	Ac-228	U-235 *	
Y-90 ^	Pu-240 *	Po-218	Th-228 *	Th-231	

^ Indicates a URS 2002 "Principal Radionuclide"
* Indicates a Garrick, et al, 2009 "Primary Nuclide"

The 2005 WTF inventory was also based on conditions in the Year 2000. This inventory was developed only for the 18 radionuclides determined to be important with respect to conducting the WVDP Performance Assessment. The revised 2020 base inventory and the projected future inventories will include these same 18 radionuclides, as identified in Exhibit II-2b. The 18 WTF radionuclides differ somewhat from the 17 URS 2002 'Principal Radionuclides,' primarily because the WTF does not contain activation products that do not carry over into high level waste (HLW).

As appropriate, the results of the 2011 Tank 8D-4 liquids and solids characterization work will be used to adjust the WTF inventory. There has been no other work since 2005

that would affect the 2005 waste inventory for Tanks 8D-1, 8D-2, 8D-3, and 8D-4, including the installation of the Tank and Vault Drying System in 2010.

Exhibit II-2b: Radionuclides Included in the WTF Inventory					
C-14	I-129	U-233	Np-237	Pu-239	Am-241
Sr-90	Cs-137	U-234	U-238	Pu-240	Cm-243
Tc-99	U-232	U-235	Pu-238	Pu-241	Cm-244

3. Task 1.3: Apply Waste Inventories to Selective Removal Scenarios

In order to provide DOE and NYSERDA with supplemental information on the comparative value of various removal scenarios for the SDA and NDA, waste inventories and exhumation volumes will be evaluated for up to six selective exhumation scenarios for each waste area. Each scenario will be defined by an exhumation target (e.g., radiological activity) and an exhumation standard (e.g., 100% of Greater Than Class C [GTCC] waste, 75% of all C-14, etc.). The scenarios may or may not be the same for the two disposal areas.

The EXWG intends to work with the agencies and the probabilistic performance assessment (PPA) contractor in selecting the exhumation scenarios and corresponding targets and standards for analysis in Task 1.3. Example scenarios that have been discussed to date include exhumation of the 'long-lived' radionuclides (i.e., 10CFR 61, Table 2), exhumation of the waste disposal areas most prone to erosion or slope failure, and exhumation of those areas suspected to have the highest levels of radiation (e.g., spent fuel assemblies). Each of these scenarios, as well as any other scenarios identified by the agencies, will be investigated.

The inventory for the SDA is reported for each 50-foot segment of each disposal trench (except for Trench 6, which is a series of special disposal holes). The EXWG intends to keep this level of detail in the updated SDA inventory. Therefore, under a given selective exhumation scenario, exhumation will be assumed to occur first in the 50-foot segment with the greatest amount of the target, then in the 50-foot segment with the next highest amount of the target, and so on until the exhumation standard has been met. For each selective exhumation scenario, plots of the percentage of target removed versus the percentage of waste removed will be prepared.

Plots of the SDA showing which 50-foot segments would be preferentially exhumed to meet a given standard will also be provided. These segments will be superimposed on a plan view of the SDA (or NDA) to better depict the relative geographic positioning of the trench segments being proposed for removal, as well as whether removal of a certain segment or group of segments would address multiple exhumation targets.

For the NDA, the inventory will first be broken down into individual waste units as defined by each of the 236 disposal holes, 12 WVDP trenches, and 3 caissons, based on a spreadsheet recently prepared by Dr. Wild that is more detailed than the inventory that he presented in URS 2000. An approach similar to that used in the SDA will then be applied to determine the amount of NDA material required to be exhumed to meet the selective exhumation target and standard under each scenario. Plots similar to those described for the SDA will be provided.

The WTF will not be included in the Task 1.3 analysis. Essentially all of the WTF waste is contained within the sludge at the bottom of the tanks or within the 'bathtub ring' on the sidewall of Tank 8D-2. Therefore, the location of each of these potentially removable items is already well known, and it would not be of value to target specific radionuclides or to determine what percentage of a particular radionuclide would be selectively removed under various scenarios similar to what is being proposed for the SDA and NDA.

4. Task 1.4: Report of Findings

Due to the somewhat independent nature of the three study tasks, the intent is to prepare a Technical Memorandum upon completion of each task documenting the task-specific results. A comprehensive draft report will then be prepared from the three Technical Memorandums upon completion of all Study 1 tasks. After review of the draft report by the agencies, the EXWG will prepare a final Study 1 Report.

D. Resource Needs

Mr. Steve Marschke will be the Lead SME for the completion of Study 1. Mr. Marschke led the 2005 inventory work for the WTF, and is highly familiar with the SDA and NDA inventories. Dr. Ralph Wild, a former SME who was primarily responsible for developing the 2000 NDA and 2002 SDA inventories, will be available to the study team on an as-needed consulting basis if any special needs arise that require additional programming work to extract specific information from the inventories. Other SMEs will participate in Study 1 by checking the decay and buildup calculations associated with Task 1.2, suggesting potential selective exhumation criteria for Task 1.3, and reviewing and commenting on the reports.

DOE and NYSERDA personnel will primarily support Study 1 in the identification and prioritization of the selective removal scenarios to be evaluated in Task 1.3. There will be no special equipment or subcontracted services required for executing Study 1.

E. Estimated Level of Effort

Exhibit II-3 presents a summary estimate of labor hours to perform the scope of work described in Section II.C above.

Exhibit II-3: Estimated Level of Effort (Man-Hours) by Task for Study 1

Task No.	Task Description	Study Area Manager	SMEs	Field PM	Field Tech Support	Admin Support	TOTAL
1.1	Comparison of Previous Inventories[1]	0	160	--	--	--	**160**
1.2	Update Inventories for Rad Decay[1]	0	160	--	--	--	**160**
1.3	Apply Waste Inventories to Scenarios[1]	0	152	--	--	--	**152**
1.4	Report of Findings	24	40	--	--	24	**88**
	[1] Includes preparation of Technical Memorandums for incorporation into Final Report						
TOTAL		**24**	**512**	**--**	**--**	**24**	**560**

F. Milestones and Schedule

Key milestones (deliverables) for Study 1 are shown in Exhibit II-4 below. Based on a July, 2015 Notice to Proceed and a 30-day review of the Draft Study 1 Report by the agencies, Study 1 is expected to be completed by the end of Calendar Year 2015.

Exhibit II-4: Proposed Milestones for Study 1

Task	Milestone
1.1	Technical Memorandum: Inventory Comparison
1.2	Technical Memorandum: Inventory Update for Selected Decay Periods
1.3	Technical Memorandum: Application of Inventories to Scenarios
1.4	**Final Study 1 Report**

III. Study 2 – Correlation Study: Waste Inventories vs. Field Study Results

A. Purpose

The purpose of Study 2 is to establish an empirical statistical relationship between the existing SDA and NDA inventories and field measurements of activity. The results of the planned field studies will be used to establish this relationship and to assess the level of confidence in that relationship, thereby helping the agencies in determining the degree to which the inventory reports can be relied upon in planning and selecting exhumation scenarios and approaches. Correlated with the resultant level of confidence in the existing inventories of the SDA and the NDA will be the ability to predict approximate locations of specific types of waste or accumulations of specific radionuclides to further support full and selective exhumation planning. This information will help, for example, in advancing the knowledge and confidence in what will be exhumed under a given scenario, thereby reducing the level of conservatism required in the design of protective methods for workers and the public.

The study results will also be used to estimate the level of effort that would be required for a broader application of the study approach, and to determine if an expanded application is warranted as a follow-on Phase 1 study to improve both the empirical relationship between the existing inventories and field measurements and the degree of confidence in that relationship. It is not expected that Study 2 will be extensive enough or precise enough to affect the inventory reports described in Study 1.

B. Data Quality Objectives

The DQOs for Study 2 address the seven steps to define the type, quality, and quantity of data needed to establish an empirical relationship between the inventory and field measurements of activity and to assess its degree of confidence. Such a relationship will be useful in planning the exhumation of materials from the SDA and NDA.

It is noteworthy that the degree to which the planned studies will satisfy the study goals remains uncertain due to the potential complex interferences of the waste materials, cover materials, native clay soils, and perched water on both the geophysical and radiological responses. In addition, the calculated (modeled) radiation levels require a number of assumptions about geometry, shielding materials, and the source term. Due to these potentially complicating factors, statistical anomalies in the data may occur. The identification of statistical outliers will trigger an in depth evaluation of the data used to generate the statistical relationship.

1. Step 1: Define the Study Problem

The problem to be studied is the degree to which the current waste inventories, as developed from past disposal records, are representative of the volumes and types of wastes that are actually present in the SDA and NDA. This determination is of primary importance to the selection and analysis of selective exhumation scenarios, as well as to the evaluation of worker risk and necessary control measures. Data collected in Study 2 will also help characterize the adjacent soil and interstitial water to further support future decisions regarding exhumation scenarios.

2. Step 2: Identify the Goals

- Use radiological modeling studies and statistically-based field studies to establish an empirical statistical relationship between the existing waste inventories and field measurements.
- Apply the results to evaluate the degree of confidence one should have in the existing inventories of the SDA and the NDA in support of future decisions on exhumation scenarios, including the design requirements for worker and public protection.
- Provide additional field data to help determine if the surrounding soil is impacted to a degree that would require removal or treatment separate from or in conjunction with waste exhumation.

Topical Questions Addressed in Study 2

Question 1: *Can the long-lived inventory in the SDA, NDA, and WTF be somehow selectively removed to reduce the time that these facilities will pose a hazard?*

Question 2: *If the long-lived inventory cannot be selectively removed from the disposal areas, can the waste be "mined" out of the SDA and NDA while leaving a majority of the surrounding soil in place?*

Question 4: *Are the robust facilities shown in the FEIS for conducting tank and disposal area removals necessary, or can removals be done using less robust, yet still protective methods, at lower cost?*

Question 6: *With respect to each of these questions, what are the uncertainties associated with estimations of changes in source term and cost given currently available information? Would additional studies likely better quantify and/or reduce these uncertainties? If so, what are these additional studies?*

3. Step 3: Identify Information Needed

- Detailed inventories for the SDA and NDA, as addressed in Study 1 (Section II).
- Geophysical data to delineate site features, particularly the location of the trench boundaries and NDA waste units to accommodate a safe and effective intrusive boring program.
- Statistically-based radiological field measurements that can remotely detect differences in waste composition.
- Degree of correlation between those measurements and what would be expected based on the reported inventory for the same location, as extracted from Microshield modeling.
- Nature and extent of radiological and chemical impacts to soil and interstitial water surrounding the waste units.

4. Step 4: Define the Study Boundaries

- The spatial study boundary will be defined by the physical limits of the SDA and NDA, with a focus on areas adjacent to the trenches and other waste units.
- To optimize the radiological field measurements, planned borings will be placed as close as practical to the trenches and waste units based on the geophysical study results while ensuring that the waste units will not be penetrated.

5. Step 5: Develop the Analytic Approach

- Within the capability of current field and data reduction technologies, use geophysical methods to: (1) define the lateral boundaries of individual waste

trenches and other disposal units within the SDA and NDA; (2) define the bottom/depth of the waste trenches and other disposal units; (3) determine the elevation of the top surface of water that is known to be present within the waste trenches; and (4) identify specific segments within the waste trenches that contain either waste monoliths (e.g., large equipment) or densely-packed waste materials that would help target the field studies.

- Conduct in-situ measurements of gamma and neutron radiation within intrusive borings at pre-selected locations as near as possible to targeted trench segments or other waste units.
- Perform direct sampling and laboratory analysis of soil and water samples collected from the intrusive borings.
- Perform a statistical assessment of the degree of correspondence between field measurements and model results.

6. Step 6: Specify Performance or Acceptance Criteria

The goal in this case is to confirm that patterns of instrument response (i.e., field measurements) are consistent with the reported inventories for a number of disparate cases, not to use the measurements to characterize the actual make-up of the inventory in a given waste unit. Therefore, rather than pre-defining quantitative acceptance criteria for the field-based geophysical and radiological measurements themselves, the acceptance criteria will focus on the degree of correlation between the results obtained from field studies and what would be expected given the radionuclide inventories.

The hypothesis being investigated is that the existing inventories are a reliable representation of what is actually buried in the waste units. The results of the field studies will be compared to modeled activity results based on the inventory records, and the magnitude of false positive (Type 1) and false negative (Type II) decision errors will be established. In this case, what defines a tolerable magnitude of false positive or false negative decision errors will be addressed by the principal stakeholders (DOE and NY SERDA) as part of their Phase II decision process.

7. Step 7: Develop the Plan for Obtaining Data

The planned studies to obtain the information needed to meet the Study 2 goals are presented in detail in Section III.C below. In addition to preparation of the final report (Task 2.5), the following four major tasks will be performed:

- Task 2.1 (Section III.C.1): Evaluation of previous related work at the SDA and NDA, and coordination with the work performed under Task 1.3 of Study 1 to help determine the preferred locations of planned borings.
- Task 2.2 (Section III.C.2): Completion of a geophysical survey to contribute to the pre-investigation understanding of the waste units, including specific locations where borings can be safely and efficiently positioned close to the waste units.
- Task 2.3 (Section III.C.3): Completion of an intrusive boring program to accommodate the downhole measurement of gamma and neutron radiation.

- Task 2.4 (Section III.C.4): Application of statistical approaches to develop a defensible correlation between the field radiological measurements and the values predicted by the Microshield model based on the published inventories.

C. Tasks to Be Performed

Five tasks will be performed under Study 2, including two field programs, two data evaluation and modeling tasks, and preparation of a final report. The approach to these tasks, as presented in this Study Plan, is not at a level of detail that would allow for task execution in the field. However, this Study Plan will be supplemented by a series of detailed TIPs that will specify the task scope, indicators to be measured, investigation techniques, instruments, statistical sampling schemes, deliverables, cost estimates and schedule, and other pertinent task-specific details. A key predecessor activity to the preparation of TIPs will be the solicitation of competitive bids for the field activities, which will further refine the approach, cost, and schedule planning.

1. Task 2.1: Evaluation of Previous Surveys and Modeling

The work activities to be performed in Task 2.1 include a review of existing data, an evaluation of previous radiological and geophysical site surveys, the selection of specific locations in the SDA and NDA where borings will be installed, and the application of accepted computer models to estimate the expected strength of gamma and neutron radiations at the selected locations based on the inventories. Specific subtasks include:

- Results from previous radiation surveys completed at the West Valley site will be reviewed and compared with the current inventory as an indicator of inventory reliability. While the value gained from this review may be limited by the overall lack of instrument response at the surfaces of the waste disposal areas during past surveys (thus prompting the need for intrusive measurements in Study 2), its completion is considered necessary to ensure that all information that might support future planning is accounted for.
- The existing SDA and NDA inventories will be used to identify specific locations for borings based on the approximate depth of waste burial and the specific types of wastes reported to be buried by the inventory data. Because the field investigation (Task 2.3) is being conducted to determine whether measured radiological levels are consistent with expected waste composition, and must account for self-shielding from soil, leachate, perched water, or high-density waste materials, the desired locations will focus on those waste units (or portions thereof) with the maximum reported levels of gamma and/or neutron radiation sources. Nevertheless, it will also be important to select locations that provide a wide range of expected radiological activity so as to produce a statistically meaningful correlation.

  For completeness with respect to the study objectives, locations that contain long-lived transuranics or other types of waste are also of interest. However, long lived transuranics are easily shielded and cannot be measured in-situ, and thus will not be targeted in favor of the in-situ measurement of gamma radiation (cesium-137 and cobalt-60) and neutron radiation (irradiated fuel) that are not easily shielded. To address the long-lived transuranics, it is being assumed that any conclusions regarding inventory utility based on the targeted radiations will coincidently apply to the inventory as a whole, including the long-lived transuranics.

- A widely accepted computer model (Microshield) will be used both to predict what would be expected to be measured at different depths inside the boring based on inventory values, as well as to convert the field-measured gamma exposure rates to concentrations of selected isotopes. Neutron flux measurements will be converted using manual calculations.

Microshield Model Selection

Microshield was selected for use because other commonly applied computer programs (e.g., RESRAD) are more applicable to an extended duration, such as a full year, and include all pathways for exposure rather than calculating the radiation levels at a specific distance that is shielded by soil, the trench cover, and the waste packaging.

2. Task 2.2: Geophysical Survey

Task 2.2 will involve geophysical studies of the SDA and NDA to support both the planning of the follow-on boring program and the overall Phase I studies. The primary objective of the geophysical program is to define the lateral boundaries of individual waste trenches and other disposal units within the SDA and NDA to allow for the safe installation of intrusive borings as near as possible to the waste units. However, the geophysical methods to be utilized in the study will be selected with consideration of three additional objectives, as follows: (1) define the bottom/depth of the waste trenches and other disposal units; (2) determine the elevation of the top surface of water that is known to be present within the waste trenches; and (3) identify specific segments within the waste trenches that contain either waste monoliths (e.g., large equipment) or densely-packed waste materials that would help target later field studies.

The progression of work activities under Task 2.2 will be as follows:

- A Statement of Work and Request for Proposal will be developed to solicit and select a qualified subcontractor to perform the geophysical surveys using the most advanced field and data interpretation technologies currently available. Upon receipt, the proposals will be reviewed and a recommendation to award a contract to the preferred subcontractor will be made to DOE and NYSERDA.
- A non-intrusive geophysical investigation will be performed across both the SDA and the NDA to confirm the boundaries of each trench in the SDA and NDA, and each borehole in the NDA, as well as to

Information from Geophysics Firms

Before proposing the geophysics study as part of this Study Plan, ECS sent a Request for Information (RFI) to four firms with a specialty in geophysics to solicit their input on whether currently available geophysical technologies are capable of meeting the objectives of the planned geophysical study. The responses indicated that, even though the attributes and restrictions of the SDA and NDA make it more challenging than other sites, it is highly likely that a suitable suite of geophysical methods will provide credible and useful information about trench boundaries (sides and bottom), contents, and locations beyond what is currently available.

The methods recommended for consideration include a magnetometer survey, an electromagnetic (EM) survey, seismic refraction tomography (SRT), multi-channel analysis of surface waves (MASW), and electrical resistivity imaging (ERI). It was also recommended that a prove-out study be conducted at the site to refine the selection of methods prior to performing the full-scale study. This recommendation will be considered during future planning efforts.

address the other study objectives cited above. A suite of geophysical investigation techniques will be used in combination to provide complementary data sets to help distinguish between different types of features and to resolve expected interferences.

- More detailed geophysical information will be collected for an area about 50 feet by 50 feet surrounding each preliminary boring location. The intent is to allow the placement of borings as close to the waste boundary as feasible based on the geophysical survey results to improve the accuracy and precision of the planned radiological measurements. Based on input from geophysics firms (refer to text box), it is expected that the geophysical surveys will be able to determine the boundary location to within a few feet.
- The geophysical results will be used as a direct line of evidence regarding the reliability of the waste inventories based on the observed locations of high densities of metal objects (e.g., equipment or large numbers of drums) when compared to the inventories. The resulting information may also be used in the future to select methods of exhumation and requirements for waste processing and packaging.

3. Task 2.3: Statistically-Based Field Investigations

In Task 2.3, a statistically-designed investigation program will be conducted based on radiological measurements using instruments located in boreholes to be drilled vertically through the geomembrane cover and clay cap. The temporary borings will be installed adjacent to (but not directly into) the waste materials in accordance with the statistical design. Because there is a continuing uncertainty regarding the level of information that can be gained from the proposed sampling opportunities, the approach will be necessarily phased and conditional toward the goal of minimizing the eventual scope of planned intrusive investigations. It is currently estimated that 10 borings will be installed in the SDA and 10 borings will be installed in the NDA to achieve the study objectives. Additional borings may be recommended to enhance the reliability of the inventory if the initial sets of borings provide valuable information for reducing inventory uncertainty. The following subtasks are proposed for Task 2.3:

- A Statement of Work and Request for Proposal will be developed to solicit and select a qualified subcontractor to install the borings and to complete the downhole radiation measurements. Upon receipt, the proposals will be reviewed and a recommendation to award a contract to the preferred subcontractor will be made to DOE and NYSERDA.
- Final locations for boreholes will be selected using both the updated inventory (Task 1.2) to identify expected areas of high and low activity, and the results of Task 1.3 to give preference to those trenches most likely to be exhumed under a selective exhumation option. The design will provide for the measurement of activity variation both within and among disposal units (e.g., SDA trench sections). The exact location of the boreholes will be determined through review of the results of the geophysical survey.
- Details regarding potential waste generation and disposition as part of these study activities will be developed in consultation with the agencies as part of more detailed work implementation packages.

- Ten borings will be judiciously placed in each of the SDA and NDA to provide for reasonable estimates of activity variation corresponding to various levels of inventoried activity within disposal units. The initial number of 20 borings was chosen to provide for reasonable initial estimates of activity variation while recognizing the need to manage costs until the methods have been tested in the field. Once the magnitude of the variation within disposal units has been assessed, a better understanding of the value to be gained from additional borings will be available for planning future studies. Additional borings may then be proposed to improve the accuracy and/or precision of the relationship between field measurements of activity and that predicted from the inventories.

  Recent discussions with NYSERDA indicate a potential interest in the use of closed-end pipes that would be driven directly into the SDA waste trenches as a supplemental method to investigate the reliability of the inventory. This option requires further evaluation from both technical feasibility and worker safety standpoints. Any future decision to employ such an approach will be documented in an addendum to this Study Plan.

- Existing penetrations through the existing disposal area caps, such as sumps, will also be evaluated for their capacity to accommodate the required equipment for subsurface radiological monitoring. If appropriate, radiological measurements will be performed within these penetrations as part of the field study to establish a supplemental set of data for comparison with the adjacent inventories.

- Radiation measurements will be conducted inside each proposed boring and each existing sump (if feasible) using a gamma spectrometer to identify the presence and quantity of Cs-137, Co-60, and other significant gamma emitters. In addition, neutron radiation will be measured with a calibrated proportional detector equivalent to a boron triflouride (BF_3) or helium (^3He) detector. It is anticipated that these radiation measurement technologies, which are currently in use to log oil or gas wells, will adequately survey the borings for gamma and neutron radiations as well as the identification of specific radionuclides. Gamma and neutron radiation levels inside of the boring will be recorded at different depths along the length of the boring. Calibrated instruments using gamma spectroscopy techniques will also be used to identify radionuclides that are contributing to the gross gamma levels.

- During boring installation, soil samples will be collected every five feet once the bottom of the clay cap is reached. The soil sampling program is intended to evaluate the nature and extent of impacts. The soil sampling results from 10 borings in each of the SDA and NDA should indicate whether no problem should be anticipated (e.g., no detections are found), or whether the soil is a major concern (e.g., several samples exhibit high levels of radiological or chemical impacts) for purposes of evaluating the overall need for including soils in an exhumation scenario. However, the data will not be sufficient to conclude that hot-spots exist or to bound distinct soil areas that would require selective removal.

  The soil samples will be monitored in the field for both radiation levels using a standard radiological detector and volatile organic compound (VOC) emissions using a vapor analyzer. The soil sample from each boring with the highest radiological or

VOC level will be selected for laboratory analysis. If no detections are observed during screening, the deepest soil sample (or, if water is encountered, the soil sample collected at the water interface) from select borings will be sent for laboratory testing such that at least three soil samples are analyzed from both the SDA and the NDA. If water is encountered in any boring, a sample of the water will be collected for the same set of analytes as the soil samples.

All soil and water samples will be analyzed for radiological constituents, metals, VOCs, and semi-volatile organic compounds (SVOCs). The radiological constituents will include those that cannot be measured in situ, such as strontium-90, uranium-238 and uranium-234.

- Following completion of the field investigation at a given boring, the boring will be filled with bentonite or equivalent to prevent infiltration of surface water and limit migration of other materials or debris into the waste cells and trenches. Portions of the cover and membrane disrupted by the boring will be inspected and repaired.
- Throughout the field studies, the cover and membrane will be protected to the extent practical. The path used to travel to each desired location will be covered with plywood or other suitable materials to distribute the weight of the equipment. The shallow depth of the borings should accommodate the use of equipment that will limit any damage to the cover and the membrane, and low ground-pressure features (e.g., wide or dual tires) will be employed. The path used to travel to the boring location will also be inspected upon boring completion so as to evaluate any changes to the cover. If repairs are required, they will be implemented. Detailed precautions will be established in the appropriate TIPs.

4. Task 2.4: Statistical Data Analysis

The direct downhole measurements and calculated inventory activity will be compared using appropriate statistical techniques as suggested by the data. These techniques will assess the correlation between the two sets of values, as well as estimate the parameters (coefficients) of the statistically appropriate relationship between them. The study design will permit the characterization of the uncertainty of the field measurements and their relationship to the activities predicted from the inventory. Both the spatial and temporal sources of variation among the field measurements made within an inventory disposal unit such as a trench section will be assessed. .

5. Task 2.5: Report Preparation

Technical Memorandums will be used to summarize the geophysical and radiological field programs and to provide the corresponding data and results at intermediate points in the Study 2 schedule. Because of the need to integrate the results of the Study 2 tasks, a final report will be prepared that covers all activities performed and all qualitative and quantitative measures of the utility of the current inventory. Any conclusions that can be extracted regarding specific isotopes or the quantities and location of specific types of waste that may be targeted for selective exhumation will be included. If appropriate, the report will provide recommendations for additional statistically designed field studies to further support the selection of waste exhumation scenarios.

D. Resource Needs

Study 2 will be led by Messrs. Bill Thomas and Doug Splitstone, both of whom are serving as SMEs as part of the EXWG. All work will be performed by these individuals except for the field program, which will be performed by specialty subcontractors under the direction of the ECS Site Project Manager. Field support staff will be provided either by ECS or through a subcontractor to ECS.

It is anticipated that two specialty subcontractors will be required for execution of the field program, one for the non-intrusive geophysical measurements and a second to install the borings and to conduct the radiation measurements. The EXWG will develop a Statement of Work and a corresponding Request for Proposal for purposes of soliciting competitive proposals from qualified subcontractors to provide the requested services. An analytical laboratory certified by New York State and EPA will also be retained for the limited program of soil and water analysis.

E. Estimated Level of Effort

Exhibit III-1 presents the estimated labor hours for the scope of work described in Section III.C above. The inclusion of a field investigation within the SDA and NDA that involves penetrations through the caps will require careful planning and extensive coordination with the agencies, including the anticipated preparation of a large number of work control documents and TIPs. These efforts are reflected in increased man-hours compared to what boring programs at non-radiological sites would demand.

Exhibit III-1: Estimated Level of Effort (Man-Hours)

Task No.	Task Description	Study Area Manager	SMEs	Field PM	Field Tech Support	Admin Support	TOTAL
2.1	Review Inventory / Identify Key Locations		104				**104**
	Calculate (Model) Radiation Conditions		84				**84**
2.2	Prepare SOW/Review Proposals	40	40			20	**100**
	Prepare Work Plans and TIPs	40	40	80		20	**180**
	Geophysical Program		100	100	300		**500**
2.3	Prepare SOW/Review Proposals	40	40			20	**100**
	Prepare Work Plans and TIPs	80	80	160		20	**340**
	Boring Program / Rad Measurements		100	150	600		**850**
2.4	Statistical Data Analysis		180				**180**
2.5	Report	24	200			40	**264**
TOTAL		**224**	**968**	**490**	**900**	**120**	**2,702**

F. Milestones

The key milestones for Study 2 are provided in Exhibit III-2. The Notice to Proceed from the agencies is assumed to occur in July 2015. However, due to the need for work

control documents and TIPs, the planned geophysical study will likely be delayed until late in the 2015 field season. It is anticipated that Study 2 will be completed late in 2016 (17-month duration). The reason for the extended schedule is that the field program involving intrusive penetrations into the SDA and NDA will be delayed until the 2016 field season to allow for the pre-planning required for intrusive drilling through the geomembrane and clay caps and into the native soils adjacent to the waste units. The project schedule will be revised and updated on a monthly basis to reflect changes as they occur.

Exhibit III-2: Proposed Milestones for Study 2

Task	Milestone
2.1	Identification of Key Locations
	Model Results: Predicted Radiological Conditions
2.2	Procurement of Geophysical Subcontractor
	Completion/Approval of Implementation Plans
	Completion of Geophysical Program
2.3	Procurement of Boring Subcontractor
	Completion/Approval of Implementation Plans
	Completion of Investigation Program
2.4	Results of Statistical Data Analysis
2.5	**Final Report**

IV. Study 3 – Review of Precedent Projects: Application to West Valley

A. Purpose

The ability to safely and effectively exhume, treat, or otherwise reduce the volume and/or activity of waste in the disposal areas and tanks at West Valley is a major challenge with considerable uncertainty. While recognizing that conditions at West Valley are somewhat unique, there is a substantial record of exhumation and treatment projects at other sites from which valuable information can be extracted. The primary purpose of Study 3 is to apply the experiences in exhuming or treating waste disposal areas and tanks at other DOE, commercial, and international sites to help determine: (1) the state-of-practice and state-of-the-art in exhumation and treatment technologies, with the latter emphasizing leachate treatment; (2) methods for worker, public, and environmental protection; (3) lessons learned; and (4) what uncertainties were encountered and how they were addressed in the decision-making process. When supplemented by the direct experience of the SMEs on similar projects, these findings will be used to formulate, at a conceptual level, a number of the most appropriate methods for waste exhumation and/or treatment at the SDA, NDA, and WTF.

B. Data Quality Objectives

Study 3 relies primarily on expert judgment both for the interpretation of how work at other sites can be transferred to conditions at the SDA, NDA, and WTF, and for the formulation of other applicable approaches. A quantitative DQO process is, therefore, difficult to apply to Study 3. Nevertheless, the seven-step process has been carried through in a qualitative manner in order to appropriately frame the Study 3 tasks to meet the study objectives.

1. Step 1: Define the Study Problem

The problem to be studied is to determine if lessons learned from waste exhumation or treatment projects at other sites under conditions similar to West Valley can be used in the development and defense of exhumation or treatment scenarios for the SDA, NDA, or WTF. Included will be the identification of the methods used for exposure control during waste exhumation, as well the decisional risks and uncertainties and how these were addressed at other sites.

Topical Questions Addressed in Study 3

Question 1: *Can the long-lived inventory in the SDA, NDA, and WTF be somehow selectively removed to reduce the time that these facilities will pose a hazard?*

Question 2: *If the long-lived inventory cannot be selectively removed from the disposal areas, can the waste be "mined" out of the SDA and NDA while leaving a majority of the surrounding soil in place?*

Question 3: *If the long-lived inventory cannot be selectively removed from the tanks, could portions of the tanks be removed while leaving surrounding tank material, or just the vaults, in place?*

Question 4: *Are the robust facilities shown in the FEIS for conducting tank and disposal area removals necessary, or can removals be done using less robust, yet still protective methods, at lower cost?*

2. Step 2: Identify the Goals

- Determine what exhumation or treatment technologies for partial and/or total removal of waste have been successfully

implemented under conditions similar to those at West Valley.

- Evaluate what technologies for exposure control during waste exhumation or tank removal other than large, fixed base structures are available and have proven effective at other sites.
- Determine what stability problems were encountered and/or what engineering features were required during waste removal from trenches if the adjacent soil was left in place.

3. Step 3: Identify Information Needed

- Evidence of successful waste exhumation or treatment at other radioactive waste sites or under otherwise similar conditions.
- Evidence of successful application of exposure control methods associated with radioactive waste exhumation or tank removals at sites with conditions similar to those at West Valley.
- Information on waste trench stability during exhumation if adjacent soils were left in place, as well as information on physical and chemical methods to stabilize the soils.

4. Step 4: Define the Study Boundaries

- Study 3 will focus on waste exhumation or treatment technologies applied to projects at seven pre-identified target sites that involve radioactive waste removal projects under conditions most similar to the SDA, NDA, and WTF.
- Pertinent aspects of additional projects may be added based on a planned review of a number of published sources of project information.

5. Step 5: Develop the Analytic Approach

- For projects at the seven targeted sites, conduct extensive literature research followed by interviews with knowledgeable project staff and possibly site visits.
- Perform a cursory review of a variety of informational sources to ensure that technological innovations successfully applied at sites other than those targeted are captured in the review of precedent projects.
- Supplement the research phase with concepts developed by the SMEs based on their own experience that may not have a precedent at other sites.

6. Step 6: Specify Performance or Acceptance Criteria

The nature of Study 3 does not involve measurements or any type of quantitative analysis that would lend itself to specific performance or acceptance criteria. Rather, expert judgment of the SMEs will be used to determine if and how waste exhumation and treatment work performed at other sites can be transferred to the development and evaluation of exhumation scenarios for the SDA, NDA, and WTF.

7. Step 7: Develop the Plan for Obtaining Data

The plan for obtaining the information (DQO Step 3) to address the study goals (DQO Step 2) consists of three major tasks, which are presented in detail in Section IV.C below. In summary, the following three tasks are planned:

- Task 3.1 (Section IV.C.1): Review of completed or ongoing radioactive waste removal and treatment projects at seven targeted sites to determine approaches, problems encountered, and how uncertainties were addressed. The seven sites are listed in Section IV.C.1.
- Task 3.2 (Section IV.C.2): Confirmatory evaluation of additional, non-targeted projects to ensure that technological innovations successfully applied on these projects are captured in this review of precedent projects.
- Task 3.3 (Section IV.C.3): Formulation of conceptual approaches that will combine the information compiled in the previous two tasks with the expertise of the SMEs to help DOE and NYSERDA make a preliminary determination of what exhumation or treatment scenarios should be used as the basis for the next round of studies by the EXWG and possibly other involved groups.

C. Tasks to Be Performed

The goal of Study 3 is to determine, through the success or failure of waste exhumation approaches at other sites, what waste removal or treatment technologies may be appropriate for application at West Valley. To meet this goal, the following three tasks are planned.

1. Task 3.1: Review of Selected Projects

In Task 3.1, the SMEs will conduct a literature search and interviews and, if warranted, expand the scope to site visits to determine approaches, problems encountered, and how uncertainties were addressed at other completed or ongoing radioactive waste removal and treatment projects. The review of precedent projects will also examine how radiological hazard categories, as defined in 10 CFR 830 Subpart B (2001), were addressed at other sites. Based on an initial review of key informational sources, projects at the following seven sites that involved the exhumation or treatment of radioactive waste were selected for detailed review in Task 3.1:

- DOE: Hanford Site (WA)
- DOE: Savannah River Site (SC)
- DOE: Idaho National Laboratory (ID)
- DOE: Oak Ridge Reservation (TN)
- Maxey Flats Low-Level Radioactive Waste Facility (KY)
- International: Sellafield, United Kingdom
- International: La Hague, France

The Hanford, Savannah River, and Idaho projects have the highest degree of similarity with West Valley, including high level waste tanks and buried radioactive wastes that range from very low-level waste to high-level wastes. Among the U.S. sites, these three sites will be reviewed to the greatest depth in Task 3.1.

The Oak Ridge site is important to review, but is not of comparable significance when compared to the other three DOE sites due to dissimilar waste streams and methods previously used for waste exhumation when compared to West Valley. The wastes produced from the Oak Ridge site are aligned with specific activities at the three main

plants, as follows: (1) K-25, the Gaseous Diffusion Plant, where wastes are primarily those associated with uranium enrichment and associated activities; (2) Y-12 plant, the National Security Complex where activities were and are devoted primarily to bomb material, with wastes that are derived from such activities; and (3) X-10, the Oak Ridge National Laboratory (ORNL), with a broad spectrum of research-derived wastes that in some cases are similar to the NDA wastes at West Valley. Some of the ORNL wastes were derived from the first separations of plutonium from the dissolution of spent fuel. Due to ORNL's reprocessing research, there were some small HLW tanks that have been decommissioned that could have some relevance to WTF decommissioning activities.

There was no excavation of wastes at the Maxey Flats site, and thus there is little to be learned about excavation from a review of this site. Rather, Maxey Flats is included in Task 3.1 because the site involved the extraction and solidification of leachate as a primary remedial component.

The inclusion of international sites is to provide a possibly different perspective on exhumation approaches, although it must be recognized that DOE and NRC design standards and safeguards may be very different than International Atomic Energy Agency (IAEA) requirements. A recently published book (*"Radioactive Waste Management and Contaminated Site Clean-Up: Processes, Technologies, and International Experience,"* 2013) addresses the experience gained and the lessons learned from recent radioactive waste remediation projects in multiple countries. Based on a review of this book, Sellafield and La Hague appear to be most similar to West Valley and, therefore, were selected for inclusion in the Study 3 analysis.

The primary sources of information on these projects will include: (1) existing project documentation, as for example exhumation work plans and remedial action completion reports; (2) presentations on the projects at professional meetings such as the annual Waste Management Symposia; (3) direct communications with the Project Manager or other individuals with extensive involvement in the projects; (4) contacts with established DOE groups of relevant experts, such as the Hanford-Savannah River-Idaho Waste Retrieval Technology Exchange and the Energy Facility Contractors Group (EFCOG) Waste Management Working Group; and (5) peer-reviewed journal articles related to relevant projects at the seven targeted sites.

The focus of the evaluation will be the methods employed for waste removal and/or treatment at these sites to formulate conceptual approaches for the SDA, NDA, and WTF in Task 3.3 (see below). The SMEs will also extract information on other primary cost drivers such as alternative ALARA controls that provide acceptable levels of exposure; alternative shielding approaches to reduce building size or walls; and ways to segment the Material at Risk (MAR), specifically safeguard materials (U233, U235, Pu 239), to reduce requirements pertaining to criticality safety, physical security, and material control and accounting of special nuclear material.

Any cost information that is made available on each project will also be compiled and evaluated to determine its relevancy with respect to exhumation activities and approaches. Those costs deemed relevant are not expected to be used in any WVDP-specific cost estimates, but may find use as a preliminary measure of comparative costs between alternative exhumation activities and approaches.

2. Task 3.2: Confirmatory Evaluation of Other Precedent Projects

A cursory review of a variety of informational sources will be completed to ensure that technological innovations successfully applied at sites other than those listed above are captured in this review of precedent projects. Information sought will be mainly from the last five years, as changes in knowledge and technology are occurring very rapidly. The following represent the primary sources of information that will be surveyed:

- Proceedings of the annual Waste Management Symposia and special DOE technical exchanges and workshops for current information on other projects at radioactive waste sites, including work from other countries;
- EPA's Contaminated Site Cleanup Information (CLU-IN) database on Superfund sites for both government and private party work on large-scale hazardous waste exhumation projects;
- Annual progress reports of the Army Environmental Center (AEC) and the Air Force Civil Engineer Center (AFCEC) on waste exhumation at Department of Defense (DOD) sites;
- EUGRIS, the European Union's website for information related to soil and water remediation at international sites.

Several active disposal sites have wastes that are similar to the SDA wastes, including: (1) Energy Solutions Barnwell Operations, located in Barnwell, South Carolina, which opened in 1971; (2) U.S. Ecology, located in Richland, Washington, which opened in 1965; and (3) Energy Solutions Clive Operations, located in Clive, Utah, which opened in 1991. These three sites will be briefly reviewed to see if any exhumation of the waste material has occurred in response to a regulatory compliance issue or other condition.

More detailed follow-on informational searches will be conducted only if the cursory review of an individual site reveals an approach or technology with high relevance to the types of issues that will have to be addressed at West Valley. For non-radiological sites, the emphasis will be on innovative remedial methods used and/or examined, including large-scale emissions controls or remote methods for waste exhumation from disposal areas and tanks.

3. Task 3.3: Formulation of Conceptual Exhumation Approaches

In this task, the information compiled from precedent projects will be evaluated for relevance to the West Valley waste units to support the formulation of conceptual exhumation scenarios for the SDA, NDA, and WTF. The intent of Task 3.3 is to provide a conceptual-level description of several exhumation scenarios for each of the three waste areas (SDA, NDA, and WTF) in order to convert the findings of Study 3 into information that more directly supports the agencies in their eventual decisions regarding the closure of each waste site. This same information will also provide the basis for the next round of more focused Phase I studies to be conducted by the EXWG. Key aspects of future work that rely on the specific exhumation approaches being planned include the formulation of pilot studies and the development of cost estimates.

The expertise of the EXWG SMEs will be used to supplement the results of the review of precedent projects for those exhumation concepts that may have no direct precedent at

other sites. The expectation is that basic concepts or individual technology elements may be borrowed from precedent projects for application to West Valley, but that some level of innovation will still be necessary both to transfer the application of those technologies to the specific conditions at the SDA, NDA, and WTF, and to account for aspects of the project not addressed by the transferred technologies.

The emphasis of this task will be on waste exhumation technologies and their potential application to West Valley. Other aspects of the exhumation process -- worker and public protection, post-exhumation waste treatment and processing, and waste disposal -- will be included in a discussion of the major advantages and disadvantages of each exhumation scenario. The potential applicability of any particularly relevant and/or creative post-exhumation approaches identified during execution of Task 3.1 will be addressed in more detail in Task 3.3.

4. Task 3.4: Report of Findings

Tasks 3.1 through 3.3 are highly interrelated and will likely involve concurrent efforts and various points of feedback. Therefore, a single consolidated report will be prepared to document the various sources of information on precedent projects and to merge all study findings and expert opinions into an initial set of conceptual exhumation and/or treatment scenarios for the SDA, NDA, and WTF, and will include the advantages and disadvantages of each scenario as applied to West Valley. The Study 3 Report will also include recommendations for the next round of studies, including the formulation of the most pertinent pilot studies, to support a more formal comparative evaluation and costing of possible exhumation scenarios.

Cost information provided in the Study 3 Report will generally be limited to what is compiled from the sites being reviewed. No independent cost estimates will be prepared as part of Study 3 given the current conceptual level of scenario development and the pending agency decisions regarding individual exhumation scenarios. However, because costs come into play in six of the seven topical questions being addressed by the EXWG, the development of exhumation-related costs will be an integral part of those follow-on studies that will be recommended in the Study 3 Report.

D. Resource Needs

Dr. Frank Parker and Mr. Jay Beech, both SMEs for the EXWG, will lead Study 3. They will provide technical direction, oversight, and review for Mr. Joseph Rustick, who will perform much of the labor-intensive research required for Tasks 3.1 and 3.2. Mr. Rustick is a Ph.D. candidate in the Nuclear Engineering program at Vanderbilt University, whose doctoral research addressed radioactive waste management activities across the DOE complex. Dr. Parker and Mr. Beech will also lead the application of the study findings to the West Valley site in Task 3.3, which will be a collaborative effort of all members of the EXWG to gain full value of their varied expertise.

E. Estimated Level of Effort

Exhibit IV-1 presents a summary estimate of labor hours for the scope of work described in Section IV.C above.

Exhibit IV-1: Estimated Level of Effort (Man-Hours)							
Task No.	Task Description	Study Area Manager	SMEs	Field PM	Field Tech Support	Admin Support	TOTAL
3.1	Review of Selected Projects	--	240	--	--	--	**240**
3.2	Confirmatory Evaluation Other Projects	--	80	--	--	--	**80**
3.3	Formulation of Exhumation Scenarios	20	120	--	--	--	**140**
3.4	Report of Findings	40	100	--	--	40	**180**
TOTAL		**60**	**540**	**--**	**--**	**40**	**640**

F. Milestones

Assuming a July, 2015 Notice to Proceed by the agencies, Study 3 is planned for completion in November, 2015. The proposed milestones for Study 3 are identified in Exhibit IV-2. The primary risk to study completion will be the availability of key outside personnel who will be contacted and possibly visited in order to gain the most complete information on precedent projects. The project schedule will be revised and updated on a monthly basis to reflect changes as they occur.

Exhibit IV-2: Proposed Milestones for Study 4	
Task	Milestone
3.1	Lessons Learned from Seven Targeted Precedent Projects
3.2	Potentially Applicable Technologies from Other Projects
3.3	Conceptual Exhumation Scenarios
3.4	**Final Report of Findings**

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